On the Compatibility of the Braille Code and Universal Grammar

Von der Philosophisch-Historischen Fakultät der Universität Stuttgart zur Erlangung der Würde eines Doktors der Philosophie (Dr. phil.) genehmigte Abhandlung

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Data	Perhaps. Perhaps not.
Captain Picard	This is hardly a scientific observation, Commander.
Data	Captain, the most elementary and valuable statement in science, the beginning of wisdom is *I do not know*.

Star Trek: The Next Generation *Where Silence has Lease*

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Contents

List of Abbreviations

σ	syllable
0-cgs	zero realisation of composite groupsign
0-cws	zero realisation of composite wordsign
0-lgs	zero realisation of lower groupsign
0-lws	zero realisation of lower wordsign
0-sf	zero realisation of shortform
0-ugs	zero realisation of upper groupsign
0-uws	zero realisation of upper wordsign
BAUK	Braille Authority of the United Kingdom
C	consonant
CC	use of contraction compatible with orthographic word segmentation
cgs	composite groupsign
Co	coda
cws	composite wordsign
f-cgs	wrong use of composite groupsign
f-cws	wrong use of composite wordsign
f-lgs	wrong use of lower groupsign
f-lws	wrong use of lower wordsign
f-sf	wrong use of shortform
f-ugs	wrong use of upper groupsign
f-uws	wrong use of upper wordsign
IC	use of contraction incompatible with orthographic word segmentation
lgs	lower groupsign
lws	lower wordsign
N	nucleus
O	onset
R	rhyme
RNIB	Royal National Institute of the Blind
sf	shortform
UG	Universal Grammar
ugs	upper groupsign
uws	upper wordsign
V	vowel

1 Introduction

Learning to spell is no simple task in English. Mastering the English writing system requires recognising letter-sound correspondences such as linking spoken /bʌs/ to written <bus> and recognising arbitrary letter combinations, e.g. <ck> as a spelling for a syllable coda as in *back*, but not as a spelling at a syllable onset as in *ckab to name but a few. Many conventional spellings of high frequency words are assumed to be memorised.

In contrast to writing and spelling, children are not taught their native language, parents rather talk to their children. As a consequence, children acquire their first language long before they are in a position to understand the relevant instruction even if the parents could provide it (Smith 1999). They acquire information about the grammar and of phonological, morphological, syntactic and semantic properties of the lexical items of the target language. One such set of information is illustrated by *blackbird* in (1). (1a) shows the phonological information, the pronunciation of *blackbird*. The morphological information acquired is that *blackbird* is a compound consisting of the adjective *black* and the noun *bird*, (1b). Syntactic information acquired is that *blackbird* is a count noun, (1c). Finally, (1d) shows some semantic information, *blackbird* is e.g. a living, winged biped.

(1) *blackbird*
a. /ˈblækbɜːd/
b. compound: $\text{black}_{\text{Adj}}$ + $\text{bird}_{\text{Noun}}$
c. count noun
d. + animate
winged biped

In language acquisition, children successfully overcome several obstacles: The input they receive is not always grammatical; it contains slips of the tongue, hesitations and incomplete sentences. Moreover, a child will never be able to cover all possible words in all possible combinations and no two children will be exposed to the same input. Regardless of these obstacles, children acquire the same system independent of intelligence, race, sex, class or other variables. Thus children must possess abstract language knowledge of an underlying very flexible system. (Cook & Newson 1996, Foster-Cohen 1999). Children show an extraordinary ability to independently deduct rules of the languages spoken to them. This requires knowledge of structural relationships, as the yes/no questions in (2) illustrate. The yes/no question in (2a') can be the result of a linear algorithm such as *put the verb in sentence-initial position.*

However, such a linear algorithm cannot produce the correct yes/no question for (2b) and would presumably result in the ungrammatical (2b'). In order to form the correct yes/no question, additional structural information needs to be accessible, i.e. it is the verb of the main clause that is moved.

(2) a. The man is tall.
a.' Is the man tall?

b. The man who is tall can play the piano.
b'. *Is the man who tall can play the piano?
b''. Can the man who is tall play the piano?

c. *Arrived the bus on time?
c'. Did the bus arrive on time? (adapted from Crain & Lillo-Martin 1999:42)

To be able to produce a sentence like (2c'), children have to acquire at least three aspects of syntax: firstly, sentences have a structure, otherwise (2b') would be as good as (2b''). Secondly, movement occurs in questions. Finally, according to the behaviour in question formation, there are at least two verb classes: verbs that move like *is* in (2a') and verbs that do not move like *arrive* in (2c').

In addition, children acquire knowledge about their language even though they have had very little or no input. One such example is knowledge about the use of *that* in (3). Examples (a) to (c) might lead the child to the conclusion that the use of the complementizer *that* is optional. Example (d) shows that this conclusion would not be correct: in (d) using *that* results in an ungrammatical sentence. Children are not taught that (3d) is ungrammatical; they just do not produce it.

(3) a. I think that Miss Marple will leave.
a'. I think Miss Marple will leave.

b. This is the book that I bought in London.
b'. This is the book I bought in London.

c. Who do you think that Miss Marple will question first?
c'. Who do you think Miss Marple will question first?

d. *Who do you think that will be questioned first?
d'. Who do you think will be questioned first? (Haegeman 1994:11)

This divergence between the data a learner is exposed to and the implicit knowledge attained by such a learner gives reason for the assumption that exposure to linguistic data is a necessary but not a sufficient prerequisite for language acquisition.

Some features of the language faculty are found in all human languages, universals. One example of a universal is the embedding principle which states that in every language a grammatical sentence as the French sentence in (4a) can become a subordinate clause in a complex sentence, (4b).

(4) a. Maigret a abandonné l'enquête.
Maigret has abandoned the enquiry.

b. Lucas a annoncé que Maigret a abandonné l'enquête.
Lucas has announced that Maigret has abandoned the enquiry.
(Haegeman 1994:12)

Other features of the language faculty are language-specific parameters. One such parameter is given in (5). Informally, (5a) and (5b) lack an overt subject. Whereas speakers of English reject a sentence as (5a) the Italian equivalent in (5b) is perfectly acceptable to speakers of Italian.

(5) a. *Has invited Louise to her house.
a'. She has invited Louise to her house.

b. Ha invitato Louisa a casa.
[she] has invited Louisa at home
b'. Lei ha invitato Louisa a casa.
She has invited Louisa at home (Haegeman 1994:10)

Children need linguistic experience to start constructing an internal grammar of their language. This is a dynamic process which eventually results in the stable adult grammar. In the acquisition process children seem to be resistant to corrections to their respective grammar which needs not be consistent with the corresponding adult grammar. In (6) anecdotal evidence of children's resistance to correction is listed (Crain & Thornton 1998:22)

(6) a. *Child* My teacher holded the rabbits and we patted them.
Parent Did you say your teacher held the baby rabbits?
Child Yes.
Parent What did you say she did?
Child She holded the baby rabbits and we patted them.
Parent Did you say she held them tightly?
Child No, she holded them loosely. (Cazden 1972)

b. *Child* Nobody don't like me.
Parent No, say, "Nobody doesn't like me".
Child Nobody don't like me.
(eight repetitions of this dialogue)
Parent No, now listen carefully, say "Nobody likes me"
Child Oh, nobody don't likes me. (McNeill 1970)

c. *Child* Want other one spoon, Daddy.
Parent You mean, you want the other spoon.
Child Yes, I want other one spoon, please, Daddy.
Parent Can you say 'the other spoon'
Child other ... one ... spoon
Parent say ... 'other'
Child other
Parent spoon
Child spoon
Parent other ... spoon
Child other ... spoon. Now give me other one spoon? (Braine 1971)

These examples illustrate that children have difficulties to understand the adult corrections. Thus the child in (1c) tries politeness in adding *please* to satisfy the father's request.

Prior to Chomsky's work, language was assumed to be learnt. The first sounds, accidentally produced by the child, are reinforced by the reactions of parents and carers (Bloomfield 1933, Skinner 1957). Yet, The speed and accuracy with which children acquire their native language has led to the hypothesis that humans are biologically conditioned to acquire language (Innateness Hypothesis) and that the internal organization of the language faculty in the brain or mind of a language learner is made of specific linguistic principles such as the embedding principle in (4), Universal Grammar (e.g., Chomsky 1975, 1981, 1986, Crain & Thornton 1998, Fanselow & Felix 1990, Foster-Cohen 1999). Thus Universal Grammar is not the grammar of a specific language. It can be seen as an innate scheme for acquiring a language or as a set of invariant representations of linguistic knowledge, universal principles, which is complemented by the setting of parameters which vary cross-linguistically. A range of options for this parameter setting is provided by Universal Grammar. At the end of the acquisition process all these options have been set and the 'core' grammar of the language being acquired, the grammar of a particular language, has been established.

Thus the part of language acquisition concerned with establishing a grammar is finite although the input each child receives is random, contains mistakes, errors and uncompleted data and negative evidence is not available to the child. In contrast to grammar, the lexicon continues to grow throughout a person's life; new entries are added, existing entries get refined. In the example of *blackbird* in (1), the orthographic representation <blackbird> will almost certainly be added. Weingarten 1998 argued that the acquisition of reading and writing is not universally dependent on teaching; it is a process comparable to language acquisition.

There are several different views on the interrelations of linguistic and non-linguistic components of cognition that may be involved in language learning and language processing. The first person to see the brain as an organ with specified functions was the German anatomist and physiologist Franz Joseph Gall (1758-1828). He was convinced that mental functions are localized in specific regions of the brain, that there are specific modules for e.g. language, music or mathematics which are supported by specific brain structures. He was proved right by the French surgeon Paul Broca (1828-1880). He had a patient who had lost the ability to use language due to brain damage. Broca showed that this language loss was not a consequence of paralysis of the speech organs or the loss of cognitive functions. He then deduced that the lesion in his patient's brain marked the area that was used for language. The study of the effect of brain damage on language production provides ample evidence for a complex yet separate language faculty in the brain. Further clinical evidence for the dissociation of language and intellectual ability is obtained from patients suffering from William's Syndrome: a hereditary condition. A low IQ of 40-50 is one of a range of physical characteristics. This coincides with the mastery of highly complex language patterns such as passive constructions, or comparatives.

Within the framework of Universal Grammar linguistic knowledge is assumed to form a self-contained module (Modularity Hypothesis) which exists separately from other cognitive processes. Thus, if language is modular it operates on linguistic principles and general cognitive processes are not available to build linguistic knowledge. As a consequence the processes underlying language production have to be independent of general cognitive processes such as analogy or problem solving (Crain & Lillo-Martin 1999, Obler & Gjerlow 1999, Smith, 1999, Yule 1996). Naturally, modularity does not disallow interactions with other mental organs. Yet, language is no longer seen as manifestation of intelligence.

Writing, especially spelling skills and braille writing skills also have a tradition of linking performance levels to intelligence and especially braille writing can be mastered by learning an abundant number of rules and lists by heart (see section 4). My motivation for writing this dissertation was to test the compatibility of the braille code with natural language, to determine whether the difficulties braille users are supposed to have with contracted braille (Gould 1942; Lorimer 1969; Troughton 1992) are an intrinsic part of the braille system and whether braillists are at a disadvantage for producing text because of the structure of contracted braille. The central question of my thesis is to investigate whether writing braille is systemically different from writing print and whether there are structural elements of *British Braille* that may be in conflict with language processes, i.e. whether the system of *British Braille* can be held responsible for poor spelling performance.

Braille is a tactile code which enables a blind person to read and write. Many languages have two versions of braille: uncontracted braille, a one to one transcription of print symbols into braille symbols, and uncontracted braille, an abbreviated form which is developed language-specifically to increase reading speed, to save space and to reduce printing costs.

Especially from the point of view of a print reader braille is a secondary system which requires many extra rules that have to be learnt. Thus it is easily considered more difficult. I do not wish to question the value of braille, whether it is used in contracted or uncontracted form.

I agree with Troughton (1992) that contracted braille may be inappropriate for some braille users. Wormsley (2003) identifies visually impaired children with additional or multiple impairments, former print readers and learners of English as a second language as a group that is at risk of not mastering contracted braille.[1]

I will concentrate on *British Braille*, the rule system of contracted braille used in the UK, and show that this system is not a mere compilation of rules and lists that have to be learnt by rote. I will replace the appropriate parts by generalisations based on the relevant underlying linguistic units. Thus I will show that cognitive processes are not the only possible route to contracted braille and that the way in which the rules of contracted braille have been compiled is far more problematic than the underlying system itself.

Many braillists receive a dual education, learning to read and write contracted braille and use full spelling on computer keyboards. Millar (1997) argues that having two orthographic representations for the same letter groups may increase memory load in retrieval. This might indeed make spelling more difficult for braillists. I will focus on possible interferences from contracted braille with natural language without the additional difficulty of mastering full spelling on a computer keyboard. I adopt Millar's (1997) axiom that print and braille are identical in linguistics. Thus models and findings

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[1] Neither Troughton nor Wormsley refer to Moon as an alternative system, especially for visually impaired people with learning disabilities or with limited sensitivity in their fingers.

for print can be used for testing hypotheses in braille. Furthermore, this implies that both systems are linguistically equal.[2]

In order to determine whether there are interferences of the code system of *British Braille* with the structures of natural language and whether there might be interferences with universal grammar by a highly artificial writing system, I will first provide a detailed analysis of the section of *British Braille* rules that govern the use of contractions. I will show that the arbitrary and cumbersome lists found for the use of many individual rules can be generalised.

Furthermore, I will examine data from a study on braille which I have developed to investigate whether there are structural elements of *British Braille* that inhibit writing performance because they interfere with language processes. I will show that there is a difference in the performance of former print readers and braillists who have never used print: only former print readers are sensitive to characteristics of Standard English Orthography. However, both groups produce errors that show a stronger sensitivity for linguistic processes than for cognitive ones.

My dissertation is organised as follows. Chapter 2 gives a concise overview of the historical background, the contemporary situation in France and the subsequent development of braille. Chapter 3 contains an introduction to *British Braille* which is followed by a detailed analysis of the rule system in Chapter 4. I will provide a concise summary of the theoretical foundation for my analyses concerning *British Braille* and the results of the braille study in Chapter 5 which provides a link to the empirical part of my work. This starts in Chapter 6 with the research design. Based on Koenig and Ashcroft (1993), I develop a system to unambiguously classify all errors obtained in the braille study in Chapter 7. The results are presented in Chapter 8 and discussed in Chapter 9. Finally, Chapter 10 contains the concluding remarks and some questions for further research.

[2] There are two major differences between print and braille. Firstly, there is no redundancy in braille. All signs differ from each other in the presence or absence of at least one dot irrespective of their unit size, i.e. whether they are letters or contractions. Secondly, print is read during pauses of eye movement whereas braille is read by movement.

2 Historical background

> Many realise that the braille code is a means for blind people to be literate, but few know why it is called the braille code or what led to its invention and its acceptance today. Many centuries ago, when versions of the alphabet were first used by those with sight, it was accepted that blind people would not be able to take part in the normal life of their community. That acceptance constituted the reason a suitable code for reading and writing was not available until comparatively recently.
>
> (Lorimer 2000:19)

In the early 19^{th} century, the development of braille was a major breakthrough in the education and consequently in the living prospects of blind people. In this chapter I will give an outline of the contemporary situation in France and the development of the first school for the blind (section 2.1). This is followed by an overview of competing tactile codes in Britain at that time (section 2.2). Sections 2.3 and 2.4 introduce Louis Braille and Charles Barbier, the inventors of this writing system and its predecessor. The beginning of braille is outlined in section 2.5, followed by the presentation of the structured development of the braille alphabet (section 2.6). The chapter concludes with the acceptance of braille as standard tactile writing system in the United Kingdom (section 2.7).

2.1 France: Valentin Haüy on the way to the first school for the blind

The first school for the blind was founded in 1784 by Valentin Haüy. Haüy was born in 1745 in Saint-Just en Chausée, a small village about 35 km east of Paris. He graduated from Paris University in languages and subsequently earned his living by translating official documents and foreign correspondence for businessmen. As an elected member of the *Bureau Académique des Ecritures* he specialised in secret codes and the deciphering of old French and foreign manuscripts (Plain-Japy: 1996). Haüy's interest in languages and their written representations was an important factor contributing to his growing involvement in the education of blind youngsters. In addition, Haüy was familiar with the work of the French philosopher Diderot (1713-1784), the first person to study the lives of blind people in detail. Trying to understand how the human brain works without the sense of sight, Diderot was most impressed by the work of Nicholas Saunderson, a blind professor of Mathematics at Cambridge University who wrote extensively on Algebra and on Newton's *Principia*. In France, Diderot observed a blind man teaching his sighted son the alphabet with the help of raised letters. (Lorimer: 1996).

Another decisive incident happened in 1771. Haüy witnessed a humiliating exhibition of an 'orchestra' of blind beggars. Dressed up in ugly gowns, pointed hats and cardboard spectacles without lenses, this group of beggars was caterwauling for the amusement of the public (Lorimer 1996:11). Haüy was appalled by this performance and subsequently set out to argue against the contemporary belief that a blind person could not be educated. He decided that blind people needed a formal education to allow them to earn their livings in dignity.

Jean François de Lesueur, a 17-year-old blind beggar, was Haüy's first pupil. They incidentally met at the entrance to St. Germain des Prés. Haüy gave a coin to the youngster. Lesueur identified the coin by touch and not only named it correctly but he returned it to Haüy as he considered it of too high a value to be a donation (Lorimer 2000:21). Very impressed by Lesueur's tactile dexterity and honesty, Haüy taught him in numeracy and reading and paid him to make up for the loss of his earnings from begging. Lesueur was very quick to learn and within six months he could decipher letters with the help of a "slotted board in which small wooden tiles could be fitted. The upper surface of the tiles were embossed with individual letters or numbers" (Lorimer 2000: 21f.).

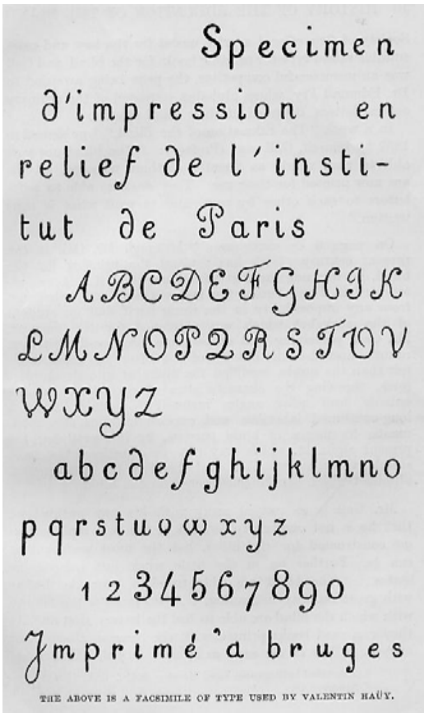
Haüy then had to prove that his first pupil had not been an extraordinarily gifted exception. He managed to secure funding for twelve blind youngsters. In February 1786 *l'Institut des Jeunes Aveugles* was opened, the very first school which offered a general education to all blind children regardless of their gender, intelligence and class. In order to keep his funding at par with the steady rise of pupils, Haüy had to gain public recognition and thus arrange public demonstrations of his pupils' achievements. He managed to get the support of the court in Versailles where his best pupils demonstrated their skills in reading, numeracy and music at Christmas 1786. As a consequence of the court's support it became fashionable to donate to *l'Institut des Jeunes Aveugles* (DBV 1990 s.v. Haüy: 256).

The Age of Enlightenment is a European intellectual movement of the 17th century in which initiated innovative developments in art, philosophy, and politics. The importance of reason was central as it enabled man to understand the outside world and improve his own condition. One result of this new school was that a sensory impairment was no longer regarded as having an automatic influence on the intelligence of the person affected. Consequently, blind children should be educated in order to earn their living by means of their education, or, if they were of lower intellectual abilities, by a manual trade.

Haüy's assumption was not proven until the early 20th century when the headmaster of the Perkins School for the Blind in Watertown, Massachusetts, Dr. Samuel Hayes applied a psychology test to his pupils. The Hayes-Test provided a scientific proof that, contrary to the common belief, the intelligence of blind people did not differ significantly from that of the sighted (Enzyklopädie des Blinden und Sehbehindertenwesens 1990:477).

The most difficult problem Haüy had to solve was to enable his pupils to read. He was not content with the system of wooden blocks he had used when first teaching Lesueur. This method showed his pupils what reading was like for sighted people while it was only a very cumbersome deciphering process for themselves. Lesueur had discovered that he could distinguish some faint impressions of letters on the reverse side of a funeral card he had picked up by chance. Haüy immediately understood the potential of this observation. As a sighted person, Haüy assumed that blind people were much like sighted people. With respect to literacy this led him to invent a method of reading by embossed Roman letters. Yet, many letters of the alphabet he used were still too complex for easy tactile discrimination. A specimen alphabet of his font is given in Figure 1.1.

Figure 1.1: Haüy Type



2.2 Competing codes in Britain

After Haüy had started the comprehensive education of blind children successfully, the rest of Europe followed promptly. Soon after the opening of *l'Institut des Jeunes Aveugles* in Paris, several schools opened in the UK: Liverpool 1791, Bristol and Edinburgh 1793, London 1799 and Glasgow 1806. As a consequence there was soon a varied offer of codes which were thought to give the pupils access to literacy. However, it took until the beginning of the 19th century before a systematic search for an appropriate literacy system was started in the UK. Literacy was desirable for two reasons: to get independent access to the gospel and as a means of distraction from the personal 'fate'. Thus most embossed publications were religious works, mainly parts of the Bible.

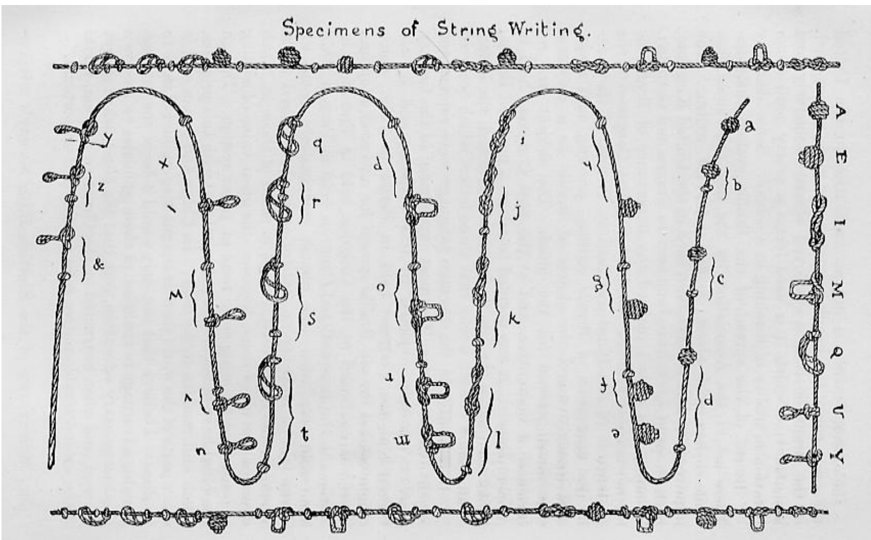
> Let them find this exercise an effectual remedy against that intolerable melancholy which corporeal darkness and mental inactivity united in the same person are too apt to produce
>
> Haüy quoted in Lorimer (1996:21)

However, in the very early stages of formal education for blind pupils many systems were so cumbersome that their function was more likely that of a memory aid. Reading for information was thus not possible with these systems.

> Two members of staff at the Edinburgh Asylum for the Blind invented a method of reading the Bible by means of knotted string (Baker 1859, pp 13-17; Ritchie 1930, p 26). The knotted alphabet consisted of seven large knots, all different, along a string representing A, E, I, M, Q, U, and Y respectively. The remaining letters were each made from a large knot plus a small single knot at a specific distance from the large knot according to its position in the alphabet.
>
> Lorimer (1996:60)

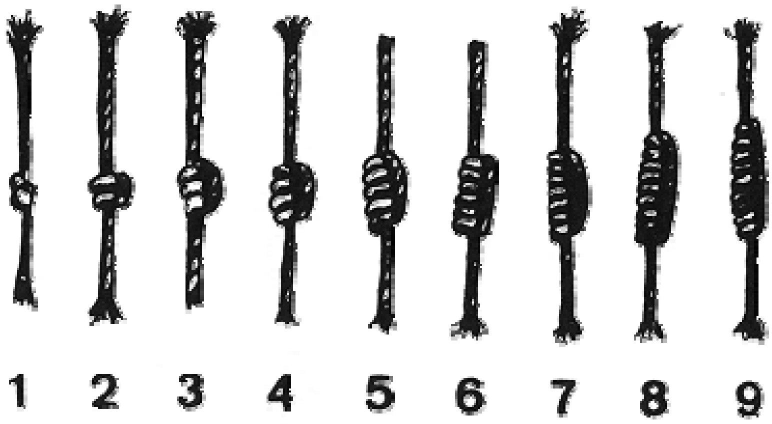
An example of the supposedly tactile alphabet is given in Figure 2.2.

Figure 2.2: String Writing



This system had a predecessor in ancient Peru, Quipu which is shown in Figure 2.3. The Spanish conquerors found boxes of differently coloured knotted woollen strings which had been used in the Inca administration for recording chronological and statistic data. Distinctive elements were the number and colour of the strings and the shape, number and position of the knots (DBV 1990:189).

Figure 2.3 Quipu counting knots



Some systems were so cumbersome that it might have been quicker to learn the text by rote rather than to master the system in which it had been produced. One such example is Gall type, a modified Roman alphabet, given in Figure 2.4.

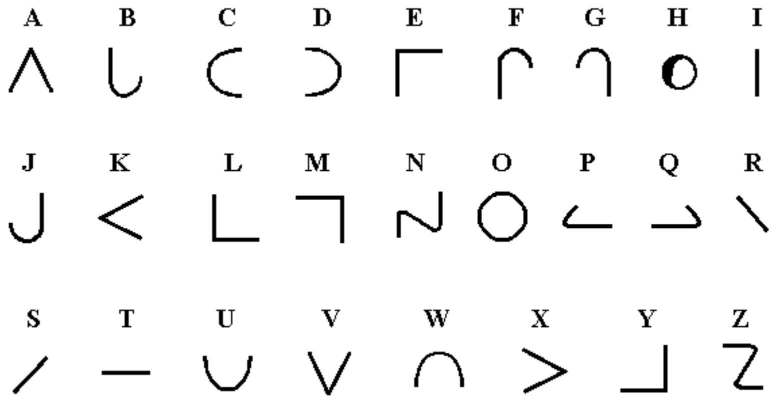
Figure 2.4: Gall Type

Gall Type was tested in two sets of trials in Edinburgh both of which yielded devastating results.

> "The result was nothing more than being able to make out letter by letter and a few short words, some of them scarcely that [...] they even averred that they could get the gospel by heart in half the time."
> Anderson quoted in Lorimer (1996:63)

The first successful tactile alphabet in Britain was designed by William Moon (1818 - 1894), a teacher who had become totally blind at the age of 21. Seeing his pupils struggling with the material available, he was determined to find a suitable solution. His alphabet is based on the modified Roman letters in combination with arbitrary shapes shown in Figure 2.5. It is the first system that puts a stronger emphasis on easy touch discrimination than easy recognition by print readers.

Figure 2.5: The Moon Alphabet



In contrast to all other contemporary systems, Moon is still in use. It is read by retracing the letters, similarly to the Roman alphabet codes of Haüy and Gall. Its advantage is that there is no limit to the size of the letters. Today Moon has its use predominantly among people with difficulties in touch perception, adventitiously blind people, who are former print readers, and multiply disabled children.

2.3 France: Louis Braille

Louis Braille, the creator of the alphabet that is used by blind people all over the world, was born in 1809 in Coupvray, a small village about 40 km east of Paris. His father was the village saddler. Imitating his father's work, Louis had managed to get hold of a sharp knife in the workshop. It slipped and cut one eye badly. He lost the sight in that eye and, due to a spreading infection, the sight in the other eye as well.

At a time where education was not available for everybody, both parents of Louis Braille were literate. They were trying to get an education for their blind son and as a start, he was sent to the local village school.

In Paris in the meantime Haüy's *l'Institut des Jeunes Aveugles* had managed to survive the French revolution, when Haüy changed allegiance, but was then to be closed under Napoleon in 1801. The pupils were sent to an annexe of the *Quince Vingts*, an asylum for blind adults, where their lessons now focused on manual skills and all academic subjects were dropped.

Haüy had followed an invitation of Tsar Alexander I to St. Petersburg. On the way he met Louis XVIII in Riga who was very impressed with Haüy's work and played a major part in the reopening of *l'Institut des Jeunes Aveugles* (Lorimer 2000:23). The school was separated from the asylum and moved to new premises on Rue St. Victor. It was reopened under the name *l'Institut Royale des Jeunes Aveugles* on February 12, 1816 (Henri 1952:8).

It is not known how the Braille family knew about the school, but Simon Braille, the father, wrote several letters to *l'Institution Royale des Jeunes Aveugles* to find out whether this school would be the right placement for his son. Louis Braille was accepted and entered the school on January 15, 1819 (Henri 1952:9).

2.4 France: Charles Barbier, an army officer's code

The early 19th century was a time where many people were enthusiastically inventing secret codes, mainly for military use. In 1819, the year in which Louis Braille entered *l'Institution Royale des Jeunes Aveugles*, Charles Barbier (1767 - 1841), a retired army officer, was working on a way of quickly transmitting secret messages across the battlefield (Henri 1952:35). Being a practically orientated person, there were two crucial requirements the code had to meet. In order not to betray the own position to the enemy, this code had to be legible at night without the use of light (Lorimer 1996:28). In addition, it should be possible to produce several copies at a time and with tools that were easily available for a soldier. The result was the punctiform phonetic code *écriture nocturne* (night writing), which consisted of the following two parts. The first part was a key for encoding and deciphering messages in the 6x6 matrix in Figure 4.6 (Henri 1952:38). [3]

Figure 2.6: Barbier's encoding key

a	i	o	u	é	è
an	in	on	un	eu	ou
b	d	g	j	v	z
p	t	q	ch	f	s
l	m	n	r	gn	ll
oi	oin	ian	ien	ion	ieu

[3] A matrix is a quadrangular arrangement of numbers which consists of $m \cdot n$ numbers or elements. These elements are arranged in m rows and n columns (Merzinger, Wirth [3]1995:166).

A translation into phonetic transcription is given in Figure 2.7. Each sound is coded by its position in the matrix. Following the conventions of algebra, the first number identifies the row, the second the column of each entry. Each coded sign thus has the appearance (m,n) with $1 < n \leq 6$ and $1 < m \leq 6$. For example, /b/ being the entry in the third row of the first column has the coding (3,1).

Figure 2.7: Barbier's encoding key in phonetic transcription

a	i	o	y	e	ɛ
ã	ɛ̃	õ	œ̃	œ	u
b	d	g	ʒ	v	z
p	t	k	ʃ	f	s
l	m	n	r	ɲ	j
wa	wɛ̃	jã	jɛ̃	jõ	jø

In the next step these co-ordinates are transmitted to another matrix which represents them as raised dot entries. The second part of the system is a punctiform matrix that varies from 1x2 to 6x2 depending on the highest numerical value in the coding. A sketch of the coded target matrix with the maximal size of six rows and two columns to be embossed is given in Figure 2.8.Thus all signs in Barbier's system could be easily embossed with a sharp soldier's tool such as a marlinespike.[4]

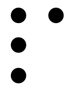
Figure 2.8: The maximum size Barbier cell

○	○
○	○
○	○
○	○
○	○
○	○

The code of /b/, (3,1), corresponds to a 3x2 matrix, 3 being the highest numerical value in the coding of /b/. The corresponding dot pattern in the punctiform matrix contains 3 dots in the first column representing the 3rd row in Figure 2.7 and 1 dot in the second column representing the first column in Figure 2.7, illustrated in Figure 2.9.

[4]A pointed tool generally used to separate strands of rope or wire.

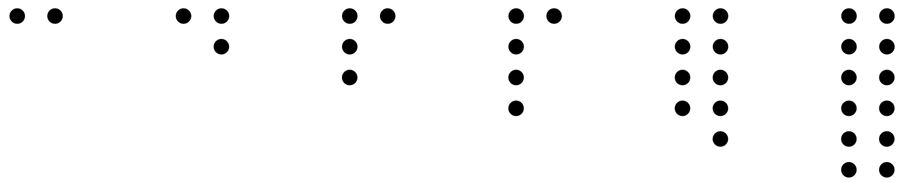
Figure 2.9: /b/



b

This method produced strings of matrixes which varied in size from a 1x2 matrix as for example the matrix representing /a/ to a 6x2 matrix representing /jø/. Figure 2.10 gives one example for each matrix size.

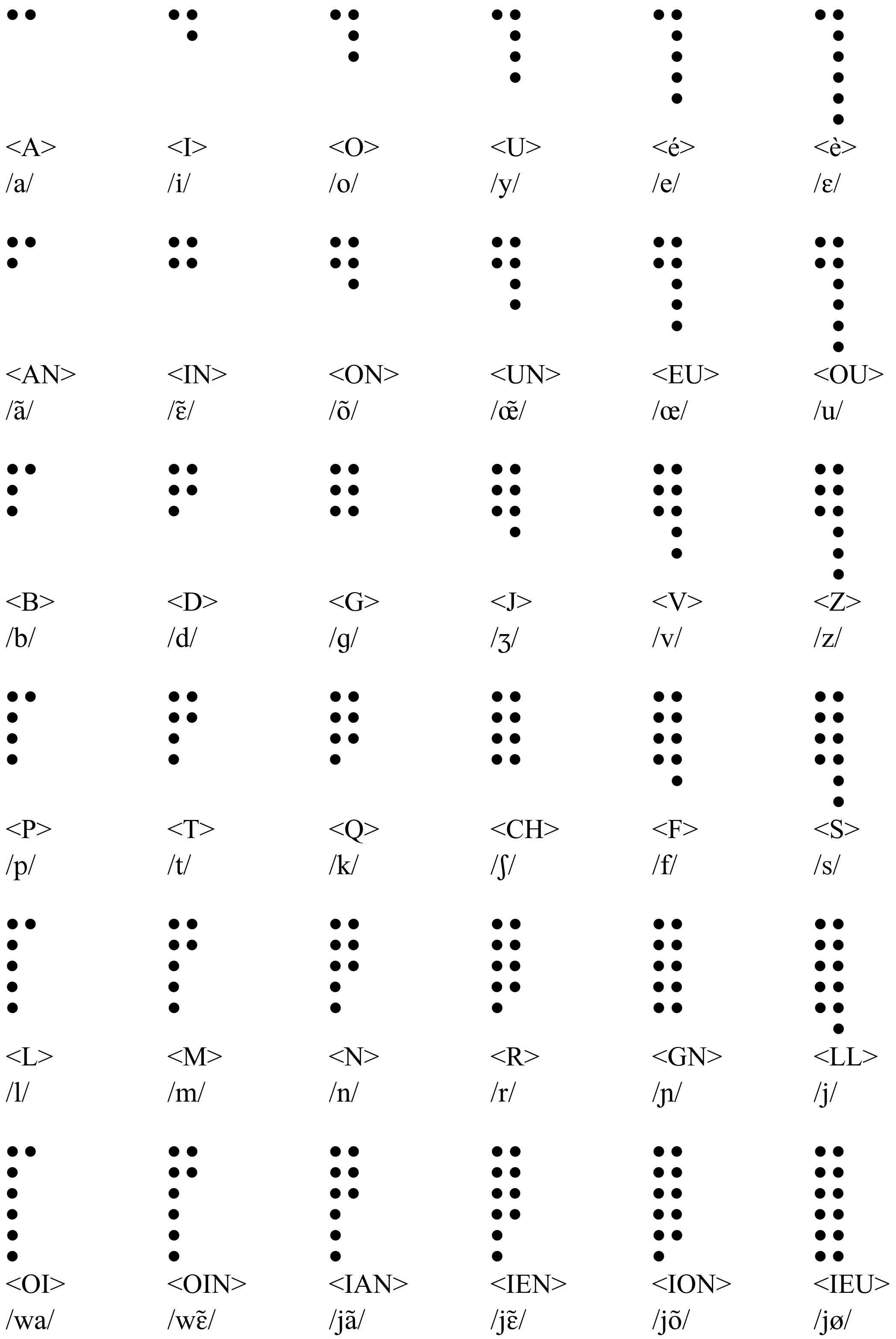
Figure 2.10: Variable matrix sizes in *écriture nocturne*



/a/ /i/ /b/ /p/ /f/ /jø/

In order to be able to decipher this code it was necessary to have the underlying encoding matrix, or the number combinations of the entries memorised. The idea of using such a code had been known since 1670 (Lana code - Henri 1952: 40) and although it is not known whether Barbier actually knew about that code since it had never been put to practice, Henri comments that he would not be surprised if he had: "Barbier en eut-il connaissance? Cela ne nous surprendrait pas." [Did Barbier know it? That would not surprise us.] (Henri 1952: 40). Figure 2.11 shows the complete set of signs that can be generated from Barbier’s encoding key in Figure 2.6.

Figure 2.11: Barbier's *écriture nocturne*



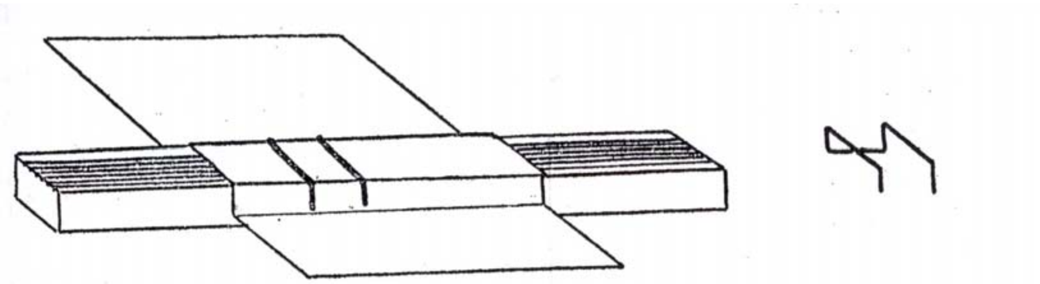
The military were not interested Barbier's code (Lorimer 2000:27). Yet, *L'Académie Royale des Sciences* recognised that this code could be useful for blind children and he was asked to give a demonstration of his code to the pupils of *l'Institut Royal des Jeunes*

Aveugles.[5] There it was received with great enthusiasm as this system was much more suitable for tactile reading than embossed Roman letters. In addition, Barbier's system had the invaluable advantage that it could be produced inexpensively by the pupils themselves. For the first time they had a means of storing information external to their memories.

2.5 The beginning of braille

In 1821 Barbier gave a demonstration of his *écriture nocturne* at *l'Institut Royal des Jeunes Aveugles*. Together with his system Barbier introduced a writing board. This was a bar of wood in the shape of a ruler. Six equidistant parallel grooves were carved into the wood. Their midpoints were set 2 $^{1}/_{4}$ mm apart so that the maximal height of each punctiform matrix totalled just over 11.25mm. The width of each matrix was 4.5mm. This was determined by a movable wire rectangle which was attached on top of the wooden bar (Henri 1952:43).

Figure 2.12: The writing board



A pointed tool was used to form the dots on the reverse side of the paper. Like with the modern slate and style, writing progressed from right to left. In order to read the raised dots, the paper had to be taken off the board and turned over. The pupils were allowed to keep writing boards for practise. Despite all enthusiasm there were two crucial shortcomings in Barbier's system. Firstly, this was a phonic system which did not include numbers nor punctuation signs. It met the requirements of the battlefield but not those of a fully-fledged writing system, especially as it produced inconsistent spellings. The second shortcoming was in the design of the system. Some signs consisted of many dots. As a consequence, they could not be perceived as a unit by one reading finger.

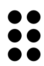
[5] "L'écriture ordinaire [...] est l'art de parler aux yeux; celle qu'a trouvée M. Charles Barbier est l'art de parler au toucher." (Henri 1952:44)
"Ordinary writing is the art of speaking to the eyes; that discovered by Monsieur Barbier is the art of speaking to the fingers" (translation by Lorimer 2000:27).

They had to be scanned in circular motion. This was complicated further by the fact that the discriminating features are at the bottom of each cell which made recognition more difficult and slowed down the writing process (Lorimer 2000, Nolan & Kederis 1969). Thus functionally, Barbier's system was a code that had to be deciphered.

Louis Braille, then aged 12, had been present at Barbier's demonstration. Like his fellow pupils he was extremely interested in this new system and tried to make it more suitable for his own needs. He met Barbier again after four years, in 1825, to suggest two crucial changes. Firstly, to reduce the size of Barbier's 6x2 matrix as it is larger than the finger pad and the left-right movement of reading is 'interrupted' by an additional circulatory movement which is necessary to retrieve all information. Braille suggested to half the matrix size in order to exclude all circulatory movements. The second suggested improvement was substituting Barbier's phonetic system with the full alphabet. Braille, then age 16, had intended no disrespect but Barbier was not prepared to be criticised by a blind youngster. A co-operation between them was not possible and Braille continued experimenting with Barbier's code at school, discussing improvements with his fellow students (Lorimer 2000:30).

The result of these amendments, Louis Braille's punctiform system of embossed dots, was first published in 1829. It uses a 3x2 matrix in which a maximum of six dots can be embossed. The size of this matrix allows $2^6 = 64$ possibilities for creating distinct characters. The basic unit in which these dots are placed is called the braille cell. This cell is small enough to fit under the finger pad in order to be perceived as one unit in reading. Each cell is approximately 6mm high. The distance between the midpoints of two dots in the same row of a cell is about 1.5mm. The dots are just over a millimetre in diameter. The dots within a braille cell are numbered from one to six. Starting from the top, dots 1 to 3 are in the left column, dots 4 to 6 are in the right column. Figure 2.14 shows a fully embossed standard size braille cell. [6]

Figure 2.14: Standard size braille cell



[6] I use the SimBraille font to present braille material. It is a free braille True Type Font available from Duxbury Systems: www:duxburysystems.com.

There is no scope for personal variation in braille writing. Handwriting does not exist in braille.[7] Variation in fonts is not possible either, there is just one braille font; different font types such as scaling, boldface, underlining and italics cannot be realised in the same way as print (Millar 1997: 35). They are indicated by a preceding functional sign.

2.6 The braille alphabet

The braille alphabet has been developed systematically to ensure maximal tactile discrimination. Louis Braille did all testing together with his fellow pupils at *l'Institut des Jeunes Aveugles*. It is thus a system which was developed for young able-bodied blind users. The first ten letters, *a* to *j*, are selected from the fifteen signs that can be formed by using the top four dots of a braille cell (Henry 1952:52). Braille began by using both columns of the cell independently. The signs in (1a) are embossed in the left column, those in (1b) in the right one. In (1c) both columns are combined.[8]

(1) a ⠁ (1) ⠃ (2) ⠂ (3)

b ⠈ (4) ⠘ (5) ⠐ (6)

c ⠉ ⠁+⠈ (7) ⠋ ⠃+⠈ (10) ⠊ ⠂+⠈ (13)

⠙ ⠁+⠘ (8) ⠛ ⠃+⠘ (11) ⠚ ⠂+⠘ (14)

⠑ ⠁+⠐ (9) ⠓ ⠃+⠐ (12) ⠒ ⠂+⠐ (15)

For touch-reading determining the exact position of a single dot within a cell is an additional difficulty, therefore Braille excluded all shapes which are only distinguished by their position within the cell. This left one of the single dot shapes, ⠁. Consequently he also excluded the second shape of each of the following pairs. ⠃, ⠘ and ⠉, ⠒ as they could be easily mistaken for each other. The remaining ten signs became the letters <a> to <j> in (2).

---

[7] Braille is usually written on a mechanical or electronic typewriter which uses six keys to emboss the dots of the braille cell. Thus, unlike on a QWERTY keyboard, in braille each letter is composed individually by embossing the required dots in the braille cell.

[8] In order to facilitate the reading of the braille examples a font is used which shows the exact location of the dots within the cell by indicating unembossed positions. The position of the dots within the cell is only a problem of reading, not one of writing and for a braillist it is usually determined by the context. The size used for this font is slightly smaller than braille and may vary in order to avoid line breaks.

(2) ⠁ ⠃ ⠉ ⠙ ⠑ ⠋ ⠛ ⠓ ⠊ ⠚
a b c d e f g h i j

The letters <k> to <t> were derived by adding dot 3, ⠄, to the letters in the corresponding positions above; similarly the letters <u> to <z> were obtained by adding dots 3 and 6, ⠤, to the first row of letters. The letter <w> was not included in the original system as the French alphabet did not use <w> at that time. It was added by Braille after an English student suggested it might be needed if the system was to be used in other languages as well (Henri 1952:54). This explains why it is the last letter preceding the set of punctuation signs in Figure 2.15.

Figure 2.15: The braille alphabet

⠁	⠃	⠉	⠙	⠑	⠋	⠛	⠓	⠊	⠚
a	b	c	d	e	f	g	h	i	j
⠅	⠇	⠍	⠝	⠕	⠏	⠟	⠗	⠎	⠞
k	l	m	n	o	p	q	r	s	t
⠥	⠧	⠭	⠽	⠵	⠯	⠿	⠷	⠮	⠾
u	v	x	y	z	ç	é	à	è	ù
⠡	⠣	⠩	⠹	⠱	⠫	⠻	⠳	⠪	⠺
â	ê	î	ô	û	ë	ï	ü	œ	w
⠂	⠆	⠒	⠲	⠢	⠖	⠶	⠦	⠔	⠴
,	;	:	.	?	!	()	«	*	»

In contrast to print, braille does not have different shapes for upper and lower case letters. The default setting for braille letters is lower case, (3a). To obtain upper case in English, the letter is preceded by a cell containing dot six only, as illustrated in (3b).

(3) a. ⠇
l

b. ⠠⠇
capital indicator-l
L

Braille does not have a separate set of numbers. Instead it uses the letters <a> to <j> preceded by the numeral sign ⠼ to represent the Arabic figures 1-9 and 0 as illustrated in Figure 2.16.

Figure 2.16: Braille numbers

⠼⠁	⠼⠃	⠼⠉	⠼⠙	⠼⠑	⠼⠋	⠼⠛	⠼⠓	⠼⠊	⠼⠚
1	2	3	4	5	6	7	8	9	0

The numeral sign ⠼ changes the letter sequence *dig* in (4a) to *497* in (4b).

(4) a. ⠙⠊⠛
dig

b. ⠼⠙⠊⠛
numeral sign dig
497

A number ends when the sequence of signs that follow the number sign is followed by a space, as in example (5).

(5) ⠼⠑ ⠝⠥⠞⠎
5 nuts

To summarize, braille is a system developed as a writing system that enables reading for information and information storage. It is designed to enable maximal tactile discrimination and leaves no space for redundancy nor for personal variation in writing.

2.7 The acceptance of braille in the UK: Thomas Rhodes Armitage

Many of the schools founded in the UK at the end of the 18th century used their own tactile reading system. As a consequence, accessibility to embossed material was limited by a person's knowledge of the various systems in use. Most tactile systems had been designed to be suitable for both visual and tactile reading from the point of view of a print reader. Their diversity was even more increased when in 1833 the *Society for the Encouragement of Arts* in Edinburgh initiated a competition to develop an alphabet for the blind which could be easily and accurately read by touch. Again, almost all entries were developed by sighted inventors rather than people using tactile systems themselves (Lorimer: 1996).

The situation changed when Dr Thomas Rhodes Armitage (1824 - 1890) had to give up his work as a physician due to sight loss. Previous difficulties with his sight had made him sensitive to the difficulties of blind men and women. He contacted a missioning society which visited blind people in their homes and accompanied one of the missionaries for several hours each day. He saw that 70 years after the first schools for the blind had been founded in the UK, these schools were able to provide some very basic education for a small number of blind youngsters only.

Armitage saw two crucial needs for change to improve educational standards. Firstly, there should be only one tactile system in the UK. Secondly education was to be followed by industrial training to lead into employment. The problem with the tactile systems was that most of them had been designed by print readers to be read by sight and touch. In addition, conferences on embossed systems were attended by sighted staff rather than touch-reading students (Thomas: not dated). To find and promote the use of a single tactile system, Armitage founded an association in 1868, the *British and Foreign Blind Association for Improving Embossed Literature for the Blind*. Eventually, this was to become the *Royal National Institute of the Blind*, the leading charity for blind people in the UK. In order to ensure that the committee members would identify the most suitable tactile system available, the selection criteria for those members were strict. They had to have sufficient sight loss to be dependent on touch reading as their primary reading mode and they had to know at least three embossed systems. In addition, they were not allowed to have any financial interest in promoting one of these systems (Lorimer 1996:83f.). The set task was not only discussing personal preferences but also to do a field study and collect information on preferences of other blind people. Participants in this survey had to know at least two different tactile systems in order to be able to voice a preference.

