Project Crystal: Enlightening Communication.

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Abstract

Access is often associated with ramps and toilets that are accessible to wheelchair users. However, the features of an internal environment, including the colour and contrast used, the lighting regime and the acoustic properties of surface finishes, can all play a vital role in the ability of deaf and hard of hearing people to understand information correctly. To many deaf and hard of hearing people, the way in which light illuminates, and therefore models, the person they are communicating with, together with the background against which the person is to be viewed, can have a fundamental effect on communication skills such as lipreading and signing. This paper will provide a summary of the initial findings from the questionnaire survey and the tests carried out as part of a research project on Deafness, Design and Communication in the Built Environment. It will highlight the importance of considering a wider range of issues when designing environments that are meant to be truly accessible to all, including deaf and hard of hearing people.

1. Background and aims of Project Crystal

Since the advent of the Disability Discrimination Act in 1995, research on various aspects of disability has certainly increased, and access, in its widest meaning, is often the main focus of such research. As a consequence, access to the built environment has also progressively come into the limelight. Access is, however, often associated with physical disabilities and aging, rather than sensory or mental disabilities (ACE, 1994). It is only in recent years that access to the built environment has started to be seen as having wider implications than ramps and lifts, although some groups, such as deaf and hard of hearing people have seldom been represented on local access groups (Imrie, 1999). Even when considering issues of access for new buildings, the views of disabled people themselves are often not integrated at the planning stage, leaving a trail of unnecessary adjustments to be made afterwards (Imrie, 1999) and showing the division existing in Britain between urban planning and social policy (Gleeson, 1999). In this context, interior design, including lighting, and its impact on disabled users, have often been overlooked, or limited its focus to a particular group, following a rather medical model of disability where particular challenges are associated to a specific impairment. For example, to date, within the UK, research to establish the

importance of colour contrast, lighting, surface finishes and spatial layout in the built environment to people with a sensory impairment has involved observing and analysing the performance and comments of visually impaired people only (Bright, Cook and Harris, 1997). Whilst it is important to address such matters, the need for deaf and hard of hearing people to be provided with suitable, user friendly, environments is equally as important.

A recent RNID (Royal National Institute for Deaf People) report (February 1999) provides evidence that deaf and hard of hearing people, in fact, still encounter numerous challenges in relation to access and communication. Over seventy percent of the RNID survey's participants felt isolated because of their deafness, while nearly forty percent avoided meeting new people. Most significantly eighty six percent also stated that their hearing loss made it difficult for them to cope with public places. As stated in the previous paragraph, up to now there has been little research in the area of deafness, communication and the built environment and this has usually focused on sound and acoustics. In spite of this research gap, anecdotal evidence suggests that deaf and hard of hearing people know how important environments are when trying to communicate. For example, some deaf people complain about 'visual dizziness' when a room has very colourful decor or wallpaper with complicated patterns. The use of surface finishes and interior spatial design are, in fact, known to influence the way in which a sensory impaired person interacts with a building and with other users (Howell, 1995). Communication for deaf and hard of hearing people can certainly be affected by the acoustic qualities of an environment but it still relies heavily on visual clues regardless of which form of communication is preferred.

Interest in the visual dimension of communication in relation to the built environment led to Project Crystal. This started in October 1999 at the University of Reading, in co-operation with the University of Hertfordshire, to look at the effect of colour and light on the communication skills of deaf and hard of hearing people, both signers and lipreaders. The Engineering and Physical Sciences Research Council (EPSRC) funded the project under the EQUAL (Extend Quality Life) Initiative. A team composed by three investigators and two research fellows carried out the research and a Project Management Group (PMG) ensured that the programme remained on target and that resources were applied effectively. A Collaborating Organisations Panel (COP) also offered expertise, comment and guidance throughout the project; because of the diverse nature of skills and experience required by the project, this was formed by leading experts in various fields, as well as comprising a number of organisations representing the deaf and hard of hearing communities. Table 1 below shows the composition of the various groups mentioned.

