# RNIB Centre for Accessible Information (CAI)

# Literature review #4.1

# Final report: Feasibility of developing a diagnostic touch test to determine braille reading potential

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# Interim report: Feasibility of developing a diagnostic touch test to determine braille reading potential

**RNIB Centre for Accessible Information (CAI)**

Prepared by: Heather Cryer (Research Officer, CAI)

21 July 2011

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### Executive summary

There are various barriers to learning braille for people with acquired sight loss. A key barrier is the belief that old age and disease such as diabetes and the perception of accompanying reduction in tactile sensitivity may prevent success in learning braille. Various research has investigated this issue, showing some relationship between touch sensitivity, however, various findings show that declining sensitivity does not prevent people from reading braille. Further research investigates differences in tactual sensitivity between blind and sighted people, showing blind people to have superior sense of touch. This may be due to practice (using their sense of touch more) and possible changes in brain functionality to process different types of information. The fact that poor touch doesn't necessarily prevent success with braille, and that touch sensitivity can be improved with practice suggests potential for a tool to test and train touch in order to encourage braille learning. A brief review of existing methods used to test touch is given, including tests specifically aimed at blind/partially sighted people for the development of 'pre-braille' skills. Further work should investigate the potential of using pre-braille training materials to give people the opportunity to try out their sense of touch before trying to learn braille. Materials from existing braille courses could be adapted and made available separately, for use in this way by individuals or rehabilitation workers.

### Introduction

Many people with acquired sight loss choose not to learn braille, for various reasons. One important reason is that many older adults feel they do not have sufficient sense of touch to be able to discriminate braille dots. In order to understand whether tactile perception could be measured and even trained, this paper investigates the relationship between touch and braille reading, and considers ways of measuring and developing tactile perception.

### 1. Barriers to learning braille for adults with acquired sight loss

Despite the many benefits of braille, only a small percentage of blind or partially sighted people read this tactile format, around 5% of those registered blind or partially sighted in the UK (**Douglas, Corcoran and Pavey, 2006**). Although braille is often thought of as something for "blind" people, braille is also read by people who are partially sighted, as people in this group may also struggle to read printed material. **Douglas et al (2006)** found that 3% of those registered partially sighted read braille.

Research suggests that frequency of braille use declines with age, and that the later in life someone loses their sight, the less likely they are to engage in learning braille (**Goudiras, Papadopoulos, Koutsoklenis, Papageorgiou and Stergiou (2009)**. Many people lose their sight due to age related diseases (**Orr, 1992**) and it is important to understand the possible barriers to learning braille for this group.

Firstly, people losing their sight may feel a stigma attached to braille. Braille is strongly associated with blindness, which may prevent those who are still coming to terms with sight loss from taking an interest (**Erin and Sumranveth, 1995;** **Schroder, 1996**) and may relate to negative stereotypes of blindness (**Wells-Jensen, 2003**).

Secondly, many people believe that the braille code is difficult to learn. This includes widely held beliefs by people unfamiliar with braille that the code is very complex (**Wells-Jensen, 2003**) with specific concerns about the complexity of contracted braille. For example, **Greaney and Reason (2000)** highlight the complexity of having contractions which differ in meaning depending on context, requiring good memory on the part of the reader (see also **Clunies-Ross (2005**) for a review of research on the subject of contracted and uncontracted braille).

It is not only potential learners who are put off by the complexity of learning braille, but also braille teachers. A number of studies have identified teacher attitudes to be an issue in braille take-up, both due to teachers' own opinions about the complexity of the braille code (**Stone, 1988; Ponchillia and Durant, 1995**) and due to deficiencies in training and resources (**Rex, 1989**).

The availability of braille teaching services may be another barrier to braille learning, an issue that has been debated for many years. **Pester (1993)** highlighted the need for more frequent braille instruction, and more encouragement for braille learners. **Franks (1998)** emphasised the importance of clear information about the benefits of braille, and well trained teachers to increase uptake and dispel negative rumours about the braille code. More recent research (**Douglas, Franks, Weston and Clements, 2009**) highlights the variation in availability of services across the UK and the lack of consensus among professionals about the purpose and benefits of braille.

