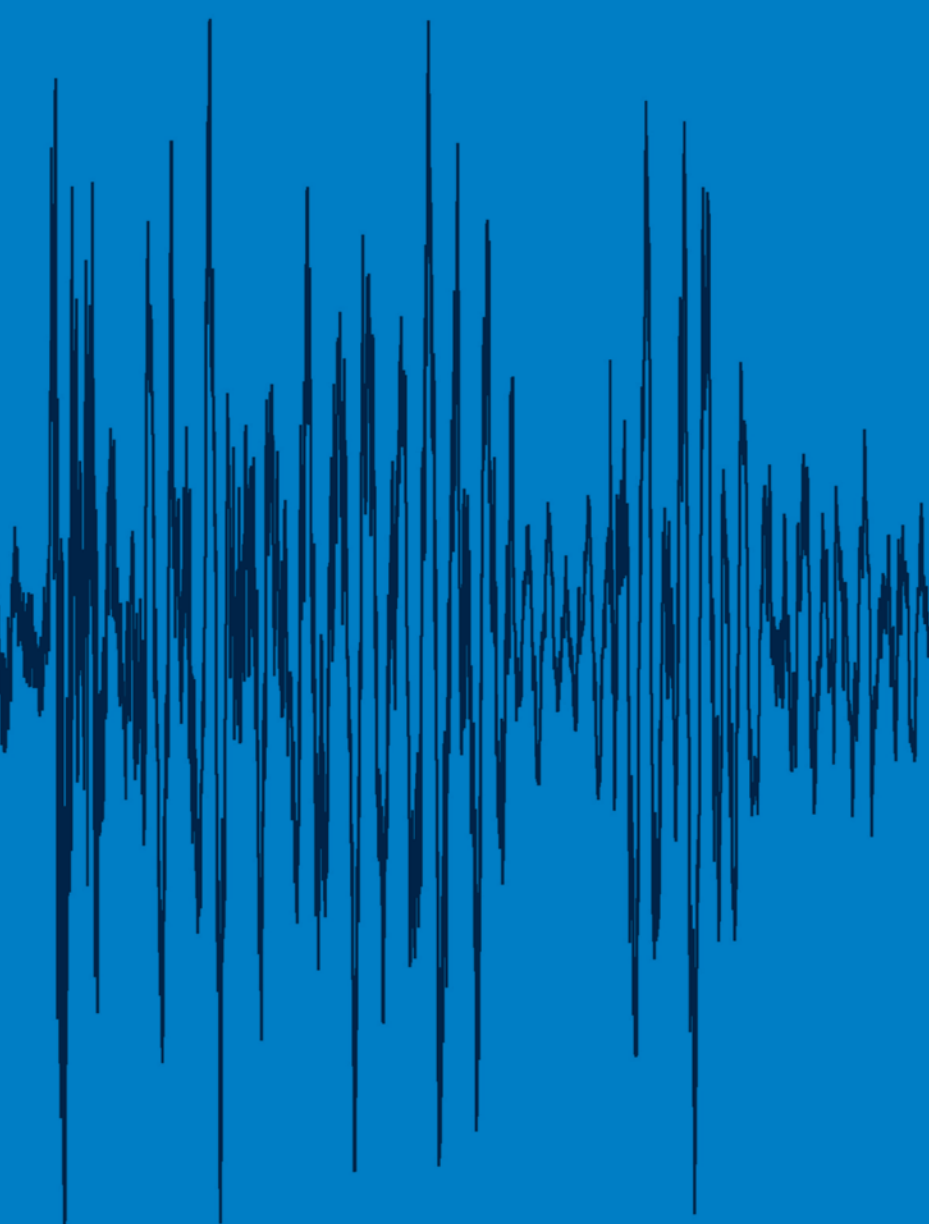


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Fit for the frontline? A focus group exploration of auditory tasks carried out by infantry and combat support personnel