Investigators:	Keith Bright (University of Reading)
	Geoff Cook (University of Reading)
	Indra Sinka (University of Hertfordshire)
Research Fellows:	Alessandra Iantaffi
	Rachael Luck
Research Team:	Investigators and Research Fellows
Project Management Group:	Investigators and Deaf@x Trust
Collaborating Organisations Panel:	Deaf@x Trust
	Royal National Institute for Deaf People (RNID)
	British Deaf Association (BDA)
	UK Council on Deafness
	Hearing Concern
	Royal Berkshire and Battle Hospital Trust
	University City of London
	Deaf Blind UK Ltd.
	Centre for Accessible Environments
	AFM Consulting

Table 1 - Composition of Research Team, PMG and COP

The aim of this research project was to establish from a representative sample of deaf and hard of hearing people the challenges they face when interacting with the built environment and to determine from them examples of good and bad design practice and material selection. This would then form the basis for the creation of design guidance for the provision of suitable internal built environments that are inclusive for all building users, including deaf and hard of hearing people. The first part of the project included a postal questionnaire survey, which was distributed to 800 deaf and hard of hearing people. Tests and interviews with 41 and focus groups with 36 deaf and hard of hearing people have also been carried out.

2. Defining deafness.

Unlike other disabilities, deafness cannot be easily categorised and it could be even argued that, rather than being disabled, deaf people belong to a linguistic minority or cultural grouping (Lane, 1997; Corker, 1998). People who identify themselves as Deaf in a political sense argue, in fact, that, within the Deaf community, a hearing loss does not disable the person. On the other hand, it could be argued that within the hearing world deaf and hard of hearing people are disabled by the reduced, or at times non-existent access to information and communication. In the context of this research, deaf and hard of hearing people are seen as part of the disability movement, whilst also retaining their status, for those who are signers, as a linguistic minority.

The interaction between hearing loss, mode of communication and self-identity is complex and not easily definable. One of the most comprehensive reviews of the existing literature, carried out by Powers and Gregory (1998) for the Department for Education and Employment (DFEE), showed how there has been little clarity in the terminology used to describe and categorise deaf and hard of hearing people. The term hearing impaired has often been used in an educational context but it is a term generally disliked by the deaf and hard of hearing communities, since it emphasises the dimension of impairment and deficit, rather than that of linguistic difference. On the other hand, labels, such as deaf with a capital D to indicate someone who is culturally deaf, regardless of their degree of hearing loss, are deeply political and might not be appropriate to describe the deaf and hard of hearing communities at large (Woodward, 1972). Hearing and consequentially any loss of it is a subjective experience (Ballantyne, 1993), on which privileged mode of communication and age at onset of hearing loss have more impact than any audiometric measurement (Baker and Battison, 1980). As Wrigley (1996:4) eloquently summarises: “Deafness is less about audiology than it is about epistemology”.

Due to the growing recognition of this reality, there has recently been a definitive move away from an audiometrically based typology towards categorisations that express the measuring of functional hearing ability, rather than hearing loss. This is described by statement of various abilities, such as ‘can understand someone talking in a loud voice in a quiet room’, or ‘can use an amplified telephone with a hearing aid’. Within the project a mixed approach to the labeling of categories was privileged. The participants were firstly given the opportunity to define themselves as ‘Profoundly Deaf’, Partially Deaf’, ‘Deafened’, ‘Hard of Hearing’, ‘Hearing’ or ‘Other’, with the option to specify a different term. These seemed, in fact, to be the terms recurring not only in the academic literature, but also in publications produced by and/or targeted to the deaf and hard of hearing communities. They were also considered to be non-offensive and inclusive of most members of

these communities. The participants were also asked to specify their preferred mode of communication and first language, as this can be such a vital characteristic of a deaf or hard of hearing person's identity. At the same time the research team decided that it would be desirable to be able to compare the results from this project to other statistical data available for the same population. Hence the categories used by the RNID (April 1999) were also included, together with a specified range of decibels that they can or cannot hear, and examples of what sounds might be within the range described. It is to the answers given by participants to these questions and more that the next section will be dedicated.