**Douglas et al (2009)** also investigated the views of adults with acquired sight loss, and found that availability and promotion of braille teaching were a key concern which may put people off learning braille. Other perceived barriers to braille uptake included the development of technology (due to the feeling that technological solutions could offer more than braille) and age. Age was a barrier in various ways. Some older people simply felt they were too old to learn something new (and for some, this view had been suggested to them!). Others felt that the reduction in sensitivity of the fingertips with age meant reading braille would not be possible for them (though it must also be noted, that some readers were keen to learn braille *because* it was a challenge).

### 2. Age, disease and tactile sensitivity

The reduction in tactile sensitivity with age is a well documented phenomenon (**Stevens, Foulke and Patterson, 1996; Legge, Madison, Vaughn, Cheong and Miller, 2008)**. This could be a key barrier to braille learning in adventitiously blind adults. Many people lose their sight due to age related conditions (**Orr, 1992**) with around 75% of those registered blind or partially sighted being over the age of 65 (**The Health and Social Care Information Centre, 2008**). Many older people are aware of the decline in functioning with age, and evidence suggests that some may choose not to learn braille simply because they *believe* they have insufficient tactile sensitivity (**Douglas et al, 2009**).

Tactile acuity may also be reduced through disease. Diabetic retinopathy is one of the five leading causes of sight loss in the UK (**Future Sight Loss UK, 2009**), and diabetes also causes nerve damage which can affect the sensitivity of the fingers (**Harley, Pichert and Morrison, 1985**). As with age-related decline, evidence suggests that some people may reject the use of braille in the belief that their diabetes holds them back (**Bernbaum, Albert and McGarry, 1989**).

Evidence suggests that tactile sensitivity can be reduced through both ageing and disease. But how does this affect braille reading ability? And how does this fit into the broader relationship between blindness and touch?

### 3.Tactile sensitivity and braille reading

#### 3.1 Diabetes and braille reading

Various research considers the effects of diabetic neuropathy on braille reading ability. **Nakada and Dellon (1989)** studied the relationship between two point discrimination threshold and ability to read braille. The two point discrimination threshold measures how far apart two points need to be for someone to perceive the two points separately rather than feeling it as one point (see section 4.1.1 for more on the two point discrimination test). They found a correlation between two-point discrimination and braille reading ability, with participants with a static two-point discrimination threshold of 5mm or above, or a moving two-point threshold of 4mm or above being unable to read braille. These findings are supported by **Bernbaum et al (1989)** who also found that those with two-point discrimination thresholds above 5mm had difficulties with braille. However, in this study, 22 out of 35 participants - all with diabetic neuropathy - were successful in learning standard sized braille. Based on these findings, **Bernbaum et al (1989)** suggest that diabetics should not be discouraged from learning braille. This view is shared by **Harley et al (1985)** who successfully trained a number of diabetics in braille. Indeed, **Harley, Pichert and Morrison (1986)** highlight the importance of motivation and practice in braille learning, as well as the potential of modified braille materials (such as jumbo braille, in which the spacing of the cell is enlarged to improve discrimination of the dots).

#### 3.2 Age and braille reading

**Stevens et al (1996)** studied the relationships between age, tactile acuity and braille reading. Findings showed that tactile acuity reduced with age, for all participants (blind and sighted, aged 18-81) at a similar rate of around 1% per year (note: of the blind participants, around half were totally blind, the rest had light perception but could not read print). A relationship was also found between tactile acuity and braille reading speed, suggesting that as tactile acuity declines, braille reading speed may also reduce.

These findings appear to make logical sense: as you age, you lose your tactile acuity, and losing tactile acuity reduces the ability to read braille. However, it should then follow that all aging braille readers would eventually lose their ability to discriminate braille dots; but this is not the case. **Legge et al (2008)** aimed to unravel this conundrum, by studying tactile acuity of blind and sighted subjects across age groups.

