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# Using a Qualitative Approach to Explore the Human Response to Vibration in Residential Environments in the United Kingdom

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## **Abstract**

As a growing number of areas in the UK become ever more densely populated, increasing construction work is being undertaken and transportation networks built in order to cope with the growing population. The development of this infrastructure, coupled with the mechanisation of modern life, often results in exposure to various types of vibration from a range of sources such as rail, road traffic and construction activity causing considerable disturbance.

The study of vibration effects within residential settings is a developing area of research. Previous research on ambient stressors in residential environments has focused primarily on noise; one of the most prevalent environmental stressors in living environments. Some noise surveys have highlighted vibration as a contributor to noise annoyance while others have explored the combined effects of noise and vibration on human response. Research on vibration is largely a quantitative effort using laboratory experiments or social surveys with associated vibration measurements in order to establish dose-response relationships.

However, as the human response to vibration is particularly diverse and complex this paper aims to explore how qualitative methodologies can compliment the quantitative approach to vibration research. People's experiences, expectations and attitudes vary with regards to vibration, the noise it produces, and the source it derives from. For the pragmatic researcher qualitative methodologies can help unravel some of these issues, providing a further understanding of the complexities of the human response to vibration in residential environments.

*Keywords: qualitative research, human response, vibration, residential environments*

## **Introduction**

According to recent estimations from the United Nations populations division, in 2008, for the first time in history more than half of the world's population live in urbanised areas (United Nations, 2008). In the UK, such continuous urbanisation and increasing population is ultimately changing the ways people live and the environments in which they reside. Van den Berg et al. (2007) argue that despite what high density living has to offer its residents in terms of: sustainability, choice and opportunities, many urbanised towns and cities are '*still far removed from the safe, clean, and liveable environments they theoretically could be*' (p80). The environmental problems associated with the urbanisation in cities and towns (for example, air pollution, road traffic, noise, crowding) has lead to psychological concerns in relation to urban residents' health and well-being, mental health, stress levels and quality of life. Evans (2003) describes how the built environment can have indirect effects on mental health by altering the psychosocial processes of personal control, social support and restoration, thus the emphasis on exploring the psychological impact of the built environment has never been stronger.

A number of environmental variables, that cause some degree of psychological/well-being disturbance, have since been investigated in terms of their effects upon resident populations. Such variables include: noise (Grimwood et al., 2002; Skinner & Grimwood, 2002), visual or physical environments/landscapes (Borst et al., 2008; Ulrich et al., 1991), odour (Miedema et al., 2000; Steinheider & Winneke, 1993) and vibration (e.g. Cawthorn et al., 1978; Maeda et al., 1998; Öhrström & Skånberg, 1996; Klæboe et al., 2003; Watts, 1984). However, the effect that vibration has, from sources outside of a person's control, such as road, rail, construction and aircraft, has become a recent focus of concern (e.g. Defra, 2007). Like most environmental variables vibration is particularly significant to the urban context due to spatial concentrations of people near major transport links (road and rail), proximity of construction sites, and the effects caused by internal vibration associated with mixed use developments/'work-live units' and apartment block living. In addition, factors such as changes to the ways we generate electricity (via wind-turbines) are resulting in new sources of vibration which may lead to further psychological impacts. Furthermore, with the need to increase the number of dwellings to accommodate those in need, particularly in key areas of the UK (Holmans, 2001; Joseph Rowntree Foundation, 2002), more housing is being built on Brownfield sites which are invariably in closer proximity to potential sources of vibration and noise.

Subsequently the human response to vibration particularly in residential urban environments is a growing body of research. A number of studies have been carried out investigating people's annoyance of vibration in residential settings (e.g. Cawthorn et al., 1978; Maeda et al., 1998; Öhrström & Skånberg, 1996; Klæboe et al., 2003; Watts, 1984). Recently the Department of Environment, Food and Rural Affairs (Defra, 2007) commissioned a pilot study to develop a methodology to investigate the human response to vibration in residential environments and have since commissioned researchers at the University of Salford to carry out a major national study using this methodology. The overarching aim of this research is to explore whether a dose-response relationship exists between annoyance levels and associated measurements of vibration in residential environments.