3. The questionnaire survey.

As stated in the first section a questionnaire survey was the first phase of the project. Before designing the questionnaire, the researchers e-mailed an appeal for advice on its design via various electronic mailbases, such as the Electronic Mail Deaf Consumer Group, bit.listserve.deaf-l, alt.society.deaf, and uk.people.deaf. This resulted in the early involvement of a variety of deaf and hard of hearing people, beyond those already present in the PMG and the COP, at the planning stage. A few replies were received and they informed the formulation of the questionnaire. Before launching the main survey, a draft of the questionnaire was submitted to both the PMG and the COP for feedback and, after the relevant changes, a pilot with 54 participants was carried out between January and March 2000. The results from the pilot informed the final format of the questionnaire and participants were sought through a variety of channels, such as articles on Teletext – Read Hear, and in the RNID, BDA, Hearing Concern, Deafax and University's publications, as well as in collaboration with members of the COP. Local groups such as Age Concern and the Tinnitus Association were also visited, in order to include older people with milder hearing losses.

As well as being printed in Arial fourteen font on non-reflective yellow paper, as recommended by the RNIB, the questionnaire was also translated in BSL on video, and participants could require a copy of the video via text phone, phone, e-mail, fax, or in writing utilising a freepost address. The purpose of this postal survey was to gain an overview of the deaf and hard of hearing population, and of their interaction with the built environment. The questionnaires also provided a detailed profile of the population investigated, and has been compared with the statistical information already available from other sources, such as the RNID statistics on the deaf and hard of hearing population in the UK (April, 1999).

Eight hundred questionnaires were sent out and 216 responses were received: a response rate of approximately 27%, which is better than what would usually be expected for a postal questionnaire. The level of deafness is shown graphically in Figure 1 and compared to the RNID statistics on the deaf and hard of hearing population in Table 2 below.

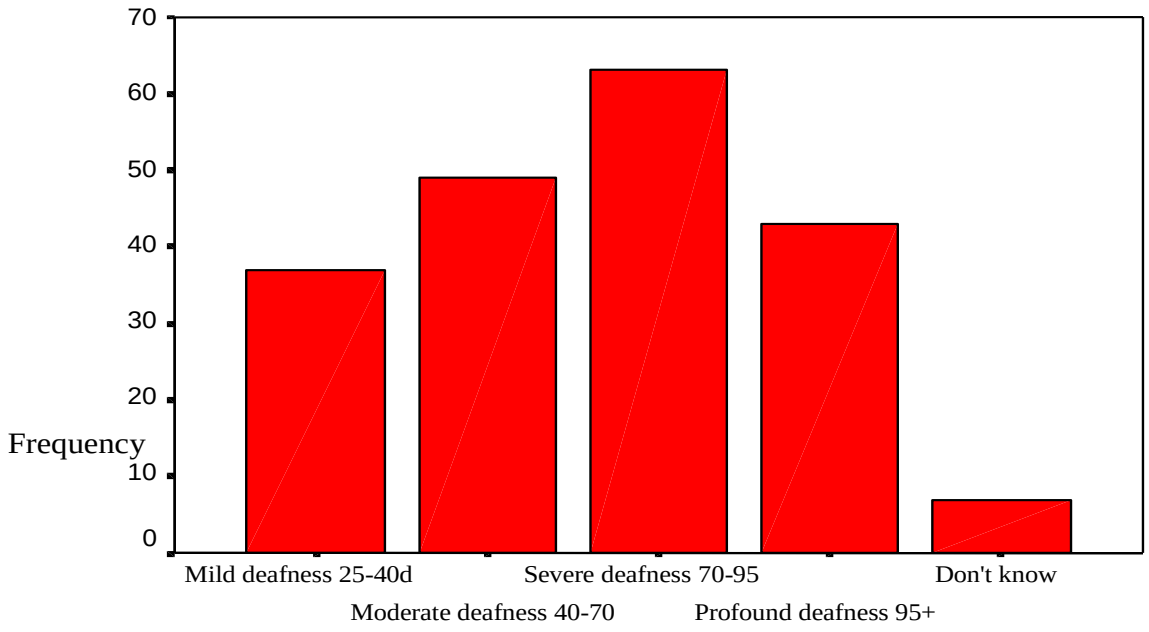

Figure 1 - Level of deafness of questionnaire participants

	Project Crystal	**RNID**
Mild deafness, 25-40dB	19%	54%
Moderate deafness 40-70dB	25%	38.5%
Severe deafness 70-95dB	32%	5.9%
Profound deafness +95dB	22%	1.6%
Don't know	3%	
Total	100%	100%