The criteria for evaluating each system were:
1. clear touch perception of the characters
2. smallest size possible which still allowed instantaneous character recognition
3. no interference with standard English orthography
4. existing abbreviations which could be adopted
5. no difference between printed and hand-written characters

(Armitage, 1870:195 quoted in Lorimer 1996: 83f.)

The council's survey came to the following conclusions. Tactile systems based on Roman letters were not suitable. The adapted systems of Lucas, Frere and Moon were suitable but not perfect. The best system available was braille (Lorimer 1996:84). It was decided that as many of the original French braille signs as possible should have the same meaning in order to facilitate translation and the sharing of books between nations. Thus the alphabet and numbers are exactly the same as in the French braille system. Contractions were to be included if they fulfilled the following criteria (Lorimer 1996: 87):

1. no omission of letters except in some words of very common occurrence, and where this omission cannot lead to incorrect spelling
2. to abbreviate by allowing characters to stand for groups of letters
3. not two meanings for the same sign
4. to assist the memory by allowing the groups of letters to occur in alphabetical order
5. not to use contractions except in words or groups of letters which occur very frequently
6. representation of common words by their initials

(Armitage, 1870:195 quoted in Lorimer 1996: 83f.)

In 1878 an international congress about tactile writing systems was held in Paris and the delegates agreed on a general adoption of braille (Lorimer 1996:35). In 1949 the UNESCO started a survey on the world-wide use of braille with the task of establishing international uniformity. Braille has continued to develop and its usage has been extended to most countries of the world. Even in languages such as Arabic, Chinese or Urdu which have a writing system different from the Roman alphabet, blind people learn to read and write their language using this six dot pattern (UNESCO: 1990).

Today braille is used world-wide. Most languages not only have a braille alphabet, punctuation signs and numeral signs, but also use a language-specific shorthand system and a set of contractions. The main aim of contracted braille is to increase reading speed and reduce bulk by introducing abbreviations for high frequency words and letter sequences.[9]

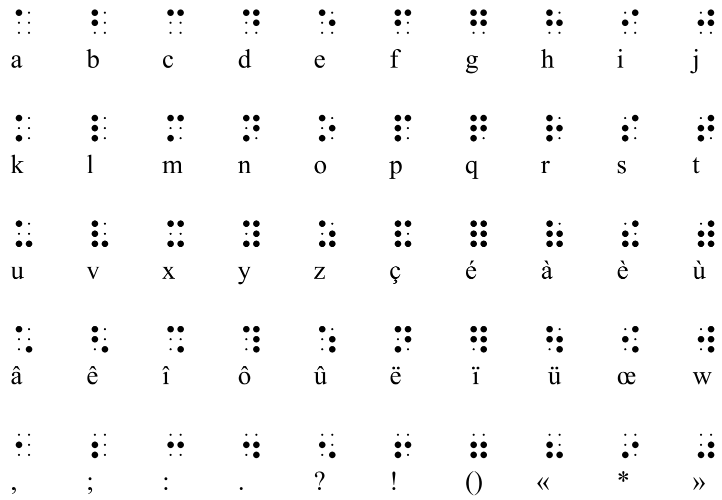
[9] The corpus used for determining high frequencies in the first set of contractions was the bible.

3 The British braille code

The original French braille code was adapted for use in Britain in the 1870s (Lorimer 1996:151). This adaptation included the development of an obligatory set of contractions which complements the alphabet, numbers and punctuation signs. The main motivation for contracted braille is to increase reading speed. Compared to visual reading, touch reading is slower and the techniques used are different. In visual reading there is an alternation of movement (saccade) and pause. In the pauses, the fixation takes place and information is gathered from the printed text. The perceptual span extends further to the right than to the left: about 15 letters or spaces to the right and three to four to the left of fixation (Ellis 1993:13). In contrast, in touch reading information is gathered during movement (Hampshire 1981:103).

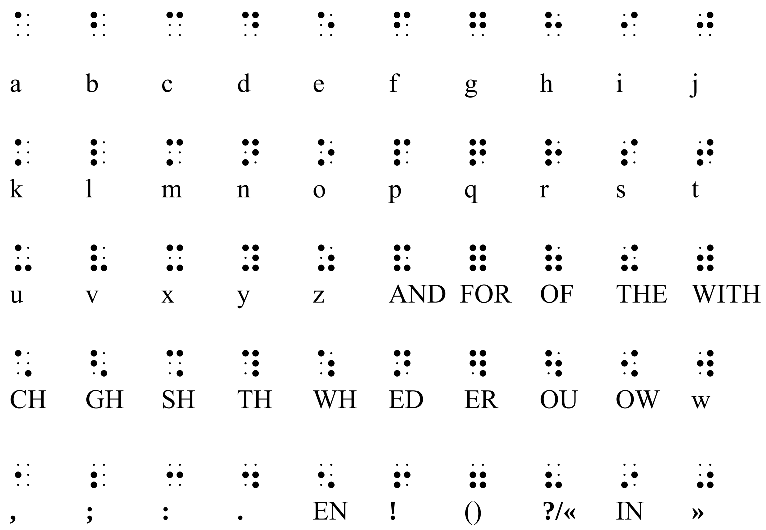
In section 2.4 the braille cell was introduced as a 2x3 matrix in which zero to six dots can be embossed. The matrix size limits the number of different single cell arrangements to 64 signs. The original French alphabet uses 51 of these 64 signs, the 50 signs in Figure 2.14, which is repeated here as Figure 3.1, plus the cell that does not emboss a dot, the space.

Figure 3.1: The braille alphabet



The English alphabet has no need for letters that are particular to French. These are *ç*, *é*, *à*, *è*, *ù*, *â*, *ê*, *î*, *ô*, *û*, *ë*, *ï*, *ü* and *œ*. In *British Braille* these signs are assigned arbitrary letter sequences which are chosen according to their frequency of occurrence. The adaptation of the French set of signs for English is given Figure 3.2 in which those letters particular to the French alphabet are substituted for by arbitrary letter sequences of high frequency.[10]

Figure 3.2: The braille alphabet with some English contractions



British Braille uses another 13 signs to complement the signs of Figure 3.2. These signs are listed in (1). In *British Braille* the signs in (1a) represent the letter sequences *ST*, *AR*, *ING* and *BLE*. The signs in (1b) are the dash and the apostrophe. The signs in (1c) and (1d) are formed by using the right column of the braille cell. As tactile discrimination of the columns in a braille cell is exceedingly difficult, they are used in context. (1c) is used as accent sign, the set in (1d) are functional signs, forming composite contractions.

(1) a. ⠌ ⠜ ⠬ ⠼
ST AR ING BLE

b. ⠤ ⠄
- '

c. ⠈

d. ⠐ ⠘ ⠸ ⠨ ⠰ ⠠

Functional signs are signs, which do not have a print equivalent. They indicate that the following cell takes a differing value. This may be a number, following the numeral

[10] In the following, braille cells that have a one-to-one correspondence to the print letters are transcribed in lower case. Sequences of upper case letters are used to represent contractions in which a single braille cell represents a sequence of print letters. As capitalisation is optional in *British Braille*, capitals will be used in the transcriptions if they are required by Standard English Orthography.

sign, or a letter sequence.[11] For example, the letter ⠞, <t>, may be preceded by each of the following functional signs: ⠐ in (2a), forming the letter sequence <time>, ⠨ in (2b), forming the letter sequence <ount> and ⠰ in (2c) forming the letter sequence <ment>.

(2) a. ⠐⠞
TIME

b. ⠨⠞
OUNT

c. ⠰⠞
MENT

Thus one of the most striking characteristics of contracted braille is that the interpretation of a sign is context-dependent. The unmarked interpretation for ⠞ is the same as in uncontracted braille, the letter *t*. Furthermore, if ⠞ occurs with a space at either side it represents the word *that*.

Since one of the major goals in developing a tactile writing system was enabling blind people to have independent access to the scripture, the bible was the corpus used for calculating the space-saving capacities of contractions. In (3a) the first sentence of Genesis 1:1 (New International Version) is given in uncontracted braille. It needs 55 signs. In contrast, the same sentence in contracted braille in (3b) needs 35 signs. In this instance contracted braille saves 36.4% space compared to uncontracted braille.

(3) a. ⠊⠝ ⠞⠓⠑ ⠃⠑⠛⠊⠝⠝⠊⠝⠛ ⠛⠕⠙ ⠉⠗⠑⠁⠞⠑⠙ ⠞⠓⠑
In the beginning God created the

⠓⠑⠁⠧⠑⠝⠎ ⠁⠝⠙ ⠞⠓⠑ ⠑⠁⠗⠞⠓⠲
heavens and the earth.

b. ⠔ ⠮ ⠆⠛⠔⠝⠬ ⠛⠕⠙ ⠉⠗⠂⠞⠫ ⠮ ⠓⠂⠧⠢⠎ ⠯⠮ ⠑⠜⠹⠲
IN THE BEgINnING god crEAtED THE hEAvENs AND/THE eAR/TH
In the beginning God created the heavens and the earth.

[11] *British Braille* glosses braille examples by using upper case letters for abbreviations, and separates a sequence of abbreviations with an oblique stroke (ia). Braille letters that have a one-to-one correspondence to the print forms are transcribed in lower case. In addition to *British Braille*, a contraction that consists of two braille cells is given in underlined upper case letters. In (ib) the combination of the functional sign ⠨, which consists of dots 4 and 6, and the letter ⠞ forms an inseparable unit to represent the letter sequence *ount*.

(i) a. ⠹⠔
TH/IN
thin

b. ⠍⠨⠞
mOUNT
mount

The standard version of braille used in the UK is contracted braille. Its use is prescribed in *British Braille* by the Braille Authority of the United Kingdom (BAUK). *British Braille* divides contractions into eight groups: simple upper wordsigns, (4a), simple upper groupsigns, (4b), simple lower wordsigns, (4c), simple lower groupsigns, (4d), composite wordsigns, (4e), composite wordsigns which may also be used as groupsigns, (4f), word-final composite groupsigns, (4g), and shortforms, (4h).

(4) a. ⠳
OUT
out

b. ⠳
OU
<ou>

c. ⠆
BE
be

d. ⠆
BE
<be>

e. ⠐⠙
<u>DAY</u>
day

f. ⠐⠙
<u>DAY</u>
<day>

g. ⠨⠙
<u>OUND</u>
<ound>

h. ⠛⠙
gd
good

In this chapter I will give an overview over the contractions used in literary braille; their use is discussed in chapter 4. In contrast to the *British Braille* examples in (4), I classify all signs as groupsigns according to form. Thus, wordsigns are a subgroup of groupsigns. The simple upper wordsign ⠳, *OUT*, in (4a) and the simple upper groupsign ⠳, *OU*, in (4b), are identical in form and are both classified as upper groupsigns (section 3.1). The lower wordsign ⠆, *BE*, in (4c) and the lower groupsign ⠆, *BE*, in (4d), are both classified as lower groupsigns (section 3.2). Composite wordsigns as ⠐⠙, DAY, in (4e), composite groupsigns ⠐⠙, DAY, in (4f) and composite groupsigns as ⠨⠙, OUND, in (4g) are classified as composite groupsigns, because they all use a functional sign followed by an upper sign (section 3.3). Finally, shortforms remain as defined in *British Braille* (section 3.4).

Traditionally, contractions are classified by form. This classification is ambiguous, one contraction can have various functions. A contraction may represent an arbitrary sequence such as the upper groupsign ⠿, *FOR*, in *form* in (5a). In (5b) the upper groupsign ⠣, *GH*, in *ghetto* represents the grapheme *gh* at the level of orthography but at the phonemic level it represents the phoneme /g/.[12],[13] In (5c) the upper groupsign ⠿, *FOR*, in *formal*, /fɔːməl/, represents the syllable /fɔː/. In *waited* in (5d) the upper groupsign ⠫, *ED*, represents the past tense morpheme, and in (5e) ⠿, *FOR*, represents the word *for*. [14]

(5) a. ⠿⠍
FORm
form

b. ⠣⠑⠞⠞⠕
GHetto
ghetto

c. ⠿⠍⠁⠇
FORmal
formal

d. ⠺⠁⠊⠞⠫
waitED
waited

e. ⠿
FOR
For

Thus the first specification of a contraction will always be its form, then its function.

---

[12] A grapheme is the smallest distinctive unit in the writing system of a language.
[13] A phoneme is the smallest distinctive unit in the sound system of a language.
[14] A morpheme is the smallest difference in the shape of a word that correlates with the smallest difference in word or sentence meaning or in grammatical structure (Katamba 1993:24).

3.1 Upper groupsigns

Upper groupsigns are single cell contractions, which occupy at least one dot in the top row of the braille cell, dot 1 or dot 4. Table 3.1 lists all upper groupsigns.

Table 3.1: Upper groupsigns

⠡	⠣	⠩	⠹	⠱
CH	GH	SH	TH	WH
⠫	⠻	⠳	⠪	
ED	ER	OU	OW	
⠌	⠜	⠬	⠼	
ST	AR	ING	BLE	
⠯	⠿	⠷	⠮	⠾
AND	FOR	OF	THE	WITH

Upper groupsigns are constant in their representations. The upper groupsign ⠷, *OF*, for example retains its interpretation independent of its position within a string of braille cells. In *often* in (6a) it is used word-initially. It represents a syllable in accordance with orthographic word segmentation. In (6b) it is word-medially in *soft* and represents and arbitrary part of the root.[15] In *hoof* in (6c) it is in word-final position corresponding to a letter sequence not compatible with word segmentation as it splits the complex grapheme <oo>. Finally, in (6d) ⠷, *OF*, represents the preposition *of* in *a cup of tea*.

(6) a. ⠷⠞⠢
OFten
often

b. ⠎⠷⠞
sOFt
soft

c. ⠓⠕⠷
hoOF
hoof

d. ⠁ ⠉⠥⠏ ⠷ ⠞⠑⠁
a cup OF tea
a cup of tea

[15] "A root is that part of a word-form which remains when all inflectional and derivational affixes have been removed" (Bauer 2003:340).
Affixes are obligatory bound morphemes which attach to roots or to other affixes (Katamba 1993:44).

The use of an upper groupsign as a whole word like ⠷, *OF*, in (6d) forms a special subgroup of upper groupsigns, upper wordsigns.[16] They are of the same form as upper groupsigns but may represent a whole word when standing in isolation.

> 8.2.1 Simple upper wordsigns may be preceded or followed by punctuation signs, and may be preceded by the italic or capital signs and by the contractions *TO*, *INTO* and *BY*.
>
> *Examples*: "YOU *HAVE* TO/GO!" ⠦⠠⠽ ⠨⠓ ⠖⠛⠖⠴
>
> *British Braille* (2004:92)

> 8.2.2 Letters or contractions shall not directly adjoin these wordsigns.
>
> *Examples*: CHildlike [not *CHILD/LIKE] [17], like<u>NESS</u> [not *LIKE/<u>NESS</u>], peoples [not PEOPLEs], STillER [not *STILL/ER], WHiCH/<u>EVER</u> [not *WHICH/<u>EVER</u>], WITH/OUt, [not *WITH/OUT]. [18]
>
> *British Braille* (2004:93)

In addition, every letter of the alphabet represents a word if it stands free, i.e. if it is only adjacent to a space as ⠙, *DO*, ⠽, *YOU*, and ⠇, *LIKE*, in (7a) or to a punctuation mark as ⠇, *LIKE*, in (7b). In (7c) a transcription of the example in Rule 8.2.1 is given, with a lower wordsign, a formatting sign and punctuation signs adjacent to upper wordsigns.

(7) a. ⠙ ⠽ ⠇ ⠍⠊⠇⠅⠦
DO YOU LIKE milk?
Do you like milk?

b. ⠱⠁⠞ ⠙⠕⠑⠎ ⠩⠑ ⠇⠦
WHat does SHe LIKE?
What does she like?

c. ⠦⠠⠽ ⠨⠓ ⠖⠛⠖⠴
open double inverted commas-capital indicator-YOU italic sign-HAVE TO-GO-exclamation mark - close double inverted commas[19]
"You *have* to go !"

If a sign other than a space or a punctuation mark is adjacent to an upper groupsign, it can no longer be used as a wordsign. Thus *childlike* in (8a) may use neither of the upper wordsigns *child* and *like.* In *without* in (8b) the upper wordsign *out* may not be used

(8) a. *⠡⠇
* CHILD LIKE

a'. ⠡⠊⠇⠙⠇⠊⠅⠑
CHildlike
childlike

---

[16] In general, wordsigns are units consisting of up to two braille cells that represent a whole word.
[17] The asterisk is used to indicate that the following forms are disallowed.
[18] Composite contractions are two cell units. They are marked as a sequence of underlined upper case letters.
[19] The interpretation of lower groupsigns depends on their position within a string of braille cells. The lower wordsign *TO* and the exclamation mark have the same form. See section 3.2.

b. *⠾⠳
* WITH/OU

b'. ⠾⠳⠞
WITH/OUt
without

At this point British Braille is inconsistent. All members of the set { *AND*, *FOR*, *OF*, *THE*, *WITH*, *a*} are sequenced unspaced, yet they are upper wordsigns and covered under Rule 8.2.2.[20] This means ⠾, *WITH*, in *without* in (8b), which is listed as one example of Rule 8.2.2, should not be used here. Table 3.2 lists all upper wordsigns that are based on letters of the alphabet and on upper groupsigns.

Table 3.2: Upper wordsigns

braille sign	letter	wordsign	braille sign	groupsign	wordsign
⠁	a	a	⠡	CH	CHILD
⠃	b	BUT	⠣	GH	
⠉	c	CAN	⠩	SH	SHALL
⠙	d	DO	⠹	TH	THIS
⠑	e	EVERY	⠱	WH	WHICH
⠋	f	FROM	⠫	ED	
⠛	g	GO	⠻	ER	
⠓	h	HAVE	⠳	OU	OUT
⠊	i	I	⠪	OW	
⠚	j	JUST	⠌	ST	STILL
⠅	k	KNOWLEDGE	⠜	AR	
⠇	l	LIKE	⠬	ING	
⠍	m	MORE	⠼	BLE	
⠝	n	NOT	⠯	AND	AND
⠕	o		⠿	FOR	FOR
⠏	p	PEOPLE	⠷	OF	OF
⠟	q	QUITE	⠮	THE	THE
⠗	r	RATHER	⠾	WITH	WITH
⠎	s	SO			
⠞	t	THAT			
⠥	u	US			
⠧	v	VERY			
⠺	w	WILL			
⠭	x	IT			
⠽	y	YOU			
⠵	z	AS			

[20] 8.2.7 The words *and*, *for*, *of*, *the*, *with*, *a* should generally follow one another without a space if occurring on the same braille line, even when a sense break or natural pause is present. British Braille (2004:96)

3.2 Lower groupsigns

All lower signs have their dots embossed in the two lower rows of the braille cell. They are either punctuation signs or represent letter sequences. The main difference between upper and lower groupsigns is that the letter sequences represented by lower groupsigns are determined by the groupsign's position within a string of adjacent braille cells. The sign ⠲ stands for the letter sequence <dis> in word-initial position, (9a), for the letter sequence <dd> in word-medial position (9b). In the absolute final position in (9c) this sign is a full stop. [21]

(9) a. ⠲⠇⠊⠅⠑
DISlike
dislike

b. ⠍⠥⠲⠽
muDDy
muddy

c. ⠝⠕ ⠎⠇⠑⠑⠏⠲
No sleep.

The full set of lower signs is given in Table 3.3. Word-initially, the letter sequence a lower groupsign represents frequently functions as a prefix. In word-medial position, lower groupsigns are mainly geminates. Only two of the lower groupsigns, ⠢, *EN*, and ⠔, *IN*, may stand in word-final position as there is no corresponding punctuation mark for these signs. All other signs function as punctuation marks in this position. Similar to upper groupsigns several lower groupsigns function as wordsigns when standing free.

[21] Punctuation marks are not groupsigns. They are, however, included in Table 3.3 in order to show how the meaning of a sign changes in relation to its position in a string of braille cells.

Table 3.3: Lower groupsigns

braille sign	word-initial	word-medial	word-final	wordsign
⠔	IN	IN	IN	IN
⠢	EN	EN	EN	ENOUGH
⠂	non-Roman letter sign	EA	comma	
⠆	BE	BB	semicolon	BE
⠒	CON	CC	colon	
⠲	DIS	DD	full stop	
⠤	COM	hyphen	hyphen	
⠖		FF	exclamation mark	TO (sequenced) [22]
⠶	round bracket open	GG	round bracket close	WERE
⠦	open double inverted commas		question mark	HIS
⠴			close double inverted commas	WAS
⠴				BY (sequenced)
⠔⠖				INTO (sequenced)

As each upper sign which uses only the two highest rows of the braille cell has a corresponding lower sign of identical shape, every sequence of lower signs must be in contact with an upper sign.[23] Otherwise the sequence ⠃⠑, <be>, in (10a) and the sequence ⠆⠢, *BE/EN*, in (10b) could be easily mistaken to be the same sequence.

(10) a. ⠃⠑
be

b. *⠆⠢
*BE/EN

b'. ⠃⠑⠢
beEN
been

Furthermore, the letter *d* in (11a) and the full stop in (11b) have the same shape. This is further emphasised by the fact that the full stop is also referred to as *lower d* in colloquial speech.

(11) a. ⠙
d

b. ⠲
full stop

The use of lower groupsigns strictly depends on the environment of the sign. In order to avoid ambiguities with punctuation marks, which are placed at the end of a sequence of braille cells, a lower groupsign may not be used in a word-final position. The two lower

[22] The lower groupsigns TO, INTO and BY have to be adjacent to the following word. If this is not possible, e.g. at a line end *to*, *into* and *by* may not be represented by these groupsigns.
[23] A shape is a dot configuration within a braille cell.

groupsigns ⠔, *IN*, and ⠢, *EN*, are exempt from this requirement as there are no corresponding punctuation marks.

As a consequence one root may have several orthographic forms. None of the words in (12) may use the lower groupsign as these signs are interpreted as punctuation marks in word-final position.

(12) a. *⠁⠲ *aDD add — a'. ⠁⠲ a. — a''. ⠁⠙⠙ add

b. *⠉⠇⠊⠖ *cliFF cliff — b'. ⠉⠇⠊⠖ cli! — b''. ⠉⠇⠊⠋⠋ cliff

c. *⠑⠶ *eGG egg — c'. ⠑⠶ e) — c''. ⠑⠛⠛ egg

d. *⠞⠂ *tEA tea — d'. ⠞⠂ t, — d''. ⠞⠑⠁ tea

In the examples in (13) the respective letter sequences occur in word-medial position and there the use of the lower groupsign is obligatory.

(13) a. ⠁⠲⠬
aDD/ING
adding

b. ⠉⠇⠊⠖⠎
cliFFs
cliffs

c. ⠑⠶⠎
eGGs
eggs

d. ⠞⠂⠃⠁⠛
tEAbag
teabag

The only context in which a lower groupsign may occur in word-final position is if it is followed by a punctuation mark, as in example (14a). Here the lower groupsign ⠂, *EA*, is used, because in the sequence <tea.> it followed by the period. In contrast, in (14b) the sequence <ea> is in an absolute final position and therefore the letters have to be spelled out in full. If the sign ⠂ is used it is interpreted as a comma and thus the sequence reads *that* followed by a comma, as in (14c).

(14) a. ⠚⠕ ⠇⠊⠅⠑⠎ ⠞⠂⠲
Jo likes tEA.
Jo likes tea.

b. ⠚⠕ ⠇⠊⠅⠑⠎ ⠞⠑⠁ ⠯ ⠅⠑⠇⠇⠽ ⠍⠊⠇⠅⠲
Jo likes tea AND Kelly milk.
Jo likes tea and Kelly milk.

c. ⠚⠕ ⠇⠊⠅⠑⠎ ⠞⠂ ⠯ ⠅⠑⠇⠇⠽ ⠍⠊⠇⠅⠲
Jo likes THAT, AND Kelly milk.
Jo likes that, and Kelly milk.

3.3 Composite groupsigns

A composite groupsign is a complex braille unit consisting of an indicator sign followed by a letter or an upper groupsign. The indicator signs in (15) consist of a combination of dots 4-6 in the right column of the braille cell. They have no print equivalent and are signs that are not part of the alphabet, numbers or punctuation signs.

(15) a. ⠐   d. ⠨

b. ⠘   e. ⠰

c. ⠸   f. ⠠

Composite groupsigns are divided into two sets, composite initial groupsigns and composite final groupsigns. Composite initial groupsigns use one of the indicator signs given in (16) in combination with the first letter or the initial upper groupsign of the letter sequence to be represented, usually a root morpheme.

(16) a. ⠐

b. ⠘

c. ⠸

In general, composite initial groupsigns are used wherever the letter sequence they represent occurs. They are blind to the function of this letter sequence within the word. Thus the composite groupsign *word* is used as a wordsign in (17a), as the root *word* in *wordless* in (17b) or as the letter sequence <word> in *sword* (17c).

(17) a. ⠘⠺
WORD
word

b. ⠘⠺⠨⠎
WORD/LESS
wordless

c. ⠎⠘⠺
sWORD
sword

The full set of composite initial groupsigns is given in Table 3.4.

Table 3.4: Composite initial groupsigns

braille sign	letter	⠐	dot 5 contraction	⠘	dot 4-5 contraction	⠸	dot 4-5-6 contraction
⠉	c					⠸⠉	CANNOT
⠙	d	⠐⠙	DAY				
⠑	e	⠐⠑	EVER				
⠋	f	⠐⠋	FATHER				
⠓	h	⠐⠓	HERE			⠸⠓	HAD
⠅	k	⠐⠅	KNOW				
⠇	l	⠐⠇	LORD				
⠍	m	⠐⠍	MOTHER			⠸⠍	MANY
⠝	n	⠐⠝	NAME				
⠕	o	⠐⠕	ONE				
⠏	p	⠐⠏	PART				
⠟	q	⠐⠟	QUESTION				
⠗	r	⠐⠗	RIGHT				
⠎	s	⠐⠎	SOME			⠸⠎	SPIRIT
⠞	t	⠐⠞	TIME				
⠥	u	⠐⠥	UNDER	⠘⠥	UPON		
⠺	w	⠐⠺	WORK	⠘⠺	WORD	⠸⠺	WORLD
⠽	y	⠐⠽	YOUNG				
⠮	THE	⠐⠮	THERE	⠘⠮	THESE	⠸⠮	THEIR
⠡	CH	⠐⠡	CHARACTER				
⠹	TH	⠐⠹	THROUGH	⠘⠹	THOSE		
⠱	WH	⠐⠱	WHERE	⠘⠱	WHOSE		
⠳	OU	⠐⠳	OUGHT				

Composite final groupsigns use the set of indicator signs in (18) which are immediately followed by the last letter of the letter sequence they represented.

(18) a. ⠨

b. ⠰

c. ⠠

Most composite final groupsigns represent a suffix like -*less* in (19a). Composite final groupsigns may not be used as wordsigns (19b) and, as predicted by their name, they may not occur in word-initial position either, (19c).

(19) a. ⠉⠜⠑⠨⠎
cAReLESS
careless

b. *⠨⠎
*LESS

b'. ⠇⠑⠎⠎
less

c. *⠨⠎⠢
*LESS/EN

c'. ⠇⠑⠎⠎⠢
lessEN
lessen

A list of composite final groupsigns is given in Table 3.5.

Table 3.5: Composite final groupsigns

braille sign	letter	⠨	dot 4-6 contraction	⠰	dot 5-6 contraction	⠠	dot 6 contraction
⠙	d	⠨⠙	OUND				
⠑	e	⠨⠑	ANCE	⠰⠑	ENCE		
⠛	g			⠰⠛	ONG		
⠇	l			⠰⠇	FUL		
⠝	n	⠨⠝	SION	⠰⠝	TION	⠠⠝	ATION
⠎	s	⠨⠎	LESS	⠰⠎	NESS		
⠞	t	⠨⠞	OUNT	⠰⠞	MENT		
⠽	y			⠰⠽	ITY	⠠⠽	ALLY

3.4 Shortforms

Contracted braille uses 76 shortforms. Shortforms are high frequency words which are specially abbreviated in braille. Like in a shorthand system, they preserve essential letters of the original word (Millar 1997:178). Thus braille shortforms are usually composed by preserving consonants and vowels in word-initial position, as shown in (20).

(20) a. ⠁⠉⠉
acc
according

b. ⠩⠙
SHd
should

c. ⠍⠌
mST
must

In contrast to groupsigns, shortforms have to retain the meaning of the root morpheme. A shortform may occur in combination with an affix as long as the form of the root is not affected by the addition of the affix. Thus in *accordingly* in (21b) the shortform for *according*, ⠁⠉⠉, may be used.

(21) a. ⠁⠉⠉
acc
according

b. ⠁⠉⠉⠇⠽
accly
accordingly

Where an upper groupsign such as ⠯, *AND*, in *sand* usually represents an arbitrary string of letters, a shortform always represents a root. Thus *mustard* in (22a) and *shoulder* in (22b) may not use the shortforms *must* and *should*.

(22) a. *⠍⠌⠜⠙
*mST/ARd

a.' ⠍⠥⠌⠜⠙
muST/ARd
mustard

b. *⠩⠙⠻
*SHdER

b.' ⠩⠳⠇⠙⠻
SH/OUldER
shoulder

Table 3.6 gives a full list of shortforms.

Table 3.6: Shortforms

shortform	transcription	full form	shortform	transcription	full form
⠁⠃	ab	about	⠓⠻⠋	hERf	herself
⠁⠃⠧	abv	above	⠓⠍	hm	him
⠁⠉⠉	acc	according	⠓⠍⠋	hmf	himself
⠁⠉⠗	acr	across	⠊⠍⠍	imm	immediate
⠁⠋	af	after	⠭⠎	xs	its
⠁⠋⠝	afn	afternoon	⠭⠋	xf	itself
⠁⠋⠺	afw	afterward	⠇⠗	lr	letter
⠁⠛	ag	again	⠇⠇	ll	little
⠁⠛⠌	agST	against	⠍⠡	mCH	much
⠁⠇⠍	alm	almost	⠍⠌	mST	must
⠁⠇⠗	alr	already	⠍⠽⠋	myf	myself
⠁⠇	al	also	⠝⠑⠉	nec	necessary
⠁⠇⠹	alTH	although	⠝⠑⠊	nei	neither
⠁⠇⠞	alt	altogether	⠕⠄⠉	o'c	o'clock
⠁⠇⠺	alw	always	⠐⠕⠋	ONEf	oneself
⠆⠉	BEc	because	⠳⠗⠧⠎	OUrvs	ourselves
⠆⠋	BEf	before	⠏⠙	pd	paid
⠆⠓	BEh	behind	⠏⠻⠉⠧	pERcv	perceive
⠆⠇	BEl	below	⠏⠻⠉⠧⠛	pERcvg	perceiving
⠆⠝	BEn	beneath	⠏⠻⠓	pERh	perhaps
⠆⠎	BEs	beside	⠟⠅	qk	quick
⠆⠞	BEt	between	⠗⠉⠧	rcv	receive
⠆⠽	BEy	beyond	⠗⠉⠧⠛	rcvg	receiving
⠃⠇	bl	blind	⠗⠚⠉	rjc	rejoice
⠃⠗⠇	brl	braille	⠗⠚⠉⠛	rjcg	rejoicing
⠡⠝	CHn	children	⠎⠙	sd	said
⠒⠉⠧	CONcv	conceive	⠩⠙	SHd	should
⠒⠉⠧⠛	CONcvg	conceiving	⠎⠡	sCH	such
⠉⠙	cd	could	⠮⠍⠧⠎	THEmvs	THEmselves
⠙⠉⠧	dcv	deceive	⠹⠽⠋	THyf	THyself
⠙⠉⠧⠛	dcvg	deceiving	⠞⠙	td	today
⠙⠉⠇	dcl	declare	⠞⠛⠗	tgr	together
⠙⠉⠇⠛	dclg	declaring	⠞⠍	tm	tomorrow
⠑⠊	ei	either	⠞⠝	tn	tonight
⠋⠌	fST	first	⠺⠙	wd	would
⠋⠗	fr	friend	⠽⠗	yr	your
⠛⠙	gd	good	⠽⠗⠋	yrf	yourself
⠛⠗⠞	grt	great	⠽⠗⠧⠎	yrvs	yourselves

3.5 Summary

British Braille is a system of contracted braille. It consists of an alphabet, numbers, formatting and punctuation signs and a set of contractions. The latter are divided into groupsigns, wordsigns and shortforms. There are 18 upper groupsigns which consist of one braille cell and represent frequent letter sequences. These letter sequences may be arbitrary as the upper groupsign ⠮, *THE* in *other* in (23a), represent a syllable as ⠮, *THE*, in *theatre* in (23b), a morpheme as ⠻, *ER* in *writer* in (23c) or represent and a phoneme or grapheme as ⠹, *TH*, *thus* in (23d).

(23) a. ⠕⠮⠗
oTHEr
other

b. ⠮⠂⠞⠗⠑
THEatre
theatre

c. ⠺⠗⠊⠞⠻
writER
writer

d. ⠹⠥⠎
THus
thus

There are 16 lower groupsigns which are distinguished by their position within a string of braille cells. ⠒ represents the string <con> word-initially, <cc> in word-medial position and a colon at the end of a string of adjacent braille cells.

There are 14 composite final groupsigns and 33 composite initial groupsigns. Both sets are two cell contractions which contain as first cell a functional element followed by a letter or an upper groupsign. Composite final groupsigns are not allowed in word-initial position. They often represent a suffix such as ⠨⠎, *LESS*, in *useless* in (24a). They may also represent arbitrary letter sequence as in *bless* in (24b).

(24) a. ⠥⠎⠑⠨⠎
useLESS
useless

b. ⠃⠨⠎
bLESS
bless

In contrast, all composite initial groupsigns may be used as groupsigns as ⠐⠗, *RIGHT*, independent of their position within a word and thus in both *rightly* in (25a) and in *fright* in (25b). In addition, they may also be used as wordsigns as in *right* in (25c).

(25) a. ⠐⠗⠇⠽
RIGHTly
rightly

b. ⠋⠐⠗
fRIGHT
fright

c. ⠐⠗
RIGHT
right

In addition to groupsigns this system contains wordsigns and shortforms. There are 34 upper wordsigns, 9 lower wordsigns and 33 composite wordsigns. *British Braille* contains a set of 76 shortforms. They are abbreviations of high frequency words which are not covered by wordsigns. Whereas wordsigns consist of one constituent groupsign, shortforms consist of sequences of letters or letters and groupsigns. *About* in (26a) contains just letters, *although* in (26b) contains an upper groupsigns, *because* in (26c) contains a lower groupsign and *oneself* in (26c) is the only shortform containing a composite groupsign.

(26) a. ⠁⠃
ab
about

b. ⠁⠇⠹
alTH
although

c. ⠆⠉
BEc
because

d. ⠐⠕⠋
ONEf
oneself

To summarize, *British Braille* contains 81 groupsigns, 76 wordsigns and 76 shortforms. They all serve the purpose to make braille less bulky and thus save reading time and printing costs.

4 Use of contractions

British Braille is the reference book edited by the standard setting braille body in Britain, the *Braille Authority of the United Kingdom* (*BAUK*). BAUK members are individuals and representatives of organisations representing people who are blind or visually impaired and co-operate with braille authorities world-wide on the standards and development of braille. *British Braille* is a prescriptive compilation of rules on the use of contracted braille and text layout. It covers terminology related to braille (chapter 1), braille characters and signs (chapter 2), a list of contractions (chapter 3), the use of punctuation signs (chapter 4), the use of composition signs such as capitals, boldface and italics (chapter 5), numbers and related signs (chapter 6), print abbreviations and symbols (chapter 7), the use of contractions (chapter 8) and finally layout and bookwork (chapter 9). It is neither concerned with braille as a primary writing medium nor with braille production by an individual who uses braille as their primary mode of writing.

> The object of this book is to provide for transcribers, copyists and proofreaders of braille a standard interpretation of the usages of inkprint, and for readers, teachers and students of braille a guide to agreed practice. However, no attempt has been made to legislate comprehensively for the writing of braille which is not derived from a print original, or which is for private use only.
>
> *British Braille* (2004:5)

Based on this statement I assume that all rules on the use of contractions in *British Braille* target braille reading. This assumption is supported by a number of rules which require that the legibility of a contracted form is more important than space-saving, especially as one of the reasons for introducing contractions was the aim to increase reading speed (Lorimer 1996:203).[24]

In this chapter, I discuss the *British Braille* rules on the use of contractions with respect to both form and function. The aim is to reveal the underlying linguistic structures that are relevant for these rules and to transform the idiosyncratic compilation of rules given by *British Braille* into a system of generalisations in order to show that they are not part of an algorithm that transforms print to braille but are based on implicit linguistic knowledge. I will concentrate on the rules that cover the use of contractions and disregard all those that govern the use of numbers and punctuation signs or formatting requirements. Thus there will be gaps in the sequence of the *British Braille* rule numbers.

[24] All *British Braille* rules are referred to as 'Rule' together with their number in the 2004 edition and all rules used here are listed in Appendix A.

Global preferences and hierarchies in the choice of braille contractions are discussed in section 4.1. The following sections contain restrictions on the use of individual contractions ordered by form: section 4.2 examines upper groupsigns, section 4.3 lower groupsigns, section 4.4 composite groupsigns and section 4.5 shortforms. In section 4.6 the 1992 and 2004 editions of *British Braille* are compared. As the 2004 edition is predominantly a liberalisation of rules with respect to the use of contractions, it is the version used for discussion of the results of the braille study in chapter 9 even if the participants cannot have been aware of the code changes at the time of the study.

4.1 Global preferences of contractions

Traditionally, braille is seen as a subsystem of print. As a consequence braille production is regarded as print to braille transcription by *British Braille*. Although there are no defining criteria for this requirement, interference with legibility has to be avoided. This is implicitly reflected in three rules on the preference of contractions: Rule 8.8.1, 8.8.5 and 8.4.29 name *distortion* as an exclusion criterion for the use of contractions which implicitly is also at work in Rule 8.9.6.[25]

> 8.8.1 Preference should normally be given to contractions which cause a word to occupy fewer cells, unless this would result in serious distortion.
>
> *Examples*: advANCEd [not *advancED], aRIGHT [not *ARiGHt], basTION [not *baSTion], dANCEr [not *dancER], happiNESS [not *happINess], meAND/ER [not *mEAndER], NAMEd [not *namED], TIMEr [not *timER], vENgeANCE [not *vENgEAnce], WITH/ER not *wiTHEr], but tablEAu [not *taBLEau]
>
> *British Braille* (2004:112)

> 8.8.5 Simple groupsigns should generally be preferred to composite contractions, provided their use does not waste space.
>
> *Examples*: adhER/ENt [not *adHEREnt], adhER/ER [not *adHEREr], cohER/ED [not *coHEREd], COMmENcED [not *COMmENCEd], COMponENt[not *COMpONEnt], CONgo [not *cONGo], CONgratulate [not *cONGratulate],CONgruITY [not *cONGruITY], eFFulgENt [not *efFULgENt], expERiENcED [not *expERiENCEd], fENcED [not *fENCEd], gaTHErED [not *gaTHEREd], haDDock [not *HADdock], hER/ED/ITY [not *HEREdITY], INfluENcEA/BLE [not *INfluENCEaBLE], poisonED [not *poisONEd], SHadOW [not *sHAD/OW],silENcER [not *silENCEr], sliTHErED [not *sliTHEREd], SpENcER [not *SpENCEr], telephonED [not *telephONEd], tonER [not *tONEr], wEA/THErED [not *wEA/THEREd].
>
> However, if the form of the word would otherwise be distorted, composite contractions should be used.
>
> *Examples*: cONEy [not *CONey], limbLESS [not *limBLEss], midDAY [not *miDDay], STrONGhold, [not *STronGHold], WHEREas [not *WH/ER/EAs]
>
> *British Braille* (2004:112f.)

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[25] The angled brackets within the *British Braille* rules are my additions.

8.4.29 The contraction for EA should not be used when the letters belong to two distinct syllables and the <a> does not begin a suffix, *or* when the form of a root word would be excessively distorted.

Examples: aurora borealis [not *aurora borEAlis], BEatific [not *bEAtific], gENealogy [not *gEN/EAlogy], habeas corpus [not *habEAs corpus], hanseatic [not *hansEAtic], Neapolitan [not *N/EApolitan], orgeat [not *orgEAt], pancreas [not *pancrEAs], pINeapple [not *pIN/EApple]

British Braille (2004:105)

8.9.6 The contraction for EA should not be used when the *e* or *a* forms part of the diphthong ae, whether printed as such [i.e. æ] or not.

Examples: Judaean [not *JudaEAn], Liliaceae [not *LiliacEAe]

British Braille (2004:114)

None of these rules contains a definition of *distortion*. For instance, *British Braille* gives one example for *serious distortion* in Rule 8.8.1. There are two possible contractions for the letter sequence <bleau> in *tableau*: the upper groupsign ⠼, *BLE*, in (1a) and the lower groupsign ⠂, *EA*, in (1a'). *British Braille* explicitly requests (1a') to be used although it violates Rule 8.8.1 [use fewest space] and Rule 8.8.3 [upper groupsign are preferred over lower groupsigns].

(1) a. *⠞⠁⠼⠁⠥
*taBLEau

a'. ⠞⠁⠃⠇⠂⠥
tablEAu
tableau

British Braille does not explain why the use of the upper groupsign ⠼, *BLE*, in (1a) is regarded more distorting than the use of the lower groupsign ⠂, *EA*, in *tableau*. There are at least two reasons for rejecting the form in (1a). Firstly it might activate a wrong lexeme, *table*, secondly it interferes with the complex grapheme <eau>.

Comparing the choice of contraction for *tableau* with the examples given to illustrate Rule 8.9.6, *Judaean*, (2a), and *Liliaceae*, (2b), it can be seen that in all three examples braille contractions must not disrupt a complex grapheme.[26] In *tableau* the use of ⠼, *BLE*, disrupts the complex grapheme <eau>; in *Judaean* and *Liliaceae* in (2) ⠂, *EA*, creates the inappropriate complex grapheme is <ea>.

(2) a. *⠚⠥⠙⠁⠂⠝
*JudaEAn

a'. ⠚⠥⠙⠁⠑⠁⠝
Judaean

b. *⠇⠊⠇⠊⠁⠉⠂⠑
*LiliacEAe

b'. ⠇⠊⠇⠊⠁⠉⠑⠁⠑
Liliaceae

[26] Since the use of capitals in braille is optional in the UK, capitals are not indicated in the braille examples.

In addition to the term *distortion, British Braille* uses two other contexts in which a contraction must not be used. Rule 8.8.6 requires that a contraction must not 'upset the usual pronunciation of words' and Rule 8.9.1 allows the use of a contraction unless it 'would make the word hard to assimilate by the reader'. Both requests are illustrated by examples without stating a definition.

> 8.8.6. Contractions should not be used which would upset the usual pronunciation of words.
>
> *Examples*: asTHma not aSThma, creATION not crEA/TION, diSHevellED not DIShevellED, gINGham, not gIN/GHam, isTHmus not iSThums, poSThumOUs not posTHumOUs
>
> *British Braille* (2004:113)

> 8.9.1. In general, contractions which bridge a prefix and the remainder of a word are permissible unless their use would make the word hard to assimilate by the reader. In particular the contractions ED, EN, ER, OF and ST are permissible. Note however, the second paragraph of 8.8.3., whereby a lower contraction may be used in preference to one of these upper contractions to avoid bridging.
>
> *Examples*: dEDuce, dEN/ATIONalise, dENominator, dENote, dERail, dERange, EDict, miSTake, miST/ERm, prEDeST/INe, prEDicaMENT, prEDicTION, prEDomINate, prERogative, prOFile, prOF/OUND, prOFuSION, rED/OU/BLE, rENew
>
> *But*: aERofoil [not *aER/OFoil], BEratED [not *bERatED], comate [not *COMate], deactivate [not *dEActivate], disulphide [not *DISulphide], INessENtial [not *iNESS/ENtial], kilowatt [not *kilOWatt], misheAR [not *miSHeAR], react [not*rEAct], sublet [not *suBLEt]
>
> *British Braille* (2004:113)

The individual restrictions of rule 8.4.29, 8.8.1, 8.8.5, 8.8.6, 8.9.6 and 8.9.1 all prevent a contraction to interfere with a complex grapheme. I summarise these restrictions in Generalisation 1. This is the most powerful generalisation on the choice of contractions. It disallows interferences of a braille contraction with decoding in braille reading, as the very justification for a braille contraction is to facilitate reading.

> Generalisation 1
> The use of a braille contraction must not interfere with decoding in braille reading by interrupting or creating complex graphemes.

This generalisation rules out interferences induced by treating braille production as an algorithmic print to braille transcription process. Complex graphemes must not be restructured inappropriately by braille contractions.[27]

Once Generalisation 1 is satisfied, space-saving is the next important factor. In example (3) there are three possibilities of contracting the letter sequence <wither>. In (3a) the letter sequence <the> is represented by the upper groupsign ⠮, *THE*. In (3b) the

[27] Allowing braille contractions to be used wherever the corresponding print letter sequence occurred has partly been in use in the early stages of contracted braille in the UK (Lorimer et al. 1982:IV:7). The discussion of allowing such a practice was started again by computer programmers working on computerized braille production in the 1970s (Lorimer et al. 1982: IV:1).

sequence of the upper groupsign ⠹, *TH*, and the upper groupsign ⠻, *ER*, represent the letter sequence <ther>. Finally, the sequence of the upper groupsigns ⠾, *WITH*, and ⠻, *ER*, are used to represent the letter sequence <wither> in (3c). Following Rule 8.8.1. [use least space] *British Braille* gives preference to the version in (3c). None of the forms interferes with decoding in braille reading but (3c) saves two spaces in comparison to the forms in (3a) and (3b).

(3) a. *⠺⠊⠮⠗
*wiTHEr

b. *⠺⠊⠹⠻
*wiTH/ER

c. ⠾⠻
WITH/ER
wither

Rule 8.8.1 [use least space] in combination with Generalisation 1 is the most powerful global rule on the use of braille contractions. In the following two subsections they are discussed with respect to restrictions based on the linguistic structure of the targeted words, section 4.1.1, and with respect to global preferences in the use of contraction due to their form, section 4.1.2.

4.1.1 Linguistic restrictions on the use of contractions

The main objective of contracted braille is to save space in order to increase reading speed. The underlying assumption is that at a constant rate the same text presented in fewer cells is read faster as all cells have to be covered by the reading finger one at a time. Yet, word superiority effects, the fact that words are read more quickly than the letters of which they consist, have been reported in braille. They are associated with word familiarity and word length (Millar 1997:153). Nolan and Kederis (1969) suggested that fast readers might process word-initial letters only and then guess the rest.

In contracted braille, effective space-saving depends on two factors: the number of saved braille cells in a contracted word and the frequency of occurrence of a certain contraction within a text. A big difference in the number of braille cells used for a word in contracted braille compared to the number of cells used for the same word in uncontracted braille can be found in the realisations of *knowledge*. In uncontracted braille *knowledge* uses the space of nine braille cells, as in (4a). In contrast, in contracted braille *knowledge* is an upper wordsign represented by the letter < k> in (4a'). Thus the use of the upper wordsign for *knowledge* saves eight braille cells.

(4) a. *⠅⠝⠕⠺⠇⠑⠙⠛⠑ a'. ⠅
*knowledge KNOWLEDGE
knowledge

Yet, the second factor, frequency of occurrence, also has to be taken into account. The definite article *the* is represented by an upper wordsign in contracted braille (5a'), saving the space of two braille cells compared to the full form in (5a).

(5) a. *⠞⠓⠑ a'. ⠮
*the THE
the

In contrast to *knowledge* in (4a'), *the* in (5a') saves just two spaces. At the same time it occurs much more frequently than *knowledge*.

Lorimer et al. (1984:II:58) calculated the mean space-saving of individual contractions in contracted braille over uncontracted braille per one million words. Comparing the space-saving power of *knowledge* and *the* based on the frequency of occurrence, *the* is first, with a saving total of 11.5% (160,285 occurrences) compared to uncontracted braille, whereas *knowledge* is on rank 150 with 960 occurrences.[28]

Independent of the question of how much space is saved by the use of a particular contraction, it must never interfere with legibility. Even though *British Braille* refers to braille production as print to braille transcription, this cannot be done by an algorithm that produces a one-to-one mapping of letter sequences to braille cells. Depending on the type of contraction (upper versus lower, simple versus complex), contracted braille needs to take the morphological, phonemic and graphemic word structure into account in order not to sacrifice legibility for saving space.

Morphology

In this section I will examine the rules that relate to elements of morphology. The aim is to see whether there are any redundancies in these rules and to determine the underlying linguistic generalisations. *British Braille* contains the following four general rules which directly relate to morphology.