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Abstract

In order to preserve their operational effectiveness and ultimately their survival, military personnel must be able to detect important acoustic signals and maintain situational awareness. The possession of sufficient hearing ability to perform job-specific auditory tasks is defined as auditory fitness for duty (AFFD). Pure tone audiometry (PTA) is used to assess AFFD in the UK military; however, it is unclear whether PTA is able to accurately predict performance on job-specific auditory tasks. The aim of the current study was to gather information about auditory tasks carried out by infantry personnel on the frontline and the environment these tasks are performed in. The study consisted of 16 focus group interviews with an average of five participants per group. Eighty British army personnel were recruited from five infantry regiments. The focus group guideline included seven open-ended questions designed to elicit information about the auditory tasks performed on operational duty. Content analysis of the data resulted in two main themes: (1) the auditory tasks personnel are expected to perform and (2) situations where personnel felt their hearing ability was reduced. Auditory tasks were divided into subthemes of sound detection, speech communication and sound localization. Reasons for reduced performance included background noise, hearing protection and attention difficulties. The current study provided an important and novel insight to the complex auditory environment experienced by British infantry personnel and identified 17 auditory tasks carried out by personnel on operational duties. These auditory tasks will be used to inform the development of a functional AFFD test for infantry personnel.

Keywords: Auditory fitness, communication, hearing loss, military, noise exposure

Introduction

For some occupations hearing impairment may place the hearing-impaired employee and others at risk of injury and death.^[1-3] For example, military personnel need to be able to communicate directly with each other whilst maintaining situational awareness in order to ensure their operational effectiveness and survival.^[4,5] However, they are also at high risk of noise-induced hearing loss (NIHL),^[6-11] which could interfere with their ability to detect and interpret sounds.^[4,6] In addition to the detrimental effect of NIHL on the quality-of-life of service personnel, NIHL also poses a significant threat to their deployability. Removing skilled

personnel from operational duties is costly considering the investment made by the employer to train personnel and maintain their operational effectiveness.^[12] It is important, in order to optimize levels of safety and efficiency, to allocate job tasks to hearing impaired personnel based on the hearing requirements of the task and the individual's hearing ability.

Auditory fitness for duty (AFFD) is a concept that refers to the possession of sufficient hearing abilities for safe and effective job performance.^[2] Auditory tasks (or “hearing critical” tasks) are tasks that place some demand on an individual's hearing and must be carried out to a specified standard. A study by Laroche *et al.*^[3] describes hearing critical tasks as those that require a number of common functional hearing abilities such as sound detection and speech communication. They also state that individuals' lacking these abilities pose a safety risk to themselves, fellow workers or the general public.^[3]

It is often assumed that employees who meet the required occupational AFFD standard are able to perform the auditory tasks required, however this assumption is rarely validated.^[2]

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The assessment of AFFD for UK military personnel currently involves testing audiometric thresholds with pass/fail cut-off values for each frequency tested.^[2] Using pure tone audiometry (PTA) alone to measure AFFD assumes a relationship between hearing sensitivity and job specific auditory tasks, such as listening to speech in the presence of a competing noise. Yet, it is widely recognized that two individuals with identical pure tone thresholds can have varying abilities when listening to speech in noise.^[13,14] Consequently, it is thought that PTA alone may not be a suitable measure for deciding whether or not an individual is able to carry out their job to a satisfactory standard.

Tufts *et al.*^[2] documented many occupations that use some form of AFFD protocol, including fire-fighters, police officers, coast guards and air traffic control personnel.^[2] Despite the large number of hearing critical occupations, few organizations have adapted their AFFD protocols in order to confirm that their employees are capable of performing job specific auditory tasks. Laroche *et al.*^[3] described the development of an AFFD protocol for Canadian coast guards from the Department of Fisheries and Oceans (DFO) using job content experts to identify hearing critical tasks. A similar process was utilized by Goldberg^[15] to determine the hearing requirements of Californian Peace Officers. Subject matter experts were used to create a list of frequent and important auditory tasks carried out by employees, together with information about background noise conditions and the consequences of poor performance on a task. Informed by the job specific auditory tasks that were identified, both the DFO and Californian Peace Officers have made amendments to their AFFD protocols to recommend the use of speech discrimination tests for employees who fail an audiometric screen.^[3,15]

The Royal Canadian Mounted Police and the US Hazardous Materials Fire-fighters have documented that their current PTA-based AFFD protocols may not fully assess functional performance on hearing critical tasks and recognize that research is required to determine safe levels of hearing impairment for specific hearing critical tasks.^[1,16] Kales proposes that the initial stage of this research would involve gathering information regarding hearing critical tasks and the environment in which they are performed.^[16]