Table 2 - Comparison between Crystal participants and the RNID statistics

When comparing the test sample of deaf and hard of hearing respondents to the RNID statistics of the deaf and hard of hearing population in the UK (RNID, April 1999), it is apparent that our sample contained a lower number of people with mild and moderate deafness. Various efforts were made by the research team to address this issue but the number of respondents with a severe or

profound hearing loss remained consistently higher than the number of participants with a mild or moderate hearing loss. The profile of the questionnaire respondents and analysis of their responses is presented in more details in other publications (Bright, Cook, Sinka, Luck and Iantaffi, 2000; 2001) and will also be included in the final design guidance to be produced at the end of the project. For the purposes of this paper a summary of some initial findings from the questionnaire is presented in Table 3 below.

	Positive effect	**Negative effect**
Building features	• Visual alarms • Pictorial Sign	• Sound alarms • Entry phones
Room decoration	• Matt paints on walls	• Gloss paints • Patterned wallpaper • Shiny posters • Textured walls
Lighting regimes	• Natural light, daylight	• Glaring lighting
Colour	• Colour contrast, especially between person and background and also on the floor.	

Table 3 – Summary of initial findings from the questionnaire survey

4. Testing the effect of colour and light on communication.

The next phase of the project was to invite a sample of participants to the University of Reading to take part in a real-world test. During the test, the participants experienced thirty scenarios obtained by combining six different lighting regimes and five background colours. For each scenario the participants were asked to carry out a simple imitation task, for which they could use either lipreading or sign language, depending on their preferred mode of communication. The participants were presented with one sentence for each scenario and, after completing the imitation task, were asked some more detailed questions by the observer. The qualitative data obtained from these interview snippets, together with the results obtained in the focus group phase of the project, will provide the research team with insights into the ‘how’ and ‘why’ certain lighting regimes and colours might be helpful or hindering to the communication process for deaf and hard of hearing people. It is, in fact, important to know not only which colours and lighting regimes affect

communication, but also how they affect it and why, in order to be able to provide detailed and accurate design guidelines.

The six lighting regimes chosen used three different types of lamp and luminaire as well as different levels of average room illuminance. The lamp types were fluorescent, tungsten halogen and incandescent and the average room illuminance levels were 150, 350 and 600 lux, that is subdued, bright and very bright. The selection of the background colours was based on the findings of a previous research project (Bright, Cook and Harris, 1997), which investigated the use of colour contrast in the built environment for people with visual impairments and produced design guidance on levels of luminance contrast. The colour system used for both the previous and current projects was the Natural Colour System (NCS), since it is easy to comprehend and is popular with architects, interior designers and building managers. The colours were chosen according to the following criteria:

- Trends in the selection of colours, based on the last ten years market data supplied by ICI Paints Ltd.;
- Colours that are widely used in buildings;
- Colours that reflect current design practice in the selection of colour schemes;
- A colour space that is reasonably systematic, in order to allow extrapolation of the results.

The test colours were chosen from the Colorama paper range and they were: Peach 93, Carnation 21, Sky Blue 01, Summer Green 59, Polar White 82. The latter was not used in the previous project but was specific to Project Crystal.

At the end of the task the participants were also guided through two repertory grids, one on light and one on colour. The repertory grid on light had the six lighting regimes as elements and that on colour used the five colour backgrounds. The constructs were also given (see section five below); they had been determined on the basis of the questionnaire survey, the pilot focus group and the piloting of the testing phase. There was also the space and flexibility to add new constructs during the interview. These were added as they emerged and were incorporated in the grid elicitation later on. A scale of one to seven was used to rate the constructs across the various elements.