8.9.1 In general, contractions which bridge a prefix and the remainder of a word are permissible unless their use would make the word hard to assimilate by the reader. In particular the contractions ED, EN, ER, OF and ST are permissible. Note however, the second paragraph of

[28] Lorimer et. al give cumulative percentages of the total mean space-saving capacity of the 189 contractions of *British Braille*. In their corpus the contractions ranking from 84 upwards together have a space-saving capacity of 9.9%.

8.8.3., whereby a lower contraction may be used in preference to one of these upper contractions to avoid bridging.

Examples: dEDuce, dEN/ATIONalise, dENominator, dENote, dERail, dERange, EDict, miSTake, miST/ERm, prEDeST/INe, prEDicaMENT, prEDicTION, prEDomINate, prERogative, prOFile, prOF/OUND, prOFuSION, rED/OU/BLE, rENew

But: aERofoil [not *aER/OFoil], BEratED [not *bERatED], comate [not *COMate], deactivate [not *dEActivate], disulphide [not *DISulphide], INessENtial [not *iNESS/ENtial], kilowatt [not *kilOWatt], misheAR [not *miSHeAR], react [not *rEAct], sublet [not *suBLEt]

British Braille (2004:113)

8.9.2 Except in the case of the contraction for EA it is usually not advisable to take advantage of a prefix in order to use a contraction which could not have been used in the original word.

Examples: DIS/INgENiOUs [not *DIS/ING/ENiOUs], electroencephalogram [not *electroENCEphalogram], unblemiSH/ED [not *unBLEmiSH/ED], unfulfillED [not *unFULfillED], unlessonED [not *unLESSonED]; but DIS/EAse, unEAtaBLE.

British Braille (2004:114)

8.9.3 Generally speaking, a contraction may bridge a word and its suffix.

Examples: borEDom, dukEDom, freEDom, orangERy, savagERy

However, bridging contractions should be avoided when aspirated *h* is preceded by *c*, *g*, *s*, *t*, or *w*, and in certain other cases.

Examples: Cunnyngham [not *CunnynGHam], kniGHthood [not *kniGH/THood], biscuity [not *biscuITY], orangeade [not *orangEAde].

British Braille (2004:114)

8.9.4 Contractions should not be used to bridge elements of compound words.

Examples: bottleneck [not *bottlENeck], hEAddress [not *hEA/DDress], hideaway [not *hidEAway], IndiaruBB/ER [not *INdiARuBB/ER], INsofAR [not *INsOF/AR], kettledrum [not *kettlEDrum], paINstakING [not *paIN/STakING], STateroom [not *STatERoom].

British Braille (2004:114)

British Braille explicitly allows the bridging of roots and affixes because it saves space. However, as one of the main objectives of contracted braille is to increase reading speed, bridging must not interfere with legibility and thus Generalisation 1 is ranked higher than the rules that govern bridging. This aspect is also at work in Rule 8.9.2 which disallows the change of a root morpheme when prefixation would sanction the use of a contraction that cannot be part of the free standing root. This restriction mainly affects the two upper groupsigns ⠼, *BLE*, and ⠬, *ING*, plus the set of composite final groupsigns, none of which may occur in word-initial position. This rule reflects word recognition in reading where a word-initial sequence is more prominent than a word-final sequence, as parsing is linear and always from left to right so that word-initial positions are always accessed before word-final positions (Millar 1997:154). As a consequence *British Braille* allows changes in a root only if these are caused by the presence of a suffix. The lower groupsign ⠂, *EA*, is exempt from this requirement:

> Another factor affecting the readability of braille words is number and distribution of dots within them. Nolan and Kederis (1969) have shown that recognition times increase not only as words become longer, but also as the dot content of cells increases. Consequently, the effect on dot density of removing a contraction should be considered before a decision to delete it is taken. For example, it has been suggested that double letter signs might be deleted because their contribution to space-saving is so small. However, these signs have another and more useful function: they serve to break up heavy contractions of dots within a word, so making the symbols adjoining them more easily recognisable.
>
> Lorimer et al. (1982:22f)

A further restriction on bridging occurs in compounds. The roots of a compound cannot be bridged by a contraction, Rule 8.9.4. Two examples are given in (6). Independent of their form, neither the upper groupsign ⠫, *ED*, in (6a) nor the lower groupsign ⠢, *EN*, in (6b) may be used to bridge the roots *kettle* and *drum* in *kettledrum* nor *bottle* and *neck* in *bottleneck*.

(6) a. *⠅⠑⠞⠞⠇⠫⠗⠥⠍ a'. ⠅⠑⠞⠞⠇⠑⠙⠗⠥⠍
*kettlEDrum kettledrum

b. *⠃⠕⠞⠞⠇⠢⠑⠉⠅ b'. ⠃⠕⠞⠞⠇⠑⠝⠑⠉⠅
*bottlENeck bottleneck

Rule 8.9.4 is supported by Rule 8.9.5 which also handles the use of contractions in compounds, although this is not explicitly stated. As all examples listed in 8.9.5 are already ruled out by 8.9.4, Rule 8.9.5 is redundant.

> 8.9.5 The contractions for CH, GH, SH, TH, THE, WH should not be used when the *h* is aspirated at the beginning of a clearly marked syllable.
>
> *Examples*: cARthorse, cOWhERd, eGGhEAd, grasshoppER, lONGhAND, rawhide, STrONGhold, sweetheARt
>
> *British Braille* (2004:114)

To sum up, *British Braille* has an implicit awareness of linguistic structures in the design of contractions; it is not merely based on frequently occurring letter strings. Many of the contractions themselves realise morphemes or phonemes. An overview of structural units that are used by contracted braille is given in Table 4.1.

Table 4.1: Structural units in contracted braille

contraction	transcription	function
⠡	CH	phoneme: /tʃ/ e.g. *chin*
⠣	GH	phoneme: /g/ e.g. *ghost*
⠩	SH	phoneme: /ʃ/ e.g. *ship*
⠹	TH	phoneme: /ð/, /θ/ e.g. *thin* morpheme: suffix e.g. *warmth*
⠱	WH	phoneme: /w/, /ʍ/ *which*
⠫	ED	morpheme: past tense suffix e.g. *played*
⠻	ER	morpheme: suffix a. comparative e.g. *wider* b. nominalisation: agentive e.g. *player*
⠬	ING	morpheme: gerund e.g. *playing*
⠆	BE	morpheme: prefix e.g. *becalm*, *bemoan*
⠢	EN	morpheme: e.g. a. prefix *entomb*, *enslave* b. suffix *wooden*, *shorten*, plural marker: *oxen*
⠔	IN	morpheme: e.g. prefix: negation e.g *intolerant*, *incoherent*
⠲	DIS	morpheme: most productive, added to nouns, verbs and adjectives: e.g. *disarm, disambiguate, disbound*
⠨⠑	ANCE	morpheme: suffix nominalisation: e.g. *surveillance*, *accordance*
⠠⠝⠕⠞	ATION	morpheme: suffix nominalisation: e.g. *inspiration*, *revelation*
⠰⠇⠊⠅⠑	FUL	morpheme: suffix e.g. *cupful*, *doubtful*
⠨⠎	LESS	morpheme: suffix e.g. *careless*
⠰⠎	NESS	morpheme: suffix nominalisation: e.g. *carelessness*
⠰⠽⠕⠥	ITY	morpheme: suffix nominalisation: e.g. *curiosity*, *suitability*
⠰⠞⠓⠁⠞	MENT	morpheme: suffix nominalisation: e.g. *employment*, *government*
⠐⠎	SOME	morpheme: suffix e.g. *troublesome*

The uses of these contractions are not exhaustive. In addition to their structural representations in Table 4.1, they may represent arbitrary letter strings. In example (7a) the composite groupsign ⠰⠽, *ITY*, realises the suffix *-ity*, whereas in (7b) the same sign is used to realise the letter string <ity> as part of the root *city*.

(7) a. ⠗⠑⠛⠥⠇⠜⠰⠽
regulAR/ITY
regularity

b. ⠉⠰⠽
cITY
city

Phonology

In general, phonological restrictions on the use of contractions are incorporated into the rules on the individual use of one particular contraction (see *Segmentation* and section 4.4). There is one general rule with an explicit reference to pronunciation in *British Braille*, Rule 8.8.6.

8.8.6 Contractions should not be used which would upset the usual pronunciation of words.
Examples: asTHma not aSThma, creATION not crEA/TION, diSHevellED not DIShevellED, gINGham, not gIN/GHam, isTHmus not iSThmus, poSThumOUs not posTHumOUs.

British Braille (2004:113)

Each example illustrating this rule has a choice of contractions. *British Braille* does not indicate whether this should imply that only then the structure of a word is taken into account. The braille representations are given in (8). In these examples the deviant forms create associations with inappropriate phonemes. This happens either by creating an inappropriate complex grapheme as <th> in *posthumous* in (8a) or by splitting a complex grapheme as <sh> in *dishevelled* in (8b).

(8) a. *⠏⠕⠎⠹⠥⠍⠳⠍⠎
*posTHumOUs

a'. ⠏⠕⠌⠓⠥⠍⠳⠍⠎
poSThumOUs
posthumous

b. *⠲⠓⠑⠧⠑⠇⠇⠫
*DIShevellED

b'. ⠙⠊⠩⠑⠧⠑⠇⠇⠫
diSHevellED
dishevelled

Table 4.2 lists phonemic transcriptions of the examples in Rule 8.8.6 and the types of interference caused by the use of the deviant forms.

Table 4.2: Rule 8.8.6: Examples

phonological form	target form	deviant form	interference caused by the deviant form
/ˈæsmə/	asTHma	aSThma	inappropriate activation of /t/
/ˈɪsməs/	isTHmus	iSThmus	inappropriate activation of /t/
/ˈpɒstjᵘₔməs/	poSThumOUs	posTHumOUs	inappropriate activation of /θ/
/dɪˈʃevəld/	diSHevellED	DIShevellED	inappropriate destruction of /ʃ/
/ˈgiŋəm/	gINGham	gIN/GHam	inappropriate destruction of /ŋ/
/kriˈeɪʃən/	creATION	crEA/TION	inappropriate deletion of /eɪ/

To summarise, Rule 8.8.6 shows that whenever there is a choice of contractions to represent a given letter sequence, the chosen contraction must not inhibit access to the phonological form of this sequence. It is already covered by Generalisation 1 [the use of a braille contraction must not interfere with decoding in braille reading] and thus redundant. Although *British Braille* does not overtly acknowledge the structure of written words, the choice of contractions must not result in an inappropriate use of complex graphemes which in turn activates an inappropriate phoneme as this is a violation of Generalisation 1.

In the next section, I will show that the use of braille contractions follows word segmentation in print.

Segmentation

In the development of braille there have been various amendments to the code. Some *British Braille* rules seem to have preserved apparently random restrictions as the code changed. One such example is the request that a certain contraction must not be used if preceded or followed by a specific letter as e.g. *tableau* in example (1) where the upper groupsign ⠼, *BLE*, must not be by followed by the letter <a>, see also section 4.2.4.

In many instances these prescriptive restrictions are not random and can be traced back to the criteria that govern end of line hyphenation in Standard English Orthography. *British Braille* contractions seem to implicitly focus on this type of word segmentation. The more complex a contraction is in form the less is it likely to bridge these segmentations. In this subsection, I will give a short overview of word segmentation according to Carney (1994) and discuss how Carney's criteria that govern hyphenation at line breaks match the use of braille contractions. He identified the following five criteria:

1. Whenever possible start each part with a consonant letter - *pal-lid*, *prob-lem*, *sub-li-mate*; but complex letter correspondences other than doublets need to be kept intact: *knick-ers*, *spa-ghetti*.
2. However, a single consonant letter after a stressed short vowel usually goes with the previous vowel letter - *sol-id*, *prod-uct*. Sometimes this happens with an unstressed vowel: *stat-istics* probably occurs as frequently as *sta-tistics*.
3. Do not separate any letter that has a marking function from what it marks - *singe-ing* (not **sing-eing*); *dicta-tion* (not **dictat-ion*); *ra-tional* (not **rat-ional*); *sale-able* (not **sal-eable*).
4. When a consonant letter string spans the point of division, split it as evenly as possible into a final and an initial string that are found otherwise occurring - *laun-dry*, *flim-sy*. With an odd number of consonants, the heavier cluster usually follows the split. Sometimes the split may give unusual letter clusters, such as the initial <dl> in *bun-dle*
5. In a complex word, it is easier for the reader if the break occurs, if possible, at an element boundary, especially a free-form boundary - *news-paper*, *semi-circle*, *defens-ive*, (cf. *cos-tive*). The inflectional endings <-ed>, <-er>, <-es>, <-est>, <-ing> and the ending <-ish> do not usually attract a previous consonant letter (*whit-ish*, *bak-er*, *lat-est*). But this may override criterion (1), giving *leav-er* as against *bea-ver*. They may not operate in proper names [...]. Elements in §Latinate or §Greek words that are not free may or may not be disregarded: *democ-racy* or *demo-cracy*, *pro-duct* or *prod-uct* (overriding criterion (2)). [...]

Carney (1994:78)

In the context of braille contractions and bridging, the most important criteria are (1), (3) and (5). Criterion (1) shows that phonological syllabification and print segmentation need not correspond. Whereas the phonological syllable prefers all consonants in the syllable onset (see section 4.2.1), print segmentation prefers consonants at either side of the incision. The second part of criterion (1) is already included in Generalisation 1 [the use of a braille contraction must not interfere with decoding in braille reading].

Criterion (3) inhibits the activation of the wrong lexemes, *SING* instead of *SINGE* or *RAT* instead of *RATE*. In addition it ensures that discontinuous graphemes of the form

<VCe#>, in which the letter <e> marks the long vowel, are not disrupted.[29] Criterion (3) can also be traced back to Generalisation 1 [the use of a braille contraction must not interfere with decoding in braille reading]. In *cone* in example (9) the letter sequence <VCe#> of criterion (3) corresponds to <one> with the discontinuous grapheme <o…e> representing the underlying /əʊ/. There are two ways of contracting the letter sequence <cone>. In (9a) the lower groupsign ⠒, *CON*, is used and although this representation uses one fewer space than (9a') with the composite initial groupsign ⠐⠕, *<u>ONE</u>*, (9a) may not be used as this version interrupts the sequence <VCe> and thus interferes with decoding in braille reading.

(9) a. *⠒⠑ *CONe   a'. ⠉⠐⠕ c<u>ONE</u> cone

Segmentation accounts for the choice of contractions in Rule 8.8.6, especially as there is a choice of contraction. The deviant examples of Rule 8.8.6 are repeated in Table 4.3.

Table 4.3: Orthographic segmentation applied to Rule 8.8.6

deviant form	phonological form	consequences of the use of the deviant form	target form	hyphenation
aSThma	/ˈæsmə/	disruption of the complex grapheme <th>	asTHma	asth-ma
posTHumOUs	/ˈpɒstjᵘₔməs/	inappropriate creation of the complex grapheme <th>	poSThumOUs	post-hu-mous
DIShevellED	/dɪˈʃevəld/	inappropriate creation of the complex grapheme <sh>	diSHevellED	di-shev-elled
gIN/GHam	/ˈgiŋəm/	inappropriate creation of the complex grapheme <gh>	gINGham	ging-ham
iSThmus	/ˈɪsməs/	disruption of the complex grapheme <th>	isTHmus	isth-mus
crEA/<u>TION</u>	/kriˈeɪʃən/	inappropriate creation of the complex grapheme <ea>	cre<u>ATION</u>	cre-a-tion

The deviant examples are ruled out by Generalisation 1 [the use of a braille contraction must not interfere with decoding in braille reading]. Rule 8.8.6 is superfluous.

[29] <VCe#> is the sequence of a vowel (V), a consonant (C), the letter <e> and a morpheme boundary (#).

4.1.2 Form of contractions

Once the requirements of legibility, Generalisation 1, and space-saving, Rule 8.8.1, are satisfied, the form of contractions is taken into account. Among the set of rules for contracted braille there are three general rules on preference that contractions should be given over one another with respect to their form.

> 8.8.2 The contractions for AND, FOR, OF, THE, WITH should be used in preference to other contractions, provided their use does not waste space.
>
> *Examples*: baTHEd [not *baTH/ED], efFORt [not *eFFort][30], OFfER [not *oFF/ER], oTHEr [not *oTH/ER], THEatre [not *TH/EAtre], THEn [not *TH/EN], but TH/ENCE [not *THEnce][31]
>
> *British Braille* (2004:112)

> 8.8.3 Simple upper groupsigns should be used in preference to simple lower groupsigns, provided their use does not waste space.
>
> *Examples*: afFORd [not *aFFord], cobBLEr [not *coBBlER], feAR [not *fEAr], gabbled [not *gaBBlED], neARly [not *nEArly], nucleAR [not *nuclEAr], rabBLE [not *raBBle][32], sacCH/AR/INe [not *saCChAR/INe], wEDdING [not *weDD/ING], *BUT* DIStINct [not *diST/INct], DISturbED [not *diSTurbED].[33]
>
> *British Braille* (2004:112)

> 8.8.5 Simple groupsigns should generally be preferred to composite contractions, provided their use does not waste space.
>
> *Examples*: adhER/ENt [not *adHEREnt], adhER/ER [not *adHEREr], cohER/ED [not *coHEREd], COMmENcED [not *COMmENCEd][34], COMponENt [not *COMpONEnt][35], CONgo [not *cONGo][36], CONgratulate [not *cONGratulate][37], CONgruITY [not *cONGruITY][38], eFFulgENt [not *efFULgENt], expERiENcED [not *expERiENCEd], fENcED [not *fENCEd], gaTHErED [not *gaTHEREd], haDDock [not *HADdock], hER/ED/ITY [not *HEREdITY], INfluENcEA/BLE [not *INfluENCEaBLE], poisonED [not *poisONEd], SHadOW [not *sHAD/OW], silENcER [not *silENCEr], sliTHErED [not *sliTHEREd], SpENcER [not *SpENCEr], telephonED [not *telephONEd], tonER [not *tONEr], wEA/THErED [not *wEA/THEREd].
>
> *British Braille* (2004:113)

Rule 8.8.1 [use least space] states the main aim of contracted braille, increasing reading speed by using fewer braille cells to be processed. In this section I will show that, particularly for simple groupsigns, space-saving is ranked higher than keeping for example a suffix constant in writing.

The data in (10) give one example for a constant orthographic representation of the regular English past tense morpheme. It has the orthographic representation, -*ed*, despite

---

[30] This use would waste space.
[31] This use would waste space.
[32] This use would waste space.
[33] *Afford* is already covered by Rule 8.8.2. In addition, the use of the lower groupsign in *afford* would waste one space.
[34] This use would waste space.
[35] This use would waste space.
[36] This use would waste space.
[37] This use would waste space.
[38] This use would waste space.

the fact that it is realised by the three allomorphs, [ɪd], [d] and [t]. It is realised by [ɪd] in verbs ending in [d] as in *mend* or [t] as in *paint* in (10a). It is realised by [t] in verbs ending in a voiceless consonant excluding [t] as *park* and *miss* in (10b). It is realised by [d] in all other environments excluding [d]. These are verbs ending in a voiced consonant excluding [d] such as *clean* and verbs ending in a vowel such *weigh* in (10c) (Katamba 1993:25).

(10) The regular English past tense morpheme *-ed*

	present		**past**	
a.	mend	[mend]	mended	[mendɪd]
	paint	[peɪnt]	painted	[peɪntɪd]
b.	miss	[mɪs]	missed	[mɪst]
	park	[pɑːk]	parked	[pɑːkt]
c.	clean	[kliːn]	cleaned	[kliːnd]
	weigh	[weɪ]	weighed	[weɪd]

Contracted braille follows this pattern of constant orthographic representations of identical functions only in parts. It uses the upper groupsign ⠫, *ED*, to represent the past tense morpheme *-ed* in all instances of (10), as illustrated in (11).

(11) a. ⠍⠢⠙⠫
mENdED
mended

b. ⠏⠁⠔⠞⠫
paINtED
painted

c. ⠍⠊⠎⠎⠫
missED
missed

d. ⠏⠜⠅⠫
pARkED
parked

e. ⠉⠇⠂⠝⠫
clEAnED
cleaned

f. ⠺⠑⠊⠣⠫
weiGH/ED
weighed

The examples in (12) show that space-saving is ranked higher than a constant orthographic representation of one morpheme. This is explicitly licensed by Rule 8.9.3 [bridging of roots and suffixes]. In the letter sequence <named> in (12a) the initial composite groupsign ⠐⠝, NAME, representing the root is preferred over the upper groupsign ⠫, *ED*, representing the past tense suffix. Parallel, in the letter sequence <anced> in (12b) the initial composite groupsign ⠨⠑, ANCE, is preferred over the upper groupsign ⠫, *ED*, representing the past tense suffix. In both examples the space of one braille cell is saved.

(12) a. *⠝⠁⠍⠫
*namED

a'. ⠐⠝⠙
<u>NAME</u>d
named

b. *⠁⠙⠧⠁⠝⠉⠫
*advancED

b'. ⠁⠙⠧⠨⠑⠙
advANCEd
advanced

Another aspect of space-saving concerns the correlation of complexity in the form of a given groupsign and the frequency of its use. Upper groupsigns are the least complex in form and are preferred to both lower groupsigns (Rule 8.8.3) and composite groupsigns (Rule 8.8.5) as long as they do not use more space.

Example (13) illustrates the preference of less complex signs provided they do not use more space, Rule 8.8.3. In each pair the braille representations use the same number of braille cells. In *coffee* in example (13a') the upper groupsign ⠷, *OF*, is preferred, following the segmentation for end of line hyphenation *cof-fee* rather than the phonological syllabification /ˈkɒ - fɪ/ reflected in (13a). In *fear* the upper groupsign ⠜, *AR* in (13b'), is preferred over the lower groupsign ⠂, *EA* in (13b) in the letter sequence <ear>. In (13c) the upper groupsigns ⠻, *ER*, and ⠫, *ED*, are preferred over the composite initial groupsign ⠐⠓, *<u>HERE</u>* to represent the letter sequence <hered>.

(13) a. *⠉⠕⠶⠑⠑
*coFFee

a'. ⠉⠷⠋⠑⠑
cOFfee
coffee

b. *⠋⠂⠗
*fEAr

b'. ⠋⠑⠜
feAR
fear

c. *⠉⠕⠐⠓⠙
*co<u>HERE</u>d

c'. ⠉⠕⠓⠻⠫
cohER/ED
cohered

The final requirement on the choice of contractions by form is given in Rule 8.8.5, preference of lower groupsigns over composite groupsigns. A single cell contraction is easier for tactile recognition than a composite groupsign, an upper groupsign is easier than a lower one.

This results in a hierarchy in which upper groupsigns are given preference over lower groupsigns and lower groupsigns are given preference over composite groupsigns as long as this respects Generalisation 1 [the use of a braille contraction must not interfere with decoding in braille reading] and Rule 8.8.1 [use least space]. Thus in *haddock* in

(14) the letter sequence <hadd> is contracted by the lower medial groupsign ⠲, *DD*, and not by the composite initial groupsign ⠸⠓, *HAD*, because both forms use six braille cells.

(14) a. *⠸⠓⠙⠕⠉⠅
*HADdock

a'. ⠓⠁⠲⠕⠉⠅
haDDock
haddock

Braille contractions have three degrees of complexity in form. Upper groupsigns are the least complex contractions, they are followed by lower groupsigns and finally by composite groupsign. Thus I unite Rules 8.8.3 and 8.8.5 in Generalisation 2.

> Generalisation 2
> The least complex contractions are to be preferred.

Within the set of upper groupsigns there is one further hierarchy. For *British Braille* the upper groupsigns ⠯, *AND*, ⠿, *FOR*, ⠷, *OF*, ⠮, *THE*, ⠾, *WITH*, are special. They are given preference over all signs as long as their use does not require more space (Rule 8.8.2).

8.8.2. The contractions for AND, FOR, OF, THE, WITH should be used in preference to other contractions, provided their use does not waste space.

Examples: baTHEd [not *baTH/ED], efFORt [not *eFFort], OFfER [not *oFF/ER], oTHEr [not *oTH/ER], THEatre [not *TH/EAtre], THEn [not *TH/EN], but TH/ENCE [not *THEnce]

British Braille (2004:112)

In the letter sequence <thed> in (15a) the upper groupsign ⠮, *THE*, is preferred over the upper groupsigns ⠹, *TH*, and ⠫, *ED*, even though no space is saved and Standard English Orthography prefers to assign a constant representation to an affix. In contrast, in *thence* in (15b) the upper groupsign ⠮, *THE*, may not be used as this requires two more spaces (violation of 8.8.1.) than the use of the composite final groupsign ⠰⠑, *ENCE*.

(15) a. *⠃⠁⠹⠫
*baTH/ED

a'. ⠃⠁⠮⠙
baTHEd
bathed

b. *⠮⠝⠉⠑
*THEnce

b'. ⠹⠰⠑
TH/ENCE
thence

In the following I will analyse the examples listed in Rule 8.8.2 to show that this list can be rewritten as a generalisation. Some of these examples are already covered by two other *British Braille* rules. Rule 8.8.1 asks for the fewest cells possible to be used. The use of the lower medial groupsign ⠖, *FF*, in *effort* in (16a) is a violation of Rule 8.8.1 as it uses one more space than the upper groupsign ⠿, *FOR*, in (16a'). In addition using it violates 8.8.3 [preference of upper groupsigns].

(16) a. *⠑⠖⠕⠗⠞ a'. ⠑⠋⠿⠞
*eFFort efFORt
effort

Rule 8.8.3. requires an upper groupsign to be used if a given letter sequence offered a choice. In (17) both realisations of *offer* use the space of three braille cells. The version in (17a) uses a lower groupsign instead of an upper groupsign and thus is already ruled out by Rule 8.8.3.

(17) a. *⠕⠖⠻ a'. ⠷⠋⠻
*oFF/ER OFfER
offer

Thus the contracted forms of *effort* in (16a) and *offer* in (17a) are excluded independent of Rule 8.8.2.

The remaining examples of Rule 8.8.2. are listed in (18). They all use the same number of braille cells in either of the two realisations given. The realisations in the accepted versions have one characteristic in common, they all use two contractions in their deviant forms and one in the correct versions.

(18) a. *⠃⠁⠹⠫ a'. ⠃⠁⠮⠙
*baTH/ED baTHEd
bathed

b. *⠕⠹⠻ b'. ⠕⠮⠗
*oTH/ER oTHEr
other

c. *⠹⠂⠞⠗⠑ c'. ⠮⠁⠞⠗⠑
*TH/EAtre THEatre
theatre

d. *⠹⠢ d'. ⠮⠝
*TH/EN THEn
then

Thus Rule 8.8.2. need not be an arbitrary list. If there is a choice of contractions, which use the same amount of space and are of the same form, i.e. do not violate Generalisation 2, the realisation that requires the fewest contractions to be used. Rule 8.8.2 is rewritten as Generalisation 3.

Generalisation 3
The fewest contractions are to be used.

4.1.3 Summary

In this section I have analysed structural restrictions and preferences in the use of braille contractions. *British Braille* contains 13 general rules on the use of braille contractions. Six of these rules govern the choice of contractions (8.8.1. to 8.8.6.), seven are concerned with the relation of contractions to the structure of words (8.9.1. to 8.9.7.).

The rule that ranks highest and disallows interference with decoding in braille reading has been left implicit in *British Braille*. I have formulated it in Generalisation 1 [a contraction must not interfere with decoding in reading] (Table 4.4). Rules 8.8.3 and 8.8.5 have been summarised in Generalisation 2. Moreover, the seemingly arbitrary list contained in Rule 8.8.2 has been reanalysed and simplified in Generalisation 3. The Rules 8.8.6, 8.9.5 and 8.9.6 have been shown to be redundant. Rule 8.8.4 deals with the choice of lower contractions in the letter sequence <ben>. This is part of the individual rules on lower groupsigns and has thus been moved to section 4.3. Rule 8.9.7 is in this form new to the 2004 edition of *British Braille* and will be discussed in section 4.6.

Table 4.4: Summary of Generalisations

Generalisation		replacing Rule
1	The use of a braille contraction must not interfere with decoding in braille reading.	8.8.6, 8.9.5, 8.9.6
2	The least complex contractions are to be preferred.	8.8.3, 8.8.5
3	The fewest contractions are to be used.	8.8.2

This leaves a set of rules which consists of *British Braille* rules and generalisations. It is summarised in Table 4.5.

Table 4.5: Hierarchy of global rules on the use of contractions

Rule	
Generalisation 1	no interference with decoding in braille reading
8.8.1.	use least space
Generalisation 3	use fewest contractions
Generalisation 2	prefer least complex contraction
8.9.1.	bridging of prefix and root
8.9.2.	do not use the presence of a prefix to change beginning of a root
8.9.3.	bridging of root and suffix
8.9.4.	no contraction across roots in compounds

My analysis and generalisation of global rules on the use of braille contractions is the foundation for the reanalysis of the rules on individual groupsigns in the subsequent sections of chapter 4.

4.2 Upper groupsigns and wordsigns

Upper groupsigns are the structurally least complex group of contractions. They have the widest range of application and are generally used wherever the letter sequence they represent occurs. Rule 8.3.1 covers all upper groupsigns except ⠼, *BLE*, and ⠬, *ING*, see section 4.2.4.

> 8.3.1. The contractions AND, FOR, OF, THE, WITH, CH, GH, SH, TH, WH, ED, ER, OU, OW, ST, AR should generally be used wherever the letters they represent occur.
>
> *Examples*: afFOReST/ATION, ARrOW, bacCHanalia, deER, dERelict, dOU/GH, EDict, faSHion, GHoST, neED, OFfice, OUtER, OWnER, pEDdlED, prOF/OUND, roOF, SH/OW/ER, smooTHEd, sOFa, sOU/TH, sOU/THErn, ST/AND/ARD, tOW/ARds, wAND/ER, WITH/ER
>
> *British Braille* (2004:96)

section 4.2 examines the restrictions for the use of upper groupsigns. Section 4.2.1 sets these restrictions in the context of morphology, section 4.2.2 in phonology. Section 4.2.3 looks at restrictions for the use of upper groupsigns with respect to orthographic segmentation and finally, section 4.2.4 discusses upper groupsigns in the context of algorithmic preferences.

4.2.1 Upper groupsigns and morpheme boundaries

An upper groupsign may represent a morpheme as in *waited* in (19a) where the past tense morpheme *-ed* corresponds to the upper groupsign ⠫, *ED*.

(19) a. ⠺⠁⠊⠞⠫
waitED
waited

As discussed in section 4.1.1, upper groupsigns need not respect morpheme boundaries. Rule 8.9.1 [bridging of prefixes] and Rule 8.9.3 [bridging of suffixes] explicitly allow any groupsign to bridge a root and an affix. More frequently upper groupsigns represent arbitrary letter strings or phonemes.

4.2.2 Upper groupsigns and syllable boundaries

Upper groupsigns may represent a phoneme such as in *shop* in (20a), where the phoneme /ʃ/ corresponds to the upper groupsign ⠩, *SH*. They may represent part of a syllable as ⠫, *ED*, in *red* in (20b), or bridge two syllables as ⠷, *OF*, in *profit* in (20c).

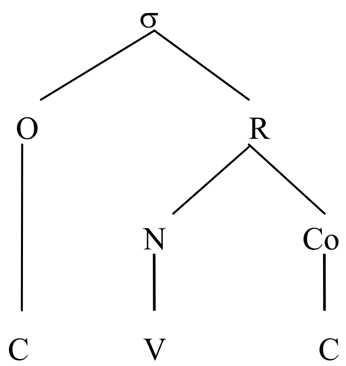
(20) a. ⠩⠕⠏
SHop
shop

b. ⠗⠫
rED
red

c. ⠏⠗⠷⠊⠞
prOFit
profit

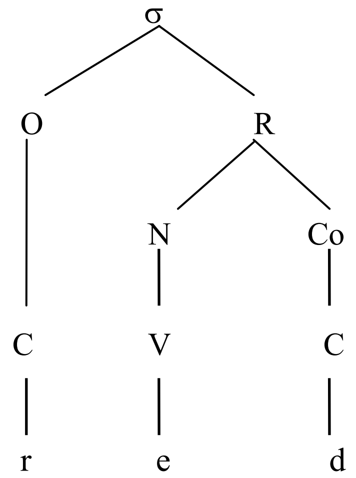
Following Carr (1993), a syllable is a phonological unit. It consists of at least one phoneme. This obligatory phoneme, usually a vowel, forms the nucleus of the syllable (N). It may be preceded by a sequence of consonants, the onset (O). Any segments following the nucleus form the coda (Co). The set of nucleus and coda is the rhyme (R). The Greek letter sigma, σ, is used as the symbol for the phonological unit syllable. Example (21) illustrates the structure of a basic syllable. In the following diagrams, C and V stand for consonant and vowel respectively, where C and V function as timing slots and denote segment length. Thus in a long vowel the sequence VV indicates the length and is dominated by a single nucleus (Carr 1993:215).

(21)



Example (22) shows this structure applied to *red.*

(22) red /red/

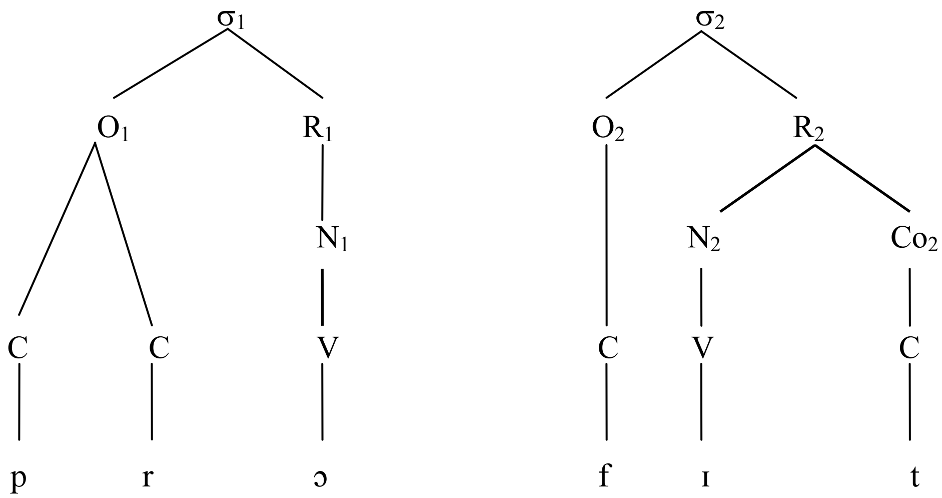


In the sequence <VCV> the consonant could occupy either the coda of the first syllable or the onset position of the second syllable. Yet, the onset position is always preferred, as stated in the Maximal Onset Principle.

> Maximal Onset Principle
> With a given string of segments in which the consonants may in principle be syllabified in more than one way, syllabification will take place such that consonants which may occupy either rhyme or onset position will occur in the onset rather than the rhyme.
>
> (Carr 1993:202)

One such example is *profit* in (23). Structurally the /f/ could occupy either the coda of the first syllable or the onset of the second syllable. Due to the Maximal Onset Principle, there is no choice and /f/ occupies the onset of the second syllable.

(23) profit: /ˈprɔfɪt/



As implicitly indicated by Rule 8.3.1, upper groupsigns need not respect boundaries of phonological syllables. Thus in *profit* in (20c) the upper groupsign ⠷, *OF*, bridges the nucleus N_1 of the first syllable, /ɔ/, and the onset O_2 of the second syllable, /f/.

4.2.3 Upper groupsigns and orthographic word segmentation

An upper groupsign may represent an arbitrary letter sequence. As structurally least complex set, upper groupsigns need not respect print segmentation (see section 4.2 Rule 8.3.1) but often do. In *effort* in (24a) and *offer* in (24b) the use of the upper groupsigns ⠿, *FOR*, and ⠷, *OF*, follow the print segmentations *ef-fort* and *of-fer*. In contrast *profit* in (24c) bridges both phonological syllabification, as illustrated in (23), and the print segmentation *pro-fit*. *Deer* in (24d) contains an upper groupsign within a monosyllabic root that cannot be segmented in print.

(24) a. ⠑⠋⠿⠞
efFORt
effort

b. ⠷⠋⠻
OFfER
offer

c. ⠏⠗⠷⠊⠞
prOFit
profit

d. ⠙⠑⠻
deER
deer

Thus Rule 8.3.1. [use of upper groupsigns] can be rewritten as Generalisation 4.

> Generalisation 4
> Upper groupsigns are to be used wherever the letter sequence they represent occurs.

Consequently, upper groupsigns are used independent of phonological syllable structure. The only exceptions are ⠼, *BLE*, and ⠬, *ING*, for code-internal reasons.

4.2.4 Upper groupsigns and algorithmic requirements

The only upper groupsigns subject to individual restrictions are the groupsigns ⠼, *BLE*, and ⠬, *ING*. They may not be used at the beginning of a word.

8.3.5 [BLE and ING] may not be used at the beginning of a word. However, they may generally be used in the middle or at the end of a word wherever the letters they represent occur.

Examples: blemiSH [not BLEmiSH], dINGhy, em-BLEm (divided at the braille line), INgle [not INGle], INgram [not INGram], sINGe.

British Braille (2004:97)

8.3.6 The contraction for ING should be used whether the *g* is pronounced hard or soft.

Examples: crING/ING, gING/ER, niGHtINGale, sING/ING

British Braille (2004:97)

8.3.7 The contraction for BLE may not generally be used before the letters *a* or *n*. *Examples*: pitCHblENde [not pitCH/BLEnde], tablEAu [not taBLEau]

British Braille (2004:97)

A second group subject to algorithmic conditions are the upper groupsigns ⠯, *AND*, ⠿, *FOR*, ⠷, *OF*, ⠮, *THE*, ⠾, *WITH*, when they are used as wordsigns. This use is discussed in 4.2.4.3.

BLE

The reason for the restriction of the use of the upper groupsign ⠼, *BLE*, is code-internal. The sign ⠼ is used as numbersign to convert all following adjacent signs into digits. Thus the upper groupsign ⠼, *BLE*, may not be used in word-initial position to avoid ambiguity. Example (25) illustrates the ambiguity that would result from such dual use.

(25) a. *⠼⠙
*BLEd

a.' ⠃⠇⠫
blED
bled

b. ⠼⠙
4

As braille uses the letters <a> to <j> to generate numbers in combination with the preceding numeral sign, ⠼, the amount of ambiguity the double use of the sign ⠼ can cause should be limited. Although there is no ambiguity in the examples in (26) the upper groupsign ⠼, *BLE*, may not be used in word-initial position.

(26) a. *⠼⠫
*BLE/ED

a' ⠃⠇⠑⠫
bleED
bleed

b. *⠼⠎⠎
*BLEss

b' ⠃⠨⠎
bLESS
bless

British Braille gives no explanation for this prescription. My assumption is that as braille has multiple readings for one sign in different positions, these should not be additionally combined with multiple interpretations of one sign in the same position. Otherwise one will end up with a highly contracted code to decipher instead of a system for reading and writing.

The second restriction on the use of the upper group sign ⠼, *BLE*, Rule 8.3.7., excludes it in the letter sequences <blea> and <blen> in (27).

(27) a. *⠞⠁⠼⠁⠥
*taBLEau
tableau

a'. ⠞⠁⠃⠇⠂⠥
tablEAu
tableau

b. *⠏⠊⠞⠡⠼⠝⠙⠑
*pitCH/BLEnde

b'. ⠏⠊⠞⠡⠃⠇⠢⠙⠑
pitCHblENde
pitchblende

This individual prescriptive restriction on the use of ⠼, *BLE*, (Rule 8.3.7) overrides two general rules on the preference of contractions, where preference is given to contractions that use fewer cells (Rule 8.8.1) and to upper groupsigns over lower groupsigns (Rule 8.8.3).

The alternative contractions in *tableau* are already discussed in section 4.1. The interference of the upper groupsign ⠼, *BLE*, with the complex grapheme <eau> is parallel to Rule 8.9.6 which inhibits the <a> in the digraph <ae> to become part of the lower groupsign ⠂, *EA*. Thus it is a violation of Generalisation 1 [no interference with decoding in braille reading]. Thus this example is ruled out independent of Rule 8.3.7.

For the second restriction in Rule 8.3.7, the prohibition of ⠼, *BLE*, in the word-medial letter sequence <blen>, *British Braille* only gives the example in (27b). Here a lower groupsign is used instead of an upper groupsign in violation of Rule 8.8.3. In addition, this prescribed use occupies one more braille cell than the use of the upper groupsign and is thus a violation of 8.8.1 [use least space]. The advantage of this use is that the root *blende* remains unchanged. This is a parallel to Rule 8.9.2 [do not use the presence of a prefix to change the beginning of a root]. Rule 8.9.2 does not apply in compounding but if its context is widened to include all morphological processes both Rules 8.3.7 and 8.9.2 can be incorporated in one generalisation, Generalisation 5.

> Generalisation 5
> Prefixation and compounding do not justify the use of contractions which cannot be used in a free-standing root.
> The only exception is the lower medial groupsign ⠂, *EA*, due to the function of its shape.

ING

Rule 8.3.5 inhibits the use of the upper groupsign ⠬, *ING*, in word-initial position, as illustrated in (28a). In word-medial and word-final position it may be used wherever the letter sequence it represents occurs, regardless of the phonological and morphological structure of the word. It may represent a letter sequence as in *sing* in (28b), a morpheme as in *playing* in (28c) and it may bridge a combined syllable and morpheme boundary as in *nightingale* in (28d). In addition, Rule 8.3.6 stresses that the use of ⠬, *ING*, is independent of the pronunciation of <g>. It is implicitly covered by Rule 8.3.5 "However, they [⠼, *BLE*, and ⠬, *ING*] may generally be used in the middle or at the end of a word wherever the letters they represent occur". Thus Rule 8.3.6 is redundant.

(28) a. *⠬⠗⠫⠊⠢⠞
*INGrEDiENt

a'. ⠔⠛⠗⠫⠊⠢⠞
INgrEDiENt
ingredient

b. ⠎⠬
sING
sing

c. ⠏⠇⠁⠽⠬
playING
playing

d. ⠝⠊⠣⠞⠬⠁⠇⠑
niGHtINGale
nightingale

The use of the upper groupsigns ⠼, *BLE*, and ⠬, *ING*, is summarised in Restriction 1.

> Restriction 1
> The upper groupsigns ⠼, *BLE*, and ⠬, *ING*, may not be used in word-initial position.

Sequencing of AND, FOR, OF, THE, WITH

Braille contractions have been shown to work independent of syllable and morpheme boundaries or word segmentations. The way in which the upper wordsigns ⠯, *AND*, ⠿, *FOR*, ⠷, *OF*, ⠮, *THE*, and ⠾, *WITH* are used is even more idiosyncratic. They adjoin to each other and to the indefinite article ⠁, *a*, in the same line of braille in order to save space.

> 8.2.7. The words AND, FOR, OF, THE, WITH, a should generally follow one another without a space if occurring on the same line of braille, even when a sense break or a natural pause is present.
>
> *Examples*: He is WITH/THE OFficER OF/THE watCH; THE ENd OFa pERfect DAY; He lookED grim AND/OF/a sad DISposiTION; Him we TH/INk OF/AND love; THE/WITH prOFits sCHeme
>
> *British Braille* (2004:94)

Rule 8.2.7 is solely based on an algorithm and explicitly ignores the linguistic structure within which it is applied. All upper wordsigns are part of the 14 highest ranking contractions in Lorimer's corpus. Together they have a space-saving capacity of approximately 50% (Lorimer et al. 1984:II:58f).

4.2.5 Summary

This section focussed on the use of upper groupsigns. Upper groupsigns are to be used independent of syllable and morpheme boundaries or print segmentations. Rule 8.3.1 [use of upper groupsigns] is summarised as Generalisation 4.

> Generalisation 4
> Upper groupsigns are to be used wherever the letter sequence they represent occurs.

Restriction 1 is the only restriction on the use of upper groupsigns, and replaces the *British Braille* Rules 8.3.5 to 8.3.7.

> Restriction 1
> The upper groupsigns ⠼, *BLE*, and ⠬, *ING*, may not be used in word-initial position.

Rules 8.3.7 and 8.9.2 can be merged into Generalisation 5.

> Generalisation 5
> Prefixation and compounding do not justify the use of contractions which cannot be used in a free-standing root.
> The only exception is the lower medial groupsign ⠂, *EA*, due to the function of its shape.

Table 4.6 shows an updated list of all generalisations and the rules they are replacing.

Table 4.6: Summary of Generalisations

Generalisation		replacing Rule
1	The use of a braille contraction must not interfere with decoding in braille reading.	8.8.6, 8.9.5, 8.9.6
2	The least complex contraction is to be preferred.	8.8.3, 8.8.5
3	The fewest contractions are to be used.	8.8.2
4	Upper groupsigns are to be used wherever the letter sequence they represent occurs.	8.3.1
5	Affixation does not justify the use of contractions which must not be used in a free-standing root. The only exception is the lower medial groupsign ⠂, EA.	8.9.2, 8.3.7

4.3 Lower groupsigns and wordsigns

The shapes of lower signs are identical to the shapes of those upper signs that use only the two top rows, the letters <a> to <j>. Lower signs are transpositions of these shapes. As the distance between the midpoints of two dots is only about 1.5 mm, every sequence of lower signs has to be adjacent to an upper sign to facilitate tactile discrimination. This is reflected in Rule 8.4.1.

> 8.4.1. Any number of lower contractions and punctuation signs may follow one another without an intervening space, provided that the string includes an upper sign and that all other rules are observed.
>
> *British Braille* (2004:98)

Rule 8.4.1 does not include free-standing lower signs. Thus the lower wordsigns ⠆, *BE*, ⠶, *WERE*, ⠦, *HIS*, ⠴, *WAS*, ⠢, *ENOUGH* and ⠔, *IN* are not in conflict with Rule 8.4.1.

As discussed in section 3.2, the interpretation of lower groupsigns is dependent on their position in an adjacent string of braille cells. The lower groupsigns with the least restricted use are ⠢, *EN*, and ⠔, *IN*. The interpretation of these braille shapes remains constant, independent of their position within a sequence of braille signs.

> 8.4.22 The lower contractions for EN and IN should generally be used wherever the letters they represent occur.
>
> *Examples*: B/EN/ENdEN, ENgINe, femIN/INe, fINal, pEN/INsula.
>
> *British Braille*: (2004:104)

Example (29) illustrates the use of the lower groupsign ⠢, *EN*. It is used in word-initial position in *end*, in (29a) with the letter ⠙, <d>, as the adjacent upper sign.[39] ⠢, *EN*, is used in word-medial position in *deny* in (29b) where both the letters ⠙, <d> and ⠽ <y>,

[39] It does not matter that ⠙ <d> has no dots embossed in the third row of the braille cell.

are adjacent upper signs. Finally, it is used in word-final position in *den* in (29c) with the adjacent letter ⠙, <d>, as upper sign.

(29) a. ⠢⠙
ENd
end

b. ⠙⠢⠽
dENy
deny

c. ⠙⠢
dEN
den

The examples for the use of the lower groupsign ⠔, *IN*, in (30), *inn*, *dined* and *din* are parallel to those in (29). The adjacent upper signs in (30) are the letters ⠝, <n>, in *inn*, ⠙, <d>, and ⠑, <e>, in *dine* and ⠙, <d>, in *din*.

(30) a. ⠔⠝
INn
inn

b. ⠙⠔⠑
dINe
dine

c. ⠙⠔
dIN
din

The use of the lower groupsigns ⠢, *EN*, and ⠔, *IN*, in Rule 8.4.1 can be summarised in Generalisation 6.

Generalisation 6 Lower groupsigns have to be used wherever the letter sequence they represent occurs.[40]

There is one global restriction on the use of lower groupsigns: every sequence of two or more lower groupsigns has to be in contact with an upper sign which functions to disambiguate the sequence; thus Restriction 2.

Restriction 2 Sequences of adjacent lower signs must not stand by themselves.

[40] The only words which consist of a letter sequence that can be represented by a sequence of lower groupsigns are *been* and *bein'* (See the use of ⠆, *BE*, in section 4.3.2).

The same holds for lower wordsigns. When they are standing free, the lower groupsigns ⠢, *EN*, and ⠔, *IN*, function as the wordsigns ⠢, *ENOUGH*, in (31a) and ⠔, *IN*, in (31b). In contrast to upper wordsigns, lower wordsigns must not be used when adjacent to a punctuation sign. A sequence of a lower wordsign and a punctuation sign does not contain an upper sign and thus the string ⠢⠲ in (31a) cannot stand for the sequence <enough.> and the string in (31b) cannot represent the sequence <in.>.

(31) a. *⠢ ⠊⠎ ⠢⠲
*ENOUGH is ENOUGH.

a'. ⠢ ⠊⠎ ⠢⠳⠣⠲
ENOUGH is EN/OU/GH.
Enough is enough.

b. *⠤⠑ ⠔⠲
COMe IN.

b'. ⠤⠑ ⠊⠝⠲
COMe in.
Come in.