The findings of **Legge et al (2008)** again demonstrated a general decline in tactile acuity with age. However, whilst this was true for the sighted participants, existing braille readers tested showed no such decline. These findings are at odds with previous studies (such as **Stevens et al, 1996**) where tactile acuity was found to decline in blind participants as well. **Legge et al (2008)** suggest that the reason for the difference is the method used to test tactile acuity. Whilst many studies test tactile acuity with "passive" measures (stimuli being pressed against the fingertip), Legge et al used an "active" measure in which participants could explore the stimuli by moving their fingertip. **Legge et al (2008)** suggest two possible reasons why this might make such a difference. Firstly, braille readers may learn effective motor strategies to pick up detailed tactile information and could go back over portions they were unsure of. Secondly, as they are free to move their finger, they could make the most of the more sensitive areas of their fingerpad even if their tactile sensitivity was in decline (see section 4 for more information about active and passive touch).

#### 3.3 Differences in tactile sensitivity between blind and sighted people

Research has shown differences between blind and sighted people in terms of their tactile sensitivity. This was demonstrated by **Stevens et al (1996)** who found that whilst tactile sensitivity reduced with age in both blind and sighted participants, sensitivity was greater in blind participants at all ages. This finding is not completely clear cut, as all the participants in the study were braille readers. This means it is difficult to know whether good tactile sensitivity makes it easier for blind people to read braille, or whether blind people develop good tactile sensitivity because they use their sense of touch more.

One way in which reading braille could affect tactile sensitivity is through a process called neuroplasticity. This term refers to the ability of the brain to change as a result of experience. Scientists use various methods to study brain activity, and can pinpoint which areas of the brain are active in different tasks. Certain parts of the cortex (the outer layer of the brain) are known to be active in processing information from each of the senses, with the somatosensory cortex dealing with touch. The whole body is represented on the somatosensory cortex with different areas responding to touch from different parts of the body. Body parts with high sensory discrimination (such as lips and fingertips) have larger areas of cortex devoted to them to process the fine detailed sensations. Research has shown that intense stimulation of a particular body part can increase its cortical representation. That is to say, the amount of "brain space" devoted to dealing with the fingertips may increase when used regularly for reading braille. This may explain why braille readers' tactile sensitivity is superior to that of non-braille readers.

"Cross modal plasticity" occurs when part of the brain dedicated to a particular function is 'recruited' to perform a different function. For example, in blindness, if visual areas of the brain receive no visual stimulation they can be used instead to process tactual information. This could mean that in blind people the lack of visual input could itself contribute to greater tactile sensitivity (**Goldreich and Kanics, 2003**).

So what does this mean? The findings showing the extent of the decline in tactile acuity due to age in sighted individuals could suggest that those who lose their sight later in life may have reduced tactile sensitivity which could affect their ability to learn braille (**Legge et al, 2008**). However, findings with diabetics (**Harley et al, 1985; Bernbaum et al 1989**) show that poor tactile acuity does not necessarily preclude learning braille. Therefore, it may be beneficial to develop a test to determine whether someone has sufficient tactile sensitivity to read braille. Furthermore, the findings that braille readers maintain high levels of acuity, ultimately due to practice, suggests there may be scope for training to improve tactile acuity. This could be done through a package of training materials to stimulate tactile sensitivity.

### 4. Existing methods used to test touch

There are a variety of existing methods for testing tactile discrimination. These are commonly used to test functioning in people who have had hand surgery, or experienced nerve damage in their fingers.

There are two broad categories of touch - active and passive. Active touch refers to exploratory touch whereas passive touch refers to the sensations when a stimulus is applied to the skin (**Foulke, 1991**). Tests of passive touch are often used as measures of tactile perception, as such tests measure the physical limits of perception allowing thresholds to be determined. However, there is some controversy over whether measures of passive touch are relevant to braille reading ability, as braille is read with active touch (with users moving their finger to explore the braille dots).

**Goldreich et al (2003)** identified potential problems with both types of testing: tests of active touch could be confounded by the motor strategies people use in exploring the stimulus, whereas passive tests could be confounded by variables such as the force with which stimuli are pressed onto the skin. A review of commonly used tests of active and passive touch tests follows.

#### 4.1 Common touch tests

##### 4.1.1 Two point discrimination threshold (2PD)

The two point discrimination threshold is a widely used test of passive tactile acuity. Also known as the 'compass test', it involves applying two points to the skin at different separations, with the person being tested reporting whether they can feel one or two points.

