# RNIB Centre for Accessible Information (CAI)

# Literature review #1a

# Identifying areas for research into an alternative tactile reading code

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# Creating a plan for tactile reading research

## RNIB Centre for Accessible Information (CAI)

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### Executive Summary

The purpose of this study was to create a plan for tactile reading research, including: identifying potential audiences for tactile codes alternative to braille; studying codes currently available; providing evidence on which to base RNIB's decision making and considering key related issues.

#### Potential audiences

Groups highlighted as potentially having a need for a tactile reading code alternative to braille were: people losing their sight later in life who may be familiar with the print alphabet;

older people who may have poor tactile sensitivity; multiply disabled children who may not be able to learn braille and deaf blind people.

#### Existing tactile reading codes

A literature review was conducted to uncover evidence for existing tactile reading codes.

##### Braille based codes

Codes based on braille such as American Braille and New York point enjoyed some use in America in the late 1800s. These were eventually abandoned in the interest of a unified braille code for English speaking countries.

Other alterations to braille have been attempted such as varying the size and spacing of braille cells. Evidence suggests there is limited benefit to this practice.

##### Modern tactile reading codes

The Fishburne code was created in 1972. Some evidence suggests it may be easy to learn, although the code is not intended as a reading code but simply for labelling. The large size of Fishburne characters may prohibit use of the code for production of longer reading materials.

The ELIA code was designed for elderly users and is based on engineering principles. Some evidence from the code's creators suggests it compares favourably to other codes. Further independent verification of these findings is required. ELIA is only available commercially therefore may be very expensive to produce on a large scale.

##### Moon

The Moon code, invented in 1847, remains in limited use today. The literature supports claims that Moon is easy to learn, can be felt by those with poor tactile sensitivity and may be useful for children with multiple learning disabilities. However, problems remain including a lack of reading material in Moon, the bulky size of such material, difficulties for individuals in writing the code and the issue of whether its design is optimal. Further research is required to determine the utility of Moon as an alternative to braille.

##### Raised print

Benefits of raised print include familiarity of the code to former print readers, and equality between blind and sighted readers (in terms of reducing social stigma and enabling easy communication with the same alphabet). However, problems include difficulty of discriminating complex print characters by touch (perhaps suggesting raised print may need to be quite large) and the issue of whether raised print should be produced with dots or raised lines. Further research is needed to determine how raised print could be usefully employed as an alternative to braille.

#### Key issues

Issues to consider in decision making regarding tactile reading codes include: the use of residual vision; the scope of tactile codes; optimal design; the purpose of the code; reading audience; and the ability for individuals to write the code.

#### Recommendations for further research

Recommendations for further research include:

* Gathering user requirements for alternative tactile reading codes
* Comparisons of existing tactile reading codes
* Further investigation of the Moon code
* Further investigation of raised print

### Introduction

The purpose of this study was to create a plan for tactile reading research, on the basis that:

* Many blind/partially sighted people cannot read braille, but may benefit from some other tactile reading system. This study aims to identify potential groups for whom this might be the case
* Various tactile reading systems have been used in the past, both in the UK and abroad. This study aims to review some of the options available, to determine whether any of these might be suitable, or whether a new code needs to be developed
* Related issues need to be identified such as training (of users and teachers), marketing, production of materials and so on

This report considers alternatives to braille. It must be noted that there are 2 grades of braille - grade 1 which uses letter for letter spelling, and grade 2 which uses contractions for common words and letter combinations (see **Clunies-Ross (2005)** for an in-depth discussion on grade 1 and 2 braille). Both grades of braille are made up of the same 6 dot matrix, meaning they do not differ in terms of tactual discrimination. However, grade 2 braille is more complex than grade 1 (due to the need to learn various contractions) therefore may be more difficult to learn. Throughout this report, where studies report direct comparison of the learning of tactile codes compared to braille, grade 1 braille is used. This may not account for the complexity of learning grade 2 braille, or for users' perceptions of the complexity of braille.

### 1. Potential audiences

As highlighted by **Heller, Nesbitt, Scrofano and Daniel (1990)**, many blind people find braille reading difficult, and this is often the case for those who lose their sight later in life. Congenitally blind people are likely to be more experienced in tactile reading, perhaps having learned braille at school, whereas former print readers may find tactile reading more of a challenge.

Furthermore, **Stevens, Foulke and Patterson (1996)** found that tactile acuity (the ability to discriminate features by touch) declines with age, and that this decline may affect braille reading. These findings suggest that older blind people may struggle to read braille due to a lack of sensitivity in their fingers, and therefore may benefit from an alternative tactile reading method which better suits their needs.

Another group of blind users who may be unable to master braille is children with multiple disabilities. According to **Knight (2000)** the braille code may be too complex for such children to learn (from a cognitive point of view) and may require a high level of tactile acuity some multiply disabled children may not have. Anecdotal evidence also suggests more simple tactile codes such as Moon may be beneficial for deaf-blind people **(Steer, 2000)**.

These findings point to a variety of blind users who may benefit from a tactile reading code alternative to braille. These include people losing their sight later in life, elderly users, children with multiple disabilities and deaf-blind people. A key task for further research into tactile reading is to determine the size of the potential audience for alternative tactile codes.

### 2. Existing tactile reading codes

Tactile reading codes have been used for hundreds of years. During this time, many codes have been developed and some discarded from use for various reasons.

The following section reviews a variety of tactile reading codes.

#### 2.1 The braille code

The standard braille code is a widely accepted means for reading by touch. The code - made up of six dots in a 3x2 matrix - was created in France during the 1820s, and was introduced in Britain around 1860. Although many people see braille as the gold standard of tactile reading codes, various alterations to the code have been suggested. These include alternative codes based on the braille dots, and alterations to the standard braille code in terms of size and spacing.

##### 2.1.1 Modifications to the standard braille code

The standard braille code was introduced to America in the 1860s, but was not adopted immediately, as various people believed they could improve it. Two such improvements which were widely used in America were American braille and New York Point.

American braille (introduced in 1868) maintained the use of a 6-dot braille cell, but allocated the characters differently to standard braille. The system was based on the principle of frequency of recurrence, whereby the most frequently used letters were assigned characters with the fewest dots **(Merry, 1937)**. This was thought to speed up reading and writing of the code.

New York Point (created by William Bell Wait, director of the New York Institution in 1868) also allocated characters in this way, and had further differences to standard braille. New York Point altered the make up of the braille cell, turning it on its side to make it 2 dots high. Furthermore, the width of the cell varied between 1 and 4 dots, to enable a larger number of combinations **(Lorimer, 2000)**. A key feature of New York point was that characters made up of just one dot did not take up a whole cell size (as they do in standard braille) which was intended to save space **(Armitage, 1870)**.