In the following sections I examine further restrictions for the use of individual lower groupsigns. Section 4.3.1 discusses the lower initial groupsign ⠤, *COM*. This is followed by the lower initial groupsigns ⠆, *BE*, ⠒, *CON*, and ⠲, *DIS*, in section 4.3.2. Lower wordsigns are studied in sections 4.3.3, ⠆, *BE*, ⠶, *WERE*, ⠦, *HIS*, ⠴, *WAS*, and in section 4.3.4, ⠖, *TO*, ⠔⠖, *INTO*, and ⠴, *BY*. The lower medial groupsign ⠂, *EA*, has the most complicated rules. It is discussed in section 4.3.5. The remaining lower medial groupsigns ⠆, *BB*, ⠒, *CC*, ⠲, *DD*, ⠖, *FF*, and ⠶ *GG*, are the topic of section 4.3.6. Section 4.3.7 gives a summary of the restrictions in the use of lower groupsigns and wordsigns.

4.3.1 The lower initial groupsign COM

The lower groupsign ⠤, *COM*, is used word-initially wherever the letter sequence it represents occurs.

8.4.19 The contraction for COM may only be used at the beginning of a word, but it need not form a syllable.

Examples: COMa, COMb, COMe, COM/FORt, BY/COMpARison, TO/COME

But it must not be used when the letters <co> are added to a complete word to give a word of cognate meaning.

Examples: comates, comingle

British Braille (2004:103)

Thus the lower groupsign ⠤, *COM*, is used as in *come* in (32a) and *compassion* in (32b) but not in *comates* in (32c) and in *comingle* in (32d).

(32) a. ⠤⠑
COMe
come

b. ⠤⠏⠁⠎⠨⠝
COMpasSION
compassion

c. *⠤⠁⠞⠑⠎
*COMates

c'. ⠉⠕⠍⠁⠞⠑⠎
comates

d. * ⠤⠬⠇⠑
*COM/INGle

d'. ⠉⠕⠍⠬⠇⠑
comINGle
comingle

British Braille does not explain why in this case bridging is forbidden. It seems that the implicit restriction here is a violation of Generalisation 1 [no interference with decoding in braille reading] caused by the bridging of the prefix *co-* and a root. Thus it may be used to represent an arbitrary letter sequence, as in *coma* in (33a), or as allomorph of the prefix *con-*, as in *compassion* in (32b), but it must not be used to bridge the prefix *co-* to a root starting with <m>, although bridging of prefix and roots is allowed by Rule 8.9.1.[41] The second part of Rule 8.4.19 is superfluous as it might result in the activation of a wrong lexeme and is thus covered by Generalisation 1 [no interference with decoding in braille reading]. For *comates* this interfering lexeme is *coma*, in (33a), for *comingle* the interfering lexeme is *coming* in (33b).

(33) a. ⠤⠁
coma

b. ⠤⠬
COM/ING
coming

As the first part of Rule 8.4.19 is already covered by Generalisation 6 and the second part can be traced back to Generalisation 1, Rule 8.4.19 is redundant.

[41] Compare section 4.4.2.2., the composite final groupsign ⠰⠽,*ITY*, may be used within an arbitrary letter sequence or as the suffix *-ity*, but not to bridge a root ending in <it> and the suffix -y.

4.3.2 The lower initial groupsigns BE, CON and DIS

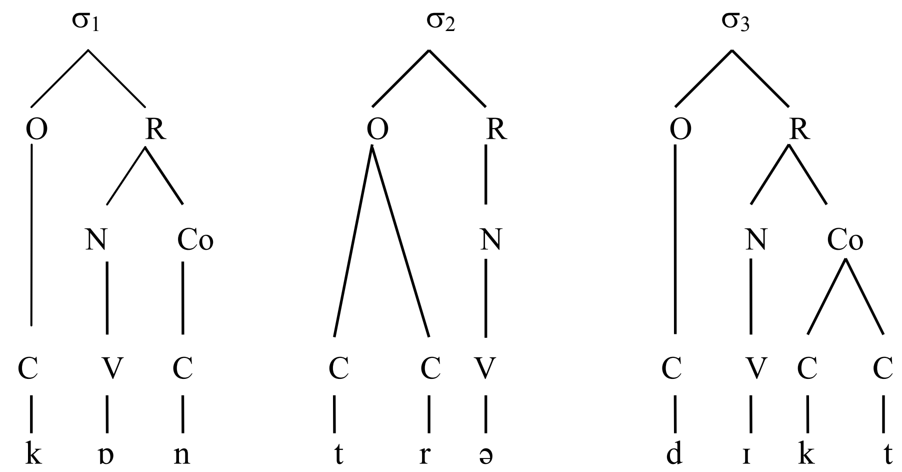
The lower groupsigns ⠆, *BE*, ⠒, *CON* and ⠲, *DIS*, are used word-initially. The *British Braille* rule that covers most of the use of these lower initial groupsigns is Rule 8.4.16.

> 8.4.16 The contractions for BE, CON and DIS may be used at the beginning of a word or after a hyphen in a hyphenated compound word, provided the letters they represent constitute a syllable, and in the case of BE it must be an unstressed syllable. They may not be used elsewhere in a word.
>
> *Examples*: BEcome, BEnign, bENefit, CONnect, DISconnect, DIStINct, INdiST/INct, conCH, disc, diSHevellED, self-DISciplINe.
>
> Note, however the following exceptions in which the contraction BE should be used:
>
> *Examples*: BE/ING, BEin'
>
> *British Braille* (2004:102)

British Braille has no definition for *syllable*. I assume that the term *syllable* in *British Braille* refers to the syllable as a unit of phonology, as introduced in section 4.2.2. Discussing Rule 8.4.16, I will start with the less complex part that governs the use of ⠒, *CON* and ⠲, *DIS* which is followed by the use of ⠆, *BE*.

In *contradict* the letter sequence <con> forms the syllable /ˌkɒn/, as illustrated in (34).

(34) contradict: /ˌkɒntrəˈdɪkt/

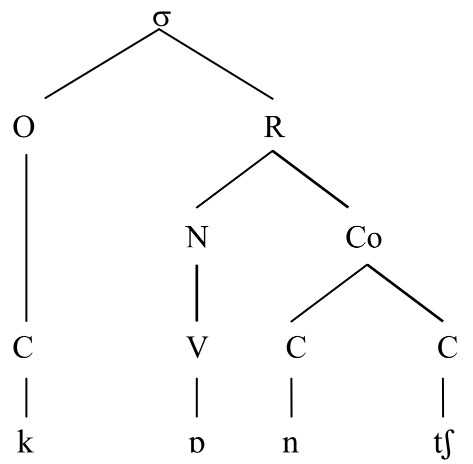


Consequently the lower initial groupsign ⠒, *CON* may be used in *contradict* in (35).

(35) a. ⠒⠞⠗⠁⠙⠊⠉⠞
CONtradict
contradict

Conch in example (36) is monosyllabic but contains a second phoneme, /tʃ/, in the coda.

(36) conch: /kɒntʃ/



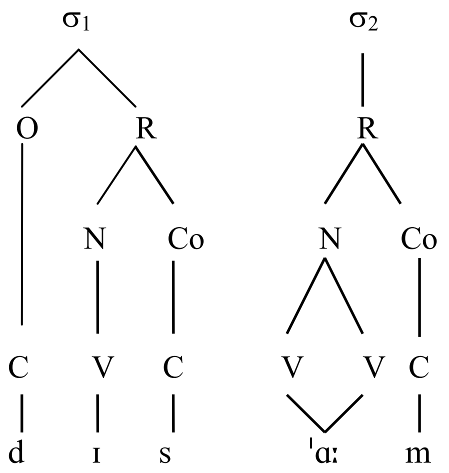
Thus the letters <con> do not form a syllable and the use of ⠒, *CON* is not possible in (37a).

(37) a. *⠒⠡
*CON/CH

a'. ⠉⠕⠝⠡
conCH
conch

The examples for the lower groupsign ⠲, *DIS*, work parallel to those for ⠒, *CON*. In *disarm* the sequence <dis> forms the syllable /ˈdɪs/, as illustrated in (38).

(38) disarm: /dɪs ˈɑːm/

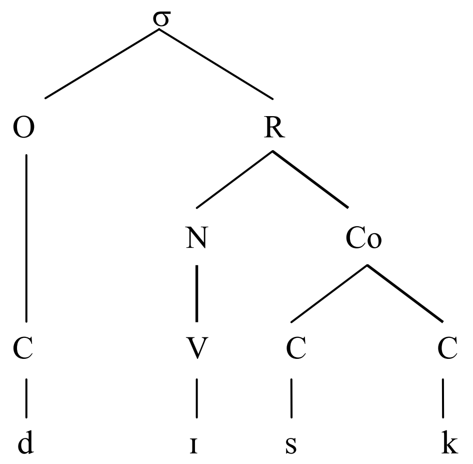


Thus the lower initial groupsign ⠲, *DIS*, may be used in *disarm* in (39).

(39) a. ⠲⠜⠍
DIS/ARm
disarm

Like *conch* in example (36), *disc* in (40) is monosyllabic.

(40) disc: / dɪsk/



The presence of the extra phoneme /k/ blocks the use of the lower groupsign ⠲, *DIS*, in *disc* in (41a).

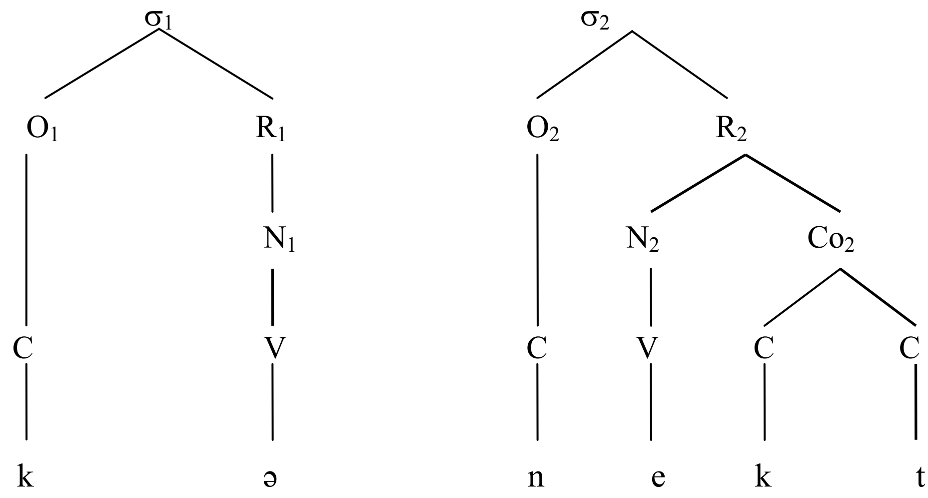
(41) a. *⠲⠉ a'. ⠙⠊⠎⠉
*DISc disc

To sum up, if Rule 8.4.16 is applied to the phonological unit *syllable*, the lower groupsigns ⠒, *CON*, and ⠲, *DIS*, may only be used if the corresponding letter strings <con> and <dis> form this syllable, as in *contradict* in (34) and in *disarm* in (38).

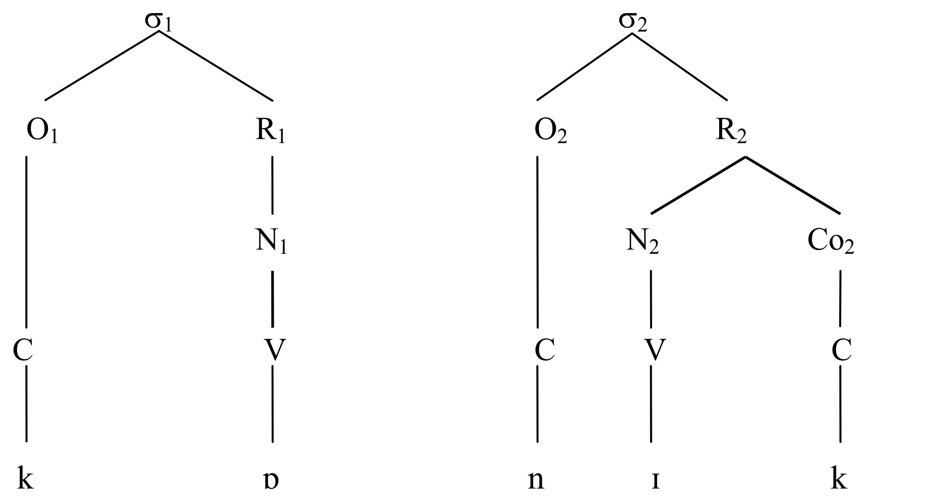
This use of *syllable* is too narrow for *connect* and *conic* with respect to the use of the lower groupsign ⠒, *CON*, and for *distil* and *disease* with respect to the use of the lower groupsign ⠲, *DIS*. All four examples are explicitly authorised by *British Braille*.[42] In *connect* in (42a) and in *conic* in (42b) the lower groupsign ⠒, *CON*, bridges the nucleus N_1 of the first syllable and the onset O_2 of the second syllable, as in both cases the *Maximal Onset Principle* requires the phoneme /n/ to appear in the onset of the second syllable.

[42] *Conic*, *distil* and *disease* are listed in *British Braille* (2004: appendix III), *connect* is one of the examples in Rule 8.4.16.

(42) a. connect: /kəˈnekt/



b. conic: /ˈkɒnɪk/



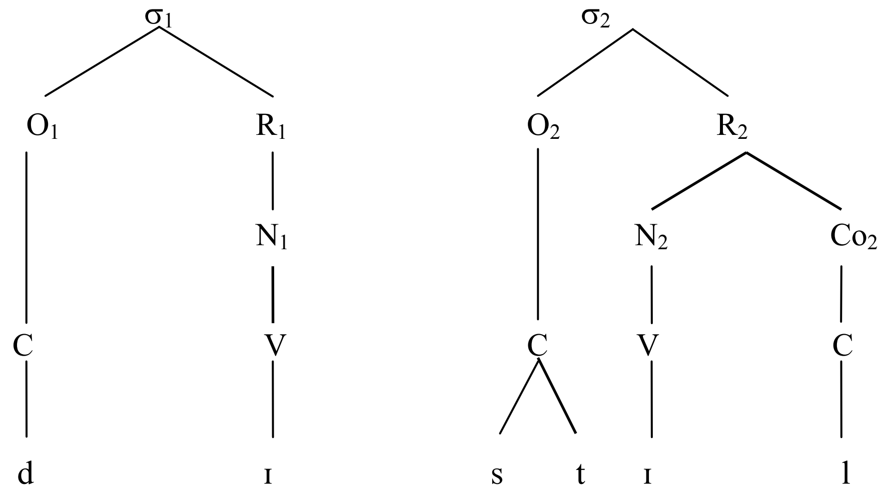
This is in conflict with Rule 8.4.16. The letter sequence <con> do not form a syllable in either *connect* in (43a) or *conic* in (43b), yet both are listed in Rule 8.4.16.

(43) a. ⠒⠝⠑⠉⠞
CONnect
connect *British Braille* (2004:102)

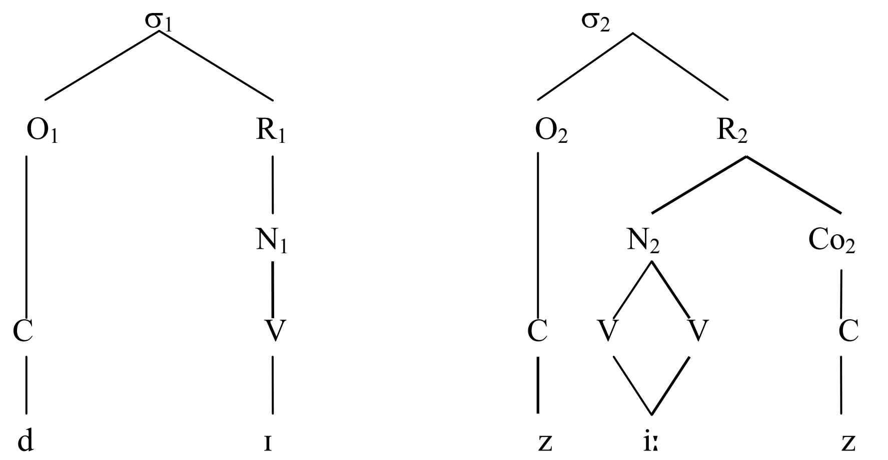
b. ⠒⠊⠉
CONic
conic *British Braille* (2004:141)

Similarly, in *distil* in (44a) and *disease* in (44b) the lower groupsign ⠲, *DIS*, bridges the nucleus N_1 of the first syllable and the onset O_2 of the second syllable, as in both cases the *Maximal Onset Principle* requires the phonemes /s/ in (44a) and /z/ in (44b) to appear in the onset of the second syllable.

(44) a. distil:/dɪˈstɪl/[43]



b. disease: /dɪˈziːz/



The lower groupsign ⠲, DIS, does not form a phonetic syllable in *distil* in (45a) nor in *disease* in (45b). Yet, its use in *distil* and *disease* is explicitly authorised by *British Braille*:

(45) a. ⠲⠌⠊⠇
DIStil
distil *British Braille* (2004:142)

b. ⠲⠂⠎⠑
DIS/EAse *British Braille* (2004:142)
disease

[43] Following Carr (1993:212) the sequence /st/ is analysed as a complex segment and thus does not violate the sonority hierarchy among segment types, where '>' means 'is more sonorous than':

(i) a > e, o > i, u > r > l > m, n > ð, v, z, ʒ > θ, f, s, ʃ > b, d, g > p, t, k

(Carr 1993:198)

As a consequence, the phonological syllable cannot be the unit in question for the interpretation of this rule. In Table 4.7 the *British Braille* examples for the use of the lower initial groupsigns ⠒, *CON*, and ⠲, *DIS*, are given together with their phonemic transcriptions and segmentations for end of line hyphenation. Examples (a) to (c) have an identical segmentation for both the phonological unit *syllable* and the orthographic unit *syllable*.

Both *con*- and *dis*- can function as prefix. If they represent a prefix they also form a distinct syllable and the respective lower groupsign is used, as in *disconnect* in (a).[44] Neither of the examples in (b) and (c), *disk* and *conch*, can use a lower groupsign as both have *syllables* that are larger than the strings <dis> and <con>, in both phonological and orthographic segmentation. Similarly in *dishevelled* in (d), the lower groupsign ⠲, *DIS*, cannot be used, as the letter sequence <dis> does not correspond to a syllable in phonological or orthographic segmentation.

The critical examples for the assumption of a phonological syllable are examples (e) to (i). If the phonological syllable is assumed to be the relevant unit *connect*, *distinct*, *self-discipline*, *distil* and *disease* should not be allowed to use the lower initial groupsigns ⠒, *CON*, and ⠲, *DIS*, as the letter sequences <con> and <dis> do not realise phonological syllables in these examples.[45] In the examples *connect*, (e), *distinct*, (f) *self-discipline* (g), *disease* (h) and *distil* (i) the boundaries of the phonological syllable and the orthographic syllable do not coincide; the use of the lower groupsign follows the segmentation according to orthographic word segmentation.

---

[44] The relevant contraction in this example is the lower initial groupsign ⠲, *DIS*, the sequence <con> is in word-medial position, the lower initial groupsign ⠒, *CON*, can thus not be used.

[45] There is no analogy to *dishevelled* because the use of the lower initial groupsign ⠲, *DIS* in *dishevelled* violates Generalisation 2 [no interference with decoding in braille reading].

Table 4.7: Rule 8.4.16.: Segmentations for ⠒, *CON*, and ⠲, *DIS*

	example	print transcription	phonemic transcription	orthographic segmentation
a	⠲⠉⠕⠝⠝⠑⠉⠞	DISconnect	/ˌdɪs - kə - ˈnekt/	dis-con-nect
b	⠙⠊⠎⠉	disc	/dɪsk/	disc
c	⠉⠕⠝⠡	conCH	/kɒntʃ/	conch
d	⠙⠊⠩⠑⠧⠑⠇⠇⠫	diSHevellED	/ dɪ - ˈʃe - vəld/	di-shev-elled
e	⠒⠝⠑⠉⠞	CONnect	/kə - ˈnekt/	con-nect
f	⠲⠞⠊⠝⠉⠞	DIStinct	/dɪ - ˈstɪŋkt/	dis-tinct
g	⠎⠑⠇⠋⠤⠲⠉⠊⠏⠇⠔⠑	self-DISciplINe	/ˌself-ˈdɪ-s$^{\text{I}}_{ə}$-pl$^{\text{I}}_{ə}$n/	self-dis-ci-pline
h	⠲⠑⠁⠎⠑	DIS/EAse	/dɪ - ˈziːz/	dis-ease
i	⠲⠞⠊⠇	DIStil	/dɪ - ˈstɪl/	dis-til

To sum up, the term *syllable* as it is used in *British Braille* in Rule 8.4.16 does not refer to the phonological unit *syllable* but follows print segmentation for the lower initial groupsigns ⠒, *CON*, and ⠲, *DIS*.

In the following the additional request *British Braille* makes for the use of the lower initial groupsigns ⠆, *BE*, is examined: it has to form an unstressed syllable. The relevant example of Rule 8.4.16 are given in Table 4.8. The lower initial groupsign ⠆, *BE*, is used in *become* in (a) and *benign* in (b). It must not be used in *benefit* in (c) nor *better* in (d) as both are stressed on the first syllable. *Being* in (e) is listed as an exception, possibly because of its frequency.

Table 4.8: Rule 8.4.16: Segmentations for BE

	example	print transcription	phonemic transcription	orthographic segmentation
a	⠆⠉⠕⠍⠑	BEcome	/bɪˈkʌm/	be-come
b	⠆⠝⠊⠛⠝	BEnign	/bɪˈnaɪn/	be-nign
c	⠃⠢⠑⠋⠊⠞	bENefit	/ˈben$^{\text{I}}_{ə}$fɪt/	ben-e-fit
d	⠃⠑⠞⠞⠻	bettER	/ˈbetə/	bet-ter
e	⠆⠬	BE/ING	/ˈbiːɪŋ/	be-ing

As in the case of ⠒, *CON* and ⠲, *DIS*, the term *syllable* as it is used in *British Braille* in Rule 8.4.16 follows orthographic word segmentation. Although in the case of the lower initial groupsign ⠆, *BE*, the stress pattern is explicitly mentioned, its use is completely covered by orthographic segmentation. It can account for the use of all examples there and effectively incorporates *being* into the rule. As the sequence <be> forms an orthographic syllable in *being*, the lower initial groupsign ⠆, *BE*, may be used. Rule 8.4.16 can be rewritten as Restriction 3.

> Restriction 3
> The lower initial groupsigns ⠆, *BE*, ⠒, *CON*, and ⠲, *DIS*, are used at the beginning of a word if the respective letter sequences can be generated by orthographic segmentation.

4.3.3 The lower wordsigns BE, WERE, HIS, WAS

The lower wordsigns ⠆, *BE*, ⠶, *WERE*, ⠦, *HIS*, and ⠴, *WAS*, must stand free and must not be used in conjunction with any other sign apart from the italic sign, ⠨.

> 8.4.14 BE, WERE, HIS and WAS may be preceded by the italic sign. They may not be used in conjunction with any other sign. The signs for WERE, HIS and WAS may not be used as parts of words.
>
> *Examples*: He *WAS* plEAsED. AS YOU wERe! IT may be! IT wasn't a wERewolf.
>
> *British Braille* (2004:101f.)

In (46) the use of ⠦, *HIS*, is only allowed in (46a) where it is not adjacent to another braille cell. In (46b') the full form has to be used, as the lower wordsign ⠦, *HIS*, must not be adjacent to the full stop.

(46) a. ⠭ ⠴ ⠦ ⠃⠕⠕⠅⠲
IT WAS HIS book.
It was his book.

b. *⠭ ⠴ ⠦⠲
*IT WAS HIS.

b'. ⠭ ⠴ ⠓⠊⠎⠲
IT WAS his.
It was his.

British Braille does explain why only the italic sign may be in contact with a lower wordsign. A possible reason is the fact that punctuation signs and signs that correspond to print functions are lower signs. The italic sign, ⠨, is an exception. Sequences of lower signs are easily mistaken for a sequence of upper signs, as (47) shows. The sequences in example (47a) and (47b) use exactly the same shapes. They differ only in the position within the braille cell.

(47) a. *⠶⠲
*WERE.

a'. ⠺⠻⠑⠲
wERe.
were.

b. ⠛⠙
gd
good

4.3.4 The lower wordsigns TO, INTO, BY

The lower wordsigns ⠖, *TO*, ⠔⠖, *INTO*, and ⠴, *BY*, must adjoin to the following word.

> 8.4.5 The lower wordsigns TO, INTO and BY should be written unspaced from a word which follows on the same braille line, even when a sense break or natural pause is present.
>
> *Examples*: BY/AND BYhe wENt TOsCHool BYbus. HIS pay WAS NOT INcrEAsED BY/AS muCH AS THAT. BY/AND lARge SHe STood BY/hER deciSION. C/OWs passED BY/FROM <u>TIME</u> TO/<u>TIME</u>.
>
> *British Braille* (2004:99)

Example (48) illustrates the use of these wordsigns where the shape ⠴ stands for *was* when free-standing in (48a) and for *by* when adjoined to the following word in (48b).

(48) a. ⠦ ⠏⠁⠽ ⠴ ⠝ ⠔⠉⠗⠂⠎⠫ ⠴⠵ ⠍⠥⠡ ⠵ ⠞⠲
HIS pay WAS NOT INcrEAsED BY/AS muCH AS THAT.
His pay was not increased by as much a that.

b. ⠉⠪⠎ ⠏⠁⠎⠎⠫ ⠴⠋ ⠞ ⠖⠞⠲
cOWs passED BY/FROM <u>TIME</u> TO/<u>TIME</u>.
Cows passed by from time to time.

In contrast to the upper wordsigns ⠯, *AND*, ⠿, *FOR*, ⠷, *OF*, ⠮, *THE*, ⠾, *WITH*, which are only written unspaced if they follow one another, the lower wordsigns ⠖, *TO*, ⠔⠖, *INTO*, and ⠴, *BY*, adjoin to every following word which saves the additional space of one blank braille cell.

4.3.5 The lower medial groupsign EA

The lower medial groupsign ⠂, *EA*, is generally used wherever the letter sequence <ea> appears word-medially.

> 8.4.27 In general the EA contraction should be used whenever EA occurs within a word.
>
> *Examples*: acrEAge, AR/EAs, CHangEAbil<u>ITY</u>, crEAte, crEAtiv<u>ITY</u>, delIN/EAte, EuropEAn, FORseEAbly, idEAliSTic, idEAs, laurEAte, likeABLe, lIN/EAge, lIN/EAl, mallEA/BLE, milEAge, miscrEAnt, nausEAtING, ocEAnic, pagEAnt, pEAcEA/BLE, pERmEA/BLE, pERmEAte, ratEA/BLE, rEAl<u>ITY</u>, rosEAte, sEAs.
>
> *British Braille* (2004:105)

Some of the examples of Rule 8.4.27 are given in (49). It may represent the complex grapheme <ea> as in *acreage* in (49a), bridge two syllables as in /krɪeɪt/, *create*, in (49b) or bridge a morpheme as <ea> in *mileage* in (49c).

(49) a. ⠁⠉⠗⠂⠛⠑
acrEAge
acreage

b. ⠉⠗⠂⠞⠑
crEAte
create

c. ⠍⠊⠇⠂⠛⠑
milEAge
mileage

At first sight the prescription to use the lower medial groupsign ⠂, *EA*, regardless of all structure seems surprising. Nolan and Kederis (1969) stated that the readability of braille characters is affected by the number of dots embossed within a braille cell. The lower medial groupsign ⠂, *EA*, consists of exactly one embossed dot, dot 2. The reason for the almost unrestricted use of this sign is its form. Following Nolan and Kederis (1969), recognition time increases not only proportional to word length. It also increases proportional to the dot density within individual cells. As the lower medial groupsign ⠂, *EA*, consists of dot 2 only, it has a dual function, in addition to space-saving it has the function to facilitate reading as its presence can interrupt sequences of dense cells and make the braille characters adjacent to it more easily recognisable (Lorimer 1982: I:22).[46]

> 8.4.28 In an unhyphenated compound word, when the first element ends or the second element begins with EA, the EA should be contracted.
>
> *Examples*: AR/EAway, moTH/EAtEN, norTH/EA/ST, sEAman, spEAkEAsy, sprEAdEAgle, tEA/<u>TIME</u>
>
> *British Braille* (2004:104)

This additional function of facilitating legibility is not particular to the lower groupsign ⠂, *EA*, only, but according to Nolan and Kederis (1969) works for all lower medial groupsigns. The only restriction on the use of the lower medial groupsign ⠂, *EA*, is Rule 8.4.29.

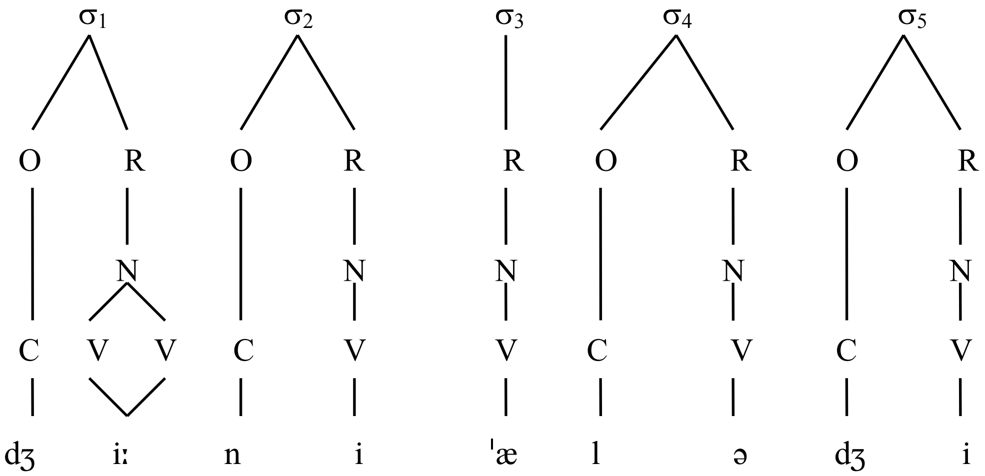
> 8.4.29. The contraction for EA should not be used
> (i) when the letters belong to two distinct syllables and the <a> does not begin a suffix, or
> (ii) when the form of a root word would be excessively distorted.
>
> *Examples*: aurora borealis [not aurora borEAlis], BEatific [not bEAtific], gENealogy [not gENEAlogy], habeas corpus [not habEAs corpus], hanseatic [not hansEAtic], Neapolitan [not N/EApolitan], orgeat [not orgEAt], pancreas [not pancrEAs], pINeapple [not pIN/EApple]
>
> *British Braille* (2004:105)

An example for condition (i) is *genealogy*. The syllable structure of *genealogy* is given in (50).

---

[46] See section 4.1.1: Morphology.

(50) genealogy /ˌdʒiːniˈælədʒi/



The sequence <ea> is realised in two separate syllables: σ_2 / ni/ and σ_3 /ˈæ / where σ_3 does not represent part of a suffix. Thus the lower medial groupsign ⠂, *EA*, must not be used in (51a).

(51) a. *⠛⠢⠂⠇⠕⠛⠽
*gEN/EAlogy

a'. ⠛⠢⠑⠁⠇⠕⠛⠽
gENealogy
genealogy

On the other hand, in *likeable* in (52a) the lower medial groupsign ⠂, *EA*, is used and bridges the root *like* and the suffix -*able* which is allowed because <a> is the first letter of the suffix -*able* and condition (i) is respected.[47]

(52) a. ⠇⠊⠅⠂⠼
likEA/BLE
likeable

The second condition of Rule 8.4.29 is very much open to interpretation. The term *excessively distorted* is not defined and the examples listed in *British Braille* do not point to an easily accessible set of exclusion criteria. To determine the forms affected by the second condition, Table 4.9 lists all examples given in *British Braille* (2004:105).

[47] In this context the upper wordsign LIKE may not be used as the root is not free-standing.

Table 4.9: Examples for restrictions in the use of the lower medial groupsign EA

	example	phonological syllabification	orthographic syllabification	reason for exclusion
(a)	pINeapple	/ˈpaɪn - æ - pəl/	pine-ap-ple	8.9.5
(b)	aurora borealis	/ə - ˌrɔː - rə bɔː - ri - ˈeɪ - lɪəs/	au-ro-ra bo-re-a-lis	8.4.29 (i)
(c)	gENealogy	/ˌdʒiː - ni - ˈæ - lə - dʒi/	ge-ne-al-o-gy	8.4.29 (i)
(d)	hanseatic	/hæn - sɪ - ˈæ - tɪk/	han-se-at-ic	8.4.29 (i)
(e)	habeas corpus	/ˌheɪ - biəs ˈkɔː - pəs/	ha-be-as cor-pus	8.4.29 (i)
(f)	pancreas	/ˈpæŋ - krɪəs/	pan-cre-as	8.4.29 (i)
(g)	BEatific	/ˌbiː - ə - ˈtɪ - fɪk/	bea-tif-ic	8.4.29 (i)
(h)	Neapolitan	/nɪə - ˈpɒ - $\mathrm{l}^{\text{ɪ}}_{\text{ə}}$ - tən/	Nea-pol-i-tan	8.4.29 (ii)
(i)	orgeat	/ˈɔː - ʒɑː/	or-geat	8.4.29 (ii)

The first example, *pineapple*, does not use the lower medial groupsign ⠂, *EA*, as generally contractions must not bridge the roots in compounds [Rule 8.9.5].

All other examples are borrowings of low frequency. However, this characteristic does not account for their exclusion. Contractions are generally used in foreign words (Rule 8.11).[48] The examples *aurora borealis* in (b), *genealogy* in (c) are excluded by condition (i). In these examples the use of the lower medial groupsign ⠂, *EA*, would bridge both the phonological syllable and the orthographic segmentation.

In *hanseatic* in (d) the use of ⠂, *EA*, would bridge the second and the third syllable which is a violation of condition (i) since <at> is not an English suffix. The examples *habeas corpus* in (e) and *pancreas* in (f), are problematic for the first part of Rule 8.4.29 as the lower medial groupsign ⠂, *EA*, would not interfere with phonological syllabification. It would, however, bridge across the orthographic segmentation of *habeas* and *pancreas*. The reverse is true for *beatific* in (g): *EA*, would not interfere with orthographic word segmentation but bridge the first and second phonological syllable.

The last two examples in Table 4.10 do not violate condition (i) of Rule 8.4.29. Using the lower medial groupsign ⠂, *EA*, in these examples would respect both phonological syllabification and segmentation for hyphenation. Consequently the *Neapolitan* in (h) and *orgeat* in (i) have to be excluded by the second condition of Rule 8.4.29 as causing excessive distortion to the form of the root.

---

[48] Rule 8.11: Foreign words, phrases, sentences, titles, names, etc., may generally be contracted, whether or not italicised or placed in quotes. The general rules on the use of contractions apply. Care should be exercised not to use contractions which would contribute to the mispronunciation of words.

In order to determine the exact exclusion criteria for the examples (g) to (i) in Table 4.10, they are compared to the examples with which the use of the lower medial groupsign ⠂, *EA*, is illustrated in Rule 8.4.29. These are listed in Table 4.10.

Table 4.10: Examples for the use of the lower medial groupsign EA.

	example	phonological syllabification	orthographic syllabification	suffix
(a)	pagEAnt	/ˈpæ - dʒənt/	pag-eant	
(b)	crEAte	/kri - ˈeɪt/	cre-ate	
(c)	crEAtivITY	/ kri - eɪ - ˈtɪ - v$^{ɪ}_{ə}$ - ti /	cre-a-ti-vi-ty	
(d)	idEAliSTic	/aɪ - ˌdɪə - ˈlɪ - stɪk/	i-deal-ist-ic	
(e)	lIN/EAl	/ˈlɪ - niəl/	lin-e-also	
(f)	ocEAnic	/ˌəʊ - ʃɪ - ˈæ - nɪk/	oce-an-ic	
(g)	rEAlITY	/ˈrɪ - æ - l$^{ɪ}_{ə}$ - ti/	re-al-i-ty	
(h)	AR/EAs	/ˈeə - riez/	ar-e-as	pl
(i)	idEAs	/aɪ - ˈdɪəz/	i-deas	pl
(j)	sEAs	/siːz/	seas	pl
(k)	CHangEAbilITY	/ˌtʃeindʒ - ə - ˈbɪ - l$^{ɪ}_{ə}$ti/	change-a-bil-i-ty	-able
(l)	likEA/BLE	/ˈlaɪ - kə - bəl/	like-a-ble	-able
(m)	mallEA/BLE	/ˈ mæ - liə - bəl/	mal-le-a-ble	-able
(n)	pEAcEA/BLE	/ˈpiː - sə - bəl/	peace-a-ble	-able
(o)	pERmEA/BLE	/ˈpɜː - miə - bəl/	per-me-a-ble	-able
(p)	FOReseEAbly	/fɔː - siː - ə - ˈbɪl$^{ɪ}_{ə}$ - ti /	fore-see-a-bly	-able
(q)	ratEA/BLE	/ˈreɪ - tə - bəl /	rate-a-ble	-able
(r)	acrEAge	/ˈeɪ - kə - rɪdʒ/	a-cre-age	-age
(s)	lIN/EAge	/ˈlɪ - ni-ɪdʒ/	lin-e-age	-age
(t)	milEAge	/ˈmaɪ - lɪdʒ/	mile-age	-age
(u)	EuropEAn	/ˌjʊə - rəˈ - piː - ən/	EU-ro-pe-an	-(e)an
(v)	miscrEAnt	/ˈmɪs - kri - ənt/	mis-cre-ant	-ant
(w)	laurEAte	/ˈlɔː - ri - $^{ɪ}_{ə}$t/	laur-e-ate	-ate
(x)	nausEAtING	/ˈnɔː - ti - eɪ - tɪŋ/	nau-se-a-ting	-ate
(y)	rosEAte (*poetic*)	/ˈrəʊ - zi - $^{ɪ}_{ə}$t/	ro-se-ate	-ate
(z)	delIN/EAte	/dɪ - ˈlɪ - ni - eit/	de-lin-e-ate	-ate
(aa)	pERmEAte	/ˈpɜː - mi - eɪt/	per-me-ate	-ate

The examples in Table 4.10 can be divided into three subgroups. In the first subgroup in examples (a) - (g) the sequence <ea> occurs within the root. As these examples are the examples illustrating Rule 8.4.27 they cannot contradict Rule 8.4.29 which restricts the use of the lower medial groupsign ⠂, *EA*, if the root in question would be distorted. They will be crucial to determine the definition of *excessive distortion* in Rule 8.4.29.

Examples (h) - (j) form the second subgroup. Their roots end in the letter sequence <ea>. Thus in the singular they must not use the lower medial groupsign ⠂, *EA*, as its occurrence in a final position is interpreted as a comma. Thus the roots *area* in (53a), *idea* in (53b) and *sea* in (53c) have two different orthographic realisations in the singular and in the plural.

(53) a. ⠜⠑⠁
ARea

a'. ⠜⠂⠎
AR/EAs
areas

b. ⠊⠙⠑⠁
idea

b'. ⠊⠙⠂⠎
idEAs
ideas

c. ⠎⠑⠁
sea

c'. ⠎⠂⠎
sEAs
seas

The examples (k) - (aa) in Table 4.10 form the third subgroup. They all use the lower medial groupsign ⠂, *EA*, to bridge a root ending in <e> and a suffix starting with <a> which is illustrated by *mileage* in example (54a) and explicitly allowed by Rule 8.4.27.

(54) a. ⠍⠊⠇⠂⠛⠑
milEAge
mileage

Thus the good examples of Rule 8.4.27 in the first subgroup of Table 4.11, *pageant*, *create*, *creativity*, *idealistic*, *lineal*, *oceanic* and *reality* are the relevant subgroup to determine why the use of the lower medial groupsign ⠂, *EA*, is not possible in the deviant examples of Rule 8.4.29, *aurora borealis*, *genealogy*, *hanseatic*, *habeas corpus*, *pancreas*, *beatific*, *Neapolitan* and *orgeat* in Table 4.10.

Table 4.11 contrasts the examples of both rules and indicates rule violations. It is divided into six subgroups. In the first five of these subgroups the good examples of Rule 8.4.27 and the deviant examples of Rule 8.4.29 are paired according to their structural patterns. If Rule 8.4.29 were adequate the identical patterns should experience identical uses of the lower medial groupsign ⠂, *EA*.

Table 4.11: Rules 8.4.27 and 8.4.29 contrasted

		example	phonological syllabification	orthographic syllabification	Rule violation
(c_1)	EA	crEAtivITY	/kri - eɪ - ˈtɪv$^{ɪ}_{ə}$ - ti /	cre-a-ti-vi-ty	8.4.29 (i)
(b_1)	EA	crEAte	/kri - ˈeɪt/	cre-ate	8.4.29 (i)
(b_2)	ea	aurora borealis	/ə - ˌrɔː - rə bɔː - ri - ˈeɪ - l$^{ɪ}_{ə}$s/	au-ro-ra bo-re-a-lis	8.4.29 (i)
(f_1)	EA	ocEAnic	/ˌəʊ - ʃɪ - ˈæ - nɪk/	oce-an-ic	8.4.29 (i)
(g_1)	EA	rEAlITY	/rɪ - ˈæ - l$^{ɪ}_{ə}$ - ti/	re-al-i-ty	8.4.29 (i)
(c_2)	ea	gENealogy	/ˌdʒiː - ni - ˈæ - lə - dʒi/	ge-ne-al-o-gy	8.4.29 (i)
(d_2)	ea	hanseatic	/hæ - nsɪ - ˈæ - tɪk/	han-se-at-ic	8.4.29 (i)
(e_1)	EA	lIN/EAl	/ˈlɪ - niəl/	lin-e-al	
(f_2)	ea	pancreas	/ˈpæŋ - krɪəs/	pan-cre-as	?
(d_1)	EA	idEAliSTic	/aɪ - ˌdɪə - ˈlɪ - stɪk/	i-deal-ist-ic	
(e_2)	ea	habeas corpus	/ˌheɪ - biəs ˈkɔː - pəs/	ha-be-as cor-pus	?
(h_2)	ea	Neapolitan	/nɪə - ˈpɒ - l$^{ɪ}_{ə}$ - tən/	nea-pol-i-tan	?
(g_2)	BE	BEatific	/ˌbiː - ə - ˈtɪ - fɪk/	bea-tif-ic	8.4.29 (i)
(a_1)	EA	pagEAnt	/ˈpæ - dʒənt/	pag-eant	
(i_2)	ea	orgeat	/ˈɔː - ʒɑː/	or-geat	?

Phonological syllabification does not help to determine the use of ⠂, *EA*. Orthographic word segmentation was shown to be the decisive factor for the use of the lower groupsigns ⠒, *CON*, and ⠲, *DIS*. The same will be examined for ⠂, *EA*. The default text-to-speech correspondence for the letter sequence <ea> is /ɪː/ according to Carney (1994:311f.). All exceptions listed by Carney are listed in example (55).

(55)
a. <ea> ≡ /e/ — abreast, already
b. <ea> ≡ /eɪ/ — break, great
c. <ea> ≡ /ɛə/ — bear, pear, swear
d. <ea> ≡ /ɪə/ — idea, laureate, lineal, fealty
e. <ea> ≡ /ɪː - ə/ — beatific, European
f. <ea> ≡ /ɪː - æ/ — caveat, beatitude
g. <ea> ≡ /ɪː - eɪ/ — create, creativity, nauseate, delineate
h. <ea> ≡ /ɪː - ɪ/ — lineage

None of the examples in Table 4.11 follow this default correspondence. In the first two subgroups the letter sequence <ea> corresponds to the disyllabic representations /ɪː - eɪ/ and /ɪ - æ/. In both the syllable structure is neglected for the good examples of Rule 8.4.27. Thus in the first subgroup the lower medial groupsign ⠂, *EA*, may bridge phonological and orthographic segmentation in *create* in (56a). In the deviant examples of Rule 8.4.29 identical structures are found. *Aurora borealis* has the same structure as *create*, but whereas *create* is allowed to use the lower medial groupsign ⠂, *EA*, this use is explicitly ruled out for *aurora borealis* in (56b).

(56) a. ⠉⠗⠂⠞⠑
crEAte
create

b. *⠁⠥⠗⠕⠗⠁ ⠃⠕⠗⠂⠇⠊⠎
*aurora borEAlis

b'. ⠁⠥⠗⠕⠗⠁ ⠃⠕⠗⠑⠁⠇⠊⠎
aurora borealis

The examples in (57) show the same pattern for the second subgroup. *Oceanic* in (57a) and *reality* in (57b) use the lower medial groupsign ⠂, *EA*, whereas *genealogy* in (57c) and *hanseatic* in (57d) must not use it.

(57) a. ⠕⠉⠂⠝⠊⠉
ocEAnic
oceanic

b. ⠗⠂⠇⠰⠽
rEAl<u>ITY</u>
reality

c. *⠛⠢⠑⠂⠇⠕⠛⠽
*gEN/EAlogy

c'. ⠛⠢⠝⠑⠁⠇⠕⠛⠽
gENealogy
genealogy

d. *⠓⠁⠝⠎⠂⠞⠊⠉
*hansEAtic

d'. ⠓⠁⠝⠎⠑⠁⠞⠊⠉
hanseatic

In the third and fourth subgroups similar parallel structures are found. These two groups differ only in stress patterns. The relevant syllable is unstressed in both subgroups but whereas in the third subgroup a preceding syllable is stressed, in the fourth subgroup it is the following syllable that bears the stress.

Although *lineal* in (58a) and *pancreas* in (58b) pattern alike, only *lineal* is allowed to use the lower medial groupsign ⠂, *EA*, and its use is explicitly ruled out for *pancreas*.

(58) a. ⠇⠔⠂⠇
lIN/EAl
lineal

b. *⠏⠁⠝⠉⠗⠂⠎
*pancrEAs

b'. ⠏⠁⠝⠉⠗⠑⠁⠎
pancreas

The same happens in the fourth subgroup where *idealistic* in (59a) may use the lower medial groupsign ⠂, *EA*, but for *habeas corpus* in (59b) and *neapolitan* in (59c) its use is explicitly forbidden by 8.4.29.

(59) a. ⠊⠙⠂⠇⠊⠌⠊⠉
idEAliSTic
idealistic

b. *⠓⠁⠃⠂⠎ ⠉⠕⠗⠏⠥⠎
*habEAs corpus

b'. ⠓⠁⠃⠑⠁⠎ ⠉⠕⠗⠏⠥⠎
habeas corpus

c. *⠝⠂⠏⠕⠇⠊⠞⠁⠝
*nEApolitan

c'. ⠝⠑⠁⠏⠕⠇⠊⠞⠁⠝
Neapolitan

The fifth subgroup consists of a single entry, *beatific*, for which the use of the lower medial groupsign ⠂, *EA*, is forbidden by Rule 8.4.29 (i).

Finally, the last subgroup consists of two entries which use representations for the letter sequence <ea> that are not part of the correspondences given by Carney (1994). Whereas *pageant* in (60a) is given to illustrate the use of the lower medial groupsign ⠂, *EA*, it must not be used in *orgeat* in (60b) although neither form violates syllabification.

(60) a. ⠏⠁⠛⠂⠝⠞
pagEAnt
pageant

b. *⠕⠗⠛⠂⠞
*orgEAt

b'. ⠕⠗⠛⠑⠁⠞
orgeat

In order to account for this difference in behaviour, *orgeat*, in contrast to *pageant*, one would have to assume that it violates the second part of Rule 8.4.29 and causes *excessive distortion*.

This assumption does not hold since ⠂, *EA*, represents the complex grapheme <ea>. One possible solution might be that the complex grapheme <ea> represents the underlying /ɑː/ which is a very irregular correspondence.

Hence the consequence is then to claim that the first part of Rule 8.4.29 is not adequate. Otherwise the following examples that illustrate the use of the lower medial groupsign ⠂, *EA*, in 8.4.27 should not be allowed to use this sign: *creativity*, *create*, *oceanic* and *reality*. This has the consequence that all deviant examples violate the second part of Rule 8.4.29, the distortion of the root. This part of Rule 8.4.29 can be directly linked to Generalisation 1 [no interference with decoding in braille reading] (section 4.1.3).

The only possible explanation is that word-frequency is the crucial factor. The characteristic all the deviant examples have in common is that they are low-frequency words. Their structural equivalents which may use the lower medial groupsign ⠂, *EA* are of higher frequency. Millar claims that legibility of complex words increases with proficiency and that proficient braille readers will distinguish patterns easily which inexperienced people find impossible to identify (Millar 1997:137).

As a consequence, parallel to Rule 8.9.6 in section 4.1. Rule 8.4.29 is redundant and covered by Generalisation 1.

4.3.6 The lower medial groupsigns BB, CC, DD, FF, GG

The lower medial groupsigns ⠆, *BB*, ⠒, *CC*, ⠲, *DD*, ⠖, *FF*, and ⠶, *GG*, are important not so much because of their space-saving capacity, but like ⠂, *EA*, they facilitate legibility in breaking up complex dot patterns as they consist of no more than four dots (Lorimer et al. 1982:I:22f). They represent the geminates <bb>, <cc>, <dd>, <ff> and <gg> whenever the respective letter sequence occurs as in (61).