As with similar noise-annoyance studies the dominant normative methodology for these vibration-response studies is to adopt a survey approach, alongside extracting relevant noise/vibration measurements, where a large population is consulted (e.g. 1000+ respondents) in order to explore their psychological response to the stimulus (noise/vibration). A large number of studies have been carried out providing relationships between expected noise annoyance and levels of noise exposure (Miedema, 2007). In this paper we look at the assumptions of this normative approach and elucidate some of its shortcomings. We then argue that researchers looking to understand the psychological response to noise and vibration will find value in moving away from the dominant

quantifiable and mechanistic approaches which are currently pervasive in the area. Building on this, the paper argues that researchers should seek to develop and utilise qualitative methodological approaches in order to help encapsulate the inherent complexities which exist when individuals try to make sense of their lives and their surroundings.

### **The normative method of investigating human response to vibration**

The normative method of investigating the human response to vibration is based, quite substantially, on the more established community noise research studies (e.g. Fields & Walker, 1982; Grimwood et al., 2002; Skinner et al., 2002). Such studies typically advocate the testing of noise levels in specific areas together with the implementation of a survey with a statistically robust sample of surrounding residents. Such studies have indicated that a relationship exists between the level of noise and the level of annoyance experienced by residents. Within the UK, a similar approach is being adopted (e.g. Defra, 2007). Similarly, this methodology has also been employed by a number of studies in other European countries (Öhrström & Skånberg, 1996; Klæboe et al., 2003). These studies adopt the recommendations of recent standards on how to develop and carry out a social survey on vibration and noise in residential environments (e.g. Nordtest Method, 2001; Fields et al., 2001; ISO/TS 15666:2003). Such studies have found results which support the hypothesis that a dose-response relationship between vibration and annoyance in residential environments is present.

However, such approaches are far from straightforward and suffer implications highlighted by acoustic researchers (e.g. Miedema and Oudshoorn, 2001) who highlight that there is no simple relationship between noise exposure and noise reactions. It is not uncommon to find significant discrepancies between the responses of people to the exact same noise level. As Vlek (2005) comments, in relation to community noise, it is important to establish noise dose-response relationships in order to set standard levels of acceptable noise around airports, busy roads and construction sites, however, the noise dose and the noise response are not simple and are experienced in conjunction with various other acoustical and non-acoustical factors. This raises the question as to whether there are more contributory factors to an individual's response to noise than simple personal annoyance. For community noise, situational, demographic and individual differences between respondents have been found to affect response to noise exposure (e.g. Fields, 1993; Job, 1988; Miedema & Vos, 1999; Ouis, 2001). Fyhri and Klæboe (2006) outline a number of variables that should be attended to such as the individual's prior experiences of noise, noise attitudes, noise sensitivity and how respondents view the response of their local councils towards noise complaints. Other research has shown that factors such as perceived control over the source of the noise may significantly influence annoyance levels (Levy-Leboyer & Naturel, 1991).

Studies that look to investigate the response to vibration have taken broadly the same approach as noise annoyance research; measurements of the level of vibration together with a social survey of respondents in the same locality to ascertain their annoyance responses. However, the shortcomings of the approach to conducting community noise surveys can be equally applied to these more recent studies of vibration annoyance. Moreover, a study of vibration, as detailed above, brings with it a number of unique issues and dose-response relationships may be much more difficult to establish for vibration in comparison to noise.

The linguistic shortcomings of our ability to use language to describe and explore the senses are widely recognised (Landry, 2006; Rodaway, 2004). In turn, sensing vibration is highly complex and is dependent on its

frequency, its direction and the duration of exposure (Griffin, 1996). Vibration is sensed by the organs of balance connected to the inner ear, large numbers of small mechano-receptors distributed internally throughout the body in muscles, tendons and joints, and receptors in the skin which provide tactile information and detect vibration at higher frequencies (Guignard, 1971). Therefore it is questionable whether people can effectively attribute their sensation to a vibration source and articulate the difference between vibration and vibration-induced noise.