Use of the British Army's current PTA-based AFFD protocol may lead to the redeployment of infantry personnel who are not capable of performing their role to an acceptable level or the medical downgrading of personnel who are still able to perform the tasks required of them. The first step in developing new AFFD standards that are representative of the tasks that infantry personnel are required to perform is to carry out a thorough job analysis. There are currently no published studies which outline the auditory tasks that infantry personnel are required to carry out in theater.^[17]

Aims

The present study was aimed to gain a greater understanding of the hearing requirements of infantry personnel. This information will ultimately be used to inform the development of a more representative AFFD test.

In addition, the study was designed to collect information about auditory tasks carried out by infantry personnel working on the frontline and the environment in which these tasks were performed. Also of interest were the underlying attitudes and behavior of personnel toward noise exposure and use of hearing protection devices.

Methods

Focus groups were judged to be the most appropriate method of job analysis as they allow participants to raise relevant issues, discover areas of agreement and disagreement and reflect on past experiences. A focus group format can facilitate articulation of perceptions that a participant may not feel comfortable discussing on a one-to-one basis.^[18]

The focus group guideline consisted of seven open-ended questions [Table 1] that were developed in consultation with subject matter experts at the Institute of Naval Medicine, Gosport. The questions were designed to elicit information about auditory tasks performed whilst on tour, sources of background noise and hearing protection. The questions were open-ended to encourage discussion whilst maintaining enough structure to ensure that all the research aims were addressed.

Two researchers were present (authors ZB and HS), one to act as facilitator — encouraging all members of the group to participate and guiding discussion, the other to take brief notes and check recording equipment during the meeting. The researchers were escorted onto military bases by a representative from the Institute of Naval Medicine; this individual was present during the focus groups but did not contribute to the audio taped discussion.

Data collection took place at the participants' normal place of work. A brief description of the research was given

Table 1: Focus group questions

Can you describe the types of noise you were exposed to whilst on tour?
Describe any situations whilst performing your job in which you think having good hearing is critical
Can you recall any time when you have been unable to hear clearly when performing your role?
Can you recall a situation when you were unable to make yourself heard?
Can you describe the impact, if any, that your hearing protection has on your ability to hear whilst on tour?
How do you communicate important signals with each other?
Can you describe any situations where determining the location of a sound source was important?

to the participants from their section commander at least 24 h before data collection and they were informed that their involvement in the study was voluntary. Before the focus group, participants were given an information sheet outlining the research aims and were reminded again that their participation was on a voluntary basis. Participants were asked to fill out a consent form and a questionnaire asking about their military rank, responsibilities and the number of tours of duty they had completed in their service career.

Focus groups began with a recap of the purpose of the study and introductions. Open-ended questions were used to keep discussion relevant to the research aims and were asked in no particular order to maintain the flow of conversation. Participants were also asked to expand on their ideas during the interview using questions such as “describe the situation you were in” and “can you explain what you mean by that?” Discussion ended when all of the questions had been addressed and the participants felt that they had no further information to add to the conversation. The focus groups were audio taped and transcribed verbatim (completed by author HS) during the months between October and November 2012.

Ethical considerations

Ethical approval was gained from the University of Southampton and the Ministry of Defence Research Ethical Committee (Ref.: 359/GEN/12). All data collected were treated confidentially and transcripts were anonymized hence any quoted material could not be attributed to an individual participant.

Participants

The study consisted of 16 semi-structured focus group interviews. Eighty British Army personnel were purposely recruited from five infantry regiments across the South of England. Recruitment of participants was terminated when no new codes were derived from the latest interview transcripts during the analysis process (when data saturation was reached, as judged by author ZB). All participants had experience of active service and had returned from an operational tour of duty abroad within 2 months of the study commencing. The participants were selected to represent a range of ranks and infantry occupations [Table 2]. The mean number of persons per group was five, with a range of 3-6.