(61) a. ⠗⠕⠆⠻⠽
roBB/ERy
robbery

b. ⠁⠒⠇⠁⠍⠠⠝
aCClamATION
acclamation

c. ⠙⠊⠖⠻⠢⠞⠊⠠⠝
diFF/ER/ENtiATION
differentiation

d. ⠁⠶⠗⠁⠧⠁⠞⠬
aGGravatING
aggravating

Their use is governed by Rule 8.4.5.

8.4.25 The contractions for EA, BB, CC, DD, FF and GG may only be used when these letters occur between letters or contractions in the same word written in one braille line. They must not begin or end a braille line.

Examples: aDDs, bEAt, daGG/ER; but: add [not aDD], easy [not EAsy].

British Braille (2004:105)

This rule can be summarised as Restriction 4:

Restriction 4 Lower medial groupsigns may only be used in the word-medial position.

The reference to the position of the contraction prevents a confusion of groupsign and punctuation sign.

4.3.7 Summary

The analyses of the *British Braille* rules that govern the use of lower groupsigns, especially Rules 8.4.16 and 8.4.29, have confirmed that the term *syllable* as it is used in *British Braille* does not refer to the phonological unit *syllable* but follows print segmentation instead. In addition, word frequency seems to be a crucial factor in determining if a contraction may be used.

Generalisation 6 replaces Rule 8.4.22 [use of lower groupsigns]:

> Generalisation 6
> Lower groupsigns are to be used wherever the letter sequence they represent occurs.

Furthermore, Rule 8.4.29 is redundant as it is covered by Generalisation 1, Rule 8.4.28 is redundant because it is covered by Generalisation 5. An updated summary of the generalisations is given in Table 4.12.

Table 4.12: Summary of Generalisations

Generalisation		replacing Rule
1	The use of a braille contraction must not interfere with decoding in braille reading.	8.4.29, 8.8.6, 8.9.5, 8.9.6
2	The least complex contraction are to be preferred.	8.8.3, 8.8.5
3	The fewest contractions are to be used.	8.8.2
4	Upper groupsigns are to be used wherever the letter sequence they represent occurs.	8.3.1
5	Affixation does not justify the use of contractions which must not be used in the root by itself. The only exception is the lower medial groupsign ⠂, EA.	8.3.7, 8.4.28, 8.9.2
6	Lower groupsigns are to be used wherever the letter sequence they represent occurs.	8.4.1, 8.4.22.

There are three new restrictions in this section. The second part of Rule 8.4.1 on sequencing lower groupsigns is covered by Restriction 2.

> Restriction 2
> Sequences of adjacent lower signs must not stand by themselves.

Rule 8.4.16 is rewritten as Restriction 3 in Table 4.13 to cover the lower initial groupsigns ⠆, *BE*, ⠒, *CON*, and ⠲, *DIS*.

> Restriction 3
> The lower initial groupsigns ⠆, *BE*, ⠒, *CON*, and ⠲, *DIS*, are used at the beginning of a word if the respective letter sequences can be generated by orthographic segmentation.

Restriction 4 summarises Rule 8.4.25

> Restriction 4
> Lower medial groupsigns may only be used in the word-medial position of a written word-form.

An updated overview of restrictions is given in Table 4.13.

Table 4.13: Summary of Restrictions

Restriction		replacing Rule
1	The upper groupsigns ⠼, *BLE*, and ⠬, *ING*, must not be used in word-initial position.	8.3.5, 8.3.6, 8.3.7.
2	Sequences of adjacent lower signs must not stand by themselves.	8.4.1
3	The lower initial groupsigns ⠆, *BE*, ⠒, *CON*, and ⠲, *DIS*, are used at the beginning of a word if the respective letter sequences can be generated by orthographic segmentation.	8.4.16
4	Lower medial groupsigns may only be used in word-medial position.	8.4.25

The following *British Braille* rules stay unchanged: Rule 8.4.5 on the lower wordsigns ⠖, *TO*, ⠔⠖, *INTO*, and ⠴, *BY*; Rule 8.4.14 on the lower wordsigns ⠆, *BE*, ⠶, *WERE*, ⠦, *HIS*, and ⠴, *WAS*; Rule 8.4.19 on the lower initial groupsign ⠤, *COM* and Rule 8.4.25 on the lower medial groupsign ⠂, *EA*, and double letters.

4.4 Composite groupsigns

A composite groupsign is a complex braille unit consisting of a functional indicator sign followed by a letter or an upper groupsign. Indicator signs are like an overt realisation of the SHIFT key on a QWERTY keyboard. They have no print equivalent and are signs that are not part of the alphabet, nor numbers or punctuation signs.

Composite groupsigns are divided into two sets, composite initial groupsigns and composite final groupsigns. Composite initial groupsigns use one of the indicator signs given in (62) in combination with the first letter or the initial upper groupsign of the letter sequence to be represented, usually a root morpheme.

(62) a. ⠐

b. ⠘

c. ⠸

In general, composite initial groupsigns are used wherever the letter sequence they represent occurs (section 4.4.1). They are blind to the function of this letter sequence within the word. Thus the composite groupsign *word* can be used as a wordsign in

(63a), as the root *word* in *wordless* in (63b) and as the letter sequence <word> in *sword* (63c).

(63) a. ⠘⠺
WORD
word

b. ⠘⠺⠨⠎
WORD/LESS
wordless

c. ⠎⠘⠺
sWORD
sword

The second set, composite final groupsigns, uses the set of indicator signs in (64) immediately followed by the last letter of the letter sequence they represent (section 4.4.2).

(64) a. ⠨

b. ⠰

c. ⠠

Most composite final groupsigns represent a suffix like -*less* in (65a) Although they may also represent an arbitrary letter string as ⠨⠎, LESS, in *bless* in (65b). Composite final groupsigns must not be used as wordsigns (65c) and, as their name suggests, they must not occur in word-initial position either, (65d).

(65) a. ⠉⠜⠑⠨⠎
cAReLESS
careless

b. ⠃⠨⠎
bLESS
bless

c. *⠨⠎
*LESS

c'. ⠇⠑⠎⠎
less

d. *⠨⠎⠢
*LESS/EN

d'. ⠇⠑⠎⠎⠢
lessEN
lessen

The following sections list additional restrictions on the use of composite groupsigns. They are subdivided according to form: section 4.4.1 discusses composite initial groupsigns, section 4.4.2 composite final groupsigns.

4.4.1 Composite initial groupsigns

The classification into composite initial groupsigns and composite final groupsigns differs from *British Braille* in as much as *British Braille* lists composite wordsigns and generalises them by form, e.g. dot 5 contractions, and gives a list of restrictions for individual wordsigns to be used as groupsigns as well. Thus, in *British Braille* composite initial groupsigns are primarily seen as wordsigns that can additionally function as groupsigns, representing letter sequences. My analysis is different in as much as composite initial groupsigns are analysed as groupsigns representing letter sequences which are subject to generalised restrictions. The advantage of this system is that it starts with the superset of a letter sequence which allows to integrate wordsigns, whereas the *British Braille* approach of separating groupsigns and wordsigns generates two individual lists.

Several composite groupsigns may be used independent of their function wherever the letters they represent occur. They are covered by the *British Braille* Rules 8.5.1 to 8.5.3 and summarised in Table 4.14.

> 8.5.1 The contraction for WORD should be used wherever the letters it represents occur.
>
> *Examples*: FOReWORD, sWORD, WORDiNESS, WORDsworTH.
>
> However, the contractions for UPON, THESE, THOSE and WHOSE should only be used where they retain their meanings as whole words.
>
> *Examples*: HERE/UPON, WHERE/UPON, WHOSEsoEVER; but cOUpon [not coUPON], hypoTHEses [not hypoTHESEs], THoseby [not THOSEby]
>
> *British Braille* (2004:106)

> 8.5.2 The following contractions should generally be used wherever the letters they represent occur: CANNOT, MANY, SPIRIT, WORLD, THEIR.
>
> *Examples*: diSPIRIT/ED, G/ER/MANY, RoMANY, THEIRs, WORLDly.
>
> The contraction HAD may generally be used when the *a* is short, unless the preference Rule (8.8.5.) directs otherwise.
>
> *Examples*: HADn't; but haDDock [not HADdock].
>
> *British Braille* (2004:106)

> 8.5.3 In general the following dot 5 contractions should be used wherever the letters they represent occur: DAY, FATHER, KNOW, LORD, MOTHER, QUESTION, RIGHT, WORK, YOUNG, CHARACTER, THROUGH, OUGHT.
>
> *Examples*: acKNOWledge, aRIGHT, bOUGHT, CHARACTERize, FATHERly, midDAY, playwRIGHT, QUESTIONnaire, RIGHTeous, sMOTHER, WORK/SHop, YOUNG/ER.
>
> *British Braille* (2004:106f.)

Table 4.14: *British Braille*: composite initial groupsigns with unrestricted use

dot 5 contractions			dot 4-5-6 contractions		
⠐⠙	<u>DAY</u>	day	⠸⠉	<u>CANNOT</u>	cannot[49]
⠐⠋	<u>FATHER</u>	father	⠸⠓	<u>HAD</u>	had
⠐⠅	<u>KNOW</u>	know	⠸⠍	<u>MANY</u>	many
⠐⠇	<u>LORD</u>	lord	⠸⠎	<u>SPIRIT</u>	spirit
⠐⠍	<u>MOTHER</u>	mother	⠸⠺	<u>WORLD</u>	world
⠐⠟	<u>QUESTION</u>	question	⠸⠮	<u>THEIR</u>	their
⠐⠗	<u>RIGHT</u>	right			
⠐⠺	<u>WORK</u>	work	dot 4-5 contraction		
⠐⠽	<u>YOUNG</u>	young	⠘⠺	<u>WORD</u>	word
⠐⠡	<u>CHARACTER</u>	character			
⠐⠹	<u>THROUGH</u>	through			
⠐⠳	<u>OUGHT</u>	ought			

Table 4.14 can be summarised in Generalisation 7 (i).[50]

> Generalisation 7 (i)
> Composite initial groupsigns are to be used wherever the letter sequence they represent occurs.

The following sections examine the restrictions on the use of composite initial groupsigns. They are divided into three groups. The first group, 4.4.1.1, consists of composite initial groupsigns which *British Braille* (2004) lists with restrictions on their use but which have already been covered by the generalisations 1 to 6. In the second group in 4.4.1.2 are composite initial groupsigns which follow phonological restrictions in their use. The third group in 4.4.1.3 studies composite initial groupsigns which are restricted by their morphological structure.

4.4.1.1 Redundant Restrictions

This section shows that the individual rules on the use of composite initial groupsigns listed in *British Braille* are already covered by the generalisations in my system and are therefore redundant.

---

[49] The reduced form *can't* uses the upper wordsign CAN in (i).

(i) ⠉⠄⠞
CAN't
can't

[50] This generalisation will be slightly modified and renamed Generalisation 7 in section 4.4.2.

PART

The composite initial groupsign ⠐⠏, PART, is generally used independent of structural relations in all environments where the letter sequence <part> is present.

8.5.8. The contraction for PART should generally be used wherever the letters it represents occur.

Examples: aPARTheid, PART/ERre, PARTial, PARTiculAR, PARTook, rePARTee, sPARTan.

However, the TH or THE contractions should be used in preference in words where TH is pronounced as a single sound.

Examples: P/AR/THian, P/AR/THEnon

British Braille (2004:107)

The exceptions listed here are already redundant within the system of *British Braille*, as the use of the composite initial groupsign ⠐⠏, *PART*, in *Parthian* in (66a) and *Parthenon* in (66b) would use the same amount of braille cells as the use of the upper groupsigns ⠜, *AR*, and ⠹, *TH*, in (66a') and ⠜, *AR*, and ⠮, *THE* in (66b) respectively. This is a violation of the *British Braille* Rule 8.8.5 [preference of simple groupsigns over composite groupsigns].

In addition, the fact that the composite initial groupsign ⠐⠏, *PART*, must not be used if it is contained in the letter sequence <parth> where <th> corresponds to either of the phonemes /θ/ or /ð/ is covered by Generalisation 1 [no interference with decoding in braille reading]. The examples in (66c) and (66d) illustrate that the composite initial groupsign ⠐⠏, *PART*, can be used wherever the letter sequence <part> occurs.

(66) a. *⠐⠏⠓⠊⠁⠝
*PARThian

a'. ⠏⠜⠹⠊⠁⠝
pAR/THian
Parthian

b. *⠐⠏⠓⠑⠝⠕⠝
*PARThenon

b'. ⠏⠜⠮⠝⠕⠝
pAR/THEnon
Parthenon

c. ⠐⠏⠇⠽
PARTly
partly

d. ⠎⠐⠏⠁⠝
sPARTan
spartan

To sum up, Rule 8.5.8 is superfluous in both systems as the restriction is already covered by the Rule 8.8.5 [preference of simple groupsigns over composite groupsigns] and Generalisation 1 respectively.

THERE

The composite initial groupsign ⠐⠮, *THERE*, may be used as root only.

> 8.5.12 The contraction for THERE may only be used in words of which the word "there" forms a component part.
>
> *Examples*: THERE/ABOUTs, THERE/AFTER, THEREfrom, but eTHErEAl [not eTHEREal], smiTHEreENs [not smiTHERE/ENs].
>
> *British Braille* (2004:108)

Thus the composite initial groupsign ⠐⠮, *THERE*, may be used in *therefrom* in (67a) but not in *ethereal* in (67b) and *smithereens* in (67c).

(67) a. ⠐⠮⠋⠗⠕⠍
THEREfrom
therefrom

b. *⠑⠐⠮⠁⠇
*eTHEREal

b'. ⠑⠮⠗⠂⠇
eTHErEAl
ethereal

c. *⠎⠍⠊⠐⠮⠢⠎
*smiTHERE/ENs

c'. ⠎⠍⠊⠮⠗⠑⠢⠎
smiTHEreENs
smithereens

In *British Braille* Rule 8.8.5 [preference of simple groupsigns over composite groupsigns] rule out the deviant example in (67b) as both variants use 5 braille cells. The deviant form in (67c) uses one fewer cell than the good form in (67c'). The two contractions ⠐⠮, *THERE*, and ⠢, *EN*, split the complex grapheme <ee>. With regard to the frequency of *smithereens* this should be enough to interfere with legibility and thus violate Generalisation 1 [no interference with decoding in braille reading] and rule out the form in (67c). In contrast, the first <e> of <ee> in *smithereens* in (67c') is not part of a contraction and does not interfere with decoding. Thus this is the preferred form even though it uses one more braille cell.

As a consequence, the composite groupsign ⠐⠮, *THERE*, need not be listed separately and, as in the case of ⠐⠏, *PART*, there is no need for a separate restriction.

UNDER

The composite initial groupsign ⠐⠥, *UNDER* is generally used wherever the letter sequence <under> occurs.

8.5.11 The contraction for <u>UNDER</u> should be used except when the letters it represents are immediately preceded by the vowels *a* or *o*.

Examples: bl<u>UNDER</u>, f<u>UNDER</u>, TH/<u>UNDE</u>R, <u>UNDER</u>take; but bOUndER [not bo<u>UNDER</u>], laundER [not la<u>UNDER</u>]

In addition, it should not be used when only the *un* is a prefix.

Example: undERivED [not UNDERivED]

British Braille (2004:108)

The composite initial groupsign ⠐⠥, *<u>UNDER</u>*, is used in *thundered* in (68a). The deviant examples of the first restriction in Rule 8.5.11 are ruled out by Generalisation 1 [no interference with decoding in braille reading]. Consequently, the letter sequence <under> as part of the string <ounder> as in *bounder* in (68b) or <aunder> as in *launder* in (68c), must not use the composite initial groupsign ⠐⠥, *<u>UNDER</u>*.[51] The second restriction disallows the use of this groupsign when *un-* is a prefix, as in *underived* in (68d). The use of ⠐⠥, *<u>UNDER</u>*, would result in an activation of a wrong lexical entry as *under* itself can function as a prefix and thus violate Generalisation 1 [no interference with decoding in braille reading].

(68) a. ⠹⠐⠥⠫
TH/<u>UNDER</u>/ED
thundered

b. *⠃⠕⠐⠥
*bo<u>UNDER</u>

b'. ⠃⠨⠙⠻
b<u>OUND</u>/ER
bounder

c. *⠇⠁⠐⠥
*la<u>UNDER</u>

c'. ⠇⠁⠥⠝⠙⠻
laundER
launder

d. *⠐⠥⠊⠧⠫
*<u>UNDER</u>ivED

d'. ⠥⠝⠙⠻⠊⠧⠫
undERivED
underived

WHERE

There is no reason to have a separate rule for the use of the composite initial groupsign ⠐⠱, *<u>WHERE</u>*. It is used wherever the letter sequence <where> occurs.

8.5.13 The contraction for <u>WHERE</u> should generally be used wherever the letters it represents occur.

Examples: no<u>WHERE</u>, <u>WHERE</u>/<u>UPON</u>, but WH/ER/<u>EVER</u> [not <u>WHERE</u>vER]

British Braille (2004:108)

[51] ⠨⠙, *<u>OUND</u>*, is a final groupsign (see section 3.1.4 for discussion).

The use of ⠐⠱, *WHERE*, is illustrated in (69). The only example where this contraction is not used is in (69c). There preference is given to the composite initial groupsign ⠐⠑, *EVER*, on the grounds of legibility.

(69) a. ⠝⠕⠐⠱
noWHERE
nowhere

b. ⠐⠱⠘⠥
WHERE/UPON
whereupon

c. *⠐⠱⠧⠻
*WHEREvER

c'. ⠱⠻⠐⠑
WH/ER/EVER
wherever

Thus Rule 8.5.13 is already redundant within the system of *British Braille*.

4.4.1.2 Phonological restrictions

All composite initial groupsigns also function as wordsigns. Several of these do not allow their phonological form to be changed when used as a groupsign. These are ⠐⠑, *EVER*, ⠐⠕, *ONE*, ⠐⠓, *HERE*, ⠐⠝, *NAME*, and ⠐⠞, *TIME*.

EVER and ONE

The composite initial groupsign ⠐⠑, *EVER*, may only be used if the stress is on the first syllable which represents this letter sequence, independent of the realisation of the first vowel.

> 8.5.4. The contraction for EVER may only be used when the stress is on the first <e> and the letter group in not preceded by an <e> or <i>.
>
> *Examples*: lEVER, fEVER, nEVER, sEVER, sEVERal; but: BElievER [not BEliEVER], pERsevERe [not pERsEVERe], revERbERate [not rEVERbERate], revERe [not rEVERe], sevERe [not sEVERe], sevER/ITY [not sEVER/ITY]
>
> *British Braille* (2004:107)

The composite initial groupsign ⠐⠕, *ONE*, is only used if the letter sequence <one> is contained within one syllable.

8.5.7 The contraction for ONE should in general only be used when all three letters it represents are pronounced as one syllable. In addition, the contraction should be used in the word ending "oney".

Examples: alONE, bONE, dONE, gONE, hONEy, lONEly, mONEy, phONEy, ST/ONE, telephONE; but: anemone [not anemONE], bayonet, [not bayONEt], colonel [not colONEl], phonetic [not phONEtic], sooneST [not soONE/ST]

However, note the following exceptions.

Examples: hONE/ST, mONEtARy

British Braille (2004:107)

These conditions are fulfilled by *fever* in (70a) and *several* in (70b). *British Braille* contradicts itself in Rule 8.5.7. The way in which this rule is written excludes all examples listed in it. The examples *bone* in (70c) and *done* in (70d) are disallowed because they are monosyllabic. Both have an extra entry in the syllable onset, /b/ for *bone* and /d/ for *done* and thus the letter sequence <one> is not "pronounced as one syllable", it is contained within one syllable.

(70) a. /ˈfiːvə/
fever

b. /ˈsevərəl/
several

c. /bəʊn/
bone

d. /dʌn/
done

Fever and *several* are stressed on the first syllable which also contains the realisation of the first <e> of the sequence <ever>, *bone* and *done* are monosyllabic. Thus the composite initial groupsigns are used for all examples in (71).

(71) a. ⠋⠐⠑
fEVER
fever

b. ⠎⠐⠑⠁⠇
sEVERal
several

c. ⠃⠐⠕
bONE
bone

d. ⠙⠐⠕
dONE
done

In the set of deviant examples, *severity* in (72a) takes the stress on the second syllable and therefore must not use the composite initial groupsign ⠐⠑, EVER, in (72a). In the case of *achiever* in (72b) the request of the stress being on the first syllable containing the sequence <ever> is fulfilled, but the use of the composite initial groupsign ⠐⠑, EVER is explicitly disallowed for the sequence <iever> and thus not used in (72b).

(72) a. /s$^{ɪ}_{ə}$ˈvɪərɪti/
severity

b. /əˈtʃiːvə/
achiever

Due to a preceding <e> the composite initial groupsign ⠐⠑, EVER, may not be used in *McKeever* in (73c) either.[52]

(73)	a. *⠎⠐⠑⠰⠽ *sEVER/ITY	a.' ⠎⠑⠧⠻⠰⠽ sevER/ITY severity
	b. *⠁⠡⠊⠐⠑ *aCHiEVER	b'. ⠁⠡⠊⠑⠧⠻ aCHievER achiever
	c. *⠍⠉⠅⠑⠐⠑ *McKeEVER	c'. ⠍⠉⠅⠑⠑⠧⠻ McKeevER

British Braille does not state why the composite initial groupsign ⠐⠑, EVER, may not be used in the letter sequences <iever> and <eever>.[53]

Comparing contractions, the structurally less complex upper groupsigns are ranked higher as an upper groupsign is obligatory in the parallel construction in (74). In *weed* in (74a') the digraph <ee> is disrupted by the upper groupsign ⠫, *ED*. Similarly in *fiend* in (74b') the digraph <ie> is disrupted by the lower groupsign ⠢, *EN*.

(74)	a. *⠺⠑⠑⠙ *weed	a'. ⠺⠑⠫ weED weed
	b. *⠋⠊⠑⠝⠙ *fiend	b'. ⠋⠊⠢⠙ fiENd fiend

The behaviour of the composite initial groupsigns ⠐⠑, EVER, can be summarised in Restriction 5.

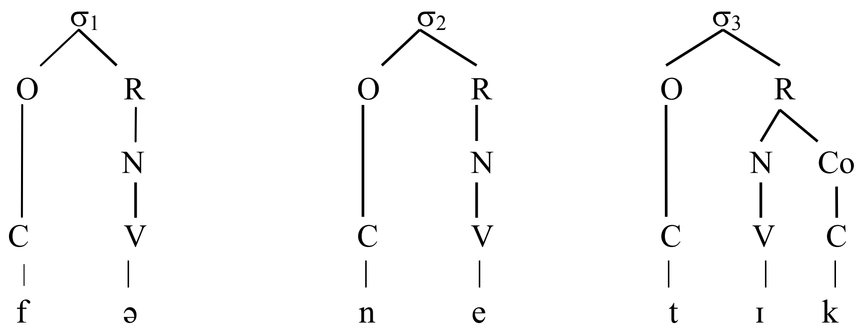
---

[52] *British Braille* only lists proper names for this letter sequence.
[53] The sequences <eever> and <iever> are extremely rare: keever, peever, reever, weever, liever, siever. None of these examples are part of *British Braille*.

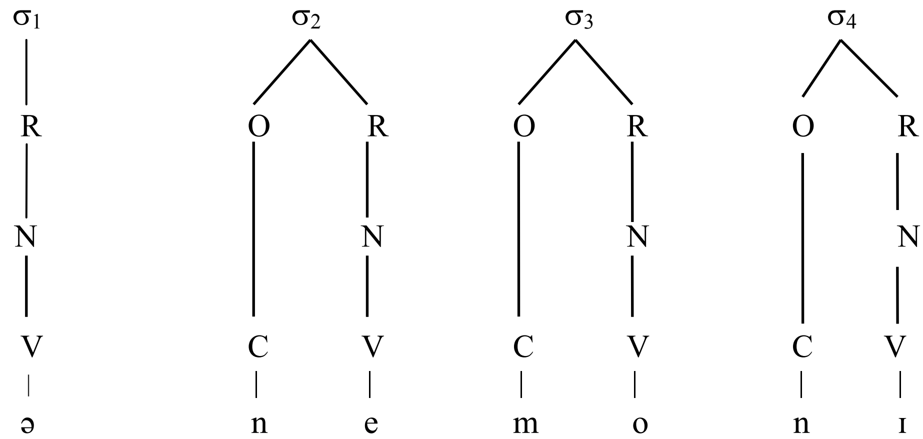
> Restriction 5
>
> The composite initial groupsigns ⠐⠑, <u>*EVER*</u>, may only be used when the syllable that contains the first vowel of the respective contraction bears a stress.

The syllable structures of *phonetic*, *anemone*, *money* and *honest* are given in (75).

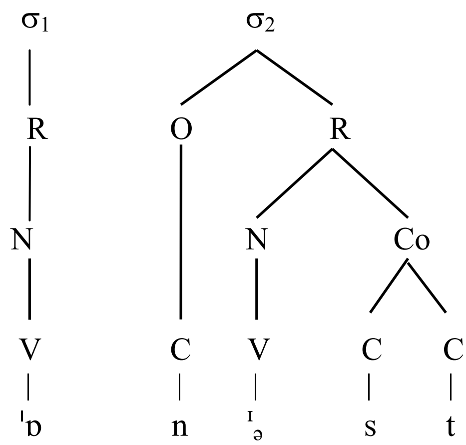
(75) a. phonetic: / fəˈnetɪk/



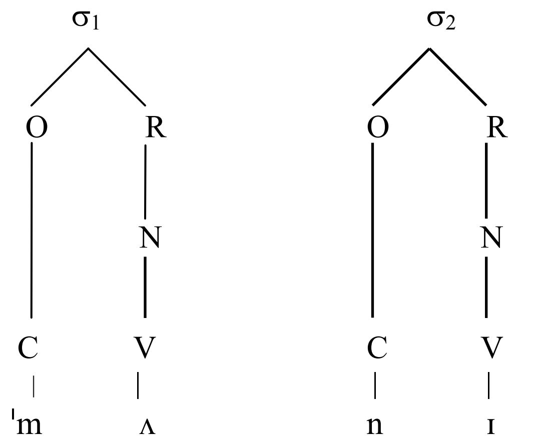
b. anemone: /əˈnemonɪ/



c. honest: /ˈɒnɪəst/



d. money: /ˈmʌnɪ/



Regarding the realisation of the letter sequence <one>, structurally all examples in (75) are identical. Following Rule 8.5.7 the composite groupsign ⠐⠕, <u>*ONE*</u>, may not be used in *phonetic* in (76a) and *anemone* in (76b).

(76) a. *⠏⠓⠐⠕⠞⠊⠉ *ph<u>ONE</u>tic — a'. ⠏⠓⠕⠝⠑⠞⠊⠉ phonetic

b. *⠁⠝⠑⠍⠐⠕ *anem<u>ONE</u> — b'. ⠁⠝⠑⠍⠕⠝⠑ anemone

British Braille offers no explanation why *honest*, in (77a'), *monetary* in (77b') and the letter sequence <oney> for example in *money* in (77c') are exempt from this rule. In none of these examples is the sequence <one> contained within one phonological syllable. My assumption is that they are of such high frequency that they are salient enough in order not to violate Generalisation 1 [no interference with braille reading].

(77) a. *⠓⠕⠝⠑⠌ *honeST — a'. ⠓⠐⠕⠌ h<u>ONE</u>/ST honest

b. *⠍⠕⠝⠑⠞⠜⠽ *monetARy — b'. ⠍⠐⠕⠞⠜⠽ m<u>ONE</u>tARy monetary

c. *⠍⠕⠝⠑⠽ *money — c'. ⠍⠐⠕⠽ m<u>ONE</u>y money

All examples given in Rule 8.5.7 are listed in Table 4.15 together with their respective phonological and orthographic syllabification. The examples (a) to (d) are monosyllabic and conform with the requirement that the letter sequence <one> is "pronounced as one syllable", if this is taken to mean 'contained within one syllable'. In (e) to (g) the letter sequence <one> is contained within one syllable in both phonological syllabification and orthographic segmentation. The examples (h) to (l) are clearly excluded, as here the use of the composite initial groupsign ⠐⠕, *ONE*, crosses both phonological syllabification and orthographic segmentation.

The crucial data is in the fourth section, examples (m) to (q). They are explicitly allowed even though they violate the requirement of being contained within one syllable for both phonological syllabification and orthographic segmentation and are thus in contradiction to the rule.

Table 4.15: Examples for Rule 8.5.7: ONE

	example	phonological syllabification	orthographic syllabification
a	bONE	/bəʊn/	bone
b	dONE	/dʌn/	done
c	gONE	/gɒn/	gone
d	ST/ONE	/stəʊn/	stone
e	alONE	/ə - ˈləʊn/	a-lone
f	lONEly	/ˈləʊ - nli/	lone-ly
g	telephONE	/ˈte - l$^{ɪ}_{ə}$ - ˌfəʊn/	tel-e-phone
h	anemone	/ə - ˈne - mo - nɪ/	a-nem-o-ne
i	bayonet	/ˈbeɪ - ə - n$^{ɪ}_{ə}$t/	bay-o-net
j	phonetic	/fə - ˈne - tɪk/	pho-net-ic
k	sooneST	/ˈsuːn - $^{ɪ}_{ə}$st/	soon-est
l	colonel	/ˈkɜː - n̩l/	colo-nel
m	hONEy	/ˈhʌ - nɪ/	hon-ey
n	mONEtARy	/ˈmʌ - n$^{ɪ}_{ə}$tərɪ/	mon-e-ta-ry
o	mONEy	/ˈmʌ - nɪ/	mon-ey
p	hONE/ST	/ˈɒ - n$^{ɪ}_{ə}$st/	hon-est
q	phONEy	/ˈfəʊ - nɪ/	pho-ney

In half of the examples of Rule 8.5.7, the letter sequence <one> contains the standard realisation /əʊ/ of the discontinuous complex grapheme <o...e>. Contrasting the deviant examples in (h) to (l) with the exceptions in (m) to (q) does not yield a satisfactory result. The choice seems to be arbitrary with the exception of two very slight tendencies: the set of exceptions in (m) to (q) is more frequent than the set in (h) to (l). In addition, the exceptions to the rule also have more regular correspondences to the underlying vowels than the set in (h) to (l).[54]

[54] A Middle English graphotactic change replaced <u> by <o> in words which contained a sequence of downstrokes such as <u>, <m>, <n> and <i> in order to avoid ambiguity (Carney 1994:68).

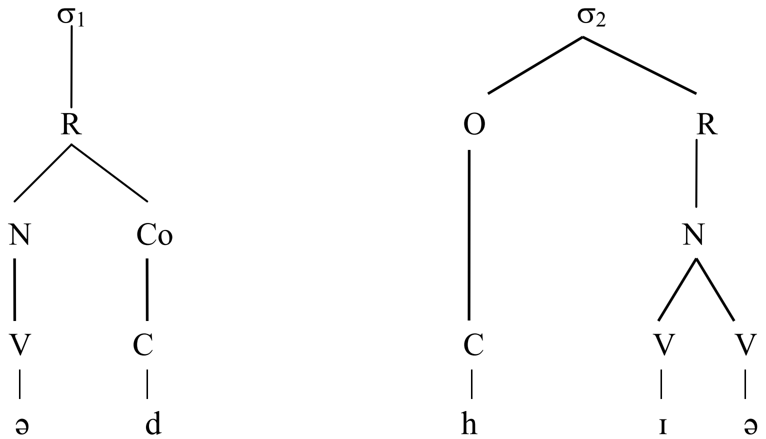
HERE

The contraction for the composite initial groupsign ⠐⠓, <u>*HERE*</u>, may only be used if the whole letter sequence <here> is contained within one syllable.

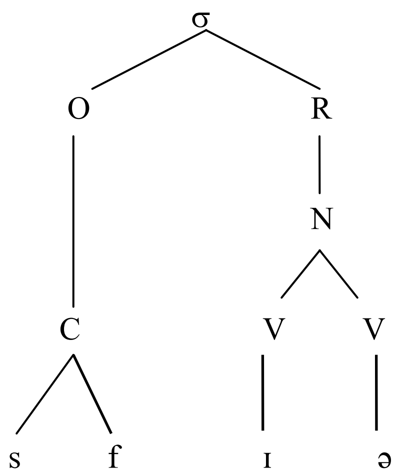
> 8.5.5 The contraction for <u>HERE</u> may only be used when the letters it represents are pronounced as one syllable.
>
> *Examples*: ad<u>HERE</u>, <u>HERE</u>to, <u>HERE</u>/WITH, sp<u>HERE</u>, but: hEResy [not <u>HERE</u>sy]
>
> *British Braille* (2004:107)

The syllable structures for *adhere*, *sphere*, and *heresy* are given in (78).

(78) a. adhere: /ədˈhɪə/

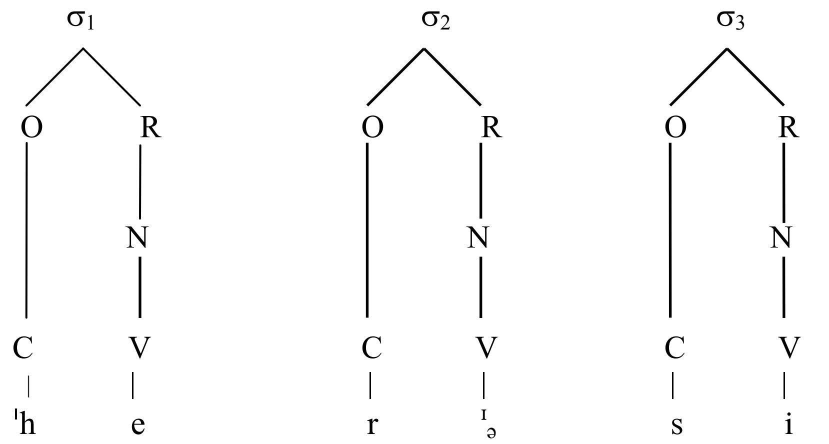


b. sphere: /sfɪə/[55]



[55] Following Carr (1993: 212) the sequence is analysed as a complex segment and thus does not violate the sonority hierarchy.

c. heresy: /ˈherɪəs i/



In *adhere* the requirement is fulfilled and the composite initial groupsign ⠐⠓, HERE, is used in (78a). *Sphere* in (79b) is monosyllabic and thus also meets this requirement, as illustrated in (79b). The way this Rule has been rewritten is problematic (see section 4.6. for a comparison of the 1992 and 2004 *British Braille* editions). The use of the composite initial groupsign ⠐⠓, HERE, in *sphere* is a rare example in which a composite groupsign interferes with a complex grapheme.[56] My assumption is that earlier *British Braille* rules have so successfully put an emphasis on *sphere* and words ending in *-oney* that they are salient enough not to interfere with reading and are thus permissible in the 2004 edition.[57]

Finally, in *heresy* the /r/ is in the onset of the second syllable and the composite initial groupsign must not be used, as illustrated in (79c).

(79) a. ⠁⠙⠐⠓
adHERE
adhere

b. ⠎⠏⠐⠓
spHERE
sphere

c. *⠐⠓⠎⠽
*HEREsy

c'. ⠓⠻⠑⠎⠽
hEResy
heresy

---

[56] The use of HERE in *sphere* is problematic. It is new to the 2004 edition of *British Braille*. *British Braille* 2004 List of changes: "In the rule concerning the contraction 'here', the condition that the 'h' should be aspirated has been removed. Thus the contraction "here" is now permissible in 'sphere'

[57] Compare the historical development of the use of the composite groupsign ⠠⠽, *ALLY*, in example (99b).

NAME and TIME

The composite initial groupsigns ⠐⠝, <u>*NAME*</u>, and ⠐⠞, <u>*TIME*</u>, may only be used if the letter sequences <name> and <time> correspond to /neɪm/ and /taɪm/.

> 8.5.6 The contraction for <u>NAME</u> may only be used when the letters it represents are pronounced as one syllable.
>
> *Examples*: <u>NAME</u>ly, <u>NAME</u>r, <u>NAME</u>sake, un<u>NAME</u>d; but ENamel [not eNAMEl], ornaMENT [not orNAMEnt], unamENdED [not uNAMEndED]
>
> *British Braille* (2004:107)

> 8.5.10 The contraction for TIME may only be used when the letters it represents are pronounced as one syllable.
>
> *Examples*: mariTIME, SOME/TIMEs, TIMEr, TIMEx, but cENtime [not cEN/TIME], cENtimetre [not cEN/TIMEtre], multimEDia [not mulTIMEdia].
>
> *British Braille* (2004:108)

Namely, *namesake*, *sometimes* and *maritime* in (80) meet this requirement.

(80) a. /ˈneɪmli/
namely

b. /ˈneɪmseɪk/
namesake

c. /ˈsʌmtaɪmz/
sometimes

d. /ˈmær$^{\text{I}}_{\text{ə}}$taɪm/
maritime

They use the respective composite initial groupsign in (81).

(81) a. ⠐⠝⠇⠽
<u>NAME</u>ly
namely

b. ⠐⠝⠎⠁⠅⠑
<u>NAME</u>sake
namesake

c. ⠐⠎⠐⠞⠎
<u>SOME</u>/<u>TIME</u>s
sometimes

d. ⠍⠜⠊⠐⠞
mARi<u>TIME</u>
maritime

Enamel, *ornament*, *centime* and *centimetre* do not meet this requirement as their phonemic representations in (82) show.

(82) a. /ɪˈnæməl/
enamel

b. /ˈɔːnəmənt/
ornament

c. /ˈsɒntiːm/
centime

d. /ˈsentˈₔmiːtə/
centimetre

As a consequence the composite initial groupsigns ⠐⠝, *NAME*, and ⠐⠞, *TIME*, must not be used for any of the example in (82). This is illustrated in (83).

(83) a. *⠑⠐⠝⠇
*e<u>NAME</u>l

a'. ⠢⠁⠍⠑⠇
ENamel
enamel

b. *⠕⠗⠐⠝⠝⠞
*or<u>NAME</u>nt

b'. ⠕⠗⠝⠁⠰⠞
ornaMENT
ornament

c. *⠉⠢⠐⠞
*cEN/<u>TIME</u>

c'. ⠉⠢⠞⠊⠍⠑
cENtime
centime

d. *⠉⠢⠐⠞⠞⠗⠑
*cEN/TIMEtre

d.' ⠉⠢⠐⠞⠞⠗⠑
cENtimetre
centimetre

The restrictions on the use of ⠐⠝, *NAME*, and ⠐⠞, *TIME*, can thus be summarised as in Restriction 6.

> Restriction 6
> The composite initial groupsigns ⠐⠝, *NAME*, and ⠐⠞, *TIME*, may only be used if the pronunciation of the groupsign and the respective corresponding wordsign are identical.

4.4.1.3 Morphological restrictions

In addition to phonological restrictions, there are several composite initial groupsigns which are only allowed to be used in their meaning as root. These are ⠐⠝, *NAME*, ⠘⠥, *UPON*, ⠘⠱, *WHOSE*, ⠘⠮, *THESE*, and ⠘⠹, *THOSE*, and ⠐⠎, *SOME*.

UPON, WHOSE, THESE and THOSE

There are five composite initial groupsigns which use the dot 4-5 indicator sign, ⠘. *WORD*, ⠘⠺ is used wherever the letter sequence <word> occurs. The other four, ⠘⠥, *UPON*, ⠘⠱, *WHOSE*, ⠘⠮, *THESE*, and ⠘⠹, *THOSE*, are used when the respective letter sequences represent the roots.

> 8.5.1 The contraction for WORD should be used wherever the letters it represents occur.
>
> *Examples*: FOReWORD, sWORD, WORDiNESS
>
> However, the contractions for UPON, THESE, THOSE and WHOSE should only be used where they retain their meanings as whole words.
>
> *Examples*: HERE/UPON, WHERE/UPON, WHOSEsoEVER; but cOUpon [not coUPON], hypoTHEses [not hypoTHESEs].
>
> *British Braille* (2004:106)

Thus in *thereupon* in (84a) the composite initial groupsign ⠘⠥, *UPON*, may be used, but not in *coupon* in (84b).

(84) a. ⠐⠮⠘⠥
THERE/UPON
thereupon

b. *⠉⠕⠘⠥
*coUPON

b'. ⠉⠳⠏⠕⠝
cOUpon
coupon

The first part of Rule 8.5.1, the use of the composite initial groupsign ⠘⠺, *WORD*, is already covered by Generalisation 7. Hence Rule 8.5.1 can be rewritten as Restriction 7.

> Restriction 7
> The composite initial groupsigns ⠘⠥, *UPON*, ⠘⠱, *WHOSE*, ⠘⠮, *THESE*, and ⠘⠹, *THOSE*, should only be used when the respective letter sequences represent the root.

SOME

According to Rule 8.5.9, the use of the composite initial groupsign ⠐⠎, *SOME*, is restricted to the letter sequence <some> being contained within one syllable of the base of the target word.

> 8.5.9 The contraction for SOME should be used wherever the letters it represents form a definite syllable of the basic word.
>
> *Examples*: CHromoSOME, hAND/SOME, hAND/SOMEr, hAND/SOME/ST; but blossomED [not blosSOMEd], gasometER, ransomED [not ranSOMEd], somERsault [not SOMErsault].
>
> *British Braille* (2004:108)

The composite initial groupsign ⠐⠎, SOME, may thus be used in *chromosome* in (85a) and in *troublesome* (85) but not in *somersault* in (85c). The example *gasometer* is already ruled out by Generalisation 1 [no interference with decoding in braille reading].

(85) a. ⠡⠗⠕⠍⠕⠐⠎
ChromoSOME
chromosome

b. ⠞⠗⠳⠼⠐⠎
trOU/BLE/SOME
troublesome

c. *⠐⠎⠗⠎⠁⠥⠇⠞
*SOMErsault

c'. ⠎⠕⠍⠻⠎⠁⠥⠇⠞
somERsault
somersault

Phonologically *somersault* is represented by three syllables: σ_1: /ˈsʌ/, σ_2: /mə/ and σ_3: /sɔːlt/. The letter sequence <some> is contained within the root but not within one syllable and thus the composite initial groupsign ⠐⠎, SOME, must not be used in *somersault* in (85c).

Thus in the case of the composite initial groupsign ⠐⠎, SOME, there are two relevant criteria: firstly, the composite initial groupsign ⠐⠎, SOME should be used wherever it represents the suffix *-some*, secondly, the letter sequence <some> has to be contained not only within a syllable but also within the base in order for ⠐⠎, SOME, to be used. The suffix *–some* will always form a syllable within the base, thus Rule 8.5.9 can be rewritten as a restriction of Generalisation 7 (i):

> Restriction 8
> The composite initial groupsign ⠐⠎, SOME, may only be used when it forms a syllable within a base.

4.4.1.5 Summary

Most restrictions on the use of composite initial groupsigns rely on their phonetic structure. This is due to the fact that every single composite initial groupsign has a dual function, as a groupsigns and as a wordsign. The *British Braille* Rules 8.5.1, 8.5.2, 8.5.3, 8.5.8, 8.5.11, 8.5.12 and 8.5.13 on the use of composite initial groupsigns have been summarised in Generalisation 7 (i).

> Generalisation 7 (i)
> Composite initial groupsigns are to be used wherever the letter sequence they represent occurs.

An updated summary of generalisations is given in Table 4.16.

Table 4.16: Summary of Generalisations

Generalisation		replacing Rule
1	The use of a braille contraction must not interfere with decoding in braille reading.	8.4.29, 8.8.6, 8.9.5, 8.9.6
2	The least complex contraction should always be preferred.	8.8.3, 8.8.5
3	The fewest contractions shall be used.	8.8.2
4	Upper groupsigns are to be used wherever the letter sequence they represent occurs.	8.3.1
5	Affixation does not justify the use of contractions which must not be used in the root by itself. The only exception is the lower medial groupsign ⠂, EA.	8.3.7, 8.4.28, 8.9.2
6	Lower groupsigns are to be used wherever the letter sequence they represent occurs.	8.4.1, 8.4.22.
7 (i)	Composite initial groupsigns are to be used wherever the letter sequence they represent occurs	8.5.1, 8.5.2, 8.5.3, 8.5.8, 8.5.11, 8.5.12, 8.5.13

British Braille Rule 8.5.5 on the use of ⠐⠓, <u>*HERE*</u>, remains unchanged, the other 6 rules are covered by Restrictions 4 to 7 and listed in Table 4.17.

Table 4.17: Summary of restrictions

Restriction		replacing Rule
1	The upper groupsigns ⠼, *BLE*, and ⠬, *ING*, must not be used in word-initial position.	8.3.5, 8.3.6, 8.3.7.
2	Sequences of adjacent lower signs must not stand by themselves.	8.4.1
3	The lower initial groupsigns ⠆, *BE*, ⠒, *CON*, and ⠲, *DIS*, are used at the beginning of a word if the respective letter sequences can be generated by orthographic segmentation.	8.4.16
4	Lower medial groupsigns may only be used in word-medial position. They are sensitive to orthographic word segmentation.	8.4.25
Rule 8.5.5.	The contraction for <u>HERE</u> may only be used when the letters it represents are pronounced as one syllable.	___
5	The composite initial groupsigns ⠐⠑, <u>*EVER*</u>, and ⠐⠕, <u>*ONE*</u>, may only be used when the syllable that contains the first vowel of the respective contraction bears a stress.	8.5.4., 8.5.7.
6	The composite initial groupsigns ⠐⠝, <u>*NAME*</u>, and ⠐⠞, <u>*TIME*</u>, may only be used if the pronunciation of the groupsign and the respective corresponding wordsign are identical.	8.5.6., 8.5.10.
7	The composite initial groupsigns ⠘⠥, <u>*UPON*</u>, ⠘⠱, <u>*WHOSE*</u>, ⠸⠹, <u>*THESE*</u>, and ⠘⠹, <u>*THOSE*</u>, should only be used when the respective letter sequences represent the root.	8.5.1.
8 (i)	The composite initial groupsign ⠐⠎, <u>*SOME*</u>, should be used when the letter sequence <some> is simultaneously contained within both a root and a syllable.	8.5.9.

This means that the use of composite initial contractions can now be governed by one generalisation and five restrictions as opposed to the 13 rules with various unexplained exceptions found in *British Braille*. The only aspect that still has to be learnt by rote is the classification of each contraction.

4.4.2 Composite final groupsigns

Composite final groupsigns are inseparable two cell units which consist of one of the functional signs in (86) in the first cell followed by the last letter of the letter sequence they represent (Lorimer 1996: 2.4).

(86) a. ⠨
b. ⠰
c. ⠠

Composite final groupsigns are to be used wherever the letter sequence they represent occurs with the exception of word-initial position.

> 8.6.1 Contractions formed with dots 4-6, 5-6 and 6 should generally be used wherever the letters they represent occur except at the beginning of a word.
>
> *Examples*: bLESS/ING, cANCEl, dANCEr, ENhANCEd, mOUNTaIN, sOUND, wOUND/ED, basTION, ceMENT, GuiNESS, INcONGruOUs, INfIN/ITY, laITY, mONGoose, sIN/FUL/NESS, spONGe, TH/ENCE, creATION, rATION/ALLY, reALLY, rotATION, squALLY
>
> *British Braille* (2004:109)

This can be incorporated into Generalisation 7, resulting in the following expanded version:

Generalisation 7 Composite groupsigns are to be used wherever the letter sequence they represent occurs.

Since many of the composite final groupsigns represent suffixes, as *-ity*, *-less*, *-ness* and *-ful* in (87), they tend not to come into conflict with other rules governing the use of contractions.

(87) a. ⠔⠋⠔⠰⠽
INfIN/ITY
infinity

b. ⠉⠜⠑⠨⠎⠰⠎
cAReLESS/NESS
carelessness

c. ⠎⠔⠠⠇⠰⠎
sIN/FUL/NESS
sinfulness

The other use of composite final groupsigns is in strings of letters frequent in word-medial or word-final position such as ⠨⠞, OUNT, in *mountain* in (88a), *count* in (88b).

(88) a. ⠍⠨⠞⠁⠔
mOUNTaIN
mountain

b. ⠉⠨⠞
cOUNT
count

There are only two signs which are restricted in their use: ⠰⠎, *NESS* and ⠰⠽, *ITY*. Both restrictions concern the morphological structure of the words in question.

NESS

The composite final groupsign ⠰⠎, *NESS*, must not be used to bridge a root ending in <en> or <in> and the suffix *-ess*.