Benefits of the test are that it does not require complex equipment and can be easily administered (**Lundborg and Rosén, 2004**). However, there are also many criticisms.

Firstly, though widely used, there is no standardised procedure for administering the test (**Lundborg et al, 2004**). This means that there is much scope for confounding variables, so results may not be comparable across different testing situations. Examples of such variables include the pressure applied, the order of presentation (e.g. whether to start with widest or smallest separations) and the number of presentations.

Also related to procedure is whether the test is run as a subjective or objective test. **Craig and Johnson (2000)** identify the difference between these two procedures. In the subjective procedure, every presentation consists of two points, with the subject being asked to report their perception of either one or two points. This is subjective in that it is measuring their perception. In the objective procedure, some trials present only one point and others two (at varying separations) and subjects must report which they felt. This is objective in that there is a right and a wrong answer. Despite the evident advantage of the objective method, **Craig et al (2000)** have further criticisms of this, specifically that it is unreliable as people use other cues to make their judgement (such as intensity) therefore it is not a true measure of spatial resolution. This view is supported by **Lundborg et al (2004)**.

Another criticism of the 2PD test is that it ultimately measures passive touch (i.e., being touched) (**Lundborg et al 2004**). For this reason it is not useful as a measure of someone's ability to read braille, which is an active, exploratory process.

Due to the many problems with the 2PD, **Craig et al (2000)** suggest alternative measures which may be better suited to measuring tactile acuity. These are gap detection and grating orientation.

##### 4.1.2 Gap detection

Gap detection is measured by pressing a stimulus against the finger. The stimulus has either a solid edge, or an edge with a gap in it. The gap varies in size, and it is expected that the smaller the gap, the less likely the subject will be able to perceive it. **Craig et al (2000)** suggest this is a good test because it is low-tech and easy to administer, and is also an objective measure of perception. However, this too is a measure of passive touch.

A similar method has been used to measure active touch perception. **Legge et al (2008)** measured tactile perception in blind and sighted participants using a tactile version of the Landolt C test. In this test, C shaped rings are presented at a range of sizes in 4 different orientations, and subjects must identify the location of the gap. The Landolt C test is commonly used in vision testing, and this tactile version aims to similarly identify the threshold of perception, but in touch. **Legge et al (2008)** were interested in the relationship between tactile acuity and braille reading, therefore they allowed subjects to actively explore the testing materials (as they would braille text). This was found to be a successful measure of tactile acuity (although **Legge et al (2008)** found no relationship between acuity and braille reading speed.)

##### 4.1.3 Grating orientation task

Another widely used test of passive tactile acuity is the grating orientation task. A series of stimuli are used, which consist of alternating grooves and ridges oriented either vertically or horizontally. Participants must indicate the orientation of the lines. The width of the grooves and ridges is varied, giving a threshold measure of the spacing at which participants can discriminate the correct orientation (see **Legge et al, 2008**).

Presentation is controlled so that pairs of stimuli differ only in orientation (**Goldreich et al, 2003**) meaning the measure is free from extraneous variables. This means grating orientation offers a reliable, quantitative measure of spatial acuity (**Van Boven, Hamilton, Kauffman, Keenan, and Pascual-Leone, 2000**). Another benefit is that the task is easy to administer (**Craig et al, 2000**).

#### 4.2 Testing touch in blind and partially sighted people

Over the years, a number of people have looked at developing ways to test touch in blind and partially sighted people. Many of these tests have been particularly aimed at blind or partially sighted children, to test either their tactile skills, or to test cognitive/perceptual abilities through touch. Whilst not directly relevant to the idea of measuring the limits of tactile perception, these tests are informative in terms of the types of activities they involve and the theory behind them.

##### 4.2.1 The haptic test battery

**Ballesteros, Bardisa, Millar and Reales (2005)** developed 'The haptic test battery', which is a psychometric test aiming to measure the perceptual and cognitive abilities of blind or partially sighted children through touch. The battery includes measures relating to active touch, including tracing lines, locating points, and scanning dot displays. Whilst this test is ultimately aimed at measuring underlying cognitive skills (such as memory and comprehension), these tests offer good examples of how to measure relevant tactile skills.