Data analysis

A qualitative, descriptive method was selected for analysis since emerging themes and ideas were of interest as well as the number of times a particular idea was mentioned. The analysis followed a typical content analysis procedure. Content analysis is a systematic, replicable technique for reducing large text data to fewer content categories based on a set of coding rules.^[19,20] The technique was ideal for the data set as it can be used to isolate the information of interest from large amounts of unstructured data.^[21] In this study, content analysis was used

primarily to identify qualitative themes but also to statistically represent the data. This method was well suited to the aims of the study, drawing out important details about infantry auditory tasks and the acoustic environment, whilst also exploring the attitudes and underlying behavior of participants.

NVivo 10^[22] was used as an aid for content analysis of the raw data. Transcripts were read thoroughly to aid familiarization before the analysis was completed. Sentences that described a certain idea or opinion were highlighted and notes were made about the common ideas and opinions. This process was continued through the first five focus groups. At this point, a list of codes was determined based on themes that emerged. The following 11 transcripts were then analyzed, with key ideas assigned to the preliminary codes (the number of preliminary codes was 39 and the total number of coded units was 1177). After the initial coding process, the codes were discussed (by authors ZB and HS) to determine whether any could be consolidated or discarded. This discussion led to changes in the coding hierarchy and drew out two themes and seven subthemes [Table 3].

To examine the reliability and objectivity of the coding process a second coder was asked to recode a sample of

Table 2: Sample characteristics

Characteristics	Number of participants, %(n)
Gender	
Male	97 (78)
Female	3 (2)
Rank	
Private	60 (48)
Lance corporal	19 (15)
Corporal	15 (12)
Sergeant	4 (3)
Warrant officer	1 (1)
Second lieutenant	1 (1)
Role	
Formation reconnaissance	38 (30)
Armored role infantry	16 (13)
Armored engineers	25 (20)
Vehicle based artillery	21 (17)
Number of tours of duty	
1	45 (36)
2	31 (25)
>2	24 (19)

Table 3: Themes and subthemes

Theme	Subtheme
1. Auditory tasks	1.1 Sound detection 1.2 Speech communication 1.3 Sound localization
2. Reasons for reduced performance	2.1 Background noise 2.2 Hearing protection devices 2.3 Stress 2.4 Attention difficulties

the data (five focus group transcriptions, 341 coded units) using the original coding descriptions. The second coder had experience of qualitative research and working with military personnel, but had not been involved with the present study. Cohen's kappa was calculated to provide a measure of inter-rater agreement. Cohen's kappa is a measurement of agreement between two raters when the coding is on a categorical scale, taking into account the likelihood of chance agreement.^[20,23] Strong agreement between coders was achieved ($\kappa = 0.795$). The discrepancies observed were most often between the codes "stress" and "attention difficulties". The coding descriptors were then adapted to clarify, which code was most appropriate. References were deemed to be relating to "stress" when the interviewee discussed an emotional reaction to a difficult or demanding situation and "attention difficulties" was considered the appropriate code when the interviewee discussed performing more than one task concurrently.

Note on qualitative research

Qualitative research provides a way to probe underlying attitudes and obtain an understanding of the important issues. It must be noted, however, that all comments cited in this article are an individual's opinions and should not be interpreted as facts.

Reporting of results

The number of references made to a particular idea is indicated (R = references), together with the number of focus groups the idea was mentioned in (S = number of sources). For instance: "Negative references to hearing protection (15R, 4S)" demonstrates that there were 15 negative comments made about hearing protection devices and these comments were voiced in four focus groups.

Results

Content analysis of the focus group data resulted in two main themes. The first theme describes the auditory tasks that infantry personnel are expected to perform as part of their operational duties. From within this theme 17 auditory tasks carried out by infantry personnel have been identified. The second main theme reveals four factors that personnel believe compromise their performance on auditory tasks.

Any duties described by personnel that required some level of hearing were highlighted in the transcripts independently by two members of the research team (authors ZB and HS). This resulted in the list of 17 tasks that were carried out by infantry personnel whilst on operational duty [Table 4]. Many of the tasks identified were carried out in background noise or using radio communication systems.