Before discussing some of the initial results obtained during this phase, it is useful to describe briefly the sample population that took part in the tests. Forty-three participants were tested but two sets of results were discounted because the test procedures were still being refined, leaving 41 valid tests. Of those, 6 participants were hearing, 3 had a mild hearing loss, 8 a moderate hearing loss, 10

a severe and 14 a profound hearing loss. The central column in Table 4 below shows the distribution of the deaf and hard of hearing (HoH) participants tested.

	Deaf and HoH Crystal participants	**RNID data**
Mild deafness	8.6%	54%
Moderate deafness	22.9%	38.5%
Severe deafness	28.6%	5.9%
Profound deafness	40%	1.6%
Total	100%	100%

Table 4 - Hearing loss of test participants compared to RNID data.

Like the sample of questionnaire respondents described in section three, the number of people with mild and moderate deafness was lower than the number of people with a severe or profound hearing loss. However, it should be noted that the number of BSL participants was purposefully increased, skewing the proportion of participants with severe or profound deafness. This section of the deaf population has been under-represented in research in the past, since it constitutes a smaller percentage of the overall deaf and hard of hearing population. It was the intention of the Project's team to ensure that the needs of this group be explored in depth as it is those people with a more significant hearing loss who rely more heavily on visual clues to communicate efficiently in the built environment. Furthermore, if the needs of this group are addressed so are those of people with mild and moderate hearing loss. Most of the participants identified spoken English as their favourite mode of communication and two thirds used some form of hearing aid, as illustrated in the figures below.

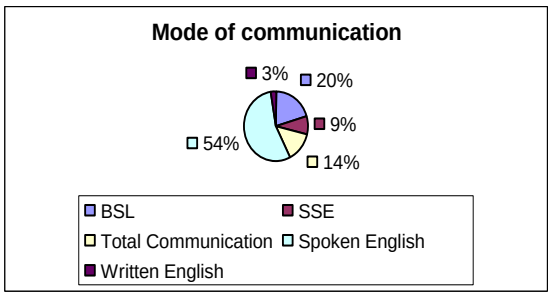

Figure 2a: Modes of communication

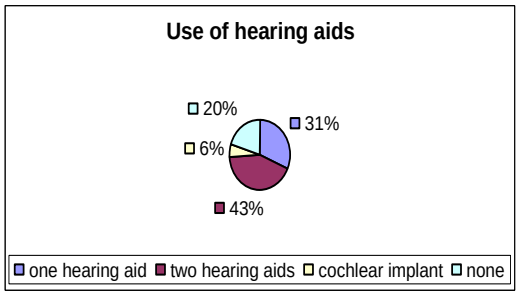

Figure 2b: Use of hearing aids

The research team has collated a vast amount of data from the tests, which is currently being analysed; only the initial results from the repertory grids are included in this paper.

5. Exploring colour and light preferences.

As stated in the previous section, the grids included constructs set by the research team, although there was space and flexibility to add new constructs as they emerged during the interview. The given constructs for the colour backgrounds were:

Hindered communication - Helped communication

No contrast - Clear contrast

Colourful / Overpowering - Plain / Subtle

Dark - Light

Tiring - Relaxing

Distracting - Not distracting

Uncomfortable - Comfortable

Unpleasant - Pleasant

New constructs, such as cold - warm, glaring - not glaring and hard - soft emerged with four participants. They were reminded throughout the elicitation process that these constructs were to be considered in the context of communication.

The grids were then entered into Web Grid II, a web based programme designed for the elicitation and analysis of repertory grids, and analysed. A cluster analysis, which groups similar items together using Shaw's FOCUS algorithm (Shaw and Gaines, 1998), was carried out for all grids. The resulting forty-one clustered grids were then compared. Table 5 below shows an overview of the results, including which colours people viewed as being helpful to communication.

	Helpful to Communication	**Hindering communication**	**Neither helpful nor hindering**
Pink	18	14	9
Blue	20	13	8
White	24	8	9
Orange	8	30	3
Green	16	25	0

Table 5 - Colours and communication

The eight people who found orange helpful, still perceived it to be a distracting and tiring colour. In those cases constructs such as light and clear contrast were associated to this element and seemed to contribute to orange being perceived as having a positive effect on communication.