When people are asked about vibration they often describe the associated noise and visual sensations alongside the physical sensation of feeling vibration (Defra, 2007). Residents may also be uncertain of the differences between noise and vibration (Howarth & Griffin, 2008). Therefore it may be difficult for a questionnaire survey to differentiate between a person's response to vibration in isolation from its additional noise and visual stimuli. Vibration is often accompanied by noise and '*vibration effects may be more subtle and less noticeable than noise*' (Defra, 2007, p.22). Subsequently, respondents may tend to think about the noise before the vibration, making the human response to vibration in residential environments a complex phenomenon to research.

Although these issues are related to how the human body senses, interprets and understands vibration this inevitably impacts on the ability of the individual to effectively articulate, in a social survey setting, their feelings of annoyance. In the following sections we present the argument for using more qualitative approaches, alongside the broader social survey method. Here we look at the opportunities such an approach can offer in order to understand more fully an individual's response to vibration. We then consider the value of being pragmatic researchers when attempting to better understand these complex individual and social issues.

### **The use of qualitative methodology to study vibration**

Identifying and measuring people's annoyance to vibration in their homes is valuable, particularly in terms of developing standards which can be used for planning purposes in order to understand vibration levels and their impact on residential populations. However, the added benefit of adopting qualitative methods to support and better understand the findings from quantitative counterparts is well established in the social sciences (Brannen, 1992; Moran-Ellis et al., 2006). It is important to note here that qualitative research methods are used by researchers with a variety of different epistemologies, however all qualitative researchers have a number of shared concerns (Willig, 2001). They are concerned with how people understand, interpret and experience their own worlds, rather than aiming to find cause-effect relationships (Parker, 1994). In terms of vibration-response studies a study that includes qualitative elements will undoubtedly help to understand the intricacies and complexities of respondents' experiences, attitudes and expectations of vibration and their environment.

In relation to urban policy, qualitative methods have an '*undeniable advantage*' if the research questions about an urban social problem are of a 'how' or 'why' nature (Maginn et al., 1998, p. 14). Qualitative research methods offer flexibility during data collection and analysis allowing for the research methods to adapt and evolve as the study unfolds. For example, the semi-structured interview allows more freedom and flexibility for respondents to describe their experiences, whereas a social survey may restrict and subsequently omit important information that the survey's questions have not directly or indirectly addressed. The questions asked during a semi-structured interview act as triggers to get respondents talking about an issue or experience and also to allow researchers to maintain control over the data collection process. Although there are an array of qualitative methods, semi-structured interviewing is perhaps the most widely used as the data can be analysed in numerous

ways by, for example, what is said (thematic analysis), how often something is said (content analysis), or how something is said (discourse analysis) and what remains unsaid (Willig, 2001). It is perhaps clear that semi-structured interviews with residents living close to vibration sources may serve to highlight issues that do not emerge from more quantitative methods, whilst also taking into account the context and the complexity involved in experiencing vibration.

Another important qualitative method is the focus group. Focus groups provide an alternative to semi-structured interviewing in that the group members discuss a social issue, therefore this method capitalises on their communication to generate data (Kitzinger, 1995). The group's interaction enables the researcher to act as a moderator (Robson, 2002) allowing the research to take its own direction. Generally group sizes of eight to twelve respondents are recommended (Stewart & Shamdasani, 1990). Focus groups of residents living near a vibration source could enable them to discuss vibration more easily. It may also highlight a community group attitude towards to source of vibration, as Kitzinger (1995) comments interpersonal communication can highlight sub-cultural values or group norms. Focus groups have been used in other areas successfully, particularly in applied health and health psychology.

The role of the researcher, particularly in terms of reflexivity is acknowledged by qualitative methodologies. Reflexivity recognises the researcher's contribution throughout the research process, and their influence on data collection and data analysis (Willig, 2001). As Strauss and Corbin (1998) point out; '*analysis is the interplay between researchers and data*' (p.13) highlighting the awareness within qualitative research of the role of the researcher and their contributions. Reflexivity can take various forms depending on the epistemological position of the researcher. However, personal reflexivity involves an awareness of the researcher's values, beliefs, expectations, knowledge and prior experiences that they bring to any research situation. Another aspect of reflexivity is the awareness of the language used by the researcher such as categories, labels and the wording of research questions, which inevitably shape the research findings. Emerging standards (e.g. Nordtest Method, 2001; Fields et al., 2001; ISO/TS 15666:2003) on the development of socio-vibration and socio-acoustic surveys aim to standardise the way in which people are asked about their experience of vibration in their homes. By taking into account the effect language has on research, qualitative methodologies problematise '*standardised*' knowledge and experience.