Whilst both of these modified codes enjoyed wide use in America for a number of years (and great competition between them), each ultimately was abandoned in the interest of a unified braille code for English speaking countries. As England and much of Europe had already settled on the use of standard braille, after much debate and a few false starts, in 1932 America adopted Standard English Braille grade 2 (**Lorimer, 2000)**.

##### 2.1.2 Alterations to the size and spacing of standard braille

Although the braille code is now widely accepted as the most used tactile reading code, other alterations to it have been suggested. Researchers have altered the size and spacing of braille to determine whether this may have any benefits for learning. Furthermore, **Tobin, Burton, Davies and Guggenheim (1986)** suggest altering braille size may be beneficial in encouraging learners with poor tactual sensitivity.

Evidence in this area is mixed. **Newman, Kindsvater and Hall (1985)** suggested there may be some benefit to using large braille characters during early braille training. This study compared two sizes of braille character, being standard (approximately 4x6 mm) and enlarged (approximately 6x9 mm). Although some advantage of enlarged braille was found (in terms of number of correct responses), this was not a straightforward relationship, as larger braille was only beneficial to learning when testing was with standard braille.

There are a variety of studies suggesting an advantage of enlarged braille, as reported by **Tobin et al (1986).** However, whilst many findings show trends suggestive of a benefit, few reach statistical significance. **Tobin et al (1986)** studied the effects of altering both the size and spacing of braille on the percentage of characters correctly recognised, and the time taken to do so. Findings indicated that spacing had a great effect, with closely spaced braille very difficult to discriminate, particularly at small sizes. With regards to size, although participants were significantly slower at reading the smallest braille tested, there was no significant difference in performance with standard and enlarged braille (note: the size of enlarged braille used was not reported in this study). These findings suggest that increasing the size of the braille cell does not speed up braille recognition.

Further work in this area is in opposition to the use of enlarged braille. **Pester, Petrosko and Poppe (1994)**  found that increasing the size of braille had no effect on recognition accuracy, and that time taken for recognition was actually slower for enlarged braille compared to standard sized (note: again, the size to which the braille was enlarged was not reported in this study).

Similar findings were reported by **Millar (1977, cited in Millar 1994)** who found recognition was slower with enlarged braille and some children needed retraining with the enlarged braille, despite being able to recognise characters in standard braille. These findings suggest that not only might enlarged braille slow down reading, but that the transformation of learned patterns may be less flexible tactually than visually.

In conclusion, evidence to support the use of enlarged braille is not compelling. The finding that size transformation of learned tactile patterns may confuse learners may have implications for learning, as learners taught using enlarged braille may struggle to make the transition to standard size braille. Furthermore, as the overwhelming majority of braille materials are produced at standard size, there may be little benefit in learning enlarged braille due to the lack of materials available. However, sales figures for devices which produce "jumbo" braille suggest there are readers who use the enlarged code. This may highlight an area for further research to explore user requirements for enlarged braille.

#### 2.2 Modern tactile reading codes

In recent years, new tactile reading codes have been developed aiming to cater for particular groups such as those highlighted previously as potentially being unable to learn or read braille.

##### 2.2.1 Fishburne

The Fishburne tactile reading code was created by S.B. Fishburne in 1972. The code is made up of four symbols (a dot, a vertical dash, a horizontal dash and a diagonal dash) which are used in a repeating pattern to make up the alphabet. The symbol differs for each row of six letters, while the pattern remains the same. For example, for letters A-F, a dot is used, with the pattern as follows: one dot in the top half of the cell (A), one dot in the bottom half of the cell (B), one dot in either half (C), two dots in the top half (D), two dots in the bottom half (E) and two dots in either half (F).

Anecdotal evidence **(Shafrath, 1986)** suggests that the Fishburne code is easy to learn and can be mastered by people with poor tactile sensitivity. **Newman (1992)** studied the learning of tactile codes by sighted children, and suggested that the Fishburne alphabet may be easier to learn than the braille alphabet. However, these findings were based on visual learning of the code, therefore do not account for tactile discrimination of the two codes as they would be used by blind users. Furthermore, Fishburne characters were displayed with lines across the centre which may have further aided pattern recognition. Indeed, other studies comparing braille and Fishburne learning by touch have found contrary results **(Mroczka, 2005).**

Overall, whilst there is some evidence that the Fishburne code may be easy to learn, it has never been intended to be a means for complete communication. Reading materials are not available in Fishburne, as it was designed as a labelling system, to offer blind users who don't read braille some further independence **(Shafrath, 1986).**  Furthermore, the size of the code (a standard cell being 12 x 24 mm, compared to a standard braille cell at 4 x 6 mm) may prohibit the use of Fishburne in publications, as materials are likely to be unwieldy.

Suggested uses for the code include labelling personal items (such as tinned food, clothes and household items) and perhaps as a training exercise to help users into tactile reading prior to learning braille **(Newman, 1992).**  Further research could investigate the use of Fishburne as a labelling code, in comparison to other means of labelling such as raised print.

##### 2.2.2 ELIA

Elementary Imprint Assistance (ELIA) was created as an alternative to braille for blind people who find braille difficult (specifically the elderly). The design of the code was based on engineering principles, and therefore uses a frame around the symbols to aid identification, and bases the symbols on the print alphabet to make use of users' existing knowledge **(ELIA Life Technologies, 2007a)**. Furthermore, the code can be produced at any size, to cater for differences in tactile acuity among users (for further information on the ELIA code see www.elialife.com).

ELIA materials are produced by converting text on a computer into the ELIA font, and printing onto swell paper, which is then raised to be read by touch. It is proposed that ELIA could be used to produce any text, including labels and reading material, therefore making it as useful as braille **(ELIA Life Technologies, 2007b)**. Specialised printers, paper and software to produce ELIA are available from ELIA Life Technologies.

**Chepaitis (1996)** reports that the ELIA code is easy to learn, suggesting 49 students learned it blindfolded with less than 3 hours of self paced learning. Further research **(Chepaitis, Griffiths, Wyatt and O'Connell, 2004)** found adult learners performed better in tests of speed and accuracy after learning ELIA, compared to groups learning to read braille (grade 1) and raised print. Whilst these findings are interesting, there are some inconsistencies within the study in terms of the time spent teaching the various codes, and the size of test materials. Furthermore, this study was carried out by people involved in the creation and promotion of ELIA, therefore independent verification of these findings is required.