Subthemes that emerged from the data either illustrated and explained the types of auditory tasks that personnel

Table 4: Infantry auditory tasks

Hearing commands in a casualty situation
Hearing grid references
Hearing directions on patrol
Hearing directions in a vehicle
Hearing fire control orders
Hearing stop commands
Hearing the briefing before a foot patrol
Communicating through an interpreter
Locating a small arms firing point
Locating an artillery firing point
Locating the moving sound source of a motorbike
Locating the moving sound source of footsteps
Locating enemy movement in maize fields
Locating a talker
Identifying the type of weapon system being fired
Determining talker identity
Detecting a malfunction in an item of machinery

are expected to perform (subthemes 1.1-1.3) or described situations where personnel felt that their hearing ability was reduced or hindered in some way (subthemes 2.1-2.4). These subthemes have been broken down further to demonstrate differing views and to add detail.

Theme 1: Auditory tasks

Subtheme 1.1: Sound detection

All of the auditory tasks described by personnel involve an initial element of sound detection.

Personnel felt that they needed to detect an enemy weapon system firing in order to determine the type of weapon being used (22R, 10S). The most common reference was referring to small arms fire and the supersonic "crack" followed by the subsonic "thump" sound that is generated.

"Rifles and when a bullet goes over your head it sends a crack and it is knowing and things like that are really important because if you don't hear them then there is no point being there because you're useless really."

Situational awareness was unsurprisingly regarded as very important by most personnel (39R, 12S). This code incorporated sounds of enemy and civilian activity.

"Listening out for the rustling, the trees moving, the crops."

"Even the local nationals walking past if they're talking I want to know how they are talking, does it sound aggressive or if they are shouting/normal."

Subtheme 1.2: Speech communication

This subtheme incorporated comments about the ways in which speech was communicated, the distance and level of communication and the equipment used to aid conversation

between personnel. Approximately 50% of the communication references referred to face-to-face communication (94R, 15S) and the other 50% to radio communication (92R, 16S).

Face-to-face communication between personnel

Personnel felt that the average distance over which speech was communicated was 5-10 m and discussed how this distance reduced or increased during certain operations, often determined by the type of terrain or whether the mission takes place during the day or at night.

“There is no set distance, it depends upon the situation you are in, the type of grounds you are on and the briefing you’ve got that day.”

Participants also described how the level of their voices also varied depending on the type of mission (64R, 12S). The largest number of references (34R, 12S) stated that voices were often raised and the participants felt this helped to make a command clearer and emphasize its importance.

“Everyone is screaming and shouting at the top of their lungs so that you can hear everything.”

Communication equipment

Infantry personnel use a number of different pieces of equipment to aid communication. The equipment mentioned during data collection falls into two categories: Radio, referred to as “comms” by the majority of personnel; this is used to communicate between base camp, vehicles and guard positions; personal role radio (PRR), a personal radio headset designed to allow the members of a unit to communicate more effectively with each other.

Personnel felt that the main radio was easier to use than the PRR and the signal received was usually clearer without obvious distortion (6R, 3S).

“But regards radios and stuff, no it is fine, can hear 100%.”

“If you are listening there is only ever one person talking but he finishes someone else can start all the time so you can’t listen to three people at the same time, it is only ever one.”

Discussion of the PRR generated predominantly negative comments. Personnel felt that they were not robust enough and remarked that some devices broke very early on during the tour of duty or that the signal received was of poor quality (16R, 7S). Many chose not to communicate via PRR.

“The PRRs they aren’t very good, the way the headphone shuts on your ear you’d think it would hear a lot more. Yeah it’s shit.”

“I think we had three PRRs to a section and it’s like, that’s insane.”

It was apparent during the focus groups (from their comments, but also the tone of their voice and their body language) that personnel were frustrated by the difficulty caused by broken or poor quality radio signals, admitting that they favor face-to-face conversation whenever feasible.

Commands

The code with the most references in this subtheme was commands (187R, 16S). This included either a demonstration or a description of the command given. It also contains references that state when commands are important. Five command situations were highlighted by personnel: Casualty situations, directions, fire control orders, grid references and stop.

“We need to know that everyone is ok so I will communicate back to them to make sure that the rest of the section is alright.”

“Target indication and the firing point things like that, anyone that’s seen the enemy, the main ones that are needed.”

Communicating via an interpreter

Personnel commented that using interpreters to talk to civilians provided an additional challenge when communicating (9R, 4S). Some personnel felt that the interpreters were well trained and useful, whereas others claimed that they were more of a hindrance than a help.