##### 4.2.2 The Tactual Profile

**Withagen, Vervloed, Janssen, Knoors, and Verhoeven (2009)** developed the tactual profile, which aims to measure tactile skills in blind or partially sighted children age 0-16. The tactual profile is graded according to age and made up of three sections – tactual sensory, tactual motor and tactual perceptual. Tactual sensory broadly covers passive touch, including tactual awareness and touch sensitivity. Tactual motor covers active touch, including exploration and manipulation. Finally, tactual perceptual covers the interpretation of tactual information, including recognition and perception of detail.

Again, this test is specifically aimed at measuring a range of tactual skills, with the purpose of identifying needs for further training (**Withagen et al, 2009**). However, some of the tests show examples relevant to measuring touch. These include tests of touch sensitivity using braille cells, and tests of discrimination in identifying deviations in raised line drawings (**Withagen, Vervloed, Janssen, Knoors and Verhoeven, 2010**).

##### 4.2.3 Braille dot chart

**Legge et al (2008)** developed a touch test which has been used experimentally with adults. The researchers wanted to develop a testing mechanism for tactile acuity similar to the Snellan chart used in vision testing, which aims to identify the threshold of perception (the Snellan chart consists of rows of letters at different sizes to identify the smallest type someone can read). Legge et al trialled a chart based on braille characters at different spacings. Braille dots were kept the same size throughout, which limited how small spacing could go, as the dots started to overlap. This meant that when used in testing, many participants could identify all the test materials, suggesting that the test was insufficiently challenging to identify the limits of their tactile acuity. This experiment suggests that using braille characters to measure tactile acuity is complex and the chart designed by Legge et al is unlikely to be a useful measure of tactile acuity thresholds.

##### 4.2.4 Touch it!

The Royal New Zealand Foundation of the Blind (RNZFB) have recently developed a new teaching programme specifically aimed at adults learning braille in later life. The Simply Touch and Read (STAR) programme includes various materials to help new braille readers, including 'Touch It!' (a basic tactual assessment tool) and 'A Touching Experience' (a tactual development tool – see 5.3 for further information). 'Touch It!' involves a series of tactile shapes, moving onto lines of dots, followed by braille characters. It aims to give an indication of someone's tactual ability, to help decide whether they are ready to learn braille (**R. Smith, personal communication, August 24 2010**).

###### 4.2.4.1 Review of Touch It! Materials

In order to determine whether RNZFB's Touch It! materials might be suitable for use in the UK as a test of potential for braille learning, a review was carried out by an experienced braille teacher. Key findings were as follows:

Positives of Touch It!

* The book contains exercises to test a variety of relevant tactile skills including shape identification, tracking, identifying space and identifying simple braille letters
* The short length of the book makes the resource affordable (therefore more likely to be used) and is not too daunting for potential users

Negatives of Touch It!

* The resources are produced on thermoform, which is a material rarely used in the UK. This is quite different from paper normally used for braille materials and therefore testing touch sensitivity with this material may not give a true indication of how potential readers might get on feeling braille dots on paper
* These resources were designed to be used with support from a braille instructor or similar. For this reason, instructions on completing the exercises are not included. This means the resources would not be suitable for users to try out for themselves as they wouldn't know what they were supposed to be doing.

#### 4.3 Summary

Touch tests designed for general use offer insight into thresholds for tactile perception. However, as most of these tests measure passive touch they are unlikely to be ideal for measuring potential to read braille dots (a process using active touch).

Touch tests designed for blind people are informative of activities to test tactile abilities, and often more relevant, testing active touch and skills which relate to reading braille (such as tracking). Of particular interest is the Touch It! resource from New Zealand which aims to measure potential for reading braille. This resource demonstrates some of the key activities which could test potential for braille learning, although some practical considerations mean this resource would not be suitable to adopt 'as is' in the UK.

### 5. Existing methods used to train touch

As discussed in section 3.3, it is likely that tactile discrimination can be improved through practice. Indeed, many braille courses include sections on 'pre-braille skills' which aim to train users in tactile skills to help prepare them for learning braille.