The ELIA alphabet has undergone some changes since its creation, which are said to make letters more easily distinguishable from each other, and to improve speed and accuracy of recognition **(ELIA Life Technologies, 2007b)**. The evidence on which these changes are based is not reported.

One potential problem with the ELIA code is that it is only available commercially through ELIA Life Technologies, and therefore may be expensive to produce on any large scale. Inclusion of ELIA materials in comparison studies of tactile codes may be of interest, to confirm or deny the findings reported by its creators. However, due to the practical cost issue, ELIA is unlikely to be a viable option for wide scale production.

#### 2.3 Moon

The tactile reading code known as Moon was developed by Dr William Moon in Brighton, England in 1847. The code is based on the print alphabet, and uses only 8 characters to represent the alphabet by rotating characters to form different letters (see appendix 1 for a detailed description of the Moon code).

The Moon code is still used, with Moon books still in circulation today. However, Moon readership is very low, with an estimated 400 readers in the UK **(Bundock, 2002).** For comparison, around 20,000 people in the UK state braille as their preferred reading format **(RNIB, 2008).**

Moon is said to be easier to learn than braille, due to its foundation in the print alphabet, and is particularly thought to be useful for older adults losing their sight later in life, who have previously read print. Furthermore, Moon characters are bigger than braille and can be produced at a variety of sizes, therefore the code is thought to be useful for people with poor sensitivity in their fingers who may struggle to discriminate braille dots. There has been recent interest in teaching the Moon code to children with multiple disabilities, who may struggle with both the cognitive and tactual demands of learning braille.

The following review of research aims to provide evidence for the above assertions regarding the utility of the Moon code, with a view to informing decision making about the potential use of Moon as an alternative to braille.

##### 2.3.1 Moon is easy to learn

There is much anecdotal evidence that Moon is easier to read than braille, on the basis that the code is based on the print alphabet. For example, **Acott (1961)** suggests that the letters which replicate their print equivalents (C, I, J, L, O and V) can be recognised at first touch. More robust evidence of the ease of learning Moon is somewhat elusive, although the following findings offer some support.

A survey of 100 Moon readers conducted by National Library for the Blind (NLB) in 2002 reported that 31% of respondents reported they read Moon because it was easier than braille **(Bundock 2002)**. Some of these respondents had not tried braille, or had been advised by professionals that they would find Moon easier. However, nearly 40% of those who stated Moon was easier than braille had tried both formats.

**Tobin and Hill (1989)** conducted a study to determine whether sighted volunteers could be engaged to teach Moon to blind people. They found that the sighted volunteers all mastered the Moon code during a one-hour training session, and of 20 blind participants, 80% felt a one-day course was sufficient for an introductory course in Moon reading. Indeed, some learners remarked on the ease of learning Moon, with one newly blind participant stating that Moon's resemblance to print letters was helpful in the formation of mental images.

##### 2.3.2 Moon requires less tactile sensitivity

As with the assertion that Moon is easy to learn, the idea that Moon requires less tactile sensitivity than braille is a commonly held belief. Indeed, the NLB survey found 38% of Moon readers reported poor sensitivity in the fingers as a reason for reading Moon, often attributed to health problems such as suffering from arthritis or diabetes **(Bundock, 2002)**.

Many older people may struggle to feel braille dots, according to **Stevens et al (1996)**. They found that tactile acuity in the fingertip declined with age, and that this decline was related to a slowing of braille reading rate (those with poorer tactile acuity read more slowly).

As Moon is physically larger than braille (8x8mm compared to 4x6mm), it seems likely that people with a poor sense of touch may find Moon easier to feel than braille.

##### 2.3.3 Moon and children with multiple disabilities

Although Moon has traditionally been used by older people, there has been recent interest in teaching the code to children with multiple disabilities. This is because braille can be too difficult for these children, perhaps due to its complexity or because it requires a high level of tactile sensitivity **(Knight, 2000**).

A study into the use of Moon with children in the UK was conducted by **McCall and McLinden (2001)**. They found that there was consistent uptake of Moon with children with additional disabilities and that the number of such children using the code may be larger than anticipated. However, it is difficult to quantify the number of young readers of Moon as their abilities ranged widely, with very few fluent readers. McCall and McLinden found that 65% of the children studied could not access Moon without one-to-one help, and that many had very low levels of skill (for example, around half of the children could locate a raised line on a blank page and one third could not recognise any Moon letters without prompting). These findings raised questions regarding the cost/benefit of teaching Moon to children with additional disabilities. McCall and McLinden suggested that whilst many teachers did not expect their pupils to ever achieve fluency in reading Moon, they felt teaching the code was worthwhile to achieve some independence in tasks such as labelling and choice making. Further study **(McCall and McLinden 2007**) found that teachers also felt teaching Moon to be worthwhile for affective reasons (i.e., the child enjoyed it) and inclusive reasons (such as the child being included in work being done by their classmates).

These findings suggest that there may be benefits to using the Moon code with children with additional learning disabilities, who may not be able to use braille. Furthermore, anecdotal reports suggest the Moon code has been valuable in educating deaf-blind children **(Steer, 2000)**.

##### 2.3.4 Potential problems with Moon

The evidence discussed suggests that Moon may be beneficial in terms of being easy to learn (particularly for former print users), easy to feel for those with poor tactile sensitivity, and potentially useful for children with additional disabilities who may not have the capability to learn braille. Whilst these findings appear to support the use of Moon, there remain a number of issues to be resolved.

Firstly, a disadvantage of Moon is that it is very bulky compared to braille, which can make Moon materials unmanageable. Whilst advances in production equipment and technology have enabled Moon to be produced double sided, it still remains significantly larger than braille.

Furthermore, writing Moon is difficult. Whilst braille users can produce their own braille using a hand frame or a 'Perkins' style typewriter, Moon is more complex. Some years ago a machine for producing Moon was invented (the Possum Moonwriter) but this required drawing the Moon letters freehand onto a plate, which involves sophisticated co-ordination that some Moon users (such as multiply disabled children) may not have **(McCall and Stone, 1992)**. Although Moon hand frames exist, these also require freehand drawing, rather than being stencils of Moon letters, therefore they have the same disadvantage.

Recent developments in technology have allowed Moon to be produced on braille embossers, using computer software to convert text or braille into the Moon code. This is an encouraging development, although as embossers and translation software are very costly, this does not solve the problem of writing for individuals. Although a simple Moon writing device does not exist, it is not to say one could not be developed. The low numbers of Moon users means the investment required to develop such a device has not been considered cost effective in recent years. This may be an area to be explored, in gathering user requirements for a simple Moon writing device.