“Like when your interpreter is trying to talk to you as well, it is hard enough to understand them anyway sometimes.”

“Depends on how good they are, some are really good, some not so good.”

Subtheme 1.3: Sound localization

Localization was mentioned in all 16 focus groups. One of the questions in the focus group guideline aimed to address whether personnel needed to localize sounds but participants often discussed this without being prompted (188R, 16S). From this subtheme, it was clear that locating a small arms firing point was of high importance for the safety of unit members and the efficiency of the mission.

“If you can’t locate that position then you’re redundant.”

Some personnel felt that they were extremely skilled in locating a firing point whereas others disagreed. Most felt that they became more skilled with experience.

“You’d have other people thinking they were being shot at from fucking behind.”

“Most of us had a pretty good idea it was in that sort of direction, not necessarily the range.”

Many commented that the unit would discuss the location of the enemy before returning fire whereas others took immediate action even if unsure.

“Yeah, everyone will have a quick little discussion, ‘we think it is over there’ and then... yeah.”

“Some people just pluck it out of the black.”

Some of the personnel had received training in localizing a firing point. This involved an exercise to highlight the acoustic stimuli that personnel should listen out for to determine the location of an enemy firing point. There were mixed opinions about the usefulness of this training.

“There was no substantial training.”

“We touched on it but it was about an hour, not even that, we just sat in a field for an hour and touched on it. We could have done more. It was good what we got.”

Theme 2: Reasons for reduced performance

Subtheme 2.1: Background noise

The background noise subtheme contained any references to a sound that interfered with an auditory task, these fell into two clear categories “continuous noise” (any sound that lasted longer than a minute) and “intermittent noise” (any sound under a minute in duration).

Continuous (74R, 15S)

The number of references was the most interesting characteristic of this code as it helped to ascertain the most prominent acoustic environment experienced by personnel. Types of noise were grouped together and included; generators (13R), radio noise (3R), wind noise (7R), machinery (noise from engineering works) (2R), engine noise (29R) and helicopters (8R). The most commonly mentioned engine noise was from the Warrior armored vehicle.

“The turbo on a CVRT is really loud and it whistles, that would damage your ears after a while, constant noise.”

“There will be an engine running or something all the time.”

Intermittent (55R, 16S)

This code contained mainly references to weapons or a specific weapon system. Some other examples of intermittent background noise included call to prayer, dogs barking and improvised explosive device explosions.

“Artillery that is just constantly firing.”

“I was in Bastian so obviously we had the ranges where we are so I would hear everything from mortars to small arms fire.”

Subtheme 2.2: Hearing protection devices

In accordance with military personal protective equipment policy, all infantry and combat support personnel should have been supplied with custom molded “Personal Integrated Hearing Protection” devices which aim to attenuate damaging noise whilst maintaining some level of situational awareness. Despite this, the overwhelming majority of comments (107 out of 127 comments about hearing protection) were negative and only three personnel admitted to wearing the devices regularly. Participants felt that they had reduced situational awareness and were not able to hear commands as clearly with the devices in their ears. Many complained that they were uncomfortable, made them feel claustrophobic and “a hassle” to insert and remove.

“So you won’t know what is going on around you, you can’t hear nothing.”

“We never got issued them.”

“Never wore them once.”

Two personnel admitted that they had been asked to remove hearing protection by a senior colleague during an artillery training exercise.

“I did a defensive shoot on a range and they told us not to wear ear defense so we weren’t shocked by the sound of it in real life and for a good half an hour afterwards I had that whiney noise in my ear.”

Subtheme 2.3: Stress

Personnel felt that they were unable to hear during combat situations, not due to their hearing levels, but due to some other factor described as panic, shock or stress (31R, 9S).

“[Participant claps loudly] that’s how I’d put it, you don’t know when it’s coming, you can’t explain it. It’s just what the fuck was that? You’re looking around and you’ve got to shout is everyone all right, yeah. I think like anything if you’re not ready for it’s going to be a shock, you’re going to be shocked yourself.”

“In a contact when every ones flapping, but you’re running over there because you can’t hear and you’re a headless chicken and you’re scared.”