**Mangold (1978)** demonstrated the benefits of such training, by showing that those who were taught using the 'Mangold developmental program of tactile perception and braille letter recognition' made fewer errors than those taught without the program. The types of skills taught in such programs are listed by **Lamb (1996)** and include tracking skills, using a light touch, fluent hand movements, using as many fingers as possible, using both hands and being able to sweep from one line of braille to the next.

This type of activity has been used particularly with young children learning to read through braille. Authors have acknowledged that there is a gap between blind and sighted children in their experiences of literacy prior to learning to read, as sighted children are exposed to a lot of incidental learning, such as seeing adults read books and so on. **Arnold (2004)** suggests there is need for deliberate provision of 'pre-literacy' activities to get blind children used to the experience of literacy.

Development of tactual skills is also relevant to adults learning braille. **Heikkilä (1990)** reported adapting Mangold's developmental program for use with adults with acquired sight loss. **Erin et al (1995)** highlight the importance of tactual development for adventitiously blind learners who must make the shift from vision to touch as their means of accessing information. Many braille courses aimed at adults include pre-braille sections, to develop such skills. A few examples of resources for training touch follow.

#### 5.1 Feeling ready to read

'Feeling ready to read' (**RNIB, 2002)** is a pre-braille scheme for children aimed at introducing tactile skills to help children prepare for becoming touch readers. The pack is based around the story of Snow White and the seven dwarves and includes tactile images related to the story. It also includes a range of activity books which aim to develop different tactile skills. These include: tracking exercises, using both hands and backtracking, texture and shape discrimination, rotation and reflection, recognising the odd one out, exploring the whole page, and using a light touch. The books use a mixture of swell paper images and braille dots, to get children used to the feeling of small dots. These types of activities may be useful to anybody starting to read by touch.

#### 5.2 Dot-to-dot

RNIB's newest braille course – Dot-to-dot (**RNIB, 2009**) – is a self teach course for learning uncontracted braille. The course starts with a pre-braille section, aimed at developing the sense of touch and encouraging good techniques in learners.

The workbooks are accompanied by instructions which can be accessed as audio or as an electronic document. These instructions give guidance and explain the exercises.

The pre-braille exercises get gradually harder, introducing a skill and developing it. The skills included are: tracking, identifying spaces, identifying the odd one out, using two hands and backtracking. The instructions also give helpful advice on how to place the hands on the page, what pressure to apply and how to move the hands.

This section of the course aims to develop the tactile sensitivity of learners. The instructions give encouragement that sensitivity will improve with practice, encouraging readers to keep trying and build up their skills. This gives learners the chance to overcome issues relating to sensitivity before starting to learn braille characters.

#### 5.3 A touching experience

'A Touching Experience' is part of RNZFB's Simply Touch and Read (STAR) programme and is a tactual development tool which aims to develop tactual skills through practice. It is designed to be used as an introduction to braille learning, to encourage tactual exploration and help the learner become familiar with using their sense of touch.

The resources are intended to be used by an instructor supporting a learner, who would choose appropriate tasks depending on the learner's progress.

'A Touching Experience' follows a similar pattern to the 'Touch It!' tactual assessment tool (see 4.2.4). This includes shapes made up of dots, lines and braille characters, and includes activities such as tracking lines and spotting the odd one out in a row of characters.

#### 5.4 Summary

Overall, the need for training in pre braille skills is well known, and many braille courses include such activities to develop tactual perception in braille learners. These activities may also be of use to people who have lost their sight before they make the commitment to learn braille, by making the activities available separately from braille courses. This could be used simply as an activity to introduce the idea of using touch, but also as an encouragement to show people that tactile perception can improve with practice. Such experience could persuade more people to learn braille.

### 6. Other issues to consider

Reading by touch is different to reading by sight in various ways. Reading braille is slower than reading print (**Simón and Heurtas, 1998; Wetzel and Knowlton, 2000**). Part of the reason for this is thought to be the sequential nature of braille reading, that each character must be perceived one by one (unlike reading print where readers can scan).