Moon produced on braille embossers is made up of embossed dots rather than raised lines, which may affect its tactile legibility. One study has compared performance using lined and dotted Moon **(McCall, Douglas and McLinden, 2007)** and found no differences in reading speed, comprehension or accuracy between the two. This study suggests various advantages to dotted Moon including the ability to convert electronic files into Moon and to store information which can be produced in Moon on demand. Whilst these initial findings are encouraging, replication of this study with a larger number of readers (including elderly readers with poor tactile acuity) may be beneficial.

Another problem in using the Moon code is that very few reading materials exist. As the Moon code has undergone some major changes over the years, there is variability in the codes used making it difficult for learners to access suitable materials. This issue raises the question of whether it is worthwhile to produce more materials in Moon, which would be a costly investment.

The biggest issue with the Moon code is that whilst we can see the benefits to Moon, it is difficult to know whether the Moon code is optimal in its current form. Although basing characters on the print alphabet is useful, not all Moon characters resemble their print equivalents, and rotating characters to produce different letters may be confusing to the reader.

##### 2.3.5 Conclusions regarding Moon

Overall, further research is required to determine whether the Moon code could be improved, and how Moon compares to other tactile codes in terms of usefulness as a tactile reading format.

Remaining questions regarding Moon which could drive future research include:

1. Is the Moon code optimal as it is, or would it benefit from some alterations? (for example, replacing rotated characters)

* what alterations should be made? How do we make these decisions?
* would changes be acceptable to current readers? (Moon has already been through many changes)

2. Evidence shows Moon can be useful, but how does it compare to other tactile formats?

3. Moon is very bulky making it difficult to read lengthy books (as they run to many volumes). Might Moon be better suited to short documents or labelling?

4. How can Moon be produced?

* do different production methods (e.g. dotted versus lined Moon) affect reading performance?

5. How can individuals write in Moon?

6. What are the potential audiences for Moon?

#### 2.4 Raised print

Raised print has been used for tactile reading for many years. In 1784 Frenchman Valentin Haüy opened L'Institute Royale des Jeunes Aveugles (Royal Institute for the Young Blind) in Paris, where he taught blind children to read using embossed print.

Since then there have been many attempts at improving the tactual discriminability of raised print, including creating more angular letters **(Gall, 1837 cited in Lorimer, 2000)** and adding serifs **(Alston, 1842 cited in Lorimer, 2000)**. Most studies into the legibility of raised print reported here use uppercase letters, although the reasoning behind this is unclear. Further research may be required to determine any differences in legibility between uppercase and lowercase letters.

There are a number of proposed benefits to using raised print for tactile reading. Firstly, for blind users who are former print readers, print characters may be more easily recognisable than codes with arbitrary characters such as braille. Secondly, it is thought to be inclusive for blind people to read in the same format as sighted readers, as some blind users feel there is some stigma attached to reading braille dots. Furthermore, raised print can be easily read by sighted people.

The following literature review examines evidence around these claims.

##### 2.4.1 Raised print is recognisable by former print readers

There is some evidence that raised letters can be read tactually by people who were former print readers. Firstly, **Austin and Sleight (1952)** studied tactual discrimination of letters, numbers and geometric forms. The letters were 12mm high and findings showed that for solid line characters (as opposed to characters made up of dots) where participants were allowed to explore the figures by moving their fingertip over them, 65% of letters were recognised with 90% accuracy.

**Acott (1961)** reports that Moon characters which mirror their print equivalents (therefore raised print) can often be recognised at first touch, and that this ability to recognise letters tactually may be beneficial in terms of motivating users when learning tactile reading. Indeed, one problem some users may have is that learning braille can be a slow process. Users may be more motivated to learn raised print with which they don't feel they are starting from scratch.

According to **Merry (1937)**, recognition of raised print is easier for former print readers due to their visual memory of the characters. Merry suggests that tactual sensations are translated into visual images, a process made easier if materials match previous visual experience. This assertion requires further empirical evidence.

**Lambert and Lederman (1989)** found that symbols which are meaningful to an observer are easier to remember (in this case, a raised print "L" to signify "ladies toilet" on a tactile map). This may suggest that familiar codes (such as the print alphabet) may be more useful to newly blind users than arbitrary codes which must be learned.

##### 2.4.2 Raised print allows equality between sighted and blind readers

With regards to the idea that using raised print includes blind readers in the sighted world, there are some who feel this very strongly. **Rainey (1893)** suggested that by ceasing production of raised print for blind users, blind readers would be cut off from the form of communication used by their family and peers. Furthermore, anecdotal evidence suggests that some users may feel there is a stigma attached to reading braille as it makes them stand out as "different" **(Tuttle, 1984)**. Therefore some users may prefer to use reading materials which are more like print.

Another benefit for blind users of using the same alphabet as sighted people is ease of communication with sighted readers. Raised print can be written using "german film", plastic sheeting which creases when written or drawn on to create a raised image. This could be used for blind and sighted readers to communicate with one another **(Heller** **et al, 1990)**.

A further benefit may be that sighted people can be involved in blind users' reading. This may be useful from a teaching perspective, or for parents of blind children **(Rainey, 1893)**. However, **Armitage (1870)** highlights thata preferable situation would be for a tactile reading code to be simple enough for the blind reader not to require sighted assistance.

##### 2.4.3 Potential problems with raised print

Whilst there is obvious benefit in using a code which may already be familiar to readers, **Armitage (1870)** points out that the first consideration in creating a tactile code should be whether or not it can be easily felt.

The print alphabet, though simple from a visual perspective, involves complex characters which may not necessarily be easy to discriminate by touch. Indeed, **Thurlow (1986)** found raised print characters were difficult to discriminate by touch, although participants performed better with simplified versions of print characters. **Loomis (1981)** discussed the differences between vision and touch, concluding that the sense of touch could never equal vision in the resolution of intricate spatial patterns.

Due to the complexity of print characters, it may be necessary for raised print to be produced in larger sizes to enable tactile discrimination of characters. **Heller et al (1990)** found performance with raised print to be better at larger sizes (57.6% correct at 5mm, compared to 92.5% correct at 11mm). Indeed, **Johnson and Phillips (1981)** found a linear relationship between recognition accuracy and size, with recognition more accurate for larger characters. **Loomis (1981)** suggests that recognition of large raised characters may be slow, due to portions of the character not being in contact with the finger pad. Characters which fit under the fingertip are beneficial in the time saved through not having to move the finger around each character to explore its full extent. However, if raised print is difficult to discriminate at such sizes, larger characters may be preferable, and as highlighted by **Heller et al (1990)**, reading slowly is preferable to not reading at all.