Subtheme 2.4: Attention difficulties

On many occasions personnel mentioned that they found it difficult to hear people talking or maintain situational awareness when they were trying to concentrate on more than one task at once (43R, 10S).

Often the tasks described by personnel involved listening to more than one competing talker, listening to a talker

and watching for a visual signal or listening and talking simultaneously.

“You can’t focus on what you are meant to be hearing, it is nothing to do with your hearing, you just can’t process everything; take everything in, do you see what I mean? You can’t do it.”

“Talking in the radio, telling you’re boy to do something, telling him to do something and can’t, you see what I mean, struggling to take it in, you miss something with your hearing.”

Discussion

The present investigation was conducted to gather information about auditory tasks carried out by infantry personnel on operational duty and the environment these tasks were being performed in. Content analysis of the focus group data resulted in two themes. Theme one, auditory tasks, describes and explains the types of auditory tasks that infantry personnel are expected to perform as part of their operational duties. From within this theme 17 auditory tasks carried out by infantry personnel have been identified. Theme two, reasons for reduced performance, revealed four aspects of the participant’s state of mind or environment that they believed compromised their performance on these auditory tasks.

The auditory tasks identified from the first theme fell into three subthemes: Speech communication, sound localization and sound detection. As expected, these results support the auditory tasks reported by Laroche *et al.*^[24] and Giguère *et al.*^[25] and are common to all hearing critical occupations. However, whilst auditory tasks carried out by infantry personnel can be categorized in this way, the participants emphasized that the tasks were often complex and carried out in diverse and changeable environments. The three auditory task subthemes are discussed below.

The first subtheme, speech communication, was felt by personnel to be vital on all operations. Participants reported that they were often expected to understand speech without visual cues such as in low visibility situations or darkness and when using the radio. The comments from participants confirm the belief held by Tufts *et al.*^[2] and Cook and Hickey^[26] that speech must be understood even when incomplete, distorted or filtered, such as commands and conversation communicated via radio. Comments such as “if blokes can’t understand what you want them to do... its life or death” and “if you can’t hear a command, there is no point you being there” emphasize the perceived importance of infantry personnel being able to hear and understand speech on the frontline.

The second subtheme, localization, contained conflicting statements from participants. Whilst personnel agreed that they needed to determine the source of small arms fire, they were unsure how accurately they were able to do this. Some participants commented that they needed visual confirmation of a firing point before they were sure of its location, while others were confident that they had correctly identified the location from the sound alone. Further research is required to determine how skilled personnel are at localizing a sound source and whether it is necessary to incorporate a test of localization into a military AFFD protocol.

All of the auditory tasks described by personnel begin with the detection of a sound or signal, whether it is speech, weapons firing or the rustling of movement through a maize field. Comments relating to these tasks resulted in the third subtheme, sound detection. The level of hearing acuity required to detect these sounds cannot be determined from the focus group data but it is unlikely that these tasks can be performed using job experience and other sensory modalities alone. Tufts *et al.*^[2] define tasks of this type as “hearing critical”. It is also not possible to conclude whether poor performance on a task would compromise the safety and/or efficiency of a mission. In short, it is not yet known whether any of the auditory tasks described by personnel are “mission critical”.

The three auditory task subthemes (speech communication, sound detection and sound localization) were discussed at length in all of the focus groups. It appears that, regardless of role or rank, all infantry personnel may be expected to perform these fundamental tasks during operational duties. It is also clear that certain roles encounter particular auditory tasks more often than others; for instance, senior personnel and mounted infantry soldiers are more likely to communicate via radio than dismounted soldiers or lower ranking personnel. Those working in engineering roles commented that they rarely had to localize a sound source but they were often expected to detect a potential vehicle fault from the sound of the engine. Due to this, there are limitations in the generalizability of the information gathered about each auditory task, assuming that only some personnel perform a specific task on a regular basis. In addition, the generalizability of these data to other military cohorts (such as the Royal Navy and the Royal Air Force) is likely to be limited due to the varied nature of military occupations.