> 8.6.5 The contraction for NESS may be used in feminine endings except when preceded by e or i, in which case the contractions for EN and IN should be used.
>
> *Examples*: bARoNESS, govER/NESS, lioNESS, mAR/CHioNESS; but: CHieftaINess, citizENess.
>
> *British Braille* (2004:109)

Generally, the composite final groupsign ⠰⠎, *NESS*, may bridge a root ending in <n> and the suffix -ess, as illustrated in *lioness* in (89a) and *baroness* in (89b). Roots ending in <en> as *citizen* in (90c) or in <in > as *chieftain* in (89d) are excluded. This restriction is probably a remnant of the previous version of Rule 8.6.5 which did not allow (89a) nor (89b) (see section 4.6).

(89) a. ⠇⠊⠕⠰⠎
lioNESS
lioness

b. ⠃⠜⠕⠰⠎
bARoNESS
baroness

c. *⠉⠊⠞⠊⠵⠑⠰⠎
*citizeNESS

c'. ⠉⠊⠞⠊⠵⠢⠑⠎⠎
citizENess
citizeness

d. *⠡⠊⠑⠋⠞⠁⠊⠰⠎
*CHieftaiNESS

d'. ⠡⠊⠑⠋⠞⠁⠔⠑⠎⠎
CHieftaINess
chieftainess

If ⠰⠎, <u>*NESS*</u>, represents the suffix -*ness*, a base ending in <e> as in *likeness* in (91a) or in <i> as in *motherliness* in (90b) cannot cause this effect.[58] Here Rule 8.8.1 holds [preference for the fewest braille cells] and ⠰⠎, <u>*NESS*</u>, is used.

(90) a. *⠇⠊⠅⠢⠝⠑⠎⠎
*likENess

a'. ⠇⠊⠅⠑⠰⠎
like<u>NESS</u>
likeness

b. *⠐⠍⠇⠔⠑⠎⠎
* <u>MOTHER</u>lINess

b'. ⠐⠍⠇⠊⠰⠎
<u>MOTHER</u>li<u>NESS</u>
motherliness

Thus, generally the use of the composite final groupsign ⠰⠎, <u>*NESS*</u>, seems only restricted in the two highly artificial examples *citizeness* and *chieftainess* in (90). As they are of extremely low frequency, there is not sufficient motivation to postulate a restriction that targets the letter sequences <iness> and <eness> in the context of the suffix -*ess*. *Chieftainess* is ruled out by Generalisation 1 [no interference with decoding in braille reading]. I don't think *citizeness* is ruled out by Generalisation 1 as well. In this case *citizeness* would have to be learnt as an exception but otherwise Rule 8.6.5 is redundant and covered by Generalisation7.

ITY

The composite final groupsign ⠠⠽, <u>*ITY*</u>, must not bridge a root and a suffix.

> 8.6.6 The contraction for <u>ITY</u> should not be used in words like the following
>
> *Examples*: biscuity [not biscu<u>ITY</u>], fruity [not fru<u>ITY</u>], hoity-toity [not ho<u>ITY</u>-to<u>ITY</u>], raBBity [not raBB/<u>ITY</u>].
>
> *British Braille* (2004:109f.)

The composite final groupsign ⠠⠽, <u>*ITY*</u>, may be used as a suffix like in *regularity* in (91a). It may also be used as part of a root, representing the letter sequence <ity> as in *city* in (91b). It may not bridge a root ending in the letter sequence <it> and the suffix -*y* as *fruity* in (91c) and in *rabbity* in (91d).

(91) a. ⠗⠑⠛⠥⠇⠜⠠⠽
regulAR/<u>ITY</u>
regularity

b. ⠉⠠⠽
c<u>ITY</u>
city

[58] The upper wordsign ⠇, *LIKE*, may not be used as the sequence <like> is not free-standing.

c. *⠗⠁⠆⠰⠽
*raBB/ITY

c'. ⠗⠁⠆⠊⠞⠽
raBBity
rabbity

d. *⠋⠗⠥⠰⠽
*fruITY

d'. ⠋⠗⠥⠊⠞⠽
fruity

The same restriction on the composite final groupsign ⠠⠽, *ALLY*, has been abandoned in the 1992 edition of *British Braille*. Since then ⠠⠽, *ALLY*, may bridge a root ending in <all> as *squal* in (92a) and the suffix *-y*, as in *squally* in (92b).

(92) a. ⠎⠟⠥⠁⠇⠇
squall

b. *⠎⠟⠥⠁⠇⠇⠽
*squally

b'. ⠎⠟⠥⠠⠽
squ*ALLY*
squally

Instead of listing the exceptions to the use of the composite final groupsign ⠰⠽, *ITY*, these may be summarised in Restriction 9.

> Restriction 9
>
> The composite final groupsign ⠰⠽, *ITY*, must not bridge a root and a suffix.

4.4.2.3 Summary

Composite initial and composite final groupsigns tend to be used wherever the letter sequence they represent occurs as long as the restrictions on their word-internal positions are respected. This is formulated in the amended Generalisation 7.

> Generalisation 7
> Composite groupsigns are to be used wherever the letter sequence they represent occurs.

An updated summary of generalisations is given in Table 4.18.

Table 4.18: Summary of Generalisations

Generalisation		replacing Rule
1	The use of a braille contraction must not interfere with decoding in braille reading.	8.4.29, 8.8.6, 8.9.5, 8.9.6
2	The least complex contraction should always be preferred.	8.8.3, 8.8.5
3	The fewest contractions shall be used.	8.8.2
4	Upper groupsigns are to be used wherever the letter sequence they represent occurs.	8.3.1
5	Affixation does not justify the use of contractions which must not be used in the root by itself. The only exception is the lower medial groupsign ⠂, EA.	8.3.7, 8.4.28, 8.9.2
6	Lower groupsigns are to be used wherever the letter sequence they represent occurs.	8.4.1, 8.4.22.
7	Composite groupsigns are to be used wherever the letter sequence they represent occurs	8.5.1, 8.5.2, 8.5.3, 8.5.8, 8.5.11, 8.5.12, 8.5.13, 8.6.1, 8.6.5

There is one restriction on the use of composite final groupsigns. The composite final groupsign ⠰⠽, <u>*ITY*</u>, must not simultaneously be used as a suffix and as a letter sequence that bridges a root and a suffix, Restriction 9 in Table 4.19.

Table 4.19: Summary of restrictions

Restriction		replacing Rule
1	The upper groupsigns ⠼, BLE, and ⠬, ING, must not be used in word-initial position.	8.3.5, 8.3.6, 8.3.7.
2	Sequences of adjacent lower signs must not stand by themselves.	8.4.1
3	The lower initial groupsigns ⠆, BE, ⠒, CON, and ⠲, DIS, are used at the beginning of a word if the respective letter sequences can be generated by orthographic segmentation.	8.4.16
4	Lower medial groupsigns may only be used in word-medial position. They are sensitive to orthographic word segmentation.	8.4.25
Rule 8.5.5.	The contraction for HERE may only be used when the letters it represents are pronounced as one syllable.	___
5	The composite initial groupsign ⠐⠑, <u>*EVER*</u>, may only be used when the syllable that contains the first vowel of the respective contraction bears a stress.	8.5.4.
6	The composite initial groupsigns ⠐⠝, <u>*NAME*</u>, and ⠐⠞, <u>*TIME*</u>, may only be used if the pronunciation of the groupsign and the respective corresponding wordsign are identical.	8.5.6., 8.5.10.
7	The composite initial groupsigns ⠘⠥, <u>*UPON*</u>, ⠘⠱, <u>*WHOSE*</u>, ⠘⠮, <u>*THESE*</u>, and ⠘⠹, <u>*THOSE*</u>, should only be used when the respective letter sequences represent the root.	8.5.1.
8	The composite initial groupsign ⠐⠎, *SOME*, should be used when the letter sequence <some> is simultaneously contained within both a syllable and the base unless it represents a suffix.	8.5.9.
9	The composite final groupsign ⠰⠽, <u>*ITY*</u>, must not bridge a root and a suffix.	8.6.6.

There are different levels of acceptance within *British Braille* itself. In the case of the composite final groupsign ⠠⠽, <u>*ALLY*</u>, this double use is now accepted. In contrast, it is still forbidden in the use of the composite final groupsign ⠰⠽, *ITY*. The composite final groupsign ⠰⠎, *NESS* is at an intermediate stage. Generally, bridging of root and suffix is allowed for ⠰⠎, *NESS* but with the restriction of roots ending in <en> and <in> if followed by the suffix *-ess*. For these roots the lower groupsigns ⠢, *EN* ⠔, *IN* have to be used, despite the violation of Rule 8.8.1 [use least space].

4.5 Shortforms

Contracted braille uses 76 shortforms (see section 3.4., Table 4.6). Shortforms are high frequency words which are specially abbreviated in braille and usually consist of the consonants and vowels in word-initial position. They are indifferent to homonymy.

> 8.7.1. Shortforms can in general be used wherever they occur as whole words, whatever their meaning.
>
> *Examples*: according (agreeing, granting); letter (epistle, one who lets, etc.); must (obligation, mould, new wine, etc); quick (alive, fast).
>
> *British Braille* (2004:110)

> 8.7.2. They may be preceded and followed by additions provided there is no interference with spelling, the basic word retains its original meaning, and the resultant word could not be mistaken for another word.
>
> *Examples*: children's; get-together; goodies; greateST; letter/ED; but: BEfriENdED; [not BE/friend/ED → BEfrED]; blINdED [not blind/ED → blED]; declAR/ATION [not declare/ATION], muST/ARd [not must/ARd], SH/OUldER [not should/ER].
>
> *British Braille* (2004:110)

> 8.7.3 Shortforms composed of the first letters of a word (e.g. after, blind, friend) must not be used before a vowel when the resulting combination of letters could be mistakenly pronounced as a word.
>
> *Examples*: aftEReFFects [not after/effects → afeFFects]; BEfriENdED [not BE/friend/ED → BEfrED]; blINdING [not blind/ING → blING]; but blindfold
>
> *British Braille* (2004:110)

The parts of Rule 8.7.2. and 8.7.3. which are concerned with legibility are already covered by Generalisation 1, no interference with decoding in braille reading. Rules 8.7.1 to 8.7.3 can thus be summarised in Generalisation 8.

Generalisation 8 Shortforms are to be used wherever the letter sequence they represent is an unaltered root.

Thus the shortform *letter* is used in all of the following examples. *Letter* in (93a) is the root. In *letters* and *lettered* it is combined with inflectional suffixes and in (93d) to (93f) it represents a root in a compound.

(93) a. ⠇⠗
lr
letter

b. ⠇⠗⠎
lrs
letters

c. ⠇⠗⠫
lrED
lettered

d. ⠇⠗⠃⠕⠭
lrbox
letterbox

e. ⠇⠗⠤⠟⠥⠁⠇⠠⠽
lr-qualITY
letter-quality

f. ⠇⠗ ⠃⠕⠍⠃
lr bomb
letter bomb

In (94b) *shoulder* must not use the shortform *should* of (94a) as *shoulder* is a different root. The shortform *declare* in (94c) must not be used in *declaration* in (94d) as the suffixation of -*ation* produces the incorrect spelling *declareation. Thus both deviant examples are ruled out by Generalisation 8.

(94) a. ⠩⠙
SHd
should

b. *⠩⠙⠻
*SHdER

b.' ⠩⠳⠇⠙⠻
SH/OUldER
shoulder

c. ⠙⠉⠇
dcl
declare

d. *⠙⠉⠇⠠⠝
*dcl/ATION

d.' ⠙⠑⠉⠇⠜⠠⠝
declAR/ATION
declaration

Generalisation 8 is restricted to shortforms. It is ranked lower than the universally applicable Generalisation 1 [no interference with decoding in braille reading]. Generalisation 1 is responsible for excluding the examples in (95).

(95) a. *⠃⠇⠫
*bl/ED

a.' ⠃⠇⠔⠙⠫
blINdED
blinded

b. *⠃⠇⠬
*bl/ING

b.' ⠃⠇⠔⠙⠬
blINdING
blinding

c. *⠆⠋⠗⠫
* BE/fr/ED

c.' ⠆⠋⠗⠊⠢⠝⠙⠫
BEfriENdED
befriended

To summarise, Generalisation 8 covers the *British Braille* rules on shortforms, Rule 8.7.1 to 8.7.3.

> Generalisation 8
> Shortforms are to be used wherever the letter sequence they represent is an unaltered root

Shortforms may be used as long as Generalisation 1 is observed [no interference with decoding in braille reading] and their use does not result in an incorrect spelling. An updated table of generalisations is given in Table 4.20.

Table 4.20: Summary of Generalisations

Generalisation		replacing Rule
1	The use of a braille contraction must not interfere with decoding in braille reading.	8.4.29, 8.8.6, 8.9.5, 8.9.6
2	The least complex contraction should always be preferred.	8.8.3, 8.8.5
3	The fewest contractions shall be used.	8.8.2
4	Upper groupsigns are to be used wherever the letter sequence they represent occurs.	8.3.1
5	Affixation does not justify the use of contractions which must not be used in the root by itself. The only exception is the lower medial groupsign ⠂, EA.	8.3.7, 8.4.28, 8.9.2
6	Lower groupsigns are to be used wherever the letter sequence they represent occurs.	8.4.1, 8.4.22.
7	Composite groupsigns are to be used wherever the letter sequence they represent occurs	8.5.1, 8.5.2, 8.5.3, 8.5.8, 8.5.11, 8.5.12, 8.5.13, 8.6.1, 8.6.5
8	Shortforms are to be used wherever the letter sequence they represent is an unaltered root	8.7.1, 8.7.2, 8.7.3

4.6 *British Braille*: The 1992 and 2004 editions compared

My chapter 4 is based on the 2004 edition of *British Braille* which is an update of the edition published in 1992 and incorporates suggestions of braille users and producers collected by the Braille Authority of the United Kingdom since the 1992 revision. Its official implementation date is August 2005.

The most extensive change is that the indication of capitals, made obligatory for braille in the United Kingdom in 1998, is now optional (Rule 5.2.1). The *British Braille* chapter concerned with the use of contractions contains eight changes that do not involve additional signs such as punctuation marks or indicator signs for formatting.

Three of these changes are concerned with general preferences for the use of contractions: 8.9.1 on the bridging of prefixes, 8.9.3 on the bridging of suffixes and 8.9.6 on digraphs.[59] One rule is concerned with the use of the lower groupsign ⠆, *BE*, 8.4.16. Finally, four rules are concerned with the use of composite groupsigns: Rule 8.5.2 on contractions which use dots 4-5-6 as indicator sign, Rule 8.5.5 on ⠐⠓, *HERE*, Rule 8.5.7 on ⠐⠕, *ONE*, and Rule 8.6.5 on ⠰⠎, *NESS*.[60]

The rule on bridging prefixes has been liberalised. Previously morphologically complex words had to be analysed to determine whether the use of a contraction was possible. If the word class of the root and the word class of prefix plus root were identical and the root and the derived word were etymologically closely related, a contraction could not be used to bridge prefix and root.

> 8.9.1. When a prefix is added to an English word to form another word of the same part of speech and with a meaning closely related to that of the original word, a contraction should not be used to bridge the prefix and the remainder of that word.
>
> *Examples*: denATIONalise [not dEN/ATIONalise], INessENtial [not iNESS/ENtial], misheAR [not miSH/eAR], mistERm [not miST/ERm], predeST/INe [not prEDeST/INe], predomINate [not prEDomINate], react [not rEAct], redOU/BLE [not rED/OU/BLE], sublet [not suBLEt].
>
> *British Braille* (1992:76)

As a consequence *redress*$_1$ in the sense of *dress again* in (96a) and *redress*$_2$ in the sense of *readjust* in (96b) had two different braille realisations. The use of the upper groupsign ⠫, *ED*, was only allowed for *redress*$_2$.

(96) a. ⠗⠑⠙⠗⠑⠎⠎
redress$_1$

b. ⠗⠫⠗⠑⠎⠎
rEDress
redress$_2$

The rule on the bridging of suffixes, 8.9.3, now has the overt restriction not to create inappropriate complex graphemes, as e.g. <th> in knighthood in (97a).

[59] References in the text are to the rules in the 2004 edition.

[60] In comparison: There are 11 changes in the use of punctuation signs; 27 changes in the use of composition signs and their interaction with contractions (adaptation of fonts, e.g. italics), 10 changes for numbers and related signs, 17 changes for abbreviations and symbols and 4 changes for layout rules.

(97) a. *⠅⠝⠊⠣⠹⠕⠕⠙ a'. ⠅⠝⠊⠣⠞⠓⠕⠕⠙
*kniGH/THood kniGHthood
knighthood

In 1992 Rule 8.9.7 disallowed simple groupsigns to interfere with the digraphs <ae> and <oe>.

8.9.7 The contraction for EA, ED, EN, ER should not be used when the *e* or *a* forms part of the diphthongs *ae* or *oe*, whether printed as such or not.

Examples: diaresis, ENcyclopaedia, Judaean, Liliaceae, maenad, Phoenicians, phoenix.

British Braille (1992:77)

In the 2004 edition, this rule has been divided into two rules, keeping the restriction for the lower medial groupsign ⠂, *EA*, (Rule 8.9.6) but not for the upper groupsigns ⠫, *ED*, and ⠻, *ER*, and the lower groupsign ⠢, *EN*, (Rule 8.9.7). This was done in order to simplify the rules.

8.9.6 The contraction for EA should not be used when the *e* or *a* forms part of the diphthong ae, whether printed as such [i.e. æ] or not.

Examples: Judaean [not JudaEAn], Liliaceae [not LiliacEAe]

British Braille (2004:114)

8.9.7 In other cases contractions can be used.

Examples: diaEResis, ENcyclopaEDia, phoENix, Betws-y-CoED, BlaENau FfeST/INiog, CaERnavon, BaEDecker, GoER/ING, GruENfeld, SchoENbERg,

British Braille (2004:115)

The examples in 8.9.7 are almost exclusively proper names and have to be learnt individually. Of the remaining three, the one most frequently used is *encyclop(a)edia*. Why Rule 8.9.7 is seen as a simplification is not clear. My assumption is that it is authorized by Rule 8.8.1, use fewest braille signs, and that Generalisation 1 [no interference with decoding in reading] is circumvented by the fact that these examples have to be learnt by rote and thus has the small benefit of saving the space of one braille cell.

Rule 8.4.16 restricts the use of the lower initial groupsign ⠆, *BE*, to an unstressed syllable which is argued to facilitate reading. *Benefit* in (98a) carries a primary stress on the first syllable. *Benediction* in (98b) carries a secondary stress on the first syllable.

(98) a. /ˈben$^{ɪ}_{ə}$fɪt/
benefit

b. /ˌben$^{ɪ}_{ə}$ˈdɪkʃən/
benediction

c. /beˈnefɪəsənt/
beneficent

Beneficent in (98c) has an unstressed first syllable and is the only member of this set that may use the lower initial groupsign ⠆, *BE*, in (99c).

(99) a. *⠆⠝⠑⠋⠊⠞
*BEnefit

a'. ⠃⠢⠑⠋⠊⠞
bENefit
benefit

b. *⠆⠝⠫⠊⠉⠰⠝
*BEnEDic<u>TION</u>

b'. ⠃⠢⠫⠊⠉⠰⠝
bEN/EDic<u>TION</u>
benediction

c. ⠆⠝⠑⠋⠊⠉⠢⠞
BEneficENt
beneficent

Finally, the four Rules concerned with the use of composite groupsigns: Rule 8.5.2 on contractions which use dots 4-5-6 as indicator sign, specifies that the composite initial groupsign ⠸⠓, *<u>HAD</u>*, is only used if the <a> is realised as a short monophthong.[61]

In Rule 8.5.5 on ⠐⠓, *<u>HERE</u>*, the restriction that the <h> has to be aspirated has been removed to include *sphere* (see section 4.4.1.2).

In Rule 8.5.7 on ⠐⠕, *ONE*, the letter sequence <oney> has been made eligible for the use of the composite initial groupsign ⠐⠕, *<u>ONE</u>*, (see section 4.4.1.2).

The composite final groupsign ⠰⠎, *<u>NESS</u>*, in Rule 8.6.5. may now be used to bridge the suffix *-ess* and a root ending in the letter <n> as in *lioness*. In the 1992 edition of *British Braille* it was listed as a property of the composite final groupsign ⠰⠎, *<u>NESS</u>*, that it could not be used in feminine endings, as in general, bridging of roots and suffixes was allowed.

8.6.5 The contraction for <u>NESS</u> should not be used in feminine endings.
Examples: bARoness, CHieftaINess, citizENess, govERness, lioness, mAR/CHioness.

British Braille (1992:74)

In general, the 2004 edition can be seen as a liberalisation with respect to the use of capitals and contractions. This is especially true for Rule 8.9.1 which governs the bridging of prefixes. For most of the remaining differing rules it provided a clarification of their use.

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[61] "**8.5.2.** A rule is now given that the contraction "had" should only be used when the "a" is short, thus excluding the case "Hadrian". In practice this is generally not a change, but previously such cases were treated as exceptions in the word list in Appendix III, and the principle was not explicitly stated in a rule."
BAUK (2004)

There are three aspects which are relevant for my braille study in chapter 6. The 2004 edition is less restrictive than the 1992 edition, especially with regard to the bridging of prefixes and roots. Yet, for a practising braillist most changes will hardly be noticed, as it is the status and not the form of many contracted examples that has been changed. They have been exceptions and are now incorporated into altered rules. Finally, the real changes, as in the case of the use of digraphs, apply to such a specialised vocabulary that these changes will probably be noticed very marginally only.

Despite the changes and the fact that the participants have not been aware of them at the time of the study in October 2004, the 2004 edition is used for discussion of the braille study in chapter 6 with the main consequence that idiosyncrasies concerning the use of the capital sign are ignored as this is now optional.

4.7 Summary

The main objective in this chapter was to identify underlying linguistic patterns that operate in the *British Braille* rules on the use of contractions these rules and to find adequate generalisations to account for these findings.

Contrary to *British Braille*'s reference of morphemes and syllables as crucial underlying units for determining the use of a contraction, I have shown that orthographic segmentation, which is not mentioned in *British Braille* is the most powerful element in determining the use of a contraction.

My generalisations are listed in Table 4.21 together with the one *British Braille* rule that remains unchanged.

Table 4.21: Hierarchy of generalisations and *British Braille* rules

Generalisation or Rule	application	content	replacing Rule
1	global	The use of a braille contraction must not interfere with decoding in braille reading.	8.8.6, 8.9.5, 8.9.6, 8.4.29
Rule 8.8.1	global	Preference should normally be given to contractions which cause a word to occupy fewer cells.	___
3	global	The fewest contractions shall be used.	8.8.2
2	global	The least complex contraction should always be preferred.	8.8.3, 8.8.5
4	global	Upper groupsigns are to be used wherever the letter sequence they represent occurs.	8.3.1
5	global	Affixation does not justify the use of contractions which cannot be used in the root by itself. The only exception is the lower medial groupsign *EA*.	8.3.7, 8.4.28, 8.9.2
6	lower groupsigns	Lower groupsigns are to be used wherever the letter sequence they represent occurs.	8.4.18, 8.4.22
7	composite groupsigns	Composite groupsigns are to be used wherever the letter sequence they represent occurs.	8.5.1, 8.5.2, 8.5.3, 8.5.8, 8.5.11, 8.5.12, 8.5.13, 8.6.1, 8.6.5
8	shortforms	Shortforms are to be used wherever the letter sequence they represent is an unaltered root.	8.7.1, 8.7.2, 8.7.3

In Table 4.22 all restrictions and all *British Braille* rules applying to the generalisations of Table 4.21 are listed.

Table 4.22: Restrictions on the use of individual contractions

Restriction or Rule		replacing Rule
1	The upper groupsigns *BLE* and *ING* must not be used in word-initial position	8.3.5, 8.3.6, 8.3.7
2	Sequences of adjacent lower signs must not stand by themselves.	
3	The lower initial groupsigns *BE*, *CON* and *DIS* are used at the beginning of a word if the respective letter sequences can be generated by orthographic segmentation.	8.4.16
4	Lower medial groupsigns may only be used in word-medial position. They are sensitive to end of line hyphenation.	8.4.25
Rule 8.4.5.	The lower wordsigns *TO*, *INTO* and *BY* should be written unspaced from a word which follows on the same braille line, even when a sense break or natural pause is present.	___
Rule 8.4.14.	[*BE*, *WERE*, *HIS* and *WAS*] ... must not be used in conjunction with any other sign. The signs for *WERE*, *HIS* and *WAS* must not be used as parts of words.	___
Rule 8.5.5.	The contraction for *HERE* may only be used when the letters it represents are pronounced as one syllable.	___
5	The composite initial groupsigns *EVER* and *ONE* may only be used when the syllable that contains the first vowel of the respective contraction bears a stress.	8.5.4, 8.5.7
6	The composite initial groupsigns *NAME* and *TIME* may only be used if the pronunciation of the groupsign and the respective corresponding wordsign are identical.	8.5.6, 8.5.10
7	The composite initial groupsigns *UPON*, *WHOSE*, *THESE* and *THOSE*, should only be used when the respective letter sequences represent the root.	8.5.1
8	The composite initial groupsign *SOME* should be used when the letter sequence <some> is simultaneously contained within both a root and a syllable.	8.5.9
9	The composite final groupsign *ITY* must not bridge a root and a suffix.	8.6.6

In this chapter the compilation of rules presented in *British Braille* has been broken down into a set of eight generalisations complemented by one of the original *British Braille* rules. The system also includes nine restrictions for the use of individual contractions or groups of contractions plus three of the original *British Braille* rules. This results in a set of 21 hierarchically ordered rules. In contrast, *British Braille* has 54 rules which themselves often consist of arbitrary lists to be learnt by rote.[62] Without taking the structures of the generalisations and restrictions into account, the number of rules to be learnt has now been reduced to less than half, to 39%.

Concerning the structure, there is a proportionate increase in sensitivity for word-internal boundaries and complexity of contractions. If a contraction represents an arbitrary string of letters in a given sequence, the relevant boundaries are the boundaries created by orthographic word segmentation.

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[62] These are the rules which are purely concerned with the use of contractions based on the letter sequences they represent. None of these rules that are concerned with the interaction of contractions and punctuation marks or formatting elements nor rules on the use of proper names and foreign words have been taken into account.

5 Writing

In this chapter I will provide a concise summary of the theoretical foundation for my analyses. Section 5.1 gives an introduction to graphemes and the concept of a distinct syllable in the orthographic system. The obstacles print-reading children need to overcome in order to acquire a writing system are illustrated in section 5.2. This is followed by the expansion to braille in section 5.3 and complemented by a concise survey on braille writing studies in section 5.4.

5.1 The English writing system

Writing systems vary in the structures of their written representations. The two extremes are meaning-based writing systems and sound-based writing systems. Chinese is the prime example of a writing system that uses symbols, which are directly linked to meanings, disregarding the phonological form of the word. Sound-based writing systems may link individual phonemes to graphemes, such as the phoneme /ɡ/ to the grapheme <g> in *goat*. One of the most regular of these sound-based writing systems is Finnish, where each written consonant and vowel corresponds to a distinctive phoneme and vice versa. Sound-based writing systems may also use characters to represent syllables, as in Japanese. Compared to meaning-based writing systems, both variants use a small number of symbols. These categories express tendencies. No language has a writing system that is purely based on meanings or on sounds (Cook: 2004).

English is essentially a sound-based writing system. Cook (2004) classifies it as an alphabetic system with a small amount of logograms.[63] The almost perfect biuniqueness of Finnish, where letters correspond directly to phonemes, is not achieved in English. Braille differs from Standard English Orthography as it includes a set of 81 groupsigns, 76 wordsigns and 76 shortforms which represent logograms, graphemes and arbitrary letter sequences, see section 3.5.

[63]Logograms are a written or printed symbols which represent a word or a morpheme in a language, e.g. the ampersand &, the per cent sign %, the mathematical symbols π and the square root√‾, the monetary values £, $, € or emoticons like ☺ and ☹.

Graphemes

In English, individual phonemes and individual graphemes vary considerably in their degree of representing such a biunique relationship. In addition, the term *grapheme* is in itself problematic as it is used with different meanings in the study of writing. Following (Carney 1994; Primus 2003; Weingarten 2003) I will use *grapheme* as the minimal distinctive unit in the orthographic system of a language.[64] A complex grapheme consists of more than one letter provided this letter string has a correspondence to a phoneme. Thus <ea> in *head* is one grapheme. Similarly the discontinuous string <a…e> in *mate* can be classified as one albeit discontinuous grapheme.[65]

Inappropriate consonant doubling is one of the most frequent spelling errors in English (Cook 2004). In Venezky's system geminate consonants are markers that indicate that the preceding vowel is checked, i.e. is a short vowel. In contrast, Thomé (1999:72) analysed consonant gemination in German as <mm> in *schwimmen*, *to swim*, in (1a) as a secondary grapheme, *Orthographem.* A secondary grapheme represents a corresponding phoneme less frequently than the corresponding primary grapheme, *Basisgraphem,* such as *zähmen*, *to tame* in (1b). In contrast to Venezky, he does not assign a function to geminate consonants.

(1) a. schwimmen
'to swim'

b. zähmen
'to tame'

Venezky (1999:82) gives a comprehensive list for English graphemes, Figure 5.1. They are termed *relational units* because they correspond to phonemes, in contrast to *markers* which are associated with the correspondences of other letters. Figure 5.1 is divided by frequency into productive graphemes that occur frequently to represent a phoneme, *major relational unit* and those who do so less often, *minor relational units*. Venezky does not give the corresponding IPA symbols nor does he assign corresponding phonemes to these graphemes. Both groups in Figure 5.1 are divided into graphemes that represent vowels such as <e> representing /e/ in *bell* in (2a) and /ɪ/ in

[64] This points towards written language as a separate system, without a direct dependency on spoken language as is expressed in phoneme-grapheme correspondences (Carney 1994; Venezky 1999; Rollings 2004). Thus the acquisition of an orthographic system equals second language acquisition.

[65] A second possibility is to analyse a final <e> in the context of a preceding vowel-consonant string as a marker that has no own correspondence to a phoneme but indicates that the preceding vowel is a free vowel, i.e. a vowel that may occur in a syllable without a coda (Venezky 1999:83f).

begin in (2b) or consonants as <gh> representing /g/ in *ghost* in (2c) within the group of *major relational units*.[66]

(2) a. bell <e> ≡ /e/

b. begin <e> ≡ /e/

c. ghost <gh> ≡ /ɪ/

A second classification criterion of these relational units is the number of their constituent elements for graphemes that represent vowels. Venezky classifies consonantal relational units as functionally compound, e.g. <dg> or functionally simple, e.g. <ch>, depending on e.g. their interaction with vowels as functionally complex consonants produce a checked vowel in the sequence VCfinal<e> as /æ/ in *badge*.[67] Functionally simple consonants produce a free vowel as /eɪ/ in *ache* in (Venezky 1999:80).

Venezky classifies <ck>, <dg> and <tch> as pseudogeminates, yet geminates are not part of this system, they are classified as markers.

Figure 5.1 Venezky: Relational units

Major relational units								
Consonants						Vowels		
Simple					Compound	Primary	Secondary	
b	gh	n	s	w	ck	a	ai/ay	ie
c	h	ng	sh	y	dg	e	au/aw	oa
ch	j	p	t	z	tch	i/y	ea	oi/oy
d	k	ph	th		wh	o	ee	oo
f	l	q	u		x	u	ei/ey	ou/ow
g	m	r	v				eu/ew	ui/uy

Minor relational units			
Consonants		Vowels	
Simple	Compound	Secondary	
kh	gn	aa	ieu/iew
rh	pph	ae	oe
sch	rrh	eau	ue
		eo	ye

[66] The sign ≡ is used to express the phoneme-grapheme correspondence.
[67] A checked vowel like /æ/ may not occur in a phonological syllable which does not contain a coda.

Syllables

The phonological unit *syllable* is defined in section 4.2.2 as a unit consisting of at least one phoneme usually a vowel. This obligatory phoneme forms the nucleus of the syllable (N). It may be preceded by a sequence of consonants, the onset (O). Any segments following the nucleus form the coda (Co). The set of nucleus and coda is the rhyme (R) (Carr: 1993).

The independent function of graphemes in the orthographic system is the basis for stipulating a structural unit which combines these graphemes, the ortho-syllable. As long as orthography is considered a second system derived from phonology, a syllable in orthography is not independent of a syllable in phonology.

Carney (1994) identifies criteria that govern word segmentation in hyphenation at line breaks (see section 4.1.1). At the same time, he rejects them as independent units in the system of orthography:

> Whether these orthographic 'syllables' can provide any basis for writing spelling correspondence rules is very dubious.
>
> Carney (1994:79)

As a consequence of phoneme-grapheme correspondences and text to speech transformations, both systems - phonology and orthography - are intertwined. Yet performance in the orthographic system can be impaired without an additional language impairment, e.g. in people with dyslexia.

Primus (2003) and Weingarten (2004) argue that the syllable in the system of phonology has a parallel functional unit in the orthographic system, the ortho-syllable. Primus (2003) shows that the unit *syllable* in orthography is sensitive to distributional requirements of its constituent graphemes and thus independent of the syllable in phonology.

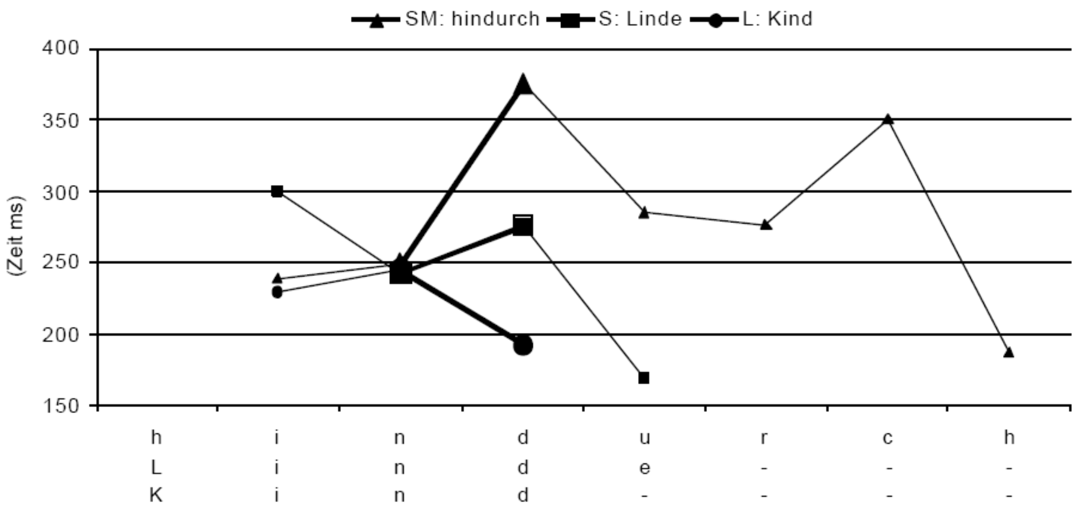
Weingarten (2004) and Weingarten, R. Nottbusch, G., & U. Will (2004) show that the invariance of ortho-syllables is a major difference between syllables in phonology and orthography. Whereas in a phonological syllable the nucleus may be omitted, this is not possible in an ortho-syllable. Each nucleus of an ortho-syllable has to contain at least one vowel grapheme. Thus the orthographic system has no parallel to vowel reduction as in *dishevelled* in (3a), where the schwa in italics indicates that it is optional. In contrast, the omission in the orthographic system in (3b) results in a spelling error.

(3) a. /dɪˈʃev*ə*ld/

b. *dishevelld

He gets further support for the syllable as an independent unit from studies on latencies in typing (Weingarten 2004). One such example is given in Figure 5.2, where he compares the latencies in the sequence <nd> in German, which can have three different functions. In *hindurch*, *through*, there is a combined syllable and morpheme boundary in this string. In *Linde*, *lime tree*, this string constitutes a syllable boundary, and in *Kind*, *child*, it is contained within one syllable. The latencies decrease with the decreasing complexitiy of the boundaries. Thus *hindurch*, *through*, where the sequence <nd> includes a syllable and a morpheme boundary shows the highest latency. In *Linde*, *lime tree*, the same string contains a syllable boundary, which is less complex than the combined syllable and morpheme boundary and more complex than the arbitrary sequence <nd> in *Kind*, *child*, which needs least time.

Figure 5.2: Latencies in the string <nd> according to function



(Will 2003 cited in Weingarten 2004)

To sum up, the notion that the orthographic system contains a distinctive syllable already occurs in Carney (1994). But he rejects it. Yet, Primus (2003) and Weingarten (2004) argue for an independent ortho-syllable. In chapter 4 I have shown that this syllable in the orthographic system is crucial in determining generalisations on the use of braille contractions.

5.2 Learning to write

> Reading and writing are a natural and automatic part of most people's lives. We find it hard to conceive that other people use quite different writing systems from our own. In particular, users of sound-based writing systems tend to assume that theirs is the only sensible way of writing and that meaning-based languages such as Chinese and Japanese are inefficient alternatives rather than being as unproblematic to their users as the ones they use themselves. (Cook 2004:16)

Learning to read and write requires recognising regular letter - sound correspondences such as linking spoken /bʌs/ to the written sequence <bus>. Additionally, irregular spellings of individual words such as *does*, which do not have a 1:1 mapping of phonemes to graphemes need to be implemented in this system.

Learners have to develop a sensitivity for recognising homophones such as the three readings of /ðeə/ the demonstrative pronoun *there*, the possessive pronoun *their*, and the contracted form of *they are*, *they're*. In addition, they have to realise that content words (nouns, verbs and adjectives) differ in form from grammatical words (articles, prepositions and conjunctions). Content words such as the nouns *inn* in (4a) or *ore* and *oar* in (4b) contain a minimum of three letters. Grammatical words such as the preposition *in* in (4a') or the conjunction *or* in (4b') need not meet this limit (Cook 2004: 57).

(4) a. /ɪn/ — inn$_N$ a'. /ɪn/ — in$_P$

b. /ɔː/ — oar$_N$/ore$_N$ b'. /ɔː/ — or$_{conj}$

Finally, learners will have to be able to recognise arbitrary letter sequences such as <ck> as a possible spelling for a syllable coda only. Thus, the string <ck> may appear at the end of a syllable as in *back*, (5a) but it cannot be used at a syllable onset. The string **ckab*, (5b), is a spelling which is not consistent with the structure of English ortho-syllables.

(5) <ck>
a. back
b. *ckab

The most frequent errors of inexperienced spellers who have just begun to develop their orthographic system are phonetic spelling errors. The string they have assembled sounds like the target but is not in accordance with spelling convention. Two examples of phonetic spelling are given in (6). Even though incorrect, both forms produce an adequate mapping of sound to *letter*, i.e. a reader will have no problems to access the underlying forms /skuːl/ for *school* in (6a) and /wʌn/ for *one* in (6b).

(6) a. *skool a'. school

b. *wun b.' one (Ellis ^{2}1993:62)

Weingarten (1998), shows that the acquisition of reading and writing is not universally dependent on teaching; it is a process comparable to second language acquisition.

Furthermore, Weingarten (2003) showed that pupils will come to correct judgements on the spelling of words despite interfering rules they might be taught in class. One of his examples is the judgement on gemination in *müssen*, (German) *to have to*. According to a method used in many primers, a pseudo-form is used, which realises both parts of the digraph <ss> phonetically. Thus [ˈ*mʏs.sən*] in (7a), is not consistent with the syllabification of *müssen* in (7b). There is no second /s/ (Weingarten 2004:11).

(7) a. [ˈmʏs.sən]

b. /ˈmʏ.sən/

Thus, decisions on the correct orthographic form of a word can be taken independently of the rules that have been learned. It can even invalidate such a rule if its application yielded a wrong result. Based on this Weingarten concludes that the orthographic knowledge has been acquired by the pupils and is only partially accessible to cognition.

> Ein Gegenstand, der einerseits so komplex ist wie die (Schrift-)Sprache und für den wir andererseits so viele Prädispositionen besitzen, wird nicht durch die Vermittlung operativer Regeln erworben, sondern muss selbsttätig gelernt werden.[68]
>
> Weingarten (2004:14)

Although a certain amount of proficiency in orthography can be achieved by learning algorithmic rules, children acquire the structures of written language as a secondary system within the language faculty. As a consequence, writing is not a translation from phonetic matter into signs of writing. This finding is supported by Cossu (1999) who states that even mastering a fairly sound-based writing system as Italian requires more than good general intelligence and, vice versa, a learning disability does not inevitably prevent a child from acquiring *orthographic skills*.

[68] Because of its complexity and the fact that we are biased against this system, (written) language cannot be mastered by the learning of rules. It is acquired by the learners themselves (Weingarten 2003:14; my translation).

5.3 Writing braille

Reading and writing are essential to succeed in the working life and a visual impairment need not prevent the development of literacy. Yet, in order for this development to succeed, an active system is necessary; speech synthesis is a passive process and does not help with the development of correct spelling and grammar. In contrast, braille is an active way of reading and writing and is essential for the development of literacy skills (Westling 2001).

Children with visual impairments learn the same language as their peers even though they may use a slightly different route to compensate for the lack of visual information. They have often been accused of developing a language void of concepts with a great amount of repetitive speech which is also found in children with disorders in the autistic spectrum. Perez-Pereira and Conti-Ramsden (1999) argue that repetitive or stereotypical speech is functional in blind children. They use it as a means of social interaction and often show a much better verbal memory than their sighted peers. Perez-Pereira and Conti-Ramsden (1999) identify a second function in stereotypic speech in blind children and analyse it as a strategy to retain more in the memory, for later analysis. As a consequence, blind children may rely more on information they get from language itself than on information of the external world, which maybe a different route to reach the same target. Millar (1997) comes to a similar result: blind children pay more attention to sounds and are therefore more skilled in using the sound of language.

Similarly, children with a visual impairment learn reading and writing very much like their sighted peers. The times where illiteracy was the logical consequence of a visual impairment ought to have finished with the development of braille. Yet, braille is a complex writing system developed by a highly intelligent young man for study purposes. Especially from the point of view of a person coming from a different background of writing, it can be seen as difficult, in a way as a Semitic writing system or language will be considered difficult by a person of European or American origin.

I believe the assumption that braille is difficult is based on two facts. Firstly, many braille teachers are sighted and braille is a system that is very fatiguing for sight reading. There is no redundancy in the system, the presence or absence of a dot is always distinctive, and double sided braille creates interferences for sight reading. Secondly, the rules of *British Braille* are very much a compilation of user suggestions. This often results in an arbitrary rule consisting of a list of examples. Definitions or explanations are usually not provided. This may easily lead to braille being perceived as *difficult* by itself. Koenig argues against this prejudice against braille.

> [S]ome people claim that the braille code is more *complex* than the print code because more symbols are used. But if a child receives good reading instruction and has a rich variety of background experiences, learning to read braille should not be 'difficult'. If a child says that braille is difficult to read, it is probably because she has heard an adult say so.
>
> (Koenig 1996:227)

Koenig does not deny that braille is more complex than print, because braille uses more symbols. This may be relevant for braillists who have been former print readers. For a child learning to read and write contracted braille from the beginning, there is no such comparison and the system will just be their writing system, even though, compared to Standard English Orthography it is more complex. In my opinion, equating complexity with difficulty includes a judgement that implies that complex systems ought to be avoided and sheds an unnecessary negative aspect on braille from the point of view of Standard English Orthography. More difficult for braille teaching is the fact that at least in the last decade the population of braillists has changed considerably. These days many more children have complex needs. This requires a highly individual approach to braille teaching.

My generalisations in chapter 4 have shown that language processes are relevant to braille. Even though *British Braille* is a compilation of rules, they are not extralinguistic rules. Like print reading children have to master idiosyncrasies of Standard English Orthography, braille readers have to do so in braille. I would like to extend the separation of phonology and writing of Primus (2003) and Weingarten (2004) and claim that braille is a writing system in its own right which has a relationship to print similar to that of print and phonology. As a consequence, knowing how to spell a word entails knowing the appropriate constituent contractions. This will restrict Wormsley's decision making to unknown forms which have to be assembled, just as print readers use phonetic spelling strategies in unknown words.

> Braille readers ultimately need to make decisions that print readers do not. For example, they need to decide whether to use the BLE contraction in the word *bled*.
>
> (Wormsley 1997:95)

5.4 Braille Studies

Many braille studies are concerned with reading: reading accuracy, reading speed and character recognition (Ashcroft 1960; Foulke 1979; Lorimer & Tobin 1979; Arter 1995; Millar 1997). More recently the focus shifted to two other aspects: the processes in the visual cortex during braille reading (e.g. Burton:2003) and the question whether it is better to start with contracted or uncontracted braille, especially as often typing on a computer keyboard is taught simultaneously (Troughton 1992; Herzberg et al. 2004; Hong & Erin 2004).[69] Fewer studies are concerned with the sign system of braille itself (Lorimer et al. 1982; Hamp & Caton 1985).[70]

I put particular emphasis on one study on braille reading which concentrates on sub-lexical segmentation (Millar: 1997). Millar focuses on latencies in words with syllables containing compatible contractions to see whether they took less processing time than words in which contractions span syllables. The objective was to test whether contractions that contained arbitrary vowel consonant sequences of high frequency, i.e. upper and lower groupsigns, took longer to process than when they respected word-internal structures. An additional question was whether this effect might decrease with proficiency braille and whether former print readers would be affected more by such violations than braillists who had no experience with print. Table 5.1 lists these high frequency contractions together with examples of target words.

Table 5.1: Examples for most frequent vowel-consonant contractions

contraction	target
ER	beER, pERson, keepER
IN	traIN, drINk, INdia
ED	bleED, likED, fatED
EN	screEN, presENt, elevEN
AR/EA	feAR, rEAp fARe

Millar's subjects showed that personal familiarity with a particular word was stronger indicator than general word frequency whether constituent contraction was to be realised within the given context. They did not support the hypothesis that inconsistent vowel-consonant contractions take longer to read than those in words containing compatible contractions. Segmentation effects were only found in recent braillists.

[69] There is also a study in progress; Alphabetic Braille and Contracted Braille (ABC Braille) American Printing House for the Blind 2002-2006.
[70] The International Council on English Braille had a Committee on contractions as part of the Unified Braille Code Research Project (Bogart et al. 2000).

A follow-up study confirmed this finding. The hypothesis tested in this study is that experienced print readers and experienced braillists showed a differing sensitivity recognising contractions that are compatible and incompatible with phonological word segmentation. Table 5.2 lists the target words used. They were all embedded at second position in a sentence and presented together with randomly distributed filler sentences. Millar defines *compatible words* as words containing an obligatory contraction which is in a position that is compatible with phonological and orthographic segmentation of the word. *Incompatible words* are defined accordingly.

Table 5.2: Target list

incompatible with word segmentation	compatible with word segmentation
THErapy	diTHEr
baTHE	anTHEm
atONE	mONEy
hONE/ST	hONEy
squAND/ER	dANDelion
hINGe	actING
syrINGe	slING
proOF	prOFile
wAND/ER	abANDon
hoOF	OF/fER

Whereas proficient braillists are reported to be indifferent to this distinction, recent braillists showed the desired effect. Yet, it remains unclear whether the groups include former print readers and braillists with no previous print experience.

I have adopted some of Millar's targets of Table 5.2 in my study to test the effects of compatibility of braille contractions with word segmentation in braille writing and found a significant divergence in the error patterns of functional former print readers and braillists who had had no previous experience with Standard English Orthography.

6 The study

The motivation for this study is to test the compatibility of contracted braille with natural language and to determine whether the difficulties braille users are supposed to have (Gould 1942; Lorimer 1969; Troughton 1992) are an intrinsic part of the braille system. The primary purpose of the study is to investigate how the use of contracted braille interferes with spelling. Standardised spelling tests for print users are judged to be not applicable to braillists because of the additional complexity attributed to contracted braille. In addition, there is no national test to assess a person's braille competence (RNIB 2003:11). The assessments available all concentrate on reading skills, character recognition and reading comprehension (Tooze 1962; Lorimer 1962; Greaney, Hill and Tobin 1998; Millar 1997).

I do not wish to question the value of contracted or uncontracted braille. I agree with Troughton (1992) that contracted braille may be inappropriate for some braille users whom Wormsley (2003) identifies as visually impaired children with additional or multiple impairments, former print readers and learners of English as a second language. I am challenging the assumption that braille is more difficult than print because braille users constantly need to make decisions on the use of contractions in particular letter sequences which print users do not have to make (Wormsley 1997:95). Following Millar (1997), I assume that for a proficient braille reader the use of contractions is part of their orthographic system and has been lexicalised. For the same reason I am also challenging the assumption that reading contracted braille involves more cognitive effort and thus leaves less resources for interpreting the text (Troughton 1992:3). Both assumptions imply that braille production is a cognitive process based solely on a print-to-braille conversion. This print-to-braille conversion by an algorithm is possible and is used in automated braille production. However, I believe this is only one possible route to contracted braille, which may be used by sighted braillists and maybe a minority of braille users, especially those who have been former print readers. Language has for a long time been seen as a manifestation of intelligence (Smith 1999:23). Chomsky's work over decades has provided ample evidence that the language faculty does indeed form a separate module. The same dissociation process from intelligence seems applicable to writing and here especially to braille writing. Weingarten (1998) and Cossu (1999) present evidence that the acquisition of writing is a process comparable to second language acquisition (see 5.2). Therefore I expect my study to be able to produce evidence of braille processing in the language faculty.