A second potential problem with raised print is that there is a widely held belief that dots are more easily recognised by touch than are embossed lines. This belief is referred to by **Merry (1937)** as a "generally recognised fact".

Evidence for this "fact" however, is somewhat inconclusive. A study by **Loomis (1985)** found a significant difference in the percentage of characters recognised between raised roman characters and braille characters of the same size. Participants correctly recognised 43.1% of raised roman characters, compared to 53.2% of braille characters. Whilst this is of interest, these findings cannot determine whether lines or dots are more easily recognised, as the study compares two different codes (roman letter and braille).

A previous study by **Loomis (1981)** found that the difference in tangibility between raised print and braille was due to braille characters being more varied and distinctive than print characters when accounting for the way in which the sense of touch filters information. This may suggest that any differences in recognition between braille and raised print may not be due to the difference between dots and lines. Indeed, this study also compared raised letters made up of embossed lines to raised letters made up of dots, and found that although participants were aware that one was made up of dots, there was no difference in tangibility between the two sets of letters. These findings support previous work by **Austin and Sleight (1952)**, perhaps suggesting that the commonly held belief that dots are superior to lines may not be accurate.

These studies have a number of drawbacks. Firstly, small samples of participants were used, meaning findings may not generalise to wider groups of people. Secondly, the studies by **Loomis (1985, 1981)** restricted the movement of participants' fingers when identifying characters, which is likely to affect recognition. Previous work has found differences in performance between active and passive touch (active touch involving exploration of the stimulus, passive touch being where the finger is held still and the stimulus is pressed upon it). **Heller (1986)** found more accurate recognition for braille characters with active touch compared to passive, and this finding was replicated for raised print characters by **Phillips, Johnson and Browne (1983)**.

More recent studies comparing braille and raised print allowed participants to explore the characters, and found no significant difference between performance with braille and raised printin terms of recognition accuracy and speed of recognition **(Heller et al, 1990)**. However, findings of this study should also be interpreted with caution as participants were not taught braille, but simply matched what they felt to a braille chart presented visually. This may have affected the time taken for participants to recognise braille characters.

The dots versus lines debate may require further research, although whatever the result, there need not be a problem for raised print. It is possible to produce raised print in "dotty" form using braille embossers, therefore further research could focus on the comparison of lined and dotty print to determine which is preferable for tactile reading.

##### 2.4.4 Conclusions regarding raised print

Overall, the evidence regarding raised print is inconclusive. There are clear advantages to using a code which is already known to some users (those who formerly read print), as this should reduce learning time thus motivating readers, and there may be benefits to using the same alphabet as sighted readers.

However, raised print may be difficult to discriminate at small sizes. Characters produced at sizes more easily discriminated may result in materials which are unwieldy and slow to read. This could suggest use of raised print may be limited to labelling and small publications. Furthermore, more evidence is required as to whether raised print is optimal in embossed lines or dots.

In summary it seems further research is required into raised print, to determine its usefulness as a tactile reading format. Unanswered questions regarding raised print which could drive future research include:

1. What is the best format for raised print? (capital letters, fonts, serifs etc)

2. What size of raised print can be read easily? How does this differ between individuals? What size is optimum?

3. Dependent on size, what materials are viable to produce in raised print? (would books be too bulky?)

4. How should raised print be produced - dots or lines? Does this affect reading performance? Which do users prefer?

5. How can users produce raised print themselves?

6. What are the potential audiences for raised print?

#### 2.5 Conclusions regarding potential tactile reading codes

In summary, whilst there are a number of tactile reading codes which have been in use over the years, many are not viable options to introduce as an alternative to braille, for various reasons including cost, practicality and lack of solid evidence. Further research to be carried out into tactile reading should focus in particular on Moon and raised print, and strive to answer the outstanding questions regarding these codes.

### 3. Key issues

In considering the future of tactile reading codes, there are a number of key issues which need to be explored. Many of these issues are interrelated, and may have implications for the design and production of tactile reading codes.

#### 3.1 Use of residual vision when reading tactile codes

Some readers of tactile codes may have remaining useful vision which could be employed when reading tactile codes. Indeed, anecdotal evidence suggests some children may use their residual vision to reinforce their learning of the Moon code **(McCall and McLinden, 2001)**.

However, evidence as to how useful residual vision may be in tactile reading is mixed. Some studies suggest that the visual guidance of hand movements when reading braille may offer spatial reference, and information from hand movements may aid generation of visual images of that which is being read **(Heller, 1993)**.

With regards to using vision to aid recognition of characters, **Millar (1997)** suggests that when using sight and touch to learn braille, sight - as the more "dominant" sense - will take over. This is demonstrated by **Millar (1971)** in that tactile information cues added nothing to visual recognition whereas visual information cues improved tactile recognition (note: this study was carried out with sighted children). It may simply be that when vision is available, people pay less attention to tactile cues, therefore Millar suggests if the aim is to learn to read by touch, vision is best excluded.

**Newman, Hall and Pullen (1992)** suggest the opposite. Participants who studied braille visually performed better on memory tests (both immediately and 48 hours later) than those who studied braille by touch. All were tested by touch. Whilst the authors suggest these findings support the use of vision (where possible) when learning braille, it is unclear how applicable this is in practice as the participants in this study were fully sighted. Furthermore, it is unclear whether visual study was with embossed braille or printed depictions of braille symbols, which is an important distinction in that people with low vision often have poor contrast sensitivity **(Rubin and Legge, 1989)**, and therefore are likely to struggle to see embossed codes on the page due to poor contrast.

##### 3.1.1 Colour contrast

Studies with readers with low vision suggest text should be printed with the highest possible contrast to improve legibility **(Russell-Minda, Jutai, Strong, Campbell, Gold, Pretty and Wilmot, 2006)**. High contrast combinations include black/dark text on a white/pale background (or vice versa).

These findings may suggest some benefit to producing tactile codes which can be easily seen visually, as well as read tactually. Examples of such production techniques include swell paper whereby black printed sections are raised to create the tactile image, or technology which embosses and prints onto the same document such as Viewplus technologies "Emprint spot dot" printer. As yet, no evidence has been located evaluating the effects of such methods on tactile reading using residual vision.

In considering contrast, thought must also be given to background colour. No studies have been found studying the paper colour of tactile codes. However, for print materials for low vision readers, combinations with high luminance contrast are recommended such as black/dark text on white/pale backgrounds, or the reverse (pale text on dark backgrounds) **(Legge, Parish, Luebker and Wurm, 1990)**.