**Wetzel and Knowlton (2006)** raise concerns around memory in braille reading. The capacity of working memory is thought to be around 7 items (or 'bits'), which could have implications for braille readers sequentially decoding text and trying to understand it. **Knowlton and Wetzel (1996)** also highlight the possibility that the slow rate at which information is perceived in braille could make it difficult to integrate information into memory.

Some research suggests that the sequential nature of braille reading affects the way in which information is perceived. **Nolan (1966)** found that the time taken for word recognition in braille is related to the number of characters in the word, but that word recognition time is longer than the sum of letter recognition times. These findings led Nolan to conclude that braille readers perceive each letter individually, and then integrate this information to form a word. This process can be helped through context or experience (e.g. longer words are more likely to be recognised part way through). Nolan concludes that reading braille is a complex cognitive process, and that a certain level of intelligence is required to succeed at it.

Whilst many agree that braille is a complex cognitive process, some disagree with Nolan's conclusions about how braille is perceived. **Simón et al (1998)** found that braille reading rates were reduced by fragmenting the display (displaying smaller amounts of text at a time). These findings suggest that in normal reading, braille readers do make use of context and other cues and integrate information as they go, rather than perceiving one braille cell at a time.

Regardless of the controversy about how braille is perceived, there are a number of aspects of braille reading which clearly demonstrate its complexity. Examples given by **Greaney et al (2000)** include some contractions taking up more than one cell, and having different meanings in different contexts.

The findings around the cognitive complexity of braille highlight a need for caution in testing or training touch to encourage people to learn braille. Whilst poor touch is often cited as a reason for not learning braille, this may not be the only thing that holds people back. It is important not to raise people's hopes of success with braille on the basis of sufficient sensitivity if they may not have the cognitive capacity to learn the code. This is an area which requires further investigation to determine whether there is a simple way to test the cognitive skills required for braille readers.

### 7. Conclusions

Poor tactile sensitivity is a much cited reason why people with acquired sight loss choose not to learn braille. However, research shows that poor touch doesn't necessarily rule out the ability to learn braille. Furthermore, there is evidence that tactile sensitivity can be improved with practice.

There are a variety of tests of tactile perception currently in use. Many focus particularly on passive touch (sensation) which may not be relevant to braille reading (which is exploratory, using active touch). Those designed specifically for use with blind and partially sighted people offer insight into relevant test activities. Of particular interest is the Touch It! test designed by RNZFB which is specifically designed to measure whether people have sufficient tactile acuity to be potential braille readers. This resource demonstrates relevant tasks for testing touch sensitivity which could indicate potential for braille learning. Whilst this resource is not currently suitable for use in the UK (due to the material used and lack of instructions for individual use), the resource demonstrates the potential of using simple tactual tasks as an indication of the future potential for learning braille.

Training tactile sensitivity to help braille reading is a common practice, and there are many good examples of how this can be achieved. Using such activities with those reluctant to learn braille may encourage them and dispel myths about being unable to learn braille. Indeed, it could be argued that a touch test is not necessarily needed but rather by measure of success with tactile training, decisions could be made around whether or not someone is likely to succeed with braille.

Such a tool could be easily adapted from existing pre-braille training materials (such as those used in the Dot-to-dot course). This could be used in two possible ways. Firstly, it could be made available to individuals who wished to 'try out' their sense of touch prior to investing in a braille course or committing to learn braille. Secondly, it could be used by rehabilitation workers to use with clients to make informed decisions about an individual's potential for braille learning.

It must be noted that poor sense of touch may not be the only reason for not learning braille, and the cognitive load of learning the code may be too much for some people. For this reason, care must be taken not to get people's hopes up about braille reading potential.

### Recommendations

Recommendations for the next steps of this project are as follows:

* Investigate the potential for pre-braille skills activities to be made available other than as part of a braille course. (for example, the pre-braille section of the Dot-to-dot course)
* Investigate the potential for these tactile training activities to be used as a measure of braille reading potential
* Trial pre-braille activities to determine the effect they have on improving touch in people who feel their tactile sensitivity holds them back from learning braille
* Conduct further investigation into the cognitive aspects of braille reading and potential for measuring whether people have the cognitive capacity to learn braille

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