Both Wormsley and Troughton seem to imply a dual standard for braillists. They measure a braille user's performance with regard to producing contracted braille on one hand and typing print on the other. It is not clear whether this performance is judged with respect to print or to braille production. If the measures refer to spelling performance in regular print typing, the implication that the use of contractions impairs typing performance is unconvincing for two reasons. The number of wordsigns used in contracted braille is the set number of 76 wordsigns and 76 shortforms. These can be committed to memory, in a similar way as both print and braille reading children have to commit the spellings of irregular words to memory. Secondly, productive groupsigns such as derivational prefixes and suffixes are best referred to by their letter values i.e. *the -ment sign* as opposed to *the 5-6-t contraction* (Wormsley 1997:99). This will also help to establish a link to the full spelling in a word like *basement*.

If Wormsley's and Troughton's criticism refers to braille production, this implies that some writing systems are assumed to be more difficult to master than others. From a cultural point of view this is probably true. Yet, in this context it can be interpreted as a reflex of braille not having the same orthographic depth as Standard English Orthography (Cook 2004:10). English print is in wide parts an alphabetic system including some aspects of morphology as for example the constant <ed> spelling of the regular English past tense morpheme *-ed* irrespective of its phonetic form (see 4.1.2). In contrast, structural units in braille are frequently represented by a contraction (see Table 4.1) which may be interpreted as more difficult if compared to Standard English Orthography but to do justice to the system it has to be judged by its own structure first.

The braille code is not merely a tactile version of the print alphabet. Moreover, there are a number of factors which influence the spelling abilities of a braillist. One of the most striking differences between print and braille is the fact that braille shows no personal variation - handwriting does not exist in braille.[71] The fact that there is no automatic and immediate feedback of one's own writing is also important. A person writing print usually reads what is being written at the time of writing. In contrast, a

[71] Manual braille production on a Perkins brailler combines elements of typing and elements of handwriting. The elements of typing are the more obvious ones as a brailler has a keyboard to produce predefined shapes and does not allow for personal variation of these shapes, other than variation caused by pressure. In contrast to this, braille contains elements of handwriting because the letters are generated individually and are not typed by hitting a predefined space which contains a predefined letter.

braillist has no possibility of simultaneously checking the output unless an electronic keyboard is used in connection with a screen-reading programme on a computer.

In order to judge competence in braille literacy there has to be a clear definition of a spelling mistake in braille. Due to the different character of this medium and the set of rules particular to braille, braille users will always have the possibility to produce errors which have no equivalent in print (see chapter 7). Furthermore, as there is no normative test which allows to compare the spelling performances of a blind youngster writing in braille to a child writing in print (RNIB 2003:11), it is not clear when the spelling performance of a braillist can be labelled as significantly poorer compared to the spelling of a sighted pupil of equal general ability.

The question whether the difficulties are generated within the system of contracted braille itself has been addressed in chapter 4. Based on the analysis of *British Braille* rules on the use of contraction I conclude that the way in which the rules of contracted braille have been compiled is far more problematic than the underlying system itself.

The base for the development of this study is the analysis of error patterns in a 55.000 word braille corpus collected from 17 subjects, 10 male, 7 female over a 7-year period (1996 - 2004). This is random data collected from schoolwork in the following subjects: Braille, English, Personal and Social Education, Personal, Social and Health Education, Religious Education, Science, Geography and Design Technology. All data was produced on a manual Perkins Brailler (section 6.1.1) which means it cannot have been processed by a spell check programme.

The weakness of this data is that there is no way of knowing how much help had been given during the production. Class teachers often provide spelling and contractions of single words to the class. Individuals may receive assistance by Learning Support Assistants (LSAs) who may have different levels of proficiency in braille. In addition, the number of LSAs present in a lesson is very much dependent on the subject and on the needs of a specific class. The amount of help given may therefore vary considerably.

The texts of this corpus are mainly essays. Worksheets, lists, poems and prayers are also included. It is complemented by a longitudinal study of 16.000 words, collected over a time span of seven years (1993 - 1999) from a girl aged 12 at the time the data collection started. This second corpus consists mainly of personal letters, stories and poems, also produced on a manual Perkins Brailler. The help this girl might have received with her texts is limited to Standard English spelling as these texts were written at home and the other family members do not know braille.

This data provides some insight into the types of difficulties encountered by a braillist. It cannot be a measure of individual competence in braille. The corpus data was used as a supplement to the formal analysis of chapter 4 for determining error patterns, to be verified in the braille study.

Methodological considerations are summarised in section 6.1. The pilot study and its implications for the development of the braille study follow in section 6.2. Section 6.3 discusses the research design. It focuses on the interaction of contracted braille, especially upper groupsigns, with Standard English Orthography and the appropriate use of braille contractions.

6.1 Methodological considerations

This section describes the characteristics of the chosen brailler (6.1.1), the timing of the test (6.1.2) and group size (6.1.3). The administration of the test is described in 6.1.4, followed by the description of the experimental group (hereafter referred to as 'subjects') in 6.1.5 and the description of the control group in 6.1.6.

6.1.1 The equipment

All data was produced on a manual Perkins Brailler shown in Figure 1. This is a mechanical apparatus similar to a typewriter, which has six keys corresponding to the six dots of the braille cell, a space bar, backspace and line advance key (Koenig 1996:234).

Figure 6.1: The Perkins Brailler

The Perkins Brailler is a sturdy machine with an ergonomic design for easy use by children and adults. All subjects were familiar with this brailler as it is the standard manual brailler in UK schools. The Perkins Brailler is an *upward* braillewriter which means the letters are embossed from underneath the paper and can be checked without first removing the paper (Hampshire 1981:50).[72]

The QWERTY design of the computer keyboard originates from the layout of manual typewriters. These were constructed in a way as not to have keys clashing when writing fast. On a QWERTY keyboard, most signs are typed by depressing one key on the keyboard. Few signs are created by depressing a sequence of keys like the SHIFT key for upper case letters and logograms such as the section sign, §, currency signs such as the pound sign, £, or the dollar sign, $, per cent, %, and the ampersand, &.

The keyboard of the Perkins Brailler consists of nine keys. The whole alphabet is generated by six keys which correspond to the six dots of the braille cell. Dots 1-3 are embossed with the left hand, starting with the index finger for dot 1. Dots 4-6 are embossed with the right hand, starting with the index finger for dot 4. Thus the strongest fingers correspond to top row in the braille cell which is used most frequently. All alphabet letters use dot 1 or dot 4 or both. To write the letter ⠁ ,<a>, just one key is pushed with the left index finger, to write the letter ⠽, <y>, all keys except the left middle finger are depressed. In contrast to the QWERTY keyboard, depressing one key too few or too many results in a different braille sign and a sequence of seemingly minor errors in typing may quickly result in an illegible word.

Extension keys for typing with a reduced amount of pressure and an adaptation for unimanual use are also available. A version that produces larger dots is often used for beginning braillists or people who are experiencing difficulties reading standard braille, the Jumbo Cell Brailler. Left and right margins are adjustable, with a bell signalling the approach of the right margin and a locking device at the end of the page prevents the paper from falling out. The technical data of these two braillers is listed in Table 6.1.

[72] Earlier braille writers such as the Stainsby are 'downward' writers which depress the dots into the paper. In order to be checked, the paper has to be taken out of the brailler. The only advantage of the Stainsby brailler is its ability to write interpoint braille - braille embossed on both sides of the paper. The spacing between the braille cells is slightly larger and the reverse side is printed offset in order not to delete any signs of the other side. Interpoint braille is possible because a touch reader does not recognise the indented reverse side and therefore there is no interference. Embossing on both sides of a page saves about 40% in bulk (Tobin 2000:57).

Table 6.1: Perkins Braillers: Technical data.

	Standard Perkins Brailler	Jumbo Cell Perkins
Distance between signs	6 mm	9.6 mm
Distance between dots	2.3 mm	3.1 mm
line spacing	10 mm	12.7 mm
maximal page size	27 cm	27 cm
weight	4.832 kg	6.204 kg
size	15 x 23 x 39 cm	15 x 23 x 39 cm

The drawbacks of the Perkins Brailler are its weight of almost 5 kg, the noise the embossing produces, its price of approximately EUR 1.200.- and the fact that it cannot produce interpoint braille (see Footnote 4).

6.1.2 Timing

The whole set-up of the study was reminiscent of exam conditions. In order not to put additional pressure on the subjects, none of the tasks was timed. The subjects were encouraged to ask any questions they had, even after the warm-up sessions. In addition, the absence of timing discouraged competition within the groups. The average time to complete the study was about 45 minutes for individuals and 60 minutes for groups.

6.1.3 Group size

The maximal group size was five participants. The major reason for limiting the group size is the amount of noise produced by embossing on a manual Perkins Brailler. Another reason for keeping the number of participants low was that the second part of the braille study encourages oral participation, a dialogue determining the target words. The final aspect was to minimise waiting time among the subjects, as there was no time limit for any of the tasks.

6.1.4 Administration of the test

As the participants should focus entirely on writing, all stimuli were presented auditorily. The stimuli were not pre-recorded for the following reasons. Only the design of the first part of the study would be suitable for pre-recorded tasks. In the second part of the study there is too much interaction involved to work with a set of pre-recorded tasks. The first part of the study consists of tasks that are assumed to be familiar to the subjects: a questionnaire, a dictation, a mismatch task and an association task. I developed the two major tasks in the second part from a phonological awareness test.

Thus none of the subjects knew the form of these tasks. As the tasks in the second part required verbal interaction in addition to writing, it was a further objective of the first part to achieve a degree of familiarisation which would facilitate interaction in the second part of the study. Thus using taped material for the first part carried the risk of preventing this necessary familiarisation, especially as the study was certainly reminiscent of exam conditions.

It was not possible to have the texts read by a native speaker. As neither the dictation nor the interactive parts show discrepancies in performance between the Exeter group that knew me and the group that wasn't familiar with me, this does not present a problem.

Whenever consent had been given, the sessions were audio-taped as a means of control for the interactive tasks in part two of the study.

All subjects were aware that this study was concerned with their use of braille. They were encouraged to ask questions at all times. If they asked for the spelling of a particular word the answer was always *Just use whatever comes first into your mind*.

The first task of part 1 is a questionnaire on the personal use of braille. Its main function was to familiarise the subjects with the set and avoid starting with probably the most intimidating task, task 2, the dictation. These two tasks had no separate pre-tests.[73] For the tasks 3 - 5 in part 1 and all tasks in part 2 each subject completed a pre-test that immediately preceded the task. If necessary, instructions were repeated after the pre-test.

6.1.5 Subjects

Pupils, students and alumni of The West of England School and College for young people with little or no sight, Exeter, the Royal National Institute of the Blind (RNIB) New College Worcester and the Royal National College for the Blind, Hereford, UK took part in this study. They were recruited via the braille departments of the respective schools.

In order to comply with school policies on equal opportunities, all 35 interested braillists were tested and there was no requirement of minimal performance in a pre-test.

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[73] The function of a pre-test is to explain the task to the subject and ensure they know the procedure. The data acquired in the pre-test is not part of the test data analysed.

The data of 16 braillists has been excluded in order to keep the group as homogeneous as possible and eliminate possibilities for noise in the data obtained. Twelve of these participants had an additional impairment, three were not native speakers of English and one braillist was excluded because he had received braille tuition for approximately one year. This leaves the data of 19 subjects: 9 male, 10 female, aged from 11:10 to 42:7 (mean 19:2).[74] None of these participants had an additional impairment. They were all native speakers of English, proficient braille users, but differed in the onset and degree of sight loss as well as years and intensity of braille use, the average years of braille use are 12:0 years. As children with visual impairments learn the same language as their peers even though they may use a slightly different route to compensate for the lack of visual information (Millar 1997, Perez-Pereira & Conti-Ramsden 1999) and as the acquisition of writing is a process comparable to second language acquisition that takes place in the language faculty (Cossu 1999, Weingarten 1998), this renders a valid sample to test the compatibility of the braille code with natural language.

6.1.6 Control group

The sighted control group consists of twenty sighted subjects, all native speakers of English, 7 male, 13 female, aged from 10:3 to 56:3 (mean 17:5). They were recruited from St. Leonard's Church, Exeter via personal contacts. Their age range, academic ability and social background was similar to that of the braillists. No member of the control group had an impairment. The control group did the print equivalent of the study without the first task, the questionnaire on the personal use of braille.

The control group provides data used for comparing responses to the individual tasks and the type of genuine spelling errors in print to those in braille to see whether they showed the same patterns. As there was no match of members of the control group and braillists for age and ability, a weighed comparison of the performances of both groups is neither intended nor possible.

6.2 The Pilot study

The pilot study took place in a German Grammar School, as part of a disability awareness module for year six pupils (12 year olds). Within this module I offered two

[74] This is an abbreviation for the age in years and months. Thus 11:10 equals 11 years and 10 months.

sessions on braille, each lasting 120 minutes. Thirteen pupils chose this session, 9 male, 4 female. The session started with the history and development of braille and an informal introduction with braille labelling on pharmaceutical packaging, on personal items such as CD-covers, playing cards, games and braille books and diagrams. The language of the pilot study was German. After a familiarisation with the braille alphabet, Figures 6.2 and 6.3, the test data was presented as a worksheet using a braille font, Figures 6.4 and 6.5 with the braille alphabet and its print correspondents on every worksheet. It consisted of two parts; a step-by-step introduction to the braille alphabet and a mismatch task followed by an association task to encourage deciphering the code. The subjects' answers were given in print for both the familiarisation and the mismatch tasks. To answer the association task the subjects 'brailled' their answers in a given 2x3 grid. None of the tasks were timed. They took about 30 minutes to complete.

The braille font had been installed on the school network and the session concluded with time to use this font for typing out individual messages.

6.2.1 Objectives

The pilot study had a dual purpose. The first objective was to determine whether exclusion criteria other than semantic ones were accessible for the mismatch task. The second one was to test the predictability of responses for the association task when possible answers had been part of the preceding mismatch task.

6.2.2 The tasks

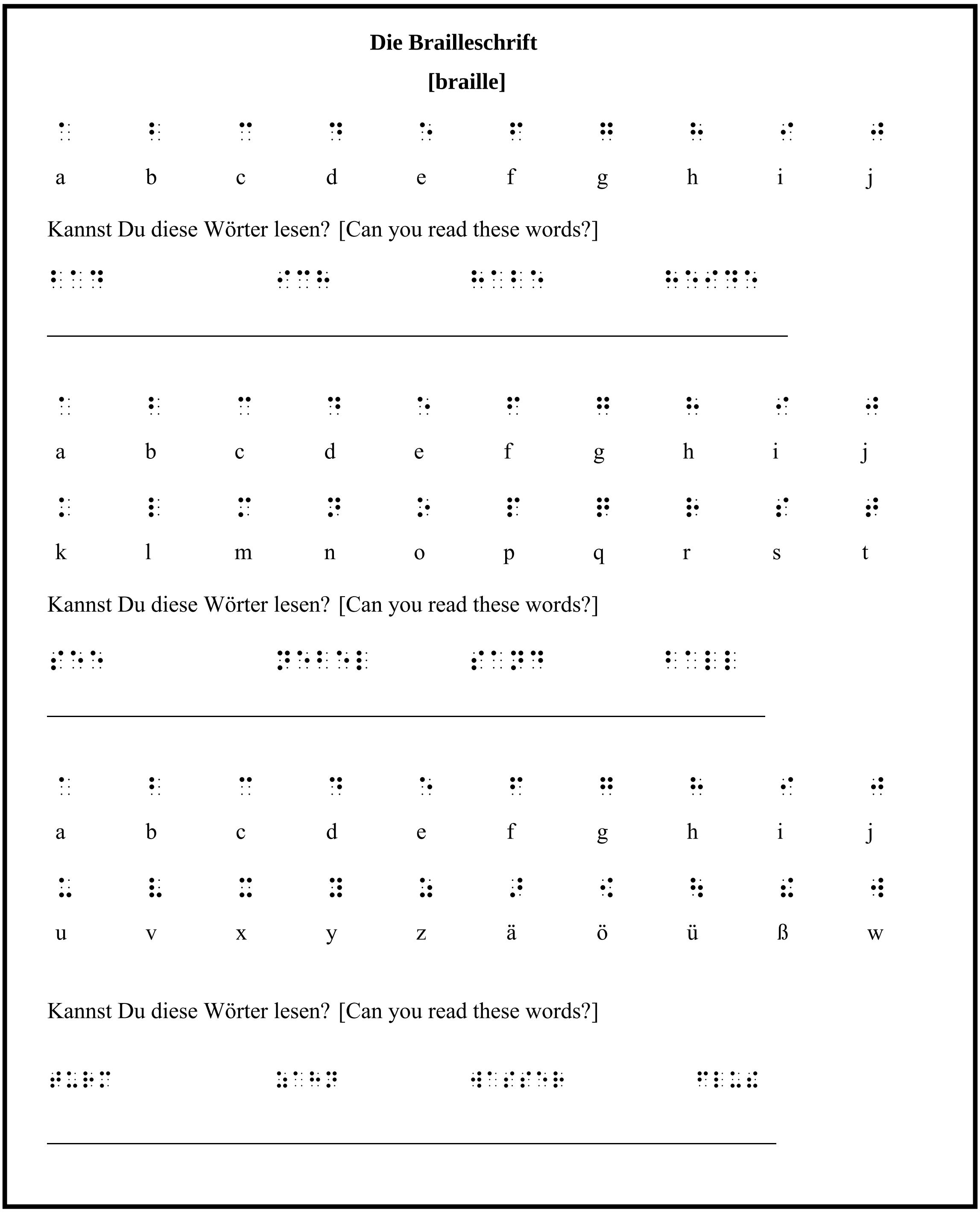
The first part, the introduction to the braille alphabet, started with deciphering of single words consisting of dots in the two top rows of the braille cell such as *ich*, *I*, in (1a).

(1) a. ⠊⠉⠓
ich
'I'

The aim of this first part was familiarisation with the dot configurations of a punctiform writing system. The worksheet is given in Figure 6.2.[75]

[75] The worksheets in Figures 6.2 to 6.5 contain glosses in contrast to the German originals.

Figure 6.2: Pilot Study: Introduction to the braille alphabet



Capital letters and numbers were also part of the introduction to braille, see Figure 6.3.

Figure 6.3: Pilot study: capital letters and numbers

Großbuchstaben und Zahlen
[capital letters and numbers]

Die Brailleschrift hat keine eigenen Großbuchstaben. Wie beim Schreiben auf dem Computer wird eine extra Taste gedrückt um einen Großbuchstaben zu erhalten.
"Braille does not have a separate set of upper case letters. Similar to writing on a computer keyboard you press an extra key to get an upper case letter"

⠇ ⠨⠇
l L[76]

Es gibt auch keine extra Zahlzeichen. Stattdessen wird wieder eine extra Taste gedrückt, die aus den ersten zehn Buchstaben a - j die Ziffern 0 - 9 macht.
Stattdessen: ⠼ wird den Buchstaben *a* bis *j* vorangestellt.
"There are no separate signs for numbers. Instead, a key is used to transform the letters <a> to <j> into the digits 0 - 9. The number sign ⠼ precedes the letters <a> to <j>."

Zahlzeichen [number signs]

⠼⠁ ⠼⠃ ⠼⠉ ⠼⠙ ⠼⠑ ⠼⠋ ⠼⠛ ⠼⠓ ⠼⠊ ⠼⠚
1 2 3 4 5 6 7 8 9 0

Jedes Kästchen enthält eine Zahl. Kreise die nebeneinander liegenden Kästchen ein, die zusammen 10 ergeben.
"There is a number in each box. Circle boxes which add up to ten."

⠼⠙	⠼⠛	⠼⠉	⠼⠓	⠼⠑	⠼⠁
⠼⠑	⠼⠙	⠼⠑	⠼⠑	⠼⠚	⠼⠃
⠼⠁	⠼⠃	⠼⠉	⠼⠑	⠼⠋	⠼⠙
⠼⠚	⠼⠃	⠼⠃	⠼⠓	⠼⠁	⠼⠛
⠼⠉	⠼⠁	⠼⠊	⠼⠑	⠼⠃	⠼⠋
⠼⠁	⠼⠛	⠼⠓	⠼⠃	⠼⠁	⠼⠊

The second part consisted of a mismatch task, Figure 6.4, and an association task, Figure 6.5. The items in the mismatch task could be excluded either for semantic, grammatical or phonetic reasons. The items relating to semantics are *kuh* (not a pet) in

[76] The capital letter indicator in German braille differs from its English counterpart, see (i).

(i) a. ⠨
capital letter indicator (German)

b. ⠠
capital letter indicator (English)

(2a), *pfirsich* (not a vegetable) in (2b), *start* (no termination) in (2c) and *klippen* (not water) in (2g). Grammatical exclusion criteria are targeted in '*rasiert'* (not regular) in (2d) and *fressen* (can also function as a verb) in (2f) and the one group operating on phonetic reasons was aimed at *dose* (no initial voiceless consonant) in (2e). [77]

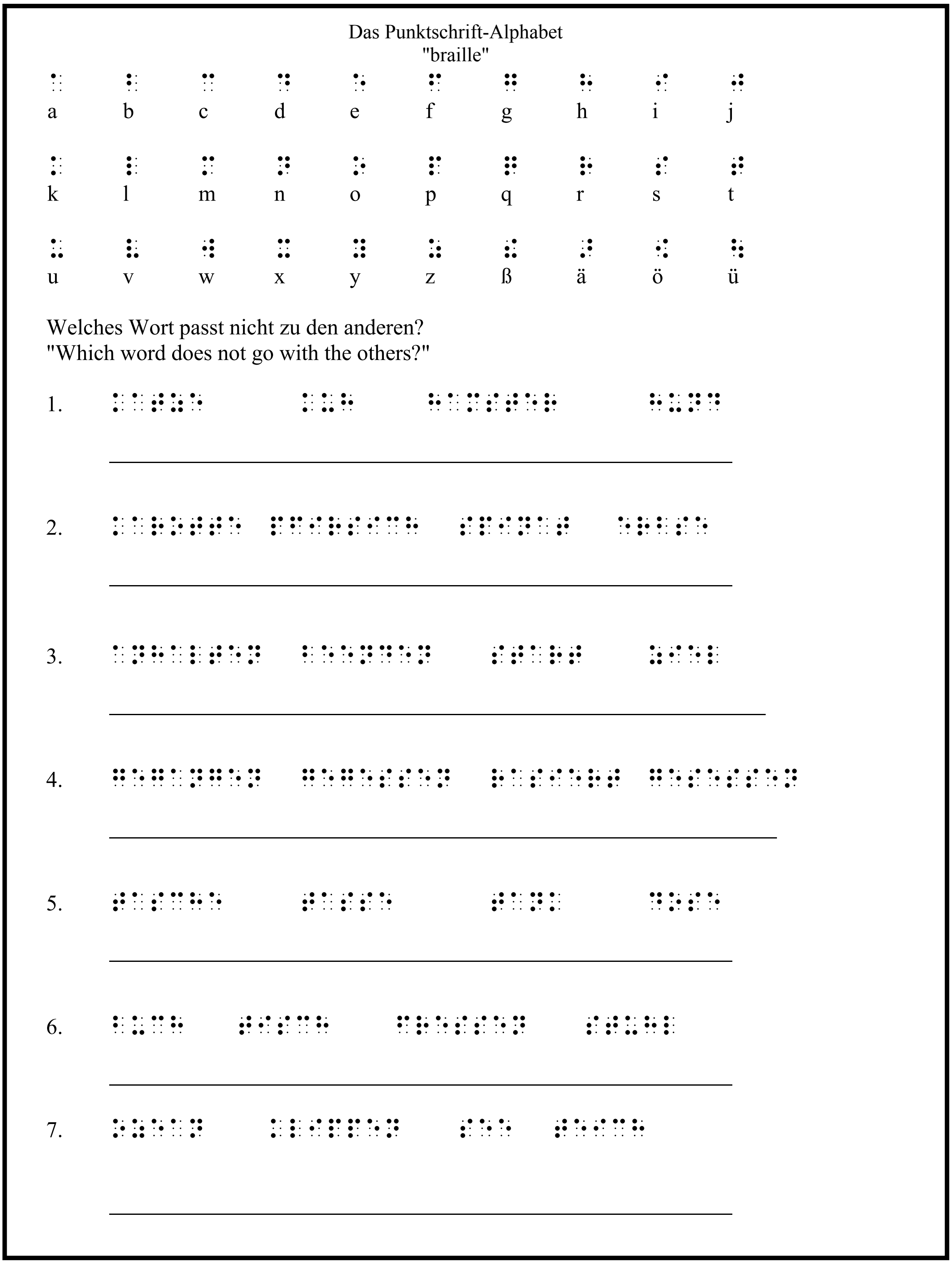
(2)

a.	katze 'cat'	kuh 'cow'	hamster 'hamster'	hund 'dog'
b.	karotte 'carrot'	pfirsich 'peach'	spinat 'spinach'	erbse 'pea'
c.	anhalten 'to stop'	beenden 'to end'	start 'start'	ziel 'finish'
d.	gegangen 'gone'	gegessen 'eaten'	rasiert 'shaved'	gesessen 'sat'
e.	tasche 'bag'	tasse 'cup'	tank 'tank'	dose 'tin'
f.	buch 'book'	tisch 'table'	fressen 'devour/fodder'	stuhl 'chair'
g.	ozean 'ocean'	klippen 'cliffs'	see 'lake/sea'	teich 'pond'

The predictions are that the sets relating to distinct superordinate groups are the easiest to identify. These are (2a), (2b) and (2g) for semantic selection criteria, and (2d) for grammatical selection criteria. (2c) and (2f) ought to be the most difficult sets because their superordinate groups are rather small (Aitchison 1994:66). In the case of (2e) it is uncertain whether they will recognise the difference in voicing in the initial consonant or try to link this set to a semantic selection criterion such as *container*.

[77] Although the capital indicator for German braille, ⠨, had been introduced it was not used in these tasks to facilitate reading and because the English capital indicator, ⠠, is optional and *per se* not part of the braille study.

Figure 6.4: Pilot study: mismatch task



The mismatch task is followed by an association task in Figure 6.5. The association task consists of the two questions in (3). Here the answers had to be given in the corresponding braille shapes. Both target groups are part of the mismatch task. The superordinate groups are *Haustier* 'pet' in (3a) for the data in (2a) and *Gemüsesorte* 'vegetable' in (3b) is linked to the data in (2b).

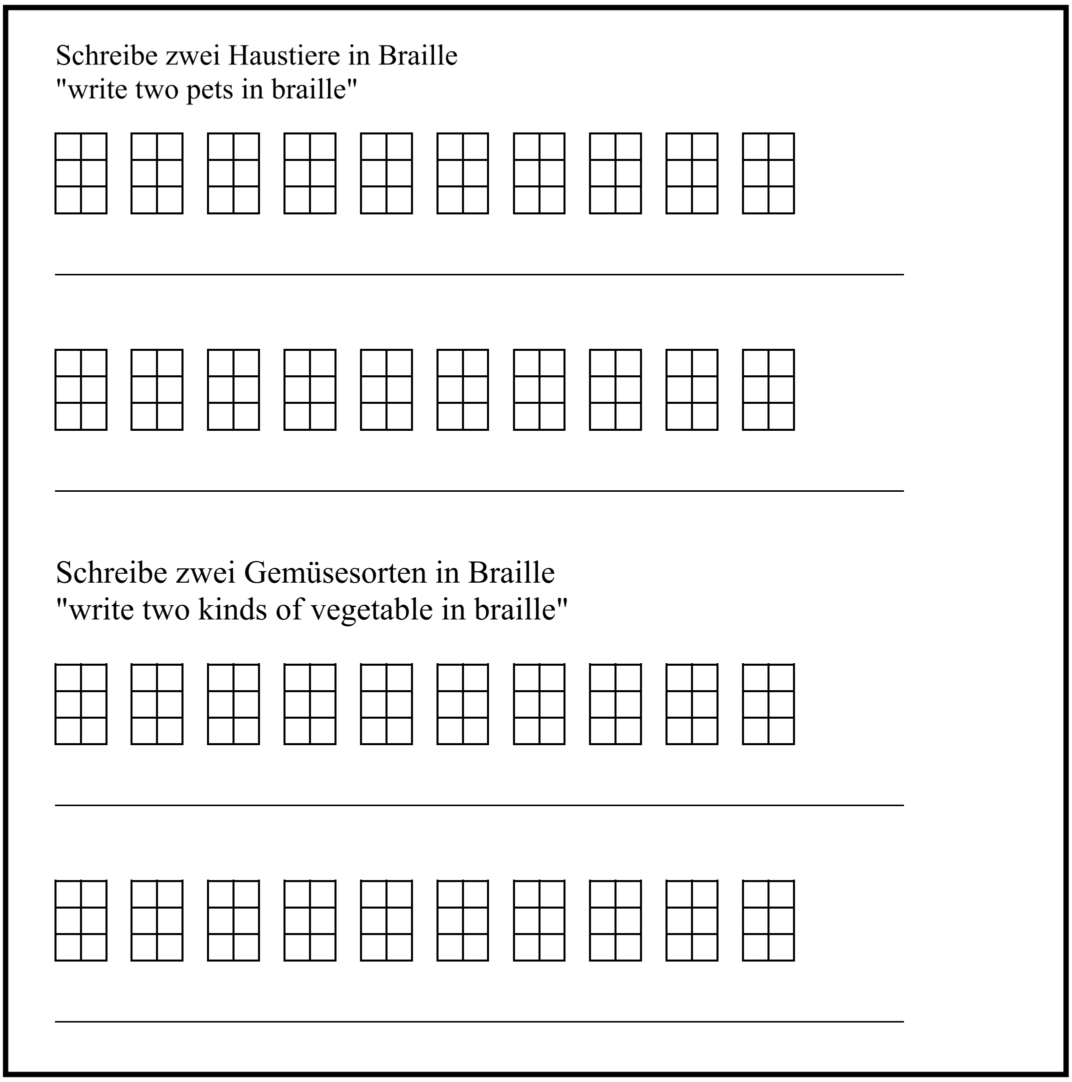
(3) a. Schreibe zwei Haustiere in Braille.
'Write two pets in braille.'

b. Schreibe zwei Gemüsesorten in Braille.
'Write two vegetables in braille.'

The aim was to determine whether the sets given in the mismatch task were so salient that these items are chosen again in the association task. There were two implicit factors for reinforcement. Firstly, it was made explicit that any item they had come across in the mismatch task was as good as anything they could think of. Secondly, they had to draw the appropriate braille characters in their solutions. As the data of the mismatch task was still available to all subjects the prediction was that some would use it, opting for the easiest way in copying the relevant shapes from the previous task.

This behaviour is relevant to the braille study because all items presented there are controlled for their braille structure and are preferred to random selections. The association task is shown in Figure 6.5.

Figure 6.5: Pilot study: Association task


Schreibe zwei Haustiere in Braille
"write two pets in braille"

Schreibe zwei Gemüsesorten in Braille
"write two kinds of vegetable in braille"

6.2.3 Results

All subjects completed the first task in Figure 6.2, deciphering the words given in braille before proceeding to the mismatch task. The accuracy rate of the selected targets is shown in Table 6.2.

Table 6.2: Mismatch task: Selections

	group	item 1	item 2	item 3	target	target selection	other selections
1	pet	katze 'cat'	hund 'dog'	hamster 'hamster'	kuh 'cow'	83.33%	item 3: 16.67%
2	vegetable	karotte 'carrot'	spinat 'spinach'	erbse 'pea'	pfirsich 'peach'	100%	
3	finish	anhalten 'to stop'	beenden 'to end'	ziel 'finish'	start 'start'	83.33%	item 1: 16.67%
4	irregular	gegangen 'gone'	gegessen 'eaten'	rasiert 'shaved'	gesessen 'sat'	100%	
5	voiceless initial cons.	tasche 'bag'	tasse 'cup'	tank 'tank'	dose 'tin'	66.67%	item 1: 25% none: 8.33%
6	noun	buch 'book'	tisch 'table'	stuhl 'chair'	fressen 'devour/fodder'	41.67%	item 1: 41.67% none: 16.67%
7	water	ozean 'ocean'	see 'lake/sea'	teich 'pond'	klippen 'cliffs'	100%	

The prediction 'easy to solve' was correct for the sets 2, 4 and 7, in these the target was selected by all subjects. For the first set 83% of the subjects selected '*kuh*' being no pet. The two differing answers were *hamster* because the distinctive feature chosen was *rodent*. [78] As anticipated, the target in set 6 was one of the most difficult ones to identify; two subjects did not produce an answer at all, five chose a different one. In contrast, set 3 caused less problems than expected with no omissions and only two differing answers. Altogether the results of the mismatch task showed that both grammatical exclusion criteria and semantic ones were accessible to the subjects.

The objective of the association task was to test whether the items in the preceding mismatch task were still salient. In the first part of the association task *katze*, *hamster* and *hund* are the relevant remnants of the mismatch task. Because they were given in braille in the mismatch task and the items of the association task had to be drawn in braille, using these items would have made this task considerably easier to subjects who are not familiar with braille. Yet, '*katze*', was only named three times (12.5%), '*hamster*' was named once (4.17%) and '*hund*' was named twice (8.33%). A complete list of tokens is given in Table 6.3.

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[78] The two children who chose *hamster* had been talking about a hamster being a rodent in contrast to all other animals listed. I assume that they had recently talked about rodents in a Biology lesson.

Table 6.3: Frequency of nominations: Pet

	salient items						
thrice	katze						
	'cat'						
twice	hund	papagei	krokodil	schildkröte	hase	kaninchen	none
	'dog'	'parrot'	'cocodile'	'turtle'	'hare'	'rabbit'	
once	hamster	wellensittich	fische	vogel	goldfisch	marc	
	'hamster'	'budgie'	'fish'	'bird'	'gold fish'	'name of pet'	

For the second part of the association task, naming of vegetables, the response rates were even lower. Despite the fact that carrots and peas are prototypical vegetables (Aitchison 1994:66) *karotte* 'carrot' was listed only twice (8.33%), its synonym, *möhre*, once (4.17%). *Spinat* 'spinach' was listed once (4.17%) and *erbse* 'pea' not at all. Table 6.4. contains a list of the vegetables selected by the subjects.

Table 6.4: Frequency of nominations: Vegetables

	salient items					
four		gurke				
times		'cucumber'				
thrice	karotte/möhre	kohl				
	'carrot'	'cabage'				
twice		lauch	paprika			
		'leek'	'pepper'			
once	spinat	ingwer	chilli	rosenkohl	petersilie	senf
	'spinach'	'ginger'	'chilli'	'Brussels sprouts'	'parsley'	'mustard'

The results of these answers showed that the preceding mismatch task was too distant for its elements to be still salient in the association task, even with the added incentive of given braille shapes in the mismatch task. In addition, *pet* and *vegetable* are stimuli that elicit very individual responses due to personal preferences which in turn ruled out the intended prototypes.

The consequences for the development of the braille study are the following: the mismatch task and the association task will start with a hypernym that allows a large set of co-hyponyms. As the task proceeds, this choice will be more limited. Secondly, the mismatch and the association task serve as training sessions for a combined mismatch and association task in which a higher degree of salience should be achieved with the intention that the elements of the mismatch task are still available for one section of the immediately following association task.

6.2.4 Consequences for the development of the braille study

The design of the braille study contains a variety of tasks. The two main objectives are to create a pleasant atmosphere, diverting the subjects from the exam-like setup with its possibility of inducing worries about failure and secondly, not to tire the subjects with just one type of repetitive task, especially as visual distraction is not possible.

Concerning the mismatch task, the pilot study shows that exclusion criteria other than semantic ones are possible to be identified and that there is a symmetrical correlation between the degree of closeness in the underlying semantic field and the accuracy achieved in the task. Despite the fact that the prediction of achieved accuracy was very high, the tokens in the braille study are weighed in such a way that all target the same braille feature. Thus the subject's choice is irrelevant as one of the offered tokens is selected (see section 6.3.3). This was done because isolating *hamster* as a rodent in the set {cat, cow, hamster, dog} showed that the distinctive element is only partly predictable even in this set which seemed to point so obviously to the target *cow*.

The results of the association task in the pilot study showed that the elements of the preceding mismatch task were already too distant to remain salient. The choices are closer to prototypes and possibly to personal preferences than to the elements of the preceding mismatch task. For the development of the braille study this has the following consequences. Firstly, the relevance of the braille forms of the prototypes determined the choice of the hypernyms in the association tasks. Secondly, a third task is developed which combines the mismatch and association task: the first part of every section asks for a mismatch in a set of four given elements. This is immediately followed by the hypernym of the three matching elements and the request to write down three members of that group. To increase the saliency of the set, it was explained that the three elements in the mismatch tasks are as good as any other they could think of and that there is no need to exclude them from the answers.

6.3 Test design

The motivation for this study is to test the compatibility of the braille code with natural language. Thus the study is designed to reveal the interaction of braille contractions with natural language, in particular to investigate whether the bridging of syllable or morpheme boundaries by arbitrary contractions influences spelling performance. The braille study consists of two parts with a total of nine partly interdependent tasks. All tasks are read to the subjects for two reasons. Firstly, they ought to concentrate on writing and more importantly, that interference from recently read material is prevented.

I am aware that maximum control over the contractions would be achieved by a dictation. Yet, I have chosen to present a variety of tasks for the following reasons. The whole set-up is similar to an exam and therefore concentrating on a dictation would intensify this feeling. As all subjects are aware that the study targets their use of braille the tasks are designed to redirect attention from spelling or on the use of contractions to word selection.[79] There is an increase in complexity of the tasks during the course of the study which is impossible when focusing on a dictation. Another argument against limiting a study on the use of braille to a dictation is that this dictation will be either a long text or a list. The disadvantage of a text is that there is a lot of material which is required to create a context but which is of no immediate use to the study. A list is not ideal either as it is exhausting to write due to its lack of context and furthermore, it is likely to be error prone for exactly that reason.

If necessary, the test can be administered in two or three sections; possible units are the first two tasks, task 3 to task 5 and task 6 to task 9. A break is always offered after completion of the first part of the study which consists of the first five tasks.

All stimuli are controlled for type and function of contractions, number of signs per word, bridging of syllable and morpheme boundaries, subsyllabic bridging, compatibility with word segmentation and target position within the task.

The warm-up session, task 1, is a questionnaire on the personal use of braille, see section 6.3.1. It is followed by a dictation, section 6.3.2. The questionnaire and the dictation are the only tasks that have no pre-tests. For tasks 3 to 9 each subject completed a pre-test that was not part of the main test body. If necessary, instructions were repeated after the pre-test. Task 3, section 6.3.3, is a mismatch task of the type *find the odd one out in the following set of four items*. Task 4, section 6.3.4, is an association

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[79] If a subject asks for the spelling of a word or whether a contraction should be used in a certain context, the prompt is the casual comment to use whatever they thought of first.

task, e.g. *Name three farm animals*. In task 5, section 6.3.5, tasks 3 and 4 are combined in such a way that one part of the association task immediately follows one set of the mismatch task, targeting its hypernym.

The main modules in the second part of the study are task 6, section 6.3.6, and task 8, section 6.3.8. I developed both based on a phonological awareness test (Cook 2004:133). They consist of three parts: first, a word has to be written to dictation. In the second step, the subject is asked to delete a given element. In task 6 phonemes are deleted, in task 8 letters. This deletion always results in a word, never in an arbitrary letter sequence. In order to ensure that forming the second item does not cause problems subjects receive help if required and the target is always repeated by the experimenter. Finally, the second item is written down. Task 7, section 6.3.7, is a filler task in order to separate tasks 6 and 8. An adjective is given to be written with its corresponding adverb. In the final task, task 9, section 6.3.9, nouns are given to be written together with their corresponding regular plural forms. This task is designed to be so easy that it ensures a positive finish of the study for all participants.

With the exception of the dictation, the task design requires the subjects to find an answer and write it down. Ideally, they will concentrate on the first demand. The activities are listed in Table 6.5 together with the level of control exercised on the use of contractions. In addition, the total of graphemes, other linguistic units and arbitrary contractions are contrasted.

The study is designed to achieve a balance between arbitrarily used contractions and contractions that represent linguistic units such as morphemes and syllables. Among the upper groupsigns graphemes are special. The set ⠡, *CH*, ⠣, *GH*, ⠩, *SH*, ⠹, *TH*, and ⠱, *WH*, ⠳, *OU*, and ⠪, *OW*, has been designed to use one braille sign where print uses a complex grapheme which in turn corresponds to a phoneme. They are assumed to be the least problematic set and to occur more frequently than morphemes, syllables and roots. Therefore, graphemes are separated from morphemes, roots and syllables. The latter form the group *linguistic unit*, which is contrasted with arbitrarily used contractions. These arbitrary contractions are further divided into arbitrary groupsigns that are compatible with word segmentation, CC, and arbitrary groupsigns that are incompatible with orthographic word segmentations, IC, (Millar 1997:204, Carney 1994).

Table 6.5: Estimated use of groupsigns by linguistic type

groupsigns	grapheme	syllable/ morpheme	arbitrary contractions	
			CC	IC
n = 228	n = 64	n = 45	n = 79	n = 40
upper groupsigns	47	21	53	12
lower groupsigns	17	12	17	9
composite groupsigns	0	12	9	19

The focus in this study is on the use of upper groupsigns. There is a continuous increase in complexity of contractions from upper groupsigns to lower groupsigns to composite groupsigns. In terms of relative frequency, a composite groupsign or a lower groupsign is less likely to function as an arbitrary contraction than an upper groupsign. Due to their structure, upper groupsigns are the major source of arbitrary contractions. Hence, they are the largest group in the overview given in Table 6.6 for a controlled use of contractions and in Table 6.7 for an estimated use of contractions.

Table 6.6: Total of controlled contractions

	task 2	task 6	task 7	task 8	task 9	total
upper groupsigns	43	12	4	5	8	71
lower groupsigns	22	2	3	5	4	38
composite groupsigns	21	2	12	0	4	37
upper wordsigns	32	2	0	5	0	39
lower wordsigns	12	0	0	2	0	14
composite wordsigns	4	5	0	0	0	11
shortforms	2	2	0	0	0	4
word total	129	28	16	20	16	209
words containing at least one contraction	97	24	13	18	4	156

For tasks 1 and 3, 4 and 5 a choice of answers is possible, therefore in Table 6.7 a mean use of contractions is given.[80] Whereas the number of words is constant for all subjects in tasks 3, 4 and 5, the word total differs in task 1, the questions on the individual use of braille. The shortest set of answers contained 34 words, the longest 135. Therefore, the mean word count is given in the total for task 1.

[80] The foundations of these estimations are discussed in section 6.3.1 for the questionnaire, in 6.3.3 for the mismatch task, in section 6.3.4 for the association task and in section 6.3.5 for the combined mismatch and association task.

Table 6.7: Estimated mean use of contractions

	task 1	task 3	task 4	task 5	total
upper groupsigns	16	11	8	20	55
lower groupsigns	9	2	2	6	19
composite groupsigns	1	1	0	4	6
upper wordsigns	3	1	0	0	4
lower wordsigns	5	0	0	0	5
composite wordsigns	0	0	0	2	2
shortforms	4	0	0	0	4
word total	72	10	15	32	129

I have included part of Millar's (1997) reading targets in my study. She classified the contractions *hoof*, *bathe* and *hinge*, which I have exchanged for *fringe*, in (4) incompatible with word segmentation without giving a definition. They all split complex graphemes of Standard English Orthography. In (4a) the complex grapheme <oo> is disrupted, in (4b) and (4c) the discontinuous graphemes <a…e> and <i…e> are affected by the upper groupsigns.

(4) a. ⠓⠕⠷
hoOF
hoof

b. ⠃⠁⠮⠑
baTHE
bathe

c. ⠋⠗⠬⠑
frINGe
fringe

Millar analyses *offer*, *them*, and *sling* compatible with word segmentation. She therefore claims that the use of contractions is unproblematic in these target items. I have used *then*, (5b), instead of *them* and *sing*, (5c), instead of *sling*, maintaining the structure with respect to the use of contractions, cf. example (1).

(5) a. ⠷⠋⠻
OFfER
offer

b. ⠮⠝
THEn
then

c. ⠎⠬
sING
sing

The examples in (4) and (5) are part of a crucial set in deciding on the importance of contractions compatible with orthographic word segmentation.

6.3.1 Task 1: Questionnaire

Task 1 is a warm-up session with the additional objective of providing background information on the subject's use of braille. Moreover, task 1 is the only task in which the subjects produce a small text sample of guided writing. In the dictation, there is no scope for variation and in all other tasks lists are produced. There are five open questions and one Yes/No question in task 1, see Figure 6.6. All answers have to be given in full sentences. This request renders the word choice in the answers partly predictable.

Figure 6.6: Task 1

Task 1: questionnaire

At first you will get some questions on your use of braille. Please write your answers in whole sentences and use grade II braille, use contractions.

1. At which age were you introduced to braille?
2. How long have you used braille?
3. Did you use print before you started braille?
4. How do you do your written homework assignments/written work? [81]
5. What is your preferred way of getting information?
6. When do you prefer to listen to a book on tape and when do you prefer to read a book?

Each question contains a set of up to five target items which have been chosen because of their use of contractions. The questionnaire and the dictation are the only tasks in which spacing between words can be tested. Therefore, the target items do not exclusively focus on groupsigns but include wordsigns as well.

A prediction is correct if 100% of the targeted items of Table 6.8 are chosen. Changes in word order are not relevant, neither are changes in word category as long as this change does not correspond to a change in contraction. I assume that there will be a decrease in the accuracy of the predictions for questions (4) to (6) because they are designed to encourage detailed answers on any aspect of the subject's choice.

Table 6.8: Task 1: List of target items

sentence	item 1	item 2	item 3	item 4	item 5
1	WAS	INtroducED	TO/<u>braille</u>		
2	HAVE	usED	<u>braille</u>	FOR	yeARs
3	prINt	<u>before</u>	ST/ARtED	<u>braille</u>	
4	DO	writtEN			
5	prefERrED	gettING	IN/FORm<u>ATION</u>		
6	prefER	TO/liSTEN	TO/a	TO/rEAd	

[81] The choice is made according to the subject's age.

These target items consist of 19 groupsigns; 12 upper groupsigns, 6 lower groupsigns and one composite groupsign. In addition, there are 8 wordsigns and 4 shortforms. Concerning wordsigns, the main target is the lower wordsign ⠖, *TO*, in question (6) because it has to be adjacent to the following word irrespective of the sentence structure.

6.3.2 Task 2: Dictation

The dictation consists of eleven sentences containing a total of 140 words. Sentence length varies from 2 - 30 words. Furthermore, this task has the highest density of composite groupsigns, see Table 6.9.

Each sentence is first read as a whole and then repeated in segments as often as necessary, at least twice. Segmentation is constant and indicated by a vertical line in Figure 6.7.

The sentences (1) to (8) are informal and contain mainly arbitrary upper and lower groupsigns which are part of a root, Table 6.11. One composite wordsign, ⠐⠞, TIME (sentence 4) and one composite groupsign ⠐⠕, ONE, in *done* (sentence 5), are used in the first eight sentences. Sentence (5) is preceded by the prompt "The next sentence is" in order to ensure that *Well done* is recognised as part of the dictation. Arbitrary lower groupsigns are predominantly used in sentence (8). Sentences (9) and (10) focus on composite groupsigns. Due to the structure of composite groupsigns (see 4.4.) both sentences are more formal than the preceding sentences containing a high proportion of morphologically complex words.

The appropriate use of punctuation marks is not part of the study. Therefore help with the choice of punctuation marks is given upon request.

Figure 6.7: Task 2

Task 2: Dictation

1. It appeared | that the bird | was caught | by a dog.

2. Jo played | with an authentic model | of a combine harvester.
3. The farmer | was selling his pig | with the help | of a neighbour.

4. Cows passed by | from time to time. (*British Braille* 2004:99)
5. Well done!

6. I think | it was his book. It must have been his! (adapted from RNIB 1992:35)
7. Which teas | do you like?

8. They created | a marvellous buffet | with meatloaf, | fried eggplant, | carrots and peas, | crusty bread, | peaches and cream | and a light cake | topped with fluffy | marshmallow | frosting. (adapted from RNIB 1992:32)
9. After much consultation | the delegation | finally made several recommendations, | which sought to increase | co-operation among the nations of the world | without the necessity for legislation | by the national governments concerned. (adapted from RNIB 1992:66)
10. There is | an unusually congenial relationship | among the younger workers | in this department. (adapted from RNIB 1992:66)
11. Enough's enough! (adapted from RNIB 1992:36)

Like the questionnaire, the dictation also targets the interaction of wordsigns and spacing between words. One such example is *his* in sentence (6). There the full form ⠓⠊⠎, *his*, and contacted form, the lower wordsign ⠦, *HIS*, of <his> are contrasted. The lower wordsign may not be used in conjunction with the exclamation mark, also a lower sign, as this produces the disallowed sequence of two adjacent lower signs in (6a). As the contracted form is present in the same sentence, it is expected that this form will also be used erroneously in combination with the exclamation mark.