Further investigation into the role of residual vision in reading tactile codes should consider the effects of both production methods and paper colours, to determine whether use can be made of residual vision when reading tactile codes.

#### 3.2 Scope of tactile reading codes

A benefit of the braille code is its versatility **(McCall and McLinden, 2001)**. Braille can be written in many different languages, and aside from literary notation, braille codes have been developed for notation of music, science and maths, as well as for leisure uses such as the braille chess code and notation of knitting patterns.

In considering alternative tactile codes, investigation should consider whether they have potential for such versatility, and whether such uses are required by users.

##### 3.2.1 Music

**Jackson (1987)** devised a system by which the Moon code could be used for musical notation, although no evidence of this in practice is reported. Others have similarly used Moon for musical notation **(Aldridge, 1989)** although again evidence for how useful this has been remains anecdotal. **Ockelford (1992)** suggests Moon music may be useful for people losing their sight later in life who wish to take up music as a hobby.

**Ockelford (1992)** also reports on other forms of tactile music notation, including raised versions of print music (deemed too complex for tactile discrimination) and tactile graphical scores (see appendix 2).

Whilst tactile music is likely to be hugely beneficial for some users, the audience for such a notation may be small. Although the braille music code is the most widely used tactile musical notation, according to **Ockelford (1992)** it is estimated less than 2% of braille readers make use of the code, representing a very small proportion of the blind and partially sighted population. This highlights a need to gather user requirements, to determine whether or not users of alternative tactile formats require it to have the capability to create musical notation.

##### 3.2.2 Maths

There is a basic mathematics code for Moon known as Staffsmaths **(McCall et al, 2007)**. Before this code was developed, Moon numbers were depicted by the first 10 letters of the Moon alphabet preceded by a number symbol. As this was thought to be complex for mathematics, unique symbols were developed for numbers along with basic mathematical operators (note: Staffsmaths is significantly less sophisticated than the braille maths code). Evidence for the use of Staffsmaths in practice is scarce.

##### 3.2.3 User requirements

User requirements for various technical notations are likely to depend on reading audience. For example, people losing their sight later in life may have less need for science or maths notation than a child in education. In gathering user requirements for alternative tactile codes, investigation should include requirements for the provision of technical notations.

Further consideration should be given to the symbols other than letters which may be required in a tactile code, such as punctuation marks and currency symbols. Requirements for such symbols may vary depending on the purpose for which users use the code. For example, punctuation will be required for books or magazines but may be of less use for labelling.

#### 3.3 Optimum design for tactile reading codes

Whilst it can be easy to suggest that existing tactile codes may not be "optimal" due to being designed for convenience or limited production methods, few guidelines exist regarding what is "optimal" in tactile reading.

However, some research regarding embossing tactile information onto cards (such as credit cards/payment cards) offers some useful suggestions regarding good design for tactile codes. **Gill and Devine-Wright (1999)** offer the following recommendations:

* Where symbols are adjacent to each other, a space of at least 2mm should be used between them to assist differentiation
* Symbols are more easily recognised when they have clearly defined central shapes, rather than peripheral features
* Symbols which are most easily distinguished incorporate straight lines and angles of more than 45° (preferably 90°)

These recommendations may be useful when considering alterations or improvements to existing tactile codes, and could act as guidelines in design of codes for maximum discriminability.

#### 3.4 The purpose of the code

Considering the purpose of a tactile reading code is important because it may have implications for design. For example, if a code is to be used for labelling only, characters may be produced much larger than if it was planned to be used for publishing of books. Furthermore, if users need to produce their own material using the code (for example, making their own labels, taking notes) provision must be made for a means by which individuals can produce the code (see section 3.6).

#### 3.5 Reading audience

A number of potential audiences for tactile reading codes other than braille were suggested earlier in this report. These included those losing their sight late in life, elderly people with poor tactile acuity, children with multiple disabilities and deaf-blind people.

Considering the potential audience is important in that the needs of different groups may not be the same. For example, older users may have poorer tactile acuity than children which may necessitate larger characters for this group. Furthermore, the experience of different groups may affect their needs - for example, there would be no benefit of "familiarity" of raised print to blind multiply disabled children who may never have experienced the print alphabet.

#### 3.6 Ability to write tactile codes

There are various purposes for which individuals may wish to write tactile codes, such as to produce labels, to take notes, and to communicate with others. This must be considered when designing tactile codes, in terms of the equipment and materials individuals would need to produce the code themselves. Such materials could include stickers featuring tactile characters which could be arranged to form words for labels, writing frames to guide the production of characters, character stencils, specialised paper and so on. Provision of writing materials should take user requirements into account, to ensure writing implements are user friendly and easy to master.

### 4. Recommendations for further research

In light of the evidence discussed in this report, it is proposed that the tactile codes on which to focus research activity are Moon and raised print. The following recommendations for further research are based on outstanding questions regarding these two codes, and the key issues mentioned previously which require exploration.

Note: There is other research activity being carried out by RNIB into the barriers to learning braille. This is closely related to this project, and indeed through understanding these barriers further work can focus on overcoming them to enable more people to become braille readers. Therefore whilst this report focuses on tactile codes alternative to braille, RNIB is also committed to improving braille literacy.

These recommendations form something of a "wish-list" for future research in this area.

#### 4.1 Qualitative study to gather user requirements for alternative tactile reading codes.

This may be a wide scale study involving participants from a range of backgrounds, ages, experience of sight loss etc. Also included may be professionals such as teachers of multiply disabled children with visual impairments, rehabilitation officers and carers.

* Ask non-braille readers whether they want/would use an alternative tactile reading code
* Study the demographics of those who do/don't want this to determine potential audiences
* Determine the size of the potential audience for an alternative tactile code
* Explore required purposes of an alternative code (e.g., do people want the ability to "read quietly", do they want a labelling system, a means for correspondence etc)
* Explore the type of required reading materials. Firstly, in terms of whether users want a code to enable reading of information such as bank statements or medical information, or whether they require longer leisure reading material such as books. Such study could involve reference groups such as sighted older people (whose reading needs are likely to be representative of older people who are losing their sight). Secondly, explore requirements for alternative notation such as maths, science and music
* Investigate the need for personal writing apparatus for tactile codes

#### 4.2 Comparison of tactile reading codes

This would need to be a carefully controlled study to systematically compare different codes on a variety of measures. Moon and raised print should be compared, both to each other and potentially to braille for reference. Other codes to include may be Fishburne and ELIA.