Theme two, reasons for reduced performance, consisted of references to poor performance on auditory tasks and the reasons for this. The most commonly mentioned, and perhaps most obvious, reason for reduced hearing ability was the introduction of background noise. Participants discussed the types of noise that interfere with auditory tasks and whilst some of these were expected, for example weapons firing and engine noise; others were less expected, such as noise from electricity generators and wind noise interfering with radio

communication. The present study has provided a detailed and unique representation of the challenges faced by personnel on operational duties with regards to interfering noise. The effects of background noise on task performance will need to be considered when ascertaining whether personnel have the necessary auditory skills for infantry occupations.

The second most commonly mentioned reason for reduced performance on auditory tasks was the use of hearing protection devices. In general, personnel were knowledgeable about the hearing protection policy and the effect of prolonged or excessive noise exposure on their hearing. In spite of this, only three personnel reported wearing hearing protection devices on a regular basis. Whilst not within the scope of this study, the focus group transcripts serve as a record of infantry attitudes toward hearing protection. The adjectives and emotive language used by participants was indicative of a group that are concerned about their hearing and their ability to safely perform the job required of them. Understandably, personnel showed greater concern for maintaining their situational awareness and ultimately their survivability. Personnel cited similar reasons to those reported by Okpala^[27] for not using hearing protection; predominantly lack of situational awareness, the perceived inability to hear commands and discomfort. Other reasons not previously reported included feelings of claustrophobia and the inconvenience of using the devices.

The final subthemes (stress and attention difficulties) address two aspects of operational duties that personnel felt affected their ability to complete auditory tasks to a satisfactory standard. Participants felt that in stressful environments (predominantly when in contact with the enemy) their ability to maintain situational awareness and understand speech was compromised. This was reported in addition to the difficulties caused by any associated background noise. This subtheme had a significant amount of overlap with the subtheme attention difficulties. Participants described situations where they were expected to complete more than one auditory task (or an auditory and a written task) as particularly stressful. An increase in cognitive load (induced by a stressful environment or by increasing the number of tasks personnel must perform) has been shown to decrease performance on auditory tasks.^[28,29] The focus group data highlights a need for further research into this area as the actual effects of increased cognitive load on military auditory tasks is unknown.

The present study has several possible limitations. The development of the coding scheme and its administration was completed by the same member of the research team. Krippendorff^[19] notes that this is less than ideal and can lead to coder bias. However, in order to reduce any effect of coder bias the inter-rater reliability was measured and there was found to be strong agreement between coders. A second limitation is that the inter-rater reliability was calculated using broad categories (e.g., “speech communication”,

“stress”, “background noise”). It was after this process that the lead author continued to divide these codes further into smaller categories (e.g., “face-to-face communication” and “communication equipment”). Inter-rater reliability was not measured for these smaller content categories.

Conclusion

The current qualitative study has provided an important and novel insight to the complex auditory environment experienced by British infantry personnel on operational duties abroad, identifying 17 auditory tasks. Comments made by participants have also highlighted four reasons for reduced performance on these auditory tasks. Due to the qualitative nature of the data collected the actual consequences of performing military auditory tasks incorrectly cannot be determined. Personnel have, on occasion, alluded to the failure of a task resulting in serious injury or fatality and have also stated that a colleague would be “useless” or “redundant” without certain hearing abilities. Without knowing the consequences of unsatisfactory performance it is not possible to determine whether or not these tasks are in fact vital to the success and safety of the mission. However, without this further information it is still clear that personnel regard their hearing as vital within an infantry role and that they strongly believe a hearing impairment would decrease job performance. The auditory demands highlighted in this study are important considerations for researchers developing AFFD protocols, both for military personnel and other hearing critical occupations. An AFFD protocol should aim to comprehensively assess all of the auditory skills required to perform safely and effectively in a given occupation. It is not yet known whether a soldier’s pure tone hearing threshold measurements can be used to predict their ability to perform complex auditory tasks on the frontline. It may be necessary to replace the current military AFFD protocol with a set of tests that more accurately predict performance on military auditory tasks. Based on the focus group findings, these are likely to incorporate speech perception, sound localization and sound detection.

Further qualitative research is being conducted to provide context-dependent information about the auditory tasks identified. This will be used to determine the exact hearing requirements for safe and effective performance and inform the development of a representative hearing test for UK infantry personnel.

The views reported in this publication are the opinions of the participants and authors and do not necessarily represent those of the Ministry of Defence.

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