Usually constructs such as unpleasant, uncomfortable, distracting, colourful and tiring were associated with being a hindrance to communication, as can be seen from the clustered grid from test forty-one shown in Figure 3.

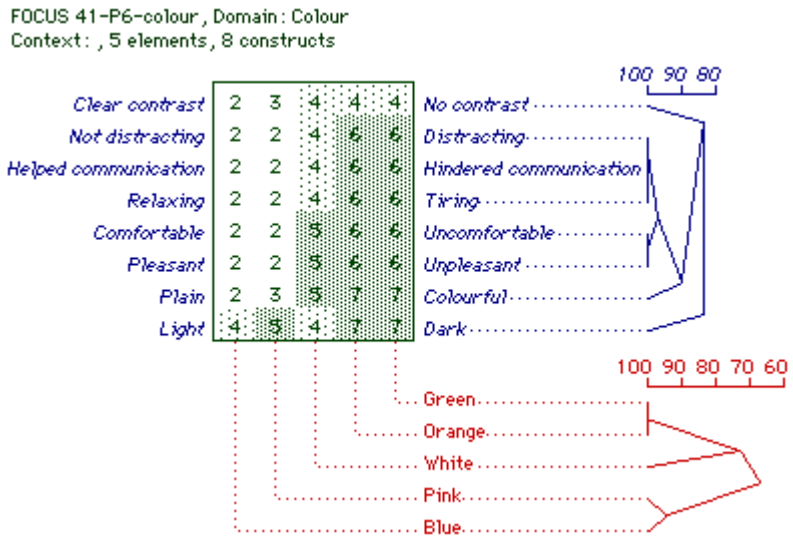

Figure 3 - Example of clustered grid

The given construct for the lighting grids were similar to those used for the grid on colour; they were:

Hindered communication - Helped communication
No contrast - Clear contrast
Dim - Bright
Uneven - Even
Glaring - Not glaring
Shadows - No shadows
Tiring - Relaxing
Harsh - Soft
Distracting - Not distracting
Inadequate - Adequate
Unpleasant - Pleasant

Eight participants introduced the construct cold - warm. Only one participant mentioned another additional construct in the context of lighting, that is light as opposed to gray. A summary of the results for the grids on lighting is shown in Table 6 below, highlighting which regime people found more or less helpful.

	Helpful to Communication	Hindering communication	Neither helpful nor hindering
Overhead and uplighters	36	1	4
2 Uplighters	4	18	19
Overhead full output	12	19	10
4 Uplighters	23	7	11
Overhead reduced output	1	35	5
Spotlights	12	19	10

Table 6 - Lighting and communication

From the grids on lighting, it is apparent that the brightest regime (600 lux) created by combining overhead lighting with the four uplighters seemed to be preferred by the majority of participants. However, further analysis is being carried out and the data from both the grids on lighting and colour and they will be compared to the qualitative data elicited during the interviews, as well as to the statistical data from the communication task and the final comparative analysis will produce more conclusive results.

6. Summing up.

Investigating the effect of lighting and colour on the communication skills of deaf and hard of hearing people was a complex yet fascinating endeavour, which required a variety of methodological approaches. Firstly, to gather more information on the deaf and hard of hearing population and their use of the built environment, the research team devised a questionnaire survey, the results of which have been briefly summarized here and discussed in more detail elsewhere (Bright et al. 2000; 2001). Secondly, an appropriate methodology was devised to test the effect of colour and light on communication for deaf and hard of hearing people and some of the initial findings indicating the preferences of the test participants in relation to colour and light have been discussed in this paper. A more detailed analysis of the qualitative data is currently in progress and a clearer picture of how the participants perceive both light and colour in relation to communication is emerging from it. Statistical analysis is also being conducted to see if these preferences and opinions relate to the participants' performance. The final results will be disseminated in the near future and compared to those from the previous Project on people with visual impairments. Design

guidance will then be produced for design professionals, the deaf and hard of hearing communities and anyone else interested in providing more inclusive environments for sensory impaired people.

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