In more recent years, a more qualitative approach to community noise has arisen from soundscapes research. A concept originating from the work of R. Murray Shafer in the mid-1970's, a soundscape refers to a person's sonic environment. Schulte-Fortkamp and Fiebig (2006) describe soundscapes in residential settings as '*environments of certain sound sources and the way people feel about those sounds contributing to the identity of those residential areas*' (p.875). Soundscape researchers use a variety of methods both quantitative and qualitative to investigate a variety of sound environments.

A qualitative methodology has been employed to explore noise beyond the dose-response relationship (Schulte-Fortkamp & Fiebig, 2006; Raimbault, 2006). Such qualitative analyses show that sound evaluations are imbedded in an individual's social and cultural structures (Schulte-Fortkamp & Fiebig, 2006). The knowledge gained from qualitative research in soundscapes can contribute to the further understanding of the factors underlying the dose-response relationships between noise and annoyance found in quantitative research. This body of growing research could provide useful direction for a future qualitative exploration of the human response to vibration in residential environments.

### **In conclusion: taking a pragmatic stance to vibration research**

We have discussed the potential qualitative approaches can have when looking at this area within the same positivist domain as a social survey is usually operationalised. It is beyond the scope of this paper to explore alternative epistemologies and their engagement with qualitative methods. It is clear to most, that the positivist paradigm has remained dominant for decades and is grounded in the desire of certain disciplines (particularly sociology and psychology) to be true social *sciences* by emulating the approaches taken by the natural sciences (Denzin & Lincoln, 1998). In terms of urban research, the rise of 'systems' planning in the 1960s marked a time when the quantitative or positivist paradigm dominated urban and regional planning policies (McLoughlin, 1969; Allmendinger, 2002). Maginn et al (2008) have commented that '*...this style of urban planning was premised on the notion that by 'running the numbers' it would be possible to obtain the solution to a particular problem*' (p.12). With the apparent acknowledgement of qualitative methods as a legitimate methodology in the 1970s (Hammersley, 1992) methodological pluralists, who employed both qualitative and quantitative methods in their research, were born (Payne, 2007).

The use of more qualitative approaches to looking at a variety of urban issues, usually studied via more quantitative means, has been called by Maginn et al., (2008) a '*pragmatic renaissance*' for urban researchers. Such a state arises from a period of post-modern and social constructionist reaction, within qualitative research, against the dominant positivist approach to social science (Greene, 1998). This has lead researchers to a position where to be effective and respond to everyday complexity research has to involve elements of the quantitative and the qualitative.

However, there is an enduring popular perception, within applied policy research, that qualitative methods are soft and/or lacking in rigour when compared to quantitative methods (Maginn et al, 2008). This is maintained by the rise and pervasiveness of evidence-based policy making which is premised on the notion that evidence can provide objective answers to research questions, and that policy-making can become a more rational decision-making process which is influenced primarily by the weight of evidence (Nutley & Homel, 2006). It is not possible to review the extensive literature that has built up around the critique of these issues which reflect, as Wells (2007, p.23) notes: '*the traditions of different areas of social and economic policy making [and] also the different epistemological, ontological and methodological approaches to social and economic research*'. However, it is clear that our communities are complex as is the reactions of individuals to the various environmental stimuli present in our everyday environments. In order to attempt to fully understand our environments we need to use all the methodological tools available to us.

In conclusion, due to the complex nature of vibration and potential difficulties in articulating attitudes, sensations and perceptions of vibration, a qualitative methodology could help unravel and explore the human response to vibration in residential environments. Such qualitative endeavours could compliment and further the knowledge acquired from more quantitative research, particularly the recent efforts to depict dose-response relationships between residents annoyance levels and associated levels of vibration (e.g. Defra, 2007, Klæboe et al., 2003). Quantitative research is employed to find the link between the source of vibration and the psychological response people exhibit, qualitative approaches help us to learn more about the link itself. This moves our pragmatic research practice from a position of knowing to a position of understanding.

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