Measures on which to compare codes could include:

* subjective user preferences
* tactual discriminability (at a range of sizes?)
* ease of learning

#### 4.3 Further investigation of Moon

Investigation of the Moon code should include:

* Trials to determine which Moon characters are commonly confused. This could lead to development of potential replacement characters (taking into account evidence regarding optimum design of tactile codes) and further trials to test these alternatives
* Trials of dotty versus lined Moon to determine effects on reading performance, discriminability and user preference
* Size trials to determine at what size Moon can be read (with implications for production of longer reading materials)
* Investigation of potential means for individuals to write Moon

Note: trials could be carried out using samples of familiar materials to give users an impression of what it would be like to read items they are used to. Sample documents may include shopping lists, cooking instructions, bingo cards, crosswords/sudoku puzzles, personal correspondence, a sample letter from a doctor's surgery, TV guide, medical information and so on.

#### 4.4 Further investigation of raised print

Investigation of raised print should include:

* Trials of different formats of raised print (upper/lower case, different fonts etc) considering evidence regarding optimal design
* Size trials with a wide range of users to determine suitable sizes in which to produce raised print
* Trials of dotty versus lined raised print to determine effects on reading performance/discriminability and user preference

As described for Moon trials (see section 4.3), samples of raised print could include familiar documents to give users an impression of how they might use a tactile code.

#### 4.5 Investigation into the use of residual vision in tactile reading

Further study into the use of residual vision in tactile reading may include:

* Evaluation of the utility of producing materials which are both tactile and visual (such as swell paper, or materials which are embossed and printed) for readers with residual vision
* Evaluation of different background colours for such materials, and their effect on reading performance

#### 4.6 Other related research ideas

* Exploration of the psychological factors involved in making the transition from reading by sight to tactile reading (related to a wider question regarding the psychological factors of adjusting to sight loss, which is outside the scope of this study)
* Investigation into what other countries are doing with regard to alternative tactile reading codes

### 5. RNIB position

RNIB are continuing research in this area, starting with an international survey of tactile reading codes (**Cryer, Gunn, Home and Morley Wilkins, in press**).

RNIB is committed to literacy for children and adults and is exploring various routes to improve access to reading and widen literacy opportunities, particularly through the promotion of uncontracted braille.

Evaluation of these activities coupled with findings in this report will help us to determine if any further research or development is still required.

However, the potential areas for research outlined in this report may be of interest to other researchers or practitioners. We would be pleased to hear from you if you embark on any research in this area, however informal, to help build knowledge in this small field.

### References

Acott, W.A. (1961). Should Moon type be retained? *New Beacon, 45 (233),* 227 - 228.

Aldridge, V. (1989). Moon and music notation. *British Journal of Visual Impairment, 7 (1),* 30.

Alston, J. (1842). Statements on the education, employment and internal arrangements adopted at the asylum for the blind. Glasgow: Smith and Son. Reprint London: Sampson, Law, Marston and Co cited in Lorimer, P. (2000). Reading by touch: Trails, battles and discoveries. Baltimore, Maryland: National Federation of the Blind.

Armitage, T.R. (1870). On the modes of reading in use by the blind, and the means for arriving at uniformity. *Journal of the Society of Arts, 28,* 195 - 201.

Austin, T.R., and Sleight, R.B. (1952). Accuracy of tactual discrimination of letters, numerals, and geometric forms. *Journal of Experimental Psychology, 43 (3),* 239 - 247.

Bundock, S. (2002) *Moon Reader Survey*. Stockport: National Library for the Blind.

Chepaitis, A.J., Griffiths, A.F., Wyatt, H.J., and O'Connell, W.F. (2004). Evaluation of tactile fonts for use by a visually impaired elderly population. *Visual Impairment Research, 6 (2-3),* 111 - 134.

Chepaitis, E.V. (1996). ELIA™: A simpler tactile code for persons with visual impairments. *Journal of Visual Impairment and Blindness, 90 (3)*, 282 - 283.

Clunies-Ross, L. (2005). Windows of perception: a review of the literature on uncontracted and contracted literary braille. RNIB internal report.

Cryer, H., Gunn, D., Home, S., and Morley Wilkins, S. (in press). International survey of tactile reading codes. RNIB Centre for Accessible Information, Birmingham: Research Report #6.

ELIA Life Technologies (2007a). Principles behind the ELIA® Alphabet Design. http://www.elialife.com/history-princip.html accessed 15:17 GMT 03/03/2008.

ELIA Life Technologies (2007b) Frequently Asked Questions. http://www.elialife.com/faq.html accessed 09:08 GMT 04/03/2008.

Gall, J. (1837). An account of the recent discoveries which have been made for facilitating the education of the blind. Edinburgh: James Gall. Reprint 1894, London: Sampson, Law, Marston and Co cited in Lorimer, P. (2000). Reading by touch: Trails, battles and discoveries. Baltimore, Maryland: National Federation of the Blind.

Gill, J., and Devine-Wright, H. (1999). Selecting cards by touch. London: RNIB Scientific Research Unit available online http://www.tiresias.org/publications/reports/tdiff.htm accessed 16:28 GMT 05/03/2008.

Heller, M.A. (1986). Active and passive tactile braille recognition. *Bulletin of the psychonomic society, 24 (3),* 201 - 202.

Heller, M.A. (1993). Influence of visual guidance on braille recognition: low lighting also helps touch. *Perception and Psychophysics, 54 (5),* 675 - 681.

Heller, M.A., Nesbitt, K.D., Scrofano, D.K., and Daniel, D. (1990). Tactual recognition of embossed Morse code, letters and braille. *Bulletin of the Psychonomic Society, 28 (1),* 11 - 13.

Jackson, M. (1987). The Moon system adapted for musical notation. *British Journal of Visual Impairment, 5 (3),* 93 - 97.

Johnson, K.O., and Phillips, J.R. (1981). Tactile spatial resolution 1. Two-point discrimination, gap detection, grating resolution and letter recognition. *Journal of Neurophysiology, 46 (6),* 1177 - 1191.

Knight, C. (2000). Moon - is it meeting children's needs? *Eye Contact, 27,* 20 - 22.

Lambert, L.M., and Lederman, S.J. (1989). An evaluation of the legibility and meaningfulness of potential map symbols. *Journal of Visual Impairment and blindness, 83,* 397 - 403.

Legge, G.E., Parish, D.H., Luebker, A., and Wurm, L.H. (1990). Psychophysics of reading. XI. Comparing luminance and color contrast. *Journal of the Optical Society of America, A7,* 2002-2010.

Loomis, J.M. (1981). On the tangibility of letters and braille. *Perception and Psychophysics, 29 (1),* 37 - 46.

Loomis, J.M. (1985). Tactile recognition of raised characters: A parametric study. *Bulletin of the Psychonomic Society, 23 (1),* 18 - 20.

Lorimer, P. (2000). Reading by touch: trials, battles and discoveries. Baltimore, Maryland: National Federation of the Blind.

McCall, S., Douglas, G., and McLinden, M. (2007). An investigation into the potential of embossed 'dotted' Moon as a production method for children using Moon as a route to literacy. *British Journal of Visual Impairment, 25 (1),* 86 - 96.

McCall, S., and McLinden, M. (2001). Accessing the National Literacy Strategy: the use of Moon with children in the United Kingdom with a visual impairment and additional learning difficulties. *British Journal of Visual Impairment, 19 (1),* 7 - 16.

McCall, S., and McLinden, M. (2007). Teachers' perspectives on the use of the Moon code to develop literacy in children with visual impairments and additional disabilities. *Journal of Visual Impairment and Blindness, 101 (10),* 601 - 612.

McCall, S., and Stone, J. (1992). Literacy for blind children through Moon: a possibility? *British Journal of Visual Impairment, 10 (2),* 53 - 54.

Merry, R.V. (1937). Fingers for eyes. The story of raised print. *Scientific Monthly, 44,* 273 - 279.

Millar, S. (1971). Visual and haptic cue utilization by preschool children: the recognition of visual and haptic stimuli presented separately and together. *Journal of Experimental Child Psychology, 12 (1),* 88 - 94.

Millar, S. (1977). Tactual and name matching by blind children. *British Journal of Psychology, 68,* 377 - 387 cited in Millar, S. (1994). Understanding and representing space. Theory and evidence from studies with blind and sighted children. Oxford: Clarendon Press.

Millar, S. (1997). Reading by touch. London: Routledge

Mroczka, M.A. (2005). Effects of study modality and study order on learning braille and other haptic alphabets used by blind persons. Unpublished doctoral dissertation, North Carolina State University, Raleigh, NC.

Newman, S.E. (1992). Children's learning of two alphabets learned by the blind: braille and Fishburne. *British Journal of Visual Impairment, 10 (1),* 21 - 23.

Newman, S.E., Hall, A.D., and Pullen, S.M. (1992). Remembering the names for visually and haptically examined braille symbols. *British Journal of Visual Impairment, 10 (3),* 101 - 103.

Newman, S.E., Kindsvater, M.B., and Hall, A.D. (1985). Braille learning: Effects of symbol size. *Bulletin of the Psychonomic Society, 23 (3),* 189 - 190.

Ockelford, A. (1992). Music notation for people with a severe visual impairment. London: RNIB. Available online http://www.rnib.org.uk/xpedio/groups/public/documents/visugate/public\_musnotsev.hcsp accessed 13:10 GMT 28/03/2008.

Pester, E.J., Petrosko, J.M., and Poppe, K.J. (1994). Optimum size and spacing for introducing blind adults to the braille code. *Re:view*, *26 (1),* 15-22.

Phillips, J.R., Johnson, K.O., and Browne, H.M. (1983). A comparison of visual and two modes of tactual letter resolution. *Perception and Psychophysics, 34 (3),* 243 - 249.

Rainey, F. (1893). Roman Letter. Paper for the World's Congress of Educators of the Blind, Chicago 1893. Available online

http://www.rnib.org.uk/xpedio/groups/public/documents/visugate/public\_romanlet.hcsp accessed 11:51 GMT 04/03/2008.

RNIB (2008). Accessing Information. Formats and ways of communicating. http://www.rnib.org.uk/xpedio/groups/public/documents/PublicWebsite/public\_method.hcsp accessed 13:43 GMT 06/03/2008.

Rubin, G.S. and Legge, G.E. (1989). Psychophysics of reading. VI. The role of contrast in low vision. *Vision Research, 29,* 79-91.

Russell-Minda, E., Jutai, J., Strong, G., Campbell, K., Gold, D., Pretty, L., and Wilmot, L. (2006). Clear Print. An evidence-based review of the research on typeface legibility for readers with low vision. Toronto: Canadian National Institute for the Blind

Available online

http://cnib.ca/en/services/accessibility/text/clearprint/Clear%20Print%20Executive%20Summary.doc accessed 16/11/2007 at 15:16 GMT.

Shafrath, M.R. (1986). An alternative to braille labelling. *Journal of Visual Impairment and Blindness, 80 (9),* 55 - 56.

Steer, M. (2000). Moon code: a valuable supplement to your communications arsenal. *Deaf-blind perspectives, 7 (3),* 8 - 10.

Stevens, J.C., Foulke, E., and Patterson, M.Q. (1996). Tactile acuity, aging and braille reading in long term blindness. *Journal of Experimental Psychology, 2 (2),* 91 - 106.

Thurlow, W.R. (1986). Some comparisons of characteristics of alphabetic codes for the deaf-blind. *Human Factors, 28 (2),* 175 - 186.

Tobin, M.J., Burton, P., Davies, B.T., and Guggenheim, J. (1986). An experimental investigation of the effects of cell size and spacing in braille: with some possible implications for the newly-blind adult learner. *New Beacon, LXX, 829,* 1333 - 135.

Tobin, M.J., and Hill, E.W. (1989). Harnessing the community: Moon script, the Moon-Writer and sighted volunteers. *British Journal of Visual Impairment, 7 (1),* 3 - 5.

Tuttle, D.W. (1984). Self-esteem and adjusting with blindness. The process of responding to life's demands. Springfield, Illinois: Charles C Thomas.

### Appendix 1 The Moon alphabet

Description:

The Moon code is made up of simplified letters based on the print alphabet. Some Moon characters are the same as print capital letters (C, I, J, L, O, V).

Some Moon characters use the same symbols which are rotated to represent different letters. For example, rotating the V symbol clockwise by 90 degrees at a time, produces the symbols K, A and X. In the same way, the letter L is rotated to form E, M, and Y; the letter C is rotated to form W, D and U, and a vertical line representing the letter I is rotated by 45 degrees to form S, T and R.

Other symbols include a straight line with a curved end (rotations of which form the letters B, F, G, J, P, Q), a circle (in two sizes, forming letters O and H) and a shape like the letter N, which rotated also forms Z.

### Appendix 2 - Tactile graphical music score

Description:

The tactile graphical score is based on printed graphical scores which use symbols. In this graphical score, time is represented by horizontal bands. Pitch is represented vertically - with notes appearing near the top of the page being higher in pitch. The intensity of the note is represented by the size of the symbol - demonstrated by small circles for quieter notes and large circles for more intense sounds. Different sounds are represented with different symbols - distinct notes being circles and continuous sounds as curved lines.

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