Likewise, in the final sentence the two forms of *enough* are contrasted, see (6b). Only the first form may use the lower wordsign. Here the letter <s> is the licensing upper sign in the sequence ⠢⠄⠎, <enough's>. Due to the minimal distance of both forms in the dictation, interference is again expected.

(6) a. *⠦⠖
*HIS!

a'. ⠓⠊⠎⠖
his!
his

b. ⠢⠄⠎ ⠢⠳⠣⠖
ENOUGH's EN/OU/GH!
enough's enough

Example (7a) is taken from sentence (4). In this sentence the lower wordsign ⠴, *BY*, and the upper wordsign ⠋, *FROM*, have to be adjacent across the interfering segmentation (see 4.3). This is explicitly demanded by *British Braille*.[82]

British Braille does not give an explanation of the terms *sense break* and *natural pause* but presents sentence (4) as an illustration for Rule 8.4.5. Sentence (4) can be divided into the three segments [Cows] [passed by] [from time to time]. In this example *by* is part of the phrasal verb *pass by* and *from* is the first element of the following prepositional phrase. Thus, either *sense break* or *natural pause* refer to the constituent boundary which ought to be bridged by writing *by* and *from*. I expect that the constituent structure is stronger than the *British Braille* rule and that the full form of *by* in (5a) will be found in the data. I further assume that this is an indicator of a language process winning over the cognitive application of the *British Braille* rule.

I believe that there is a parallelism of word internal bridging and bridging across constituents. This can be compared to the arbitrary use of groupsigns. These groupsigns are subdivided into groupsigns that are compatible with word segmentation, such as the upper groupsign ⠜, *AR*, in *started* (task 1) and groupsigns that are incompatible with word segmentations, such as again the upper groupsign ⠜, *AR*, in *year*, where the contraction interferes with the secondary grapheme <ea> (Venetzky 1999:82, Carney 1994:192). If this compatibility - incompatibility distinction is applied at sentence level, bridging of *by* as part of the phrasal verb *pass by* and the following preposition *from* in (5a') is incompatible with sentence segmentation as bridging in this instance does not result in a constituent.[83] In contrast, the data in (7b) and (7c) illustrate compatible bridging which is a fusion of constituents. The last example on spacing is (7d). The analysis of the corpus data has shown that some braillists widen the *British Braille* rule 8.4.5 to include other lower wordsigns, most frequently the lower wordsign ⠔, *IN*.

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[82] 8.4.5 The lower wordsigns TO, INTO and BY should be written unspaced from a word which follows on the same braille line, even when a sense break or natural pause is present.
British Braille (2004:99)

[83] According to Haegeman and Guéron (1999) a phrasal verb and a particle form a syntactic unit. They are assumed to be base-generated as two distinct categories, a VP with a Particle Phrase complement. The particle then moves and incorporates into the verb to form the complex unit V*. The main motivation for this analysis was the question how a complement DP of a phrasal verb as *tear up* in (i) can receive Case.

(i) John tore up the letter.

(Haegeman and Guéron 1999: 257f)

(7) a. *passED by FROM

a'. passED BY|FROM
passed by from

b. BY/THE nATIONal govERnMENTs
by the national governments

c. WITH/a COMbINe hARveST/ER
with a combine harvester

d. IN THIS dePART/MENT
in this department

These sequences are included in the text samples as indicators for cognitive processes. I suggest that the rules for omitting spaces between members of the set {and, for, of the with, a} and any member of the set {to, into, by} and any following word have to be memorised. They operate like an algorithm without taking sentence structure into account.

The words listed in (8) are another attempt at reaching the cognitive level in braille production. All of these examples are among the 1000 most frequently used written words (Longman Corpus Network 1995) and contain composite groupsigns of low frequency. All groupsigns are arbitrary components of a root but are not incompatible with word segmentation. As a consequence, I expect that there will be subjects who do not produce these contractions.

(8) a. *among

a'. amONG
among

b. *sOU/GHt

b'. sOUGHT
sought

c. *depARtMENT

c'. dePART/MENT
department

d. *sevERal

d'. sEVERal
several

The analysis of the corpus data has shown that some braillists have a tendency to produce error clusters in complex sentences. Therefore the dictation includes two longer sentences, the colloquial sentence (8) with 26 words in total and the formal sentence (9) with a total of 30 words.

Table 6.9 lists the distribution of all groupsigns, wordsigns and shortforms which occur in the dictation. The following abbreviations are used: upper groupsign (UGS), upper wordsign (UWS), lower groupsign (LGS), lower wordsign (LWS), composite groupsign (CGS), composite wordsign (CWS) and shortform (SF).

Table 6.9: Task 2: Distribution of contractions

	word total	uncontracted words	derived words	UGS	UWS	LGS	LWS	CGS	CWS	SF
1	10	3	0	3	3		2			
2	10	4	0	5	2	2				
3	13	3	0	5	4		2			
4	8	0	0	2	1		2		2	
5	2	1	0					1		
6	12	3	0	1	3	2	2			1
7	5	0	0		4	1				
8	26	3	3	15	4	9				
9	30	1	11	7	8	5	2	13	1	1
10	14	4	2	3	2	1	1	8	1	
11	3	0	0	2		1	1			
total	133	22	16	43	31	21	12	22	4	2

6.3.3 Task 3: Mismatch task

Task 3 is a mismatch task. Ten sets of four words are presented to the subjects. Each set is read out at least twice, approximately in one second intervals between the items.[84] In each set the subject has to isolate the least suitable item and write it down. Each set is controlled for the type of contraction used. Therefore, all items within a set are of equal interest, independent of the subject's selection. The target position within the presented sets was randomised.

In the pre-test in (9) it was pointed out that each selection is an individual decision. One possible selection is *cow* as it is not a pet, another is *hamster* as it is a rodent or the only word that contains two syllables. There are two reasons for discussing the possible solutions. Firstly, one is to ease the worry about finding the right answer and, secondly, to show that semantics need not be the only selection criterion.

(9) Which one does not go with the other three: *cat*, *dog*, *hamster*, *cow*

If necessary vocabulary help is given and each definition is written down in order to ensure all following subjects who might require assistance will obtain the same response. One example is *freighter* which is described as 'a sea-going vessel'

[84] This pause was not timed but is confirmed by the tapes.

Figure 6.8: Task 3

Task 3: Mismatch task
I will give you four words at a time. Decide for yourselves which one does not go with the other three and write that one down.

One example: cat, dog, hamster, cow
It could be cow, because it is not a pet; it could be hamster, because it has two syllables

1. peach	carrot	swede	spinach
2. soft	light	hard	rough
3. whiskers	beard	fringe	chin
4. coach	freighter	ferry	yacht
5. parsley	carnation	lemon balm	coriander
6. ship	sheet	shall	child
7. sigh	stab	sheet	shark
8. ship	chip	cheer	jeer
9. shadow	rustle	jingle	crash
10. host	chop	mash	stir

The most demanding task in developing these sets was trying to keep the type of braille contraction constant together with the number of signs per item. Table 6.10 lists the details of all items in task 3. In line 4 the hypernym for all items is *boat type*. The co-hyponyms are *freighter*, *ferry* and *yacht*, the mismatch and target item is *coach*. All words in this set contain at least one upper groupsign. *Ferry*, *yacht* and *coach* use 4 signs, *freighter* uses seven. Ideally the last two columns are identical for all types of contractions and the number of signs in each line, as for example in line 8 and 10. Weighing the type of contraction against the number of signs per item, I have given preference to the type of braille contractions.

Table 6.10: Task 3: Structure of target items

	hypernym	item 1	item 2	item 3	target	braille contraction	signs per item
1.	vegetables	cARrot	swEDe	spINaCH	pEA/CH	UGS (+LGS)	5-4-5-3
2.	adjectives describing 'touch'	sOFt	hARd	rOU/GH	liGHt	UGS	3-3-3-4
3.	types of hair	WHiskERs	beARd	frINGe	CH/IN	UGS	6-4-4-2
4.	boat	freiGHtER	fERry	yaCHt	coaCH	UGS	7-4-4-4
5.	herbs	pARsley	lemon balm	coriAND/ER	cARnATION	mix	6-9-6-4
6.	manner of onset consonant	SHip	SHeet	SHALL	CHILD	UGS/UWS	3-4-1-1
7.	place of onset consonant	siGH	STab	sEAt	SH/ARk	UGS/LGS	3
8.	voiceless onset consonant	SHip	CHip	CHeER	jeER	UGS	3
9.	sound	ruSTle	jINGle	craSH	SHadOW	UGS	5-4-4-4
10.	cooking	CHop	maSH	STir	hoST	UGS	3

6.3.4 Task 4: Association task

The main function of the association task is to prepare task 5, which is a combination of task 3 and task 4. Five hypernyms were given as stimuli, one at a time. Four of these were related to the previous task, the last one, *fruit*, was chosen as an easy task to finish this section. For each hypernym, the subjects have to write down three co-hyponyms as in the pre-test in (10).

(10) *Question*: Name three pets.

A link to the previous task was established to make sure *cat, dog* and *hamster* are not excluded because they were part of the previous pre-test. If producing three herbs is difficult the prompt is to think of Simon and Garfunkel *Scarborough Fair*. [85]

Figure 6.9: Task 4

Task 4: Association task

In this task you will be given a number of 'group' names such as *pets* and your job is to write down three members of that group; for the *pet* example: *cat, dog, hamster*; the three examples you have heard in the last task are just as good as any other three pets you can think of.

1. Name three vegetables.
2. Name three things you do in the kitchen.
3. Name three boats.
4. Name three herbs. **Hint: "Think of Simon and Garfunkel *Scarborough Fair*."**
5. Name three fruits.

The target items are listed in Table 6.11. As the pilot study has shown that the preceding mismatch task does not render these items salient enough to be reused in the association task, I assume that the items of the mismatch task will occur only sporadically. Thus the expected answers are prototypical fruits like *apple*, *banana* and *strawberry*. The last item in this task is not part of the mismatch task. Its prime function is to be an easy exercise to complete this task.

Table 6.11: Task 4: List of target items based on task 3

	item 1	item 2	item 3
1	cARrot	swEDe	spINaCH
2	maSH	STir	CHop
3	freiGHtER	fERry	yaCHt
4	pARsley	lemon balm	coriAND/ER
5	apple	banana	STrawbERry

[85] "Are you going to Scarborough Fair, parsley sage, rosemary and thyme..."
All subjects knew this song and subsequently managed to complete this part of task 4.

6.3.5 Task 5: Combined mismatch & association task

Task 5 is a combination of a mismatch and an association task. The pilot study showed that when the mismatch task and the association task were presented one after the other, the items of the mismatch task were no longer salient in the association task. Thus the elements of the mismatch task and of the association task are combined in task 5.

Seven sets of four words are presented as stimuli. Each set contains three possible co-hyponyms and one unrelated element. They are presented as illustrated in the pre-test in (11a). As in task 3, the subjects have to select the element they consider least suitable and write it down. Immediately afterwards they are asked to produce three co-hyponyms of the hypernym implied in the stimulus, (11b).

(11) a. mandarin nectarine cherry feather

b. Name three fruits

I start with *pet* and expect to get prototypical pets such as *cat* and *dog* en masse. Unfortunately, they do not contain braille contractions. Thus the sets get more specific during the task. This ensures that the set of responses is a highly controlled one. Each target set is controlled for the type of contraction used. Thus all items within a set are of equal interest, independent of the actual selection. In addition, all contractions are controlled for their compatibility with word segmentation. The target position within the presented sets is random. The complete task is given in Figure 6.10.

Figure 6.10: Task 5

Task 5: Combined Mismatch and Association task

Again you will get four words at a time. Decide for yourselves, which one does not go with the other three and write that one down. Immediately afterwards you will be given a 'group' name, so please write down three members of that group.

1. goldfish canary hamster sparrow

   name three pets

2. mother father character sister

   name three people who belong to a family

3. head hoof chest thigh

   name three body parts

4. forehead eyebrow forearm cheekbone

   name three parts of your face

5. liver brain heart chin

   name three organs

6. never sometimes usually really

   name three adverbs of frequency

   Hint: How often something happens

7. haddock shellfish sea trout mackerel

   name three fish

   Hint: Fish in a fish and chip shop

Item 4 in Table 6.12 is the target item for the first part of the combined mismatch and association task, selection of the "odd one out". All other items are stimuli for the second part of the task, finding co-hyponyms. As in task 4, keeping the type of braille contractions and the number of signs per item constant in each set is not possible. I have chosen the items so that there is at least one other item per set that uses the same type of contraction and the same number of signs as the target item, listed in the last column for each of the 4 items.[86] Thus the target type of contraction in the first row are upper groupsigns (UGS) and the first item consists of 7 braille cells, items 2-4 consist of 5 braille cells each.

[86] *Sister* is also a possible target, as it is the only item that does not consist of a wordsign.

Table 6.12: Task 5: structure of target items

	hypernym	item 1	item 2	item 3	item 4 (target)	braille contraction	signs per item
1.	pets	goldfiSH	canARy	hamST/ER	spARrOW	UGS	7-5-5-5
2.	family	MOTHER	FATHER	siST/ER	CHARACTER	CWS	1-1-4-1
3.	body parts	hEAd	CHeST	THiGH	hoOF	UGS/LGS	3-3-3-3
4.	face	FORehEAd	eyebrOW	CHeekbONE	FOReARm	UGS/LGS/CGS	5-6-6-4
5.	organs	livER	braIN	heARt	CH/IN	UGS/LGS	4-4-4-2
6.	frequency adverb	nEVER	SOME/TIMEs	usuALLY	reALLY	CGS	2-3-4-3
7.	fish	haDDock	sea trOUt	mackERel	SHellfiSH	UGS/LGS	6-7-7-7

The combined mismatch and association task is the final task of the first part of the study. At this point all subjects are offered a break.

The second part is more restrictive with respect to word choice as in this part all target words are controlled for. The assumption is that by this time they feel confident in handling the different tasks and will not be too concerned with the spelling. Should there be a difficulty in determining this target word, help is given, because the underlying tasks of identifying phonemes, section 6.3.6, building adverbs, section 6.3.7, deleting letters, 6.3.8 or building regular noun plurals, section 6.3.9 is not a central part of the study.

6.3.6 Task 6: Phoneme omission

This task is developed from a phonological awareness test (Cook 2004). It consists of three parts. First a word is written to dictation. In the second step a given phoneme has to be removed from the syllable onset, usually the syllable onset of the initial syllable. The resulting phoneme sequence always corresponds to a word, never to a pseudo-word. Ideally the subject independently says the second word. However, as the focus is not on phoneme awareness but on written word production all help needed to produce the second form is given and the choice is always confirmed by the experimenter. The third step is to write it down.

Two word pairs are given as pre-test. The first word pair in (12) illustrates the procedure of the task.

(12) a. First I will say a word and ask you to write that down, for example *coat*. Can you write that down for me, please.

b. Now the second part is to leave out a sound in this word and you get another word.
Which word do you get if you leave out the /k/ in *coat*
[leave time to respond]
oat, right.

c. Brilliant, can you write that down for me as well, please.

The second pair, given in (13), follows immediately afterwards. It has the function to emphasise that a phoneme is left out, not a letter.

(13) a. The next word is *make*. Can you write that down for me, please.

b. Which word do you get if you leave out the /m/ in *make*?

c. *Ache*, right, can you write that down as well, please.

In the first set *coat – oat* the distinction between phoneme and letter is not evident, see example (14a). Independent of the interpretation of this element, either results in the target word. The second set is a control element to clarify whether the subjects focus on letters instead of phonemes. Should the focus indeed be on the letter, this set is intended to provoke a reaction such as "But <ake> is not a word".

(14) a. /kəʊt/ /əʊt/
coat oat

b. /meɪk/ /eɪk/
make ache

The complete task is given in Figure 6.11. It has a total of 15 single word stimuli which are divided into three units of equal size. In the first set of five, the first phoneme is deleted. As the subjects get acquainted with the task it becomes more challenging in the second block with respect to both, phoneme deletion and choice of braille contraction. In the final five pairs it is always the second phoneme in the word-initial syllable that gets deleted. Concerning the execution of the task, the variation in the deletion pattern is not only an element to maintain concentration, but it allows variation in the change of types of contractions which can not be covered by the first two blocks.

Figure 6.11: Task 6

Task 6: Phoneme omission

This task consists of three parts. First I will say a word and ask you to write that down, for example *coat*. Can you write that down for me, please. Excellent, now the second part is to leave out a sound in this word and you get another word. Which word do you get if you leave out the /k/ in *coat* [leave time to respond] *oat*, right? Brilliant, can you write that down for me as well, please.

The next word is **make**. Which word do you get if you leave out the /m/ in **make**? ⇒ ache

In the first group it is always the first sound that is left out

1. The next word is **pew**. Which word do you get if you leave out the /p/ in **pew**? ⇒ Jew/ewe/you
2. The next word is **bright**. Which word do you get if you leave out the /b/ in **bright**? ⇒ right
3. The next word is **stand**.[87] Which word do you get if you leave out the /t/ in **stand**? ⇒ sand
4. The next word is **for**. Which word do you get if you leave out the /f/ in **for**? ⇒ or
5. The next word is **braille** Which word do you get if you leave out the /b/ in **braille**? ⇒ rail

Now it's getting really tough.

1. The next word is **ghost**. Which word do you get if you leave out the /s/ in **ghost** ? ⇒ goat
2. The next word is **mother**. Which word do you get if you leave out the /m/ in **mother**? ⇒ other
3. The next word is **below**. Which word do you get if you leave out the /i/ in **below**? ⇒ blow
4. The next word is **parrot**. Which word do you get if you leave out the /ə/ in **parrot**? ⇒ part[88]
5. The next word is **world**. Which word do you get if you leave out the /l/ in **world**? ⇒ word

In the next group its always the second sound that is left out.

1. As in **snail.** Which word do you get if you leave out the /n/ in **snail**? ⇒ sail
2. The next word is **spin**. Which word do you get if you leave out the /p/ in **spin**? ⇒ sin
3. The next word is **glow**. Which word do you get if you leave out the /l/ in **glow**? ⇒ go
4. The next word is **fright**. Which word do you get if you leave out the /r/ in **fright**? ⇒ fight
5. The next word is **crash**. Which word do you get if you leave out the /r/ in **crash**? ⇒ cash

As this task is an adaptation of a phoneme awareness test, the deletion of phonemes is kept as simple as possible and takes place in the syllable onset. In addition, the resulting word is of the same word category as the stimulus. Table 6.13 lists input and target items in the first two columns together with the contraction types affected by the phoneme omission and their classification, whether they are compatible, CC, or incompatible, IC, with orthographic word segmentation.[89] For example in line 7, the input *mother* is a composite wordsign and the target *other* contains an upper groupsign incompatible with orthographic word segmentation.

[87] This item ought to have been in the last group. However, the error was not noticed by a single subject.

˥ θhis works in the ʃouth ʷest of ɛngland where /æ/ is substituted for by /ɑː/.

[89] The sign ∅ indicates that no contraction is used.

Table 6.13: Task 6: Contraction types in targets

	input	target	contraction types		compatibility with word segmentation	
			input	target	input	target
1.	pew	yew/ ewe/ YOU	Ø	Ø/UWS	∅	∅
2.	bRIGHT	RIGHT	CGS	CWS	CC	WORDSIGN
3.	ST/AND	sAND	UGS	UGS	CC	CC
4.	FOR	or	UWS	Ø	WORDSIGN	∅
5.	braille	rail	SF	Ø	SHORTFORM	∅
6.	GHoST	goat	UGS, UGS	Ø	CC	∅
7.	MOTHER	oTHEr	CWS	UGS	WORDSIGN	IC
8.	below	blOW	SF	UGS	SHORTFORM	CC
9.	pARrot	PART	UGS	CWS	CC	WORDSIGN
10.	WORLD	WORD	CWS	CWS	WORDSIGN	WORDSIGN
11.	snail	sail	Ø	Ø	∅	∅
12.	spIN	sIN	LGS	LGS	CC	CC
13.	glOW	GO	UGS	UWS	CC	WORDSIGN
14.	fRIGHT	fiGHt	CGS	UGS	CC	CC
15.	craSH	caSH	Ø	Ø	CC	CC

In order to aim at the distinction of producing braille via cognitive or via language processes, all pairs of stimuli are constructed to achieve a maximum of change in the use of elements of contracted braille. I assume that this additional difficulty will help to polarize between braillists who use cognitive paths and those who use language processes to write these samples. This task already includes a cognitive activity, leaving out a phoneme, it ought to show a better performance in those braillist who use language processes, especially as this task does not contain any low-frequency words.

6.3.7 Task 7: Adverb formation

Task 7 functions mainly as a filler task to separate task 6 and task 8. In task 7 a given adjective has to be written down together with its corresponding adverb. To ensure that the term adverb was not a problem the complete set was given in the pre-test in (15).

(15) nice - nicely

Any help that may be needed to find the corresponding adverbs is given, as again the focus of the study is on writing, not on adverb formation. The entire task is given in Figure 6.12.

Figure 6.12: Task 7

Task 7: Adverb formation

This task concentrates on adverbs formed from adjectives like *nice* and *nicely*. I will give you an adjective, such as *nice* and ask you to write that down. Then it is your turn; find the adverb that is built from that adjective and write that down as well.

1. normal
2. careless
3. final
4. professional
5. happy
6. real
7. joyful

Regarding braille production, an important aspect in the design of this task is the generation of adverbs ending in the letter sequence <ally>. This causes a change in the corresponding adjectives ending in <al>, as the sequence <ally> is represented as the composite groupsign ⠠⠽, *ALLY*. Four of the chosen adverbs use this pattern and one of these changes a contraction within the root to do so. Table 6.14 lists the contraction types used in task 7.

Table 6.14: Task 7: structure of target items

	item 1	item 2
1	normal	normALLY
2	cAReLESS	cAReLESSly
3	fINal	fIN/ALLY
4	prOFesSIONal	prOFesSION/ALLY
5	happy	happily
6	rEAL	reALLY
7	joyFUL	joyFULly

6.3.8 Task 8: Letter omission

Task 8 has the same origin and structure as task 6. They differ with respect to the type of element deleted. In task 6 a phoneme is deleted and in task 8 it is a letter. Task 8 is based on the same phonological awareness test (Cook 2004) and consists of three parts. First, a word is written to dictation. In the next step a letter is named to be deleted. The resulting sequence is always a word, never a pseudo-word. Ideally this is orally produced by the subject. It is always repeated by the experimenter before. In a third step the result of the deletion is written down. Ten single words are presented as stimuli. Because of the similarity with task 6 only the pair in (16) is given as a pre-test.

(16) a. First I will again say a word and ask you to write that down, for example *chap*. Can you write that down for me, please.

b. Which word do you get if you leave out the letter <h> in *chap* - *cap*, right.

c. Can you write that down for me as well, please.

Any help that may be needed in finding the second member of each pair is given, as the focus of the task is on braille production. The whole task is given in Figure 6.13.

Figure 6.13: Task 8

Task 8: Letter omission

This task is similar to the first one we did today. It also consists of two parts. First I will again say a word and ask you to write that down, for example *chap*. Can you write that down for me, please. Excellent, now the second part is to leave out a letter in this word. Which word do you get if you leave out the letter <h> in *chap* - *cap*, right? Brilliant, can you write that down for me as well, please.

1.	The next word is **then**.	Which word do you get if you leave out the letter <t> in t**hen**?	⇒	hen
2.	The next word is **this**.	Which word do you get if you leave out the letter <t> in **this**?	⇒	his
3.	The next word is **the**.	Which word do you get if you leave out the letter <t> in **the**?	⇒	he
4.	The next word is **that**.	Which word do you get if you leave out the letter <t> in **that** ?	⇒	hat
5.	The next word is **every**.	Which word do you get if you leave out the first <e> in **every**?	⇒	very
6.	The next word is **feather**.	Which word do you get if you leave out the first <e> in **feather**?	⇒	father
7.	The next word is **wash**.	Which word do you get if you leave out the letter <h> in **wash**?	⇒	was
8.	The next word is **bathe**.	Which word do you get if you leave out the letter <e> in **bathe**?	⇒	bath
9.	The next word is **comet**.	Which word do you get if you leave out the letter <t> in **comet**?	⇒	come
10.	The next word is **sing**.	Which word do you get if you leave out the letter <g> in **sing**?	⇒	sin

Like task 6, this task is an adaptation of a phoneme awareness test. As the procedure is now familiar, the execution of task 8 is more complex than task 6. In the first four sets the complex print grapheme <th> is destroyed by the deletion of its constituent letter <t>. The resulting word is mostly of the same word category as the stimulus. Table 6.15 gives a list of all contractions that are affected by the letter deletion. In the second row the upper wordsign ⠹, *THIS*, has to be divided into its constituent letters in order to be able to delete the first letter and get the sequence <his> which is a lower wordsign.

Table 6.15: Task 8: Contraction types in target items

	input	target	contraction types		compatibility with word segmentation	
			input	target	input	target
1.	TH/EN	hEN	UGS, LGS	LGS	CC	CC
2.	THIS	HIS	UWS	LWS	WORDSIGN	WORDSIGN
3.	THE	he	UWS	Ø	WORDSIGN	∅
4.	THAT	hat	UWS	Ø	WORDSIGN	∅
5.	EVERY	VERY	UWS	UWS	WORDSIGN	WORDSIGN
6.	fEA/THEr	FATHER	LGS, UGS	CWS	CC, IC	WORDSIGN
7.	waSH	WAS	UGS	LWS	CC	WORDSIGN
8.	baTHE	baTH	UGS	UGS	IC	CC
9.	COMet	COMe	LGS	LGS	CC	CC
10.	sING	sIN	UGS	UGS	CC	CC

6.3.9 Task 9: Plural formation

The main objective of the final task is to ensure a positive finish of the study. This task ought to be considered very easy by all subjects. In this task pairs of nouns in their singular and plural forms have to be written**.** Seven nouns are given in their singular form. They are to be written down together with the corresponding regular plural forms. The pre-test consists of the pair *coat – coats.* The complete task is given in Figure 6.14.

Figure 6.14: Task 9

Task 9: Plural formation

This task concentrates on plural formation.
I will give you a noun, such as *coat* and ask you to write that down. The next step is to form the plural of that noun, in our case *coats* and write that down as well.

1. egg
2. grandmother
3. idea
4. disagreement
5. effort
6. offer
7. hat

Similar to task 7, changes in the use of braille contractions are targeted in word-final position. Here they are the lower groupsigns ⠶, *GG*, and ⠂, *EA*, in *egg* and *idea*. They may only be used in the plural forms as in the singular these sequences are in word-final position (see section 4.3), as listed in Table 6.16.

Table 6.16: Task 9: Selection of target items

	item 1	item 2
1	egg	eGGs
2	grAND/MOTHER	grAND/MOTHERs
3	idea	idEAs
4	DISagreeMENT	DISagreeMENTs
5	efFORt	efFORts
6	OFfER	OFfERs
7	hat	hats

6.3.10 Summary

This study consists of nine partly interdependent tasks. With the exception of the final task, the complexity of the tasks increases during the course of the study in order to make the subjects, who are all aware that the study targets their use of braille, focus on the task itself and not on their typing. A variety of tasks has been chosen in order to maintain concentration and keep the subjects focused on the tasks.

Three types of writing are produced. In task 1, the questionnaire, the output is a small sample of guided writing with moderate control on word-choice and consequently on the choice of contractions. The second task, the dictation, produces a compilation of individual sentences with total control of the output. All other tasks produce lists. In tasks 3 to 5 these lists are created individually, again with moderate control of the output. The lists in the final group of tasks, 6 to 9, are invariant, thus there is total control of the use of contractions.

The study has been designed to elicit a maximum of braille contractions. The aim was to achieve a balance between arbitrarily used contractions and contractions that represent linguistic units such as morphemes and syllables. Due to the structure of contracted braille, upper groupsigns are the most frequent contractions, especially since some correspond to complex graphemes such as <th>. There is a continuous increase in complexity of contractions from upper groupsigns to lower groupsigns to composite groupsigns in the system of contracted braille. Thus in terms of relative frequency, an upper groupsign is more likely to function as an arbitrary contraction than a composite or a lower groupsign. These more often represent linguistic units.

As this study is designed to produce extremely high density of braille contractions and the majority of words are of standard frequency, braille code errors ought to outnumber spelling errors if braille is a separate system, inaccessible by Universal Grammar, which is superimposed on print and dependent on cognitive processes.

7 Typology of errors

In this chapter I will develop a system of error classification which can unambiguously classify all errors I obtained in the braille study. I consider braille to be a system that contains elements of Standard English print expanded by a set of supplements to meet the needs of a particular group, creating a comprehensive complex system, not a duality of two competing systems. Nevertheless, spelling errors and braille code errors are classified as two different categories.

Section 7.1 discusses two studies on error classification. Section 7.2 gives the error classification I devised to use in my braille study.

7.1 Two studies on error classification

The following two studies on error classification are the basis of error classification for the data obtained in the braille study. I use both in a modified way.

Koenig & Ashcroft (1993) compare spelling abilities of blind pupils to that of their sighted peers in the US (section 7.1.1); the study by the National Foundation for Educational Research, NFER, classifies the main spelling errors of 11- and 15-year-old pupils in the UK, also giving their comparative frequencies (section 7.1.2).

7.1.1 Koenig and Ashcroft

Koenig & Ashcroft (1993) produced an analysis and a categorisation of errors as part of a study of writing skills of blind schoolchildren in the US. In order to compare spelling levels of students who were using braille with those of students who were using print, Koenig developed an error analysis with the aim "to separate 'true' errors in spelling from errors in braille orthography (the application of rules and the use of contractions required in writing in Grade 2 braille code [contracted braille])" (Koenig & Ashcroft 1993:13). They classified errors into spelling errors and braille code errors. Braille code errors are then subdivided according to the unit involved in producing the error, i.e. braille cell, word, larger than word. Koenig's spelling errors are given in Figure 7.1. They incorporate errors that are particular to contracted braille.

Koenig's first category in (A) is a separate category for homophones relating to braille contractions. The braille code provides only five possible homophone sets of homophones which are listed in (1).

(1) a. ⠐⠮ THERE there | ⠸⠮ THEIR their | ⠮⠽⠄⠗⠑ THEy're they're

b. ⠐⠗ RIGHT right | ⠺⠗⠊⠞⠑ write write | ⠗⠊⠞⠑ rite rite | ⠺⠐⠗ wRIGHT wright

c. ⠐⠞ TIME time | ⠹⠽⠍⠑ THyme thyme

d. ⠱ WHICH which | ⠺⠊⠞⠡ witCH witch

e. ⠓ HAVE /əv/ have | ⠷ OF /əv/ of

Koenig does not refer to morphological errors such as plural *–s* vs. the genitive inflection. Whether such homophones as the pair *teas* vs. *tea's* in (2a) are classified in this group if they are used erroneously remains unclear.

(2) a. ⠞⠂⠎ tEAs | ⠞⠑⠁⠄⠎ tea's

Even though the errors in (A) in Figure 7.1 are related to braille, they are not particular to braille.[90] Print writers show the same error patterns in these homophone sets. In addition, they constitute a very small closed group. It is therefore not evident why they should be classified as a separate group.

Once they are stripped of all braille code elements, the examples in (B) and (C) both contain spelling errors. I do not agree with this dual process. The example in (B) ignores the fact that *against* ought to be represented by a shortform and this type of error can either be analysed as a braille code error, because the shortform has not been realised, or as a combination of braille code error and spelling error. Likewise in (C), this example is predominantly a wrong use of the composite groupsign ⠐⠑, *EVER*.

Illegible words are often but not exclusively an accumulation of spelling errors and braille code errors; unfortunately Koenig does not give an example. In contracted braille it is not possible to guess the number of letters involved in a word. A misprinted sign can generally be either a letter of the alphabet or a contraction. As a consequence, it is

[90] I have modified all transcriptions to be consistent with those in the other chapters. In addition, I have removed the capital letter indicators in the examples, as capitals are not obligatory in *British Braille*.

possible that a sequence of erroneously chosen or misprinted signs can not be decoded by the context and remain uninterpretable.

Only category (D) spelling errors are true spelling errors. They do not involve an additional braille code element. In *terrible* the gemination of <r> remains unrealised. Koenig's classification provides no further analysis of the category *true misspelling*.

Figure 7.1: Spelling Errors

	Error Categories and Subcategories	Observed Response	Expected Response
A	Homophone error related to braille contraction	⠐⠮ THERE[91] there	⠸⠮ THEIR their
B	Unsuccessful attempt at full spelling of contraction	⠁⠛⠔⠌ agIN/ST aginst	⠁⠛⠌ agST against
C	Other braille related misspelling	⠐⠑⠐⠱ EVER/WHERE everwhere	⠐⠑⠽⠐⠱ EVERyWHERE everywhere
D	True misspelling	⠞⠻⠊⠼ tERiBLE teribile	⠞⠻⠗⠊⠼ tERriBLE terrible
E	Illegible word		

Braille code errors are divided into the three groups: character-level error (Figure 7.2), word-level error (Figure 7.3) and interword-level error (Figure 7.4).

The character-level errors in Figure 7.2 can be divided into two categories. The first one are random errors of a certain form, (A) and (B) show a discrepancy of one dot to the target shape. These are often influenced by the dot configuration in an adjacent cell and are similar to typos in print and not necessarily braille code errors. A second category of errors can be identified in (C) to (G), periodic transformation of the target. These are often recurrent patterns and thus predictable within the output of a single subject.

[91] All transcriptions used for the discussion of this system are mine, capital letter indicators have been removed from the examples as they do not contribute to the discussion and are not obligatory in *British Braille*.

Figure 7.2: Character-level Errors

	Error Categories and Subcategories	Observed Response	Expected Response
A	Missed dot	⠍⠕⠅ mok	⠍⠕⠍ mom
B	Added dot	⠇⠁⠝⠁⠝⠁ lanana	⠃⠁⠝⠁⠝⠁ banana
C	Reversal	⠚⠊⠇⠇ jill	⠓⠊⠇⠇ hill
D	Rotation	⠝ NOT not	⠮ THE the
E	Vertical misalignment	⠃⠉ bc	⠆⠉ BEc because
F	Misplaced dot	⠊ i	⠉ c
G	Malformed signal dot	⠝⠐⠝ n-dot5-n	⠝⠠⠝ nATION nation

In Figure 7.3 errors in the use of contractions are listed. All errors labelled *word-level contraction error* are pure braille code errors. (A) is the omission of a contraction within a word. To be consistent (D) ought to be labelled *Nonuse of appropriate shortform*, (E) *false use of appropriate shortform*. The inappropriate use of the upper groupsign ⠌, *ST*, in (D) is only the result of not using the shortform. Examples (B), (C) and (F) are concerned with the sequencing of lower groupsigns, where in (B) the lower groupsign ⠢, *EN*, is not realised and in (C) and (F) the lower wordsigns ⠦, *HIS*, and ⠶, *WERE*, are used wrongly.

Figure 7.3.: Word-level Contraction Errors

	Error Categoeries and Subcategories	Observed Response	Expected Response
A	Nonuse of appropriate contraction	city	cITY city
B	Nonuse of appropriate contraction in conjunction with punctuation	hiDDen.	hiDD/EN. hidden
C	Inappropriate use of contraction when full spelling required	BY/HIS	BYhis by his
D	Inappropriate use of partially contracted spelling	firST	fST first
E	Inappropriate addition of contraction or letter resulting in extra letter	rcvER receiveER	rcvr receiver
F	Inappropriate use of contraction in conjunction with punctuation	"WERE	"wERe "were

All inappropriate spacings are listed in Figure 7.4. (A) to (C) are related to rules on the individual use of contractions. Consequently, they are all wrong uses of individual contractions and ought to be classified accordingly.

Example (D) is concerned with an accidentally omitted space. It is not clear why an accidentally omitted space is classified as an interword-level error and its counterpart, an accidentally inserted space is a miscellaneous braille related error (Figure 7.5, D).

Figure 7.4: Interword-level Errors

	Error Categories and Subcategories	Observed Response	Expected Response
A	Inappropriate spacing: a, and, for, of, the, with	AND THE	AND/THE and the
B	Inappropriate spacing to, into, by	TO be	TObe to be
C	Inappropriate spacing: in, was	IN/THE	IN THE in the
D	Randomly omitted space between words	heran	he ran

The last group devised by Koenig are miscellaneous errors related to braille in Figure 7.5. They are not part of the braille code errors. The categories (A) and (B) are concerned with formatting and the use of the number sign. The classification of (C) as a braille related error seems to imply that there was no space at the end of the braille line to accommodate the two more cells for <ld> in *gold*. The use of the full cell for correction purposes in (E) is not a mistake in *British Braille*. Finally, (F) is the result of the use of a wrong wordsign and ought to be part of the word-level errors.

Figure 7.5: Miscellaneous Braille-related Errors

	Error Categories and Subcategories	Observed Response	Expected Response
A	Inappropriate use of composition sign	⠠⠠⠊	⠠⠊
B	Inappropriate use of number	⠼⠂⠢⠖	⠼⠁⠑⠋
C	End-of-line error not related to use of contractions	⠛⠕⠤ ⠇⠙⠋⠊⠩ go- ldfiSH	⠛⠕⠇⠙⠤ ⠋⠊⠩ gold- fiSH gold-fish
D	Randomly added dots/spaces next to or within word	⠋ ⠗⠕⠛ f rog	⠋⠗⠕⠛ frog
E	Use of full cells for correction purposes	⠌⠿⠕⠏ ST-blank-op	⠌⠕⠏ STop stop
F	Word choice error related to contraction	⠱ WHICH	⠐⠱ WHERE where

To sum up, Koenig's classification is designed to enable a comparison of spelling abilities in print and braille users. The way in which the spelling errors are classified suggests a dual way to contracted braille: first the full version of the target word is assembled and in the next step the contracted form is produced. This is evident from the fact that wrong uses of shortforms and groupsigns are classified as spelling errors. I consider this classification problematic for the analysis of errors with regard to both form and function within the braille code.

Although I will maintain the separation of braille code errors and spelling errors I will try to identify dependences in errors which combine erroneous elements of both Standard English Orthography and *British Braille* (see *complex errors* section 7.2.5).

7.1.2 Classification of spelling errors

The National Foundation for Educational Research (NFER) produced a classification of spelling errors to measure the spelling abilities of English school children at age 11 and 15. They classify spelling errors purely according to form without acknowledging any underlying processes that have caused these errors, see Figure 7.6. (Brooks, et al. (1993) cited in Cook 2004:124). Mistakes caused by adding an extra letter as the inappropriate gemination of <l> in *until* in (1) are classified as *insertion*. Similarly, the erroneous omission of the gemination of <r> in *occurring* in (2) is classified as *omission*. The substitution of a single letter as in *definite* in (3) where <i> is substituted for by <a> is classified as *substitution*. In (4) the exchange of the string <ie> for <ei> is termed *transposition*. A *grapheme substitution* as replacing the string target <ough> by <or> in *thought* in (5) involves more than one 'letter' but is the result of a single trigger.

Figure 7.6: Types and proportions of 'major' spelling mistakes in English children

(1)	insertion	'untill/until'	17 %
(2)	omission	'occuring/occurring'	36 %
(3)	substitution	'definate/definite'	19 %
(4)	transposition	'freind/friend'	5 %
(5)	grapheme substitution	'thort/thought'	19 %
(6)	other		3 %

The shortcoming of this system is that the classification is based on letters, not on graphemes. A string like <ghoast>, superficially looks like it belongs to 'insertion' as it contains an extra <a>, but it is a substitution of the target <o> by the complex grapheme <oa>.

7.2 Braille Study: Error classification

The following section lists all error categories I am using to classify the errors of the braille study in chapter 8. My classification has been developed on the basis of those by Koenig & Ashcroft and the NEFR study in combination with my corpus data.

In contrast to those studies, my aim is not to provide a means of measuring performance or proficiency in braille users. I am investigating whether the system of contracted braille contains elements which might interfere with spelling performance and whether errors which do not contain elements specific to braille have a similar pattern to the spelling errors found in the control group of print users.

Data which contains perception errors such as producing *sheet* instead of *seat* and test errors such as adding a random suffix instead of building the adverb of a given adjective are listed in Table 7.1.

Table 7.1: Excluded material

error type	target	data obtained	total (all subjects)
perception error	*sheet* /ʃiːt/	*seat* /siːt/	67
test error	carelessly	carelessness	27
compound spacing	meatloaf	meat loaf	30

In addition, extra spaces in compounds have been disregarded as they are subject to changes in the development of the compound (Bauer 1983; 2003). Thus variants such as those for *teabag* in (3) have been disregarded.

(3) a. tea bag

b. tea-bag

c. teabag

As none of the error types in Table 7.1 are relevant to the question whether *British Braille* contains elements or processes which are in conflict with Standard English Orthography they have been disregarded. My analysis does not imply a print-to-braille conversion at any point of braille writing. I make a distinction between the following categories: mechanical errors (7.2.1), spelling errors (7.2.2), braille code errors (7.2.3), complex errors (7.2.4), ambiguous errors (7.2.5) and unclassified errors (7.2.6).

7.2.1 Mechanical errors

Mechanical errors are errors comparable to typing errors in touch-typing. They consist of monitoring errors due to lack of feedback and of typing errors.

I have introduced the category *monitoring error* because the monitoring of braille output is different from the monitoring of print output, especially as a braillist's feedback is generally limited to kinaesthetic feedback and there is no automatic access to the output. In order to proof read the output, writing has to be interrupted and the hands have to move onto the text (CNIB 1997:70). In contrast, a print writer predominantly relies on visual feedback, with kinaesthetic feedback also accessible.

This difference is reflected in the samples: the sighted control group showed much more crossing out and correcting than the braillists did.[92] Monitoring errors can account for the errors in (4). Letters or letter sequences are doubled because the contraction is accessed during the writing process. It is inserted but if some of its constituent letters have already been written they are not deleted. Whereas *normal* does not use a contraction, *normally* contains the composite groupsign ⠠⠽, *ALLY*. The sequence ⠁⠇⠠⠽, *alALLY*, in (4a) indicates that the intended spelling had advanced to the end of the root <normal> before the composite groupsign ⠠⠽, *ALLY*, was typed. The constituent letters of the groupsign, ⠁⠇, *al*, remained undeleted. Likewise in (4b), <real> contains the lower groupsign ⠂, *EA*. In *really* the composite groupsign ⠠⠽, *ALLY*, is given preference as it uses less space, rule 8.8.1. The sequence ⠂⠠⠽, *EA/ALLY*, indicates that the spelling intended for *really* was progressed as far as <rea> before the composite groupsign ⠠⠽, *ALLY*, was inserted; the full spelling had been started, but the sequence <al> was not deleted when the contraction was inserted.

(4) a. *⠝⠕⠗⠍⠁⠇⠠⠽ — *normalALLY a'. ⠝⠕⠗⠍⠠⠽ — normALLY, normally

b. *⠗⠂⠠⠽ — *rEA/ALLY b'. ⠗⠑⠠⠽ — reALLY, really

Another example of a monitoring error is given in (5). The context was *at night* and it is again assumed that with visual feedback this error would have been corrected.

(5) a. *⠁⠞ ⠞⠊⠣⠞ — *at tiGHt a'. ⠁⠞ ⠝⠊⠣⠞ — at niGHt, at night

On a QWERTY keyboard typing errors are often letters adjacent to the target key as in (6a) or reflexes of a different speed of the two hands, as in (6b).

(6) a. *dor a'. dot

b. *dto b'. dot

[92] There are several methods for correcting braille. The least precise is to scratch out the embossed sign with the fingernail and then type it again. Instead of a fingernail a braille eraser can be used to push the relevant dots back into the page. This requires precision and skill in order not to damage the page. Another possibility is to cover the relevant section with the fully embossed braille cell and then write the corrected part again.

In braille, every letter gets embossed separately. The fingers are kept steady over the same keys and do not move across the keyboard. The relevant environment for a braillist is the preceding and following sign. If single extra dots or missing dots can be linked to the immediate environment I interpreted them as typos.[93]

As the index finger is the strongest finger, extra dots are most likely to appear in the highest row, dots 1 (left index finger) and 4 (right index finger). In (7a) the typo consists of an extra dot 1 (+ L_1) in the second cell of the composite groupsign ⠨⠎, <u>*LESS*</u>, thus creating a groupsign which consists of the indicator sign dot 4-6 used for the composite groupsign ⠨⠎, <u>*LESS*</u>, and the letter <p>, ⠨⠏, <u>*dot46-p*</u>. Dot 1 is part of both the preceding letter ⠑, <e>, and the following letter ⠇,<l>. Similarly in (7b), the typo consists of an extra dot 4 (+ R_1) in the second cell of the word. This dot is present in both adjacent cells; in the preceding ⠍, <m>, and the following ⠹, *TH*.

(7) a. *⠉⠜⠑⠨⠏⠇⠽ — a'. ⠉⠜⠑⠨⠎⠇⠽
*cARe-dot46-ply — cAReLESSly
carelessly

b. *⠍⠻⠹ — b'. ⠍⠳⠹
*mER/TH — mOU/TH
mouth

Monitoring errors are more likely to occur in braille than in print for two reasons. Firstly, a braillist only gets direct kinaesthetic feedback when writing, whereas a sighted writer usually reads what is being written. Secondly, due to the complexity of the sign system in braille there is no redundancy in the target shape; every alternation of the dot matrix will invariably result in a mistake.

7.2.3 Spelling errors

Spelling errors are errors which are not in accordance with Standard English Orthography, such as **storey* in (8a).

(8) a. *⠌⠕⠗⠑⠽ — a'. ⠌⠕⠗⠽
*STorey — STory
story

Spelling errors can be classified either according to form compared to the correct target and by the process that caused the erroneous result. Thus the error in **storey* in (8a) is an insertion according to form. It is caused by an instance of phonetic spelling, in this

[93] This definition of typo allows the addition or subtraction of one dot to the target shape. An error resulting in a cell that uses the same number of dots is not a typo in this definition.

case dialect spelling which represents the underlying dialectal variant [stɔːreɪ], typical for the South West of England.

In the following two subsections, I will first present the classification of spelling errors by form, then that by function.

Spelling errors by form

My error analysis is a modification NFER classification. A drawback of the NFER classification is that its distinction is based on letters. In accordance with Venetzky (1998:82) I use graphemes as smallest distinctive units for error classification. The extra <t> in **carrotts* in (9a) is an example of *insertion*; the missing <n> in **goverments* in (9b) is an example of *omission*.

(9) a. *⠉⠜⠗⠕⠞⠞⠎ — a'. ⠉⠜⠗⠕⠞⠎
*cARrotts — cARrots
— carrots

b. *⠛⠕⠧⠻⠝⠰⠞⠎ — b'. ⠛⠕⠧⠻⠝⠰⠞⠎
*govER/MENTs — govERnMENTs
— governments

In order to be able to retain complex graphemes such as <th> in *thyme* as units, the term *letter substitution* in the NFER classification is renamed *grapheme substitution*. Thus all examples in (10) are grapheme substitutions. In *thyme* in (10a) the target <y> is substituted by an <i>. In *much* in (10b) the target <u> is substituted by <ou>. Contrary to the classification it does not consist of a letter insertion. Similarly, in *thyme* in (10c) the target <th> is substituted for by <t> and is not a letter omission.

(10) a. *⠹⠊⠍⠑ — a'. ⠹⠽⠍⠑
*THime — THyme
— thyme

b. *⠍⠳⠡ — b'. ⠍⠥⠡
*mOU/CH — muCH
— much

c. *⠞⠽⠍⠑ — c'. ⠹⠽⠍⠑
*tyme — THyme
— thyme

The NFER category *letter transposition* as illustrated in (11a) remains unchanged with respect to the ordering of the surface string. Yet again, the underlying unit is the grapheme, not the letter. There target sequence <el> is realised as the permutation <le> in **modle*.

(11) a. *⠍⠕⠙⠇⠑ a'. ⠍⠕⠙⠑⠇
*modle model

As the label *grapheme substitution* is now used for the examples in (10), a grapheme substitution which is caused by a single trigger and involves at least two graphemes is labelled *complex substitution*, corresponding to the NFER category *grapheme substitution*. The spelling errors in (12a) look like two gemination errors, a insertion of <c> and a omission of <m>. They are classified as a complex substitution, as the one underlying trigger is the gemination error. The form **pueue* in (12b) is in analogy with *queue*, again one underlying trigger.

(12) a. *⠗⠑⠒⠕⠍⠢⠙⠰⠝⠎ a'. ⠗⠑⠉⠕⠍⠍⠢⠙⠰⠝⠎
*reCComENdATIONs recommENdATIONs
recommendations

b. *⠏⠥⠑⠥⠑ b'. ⠏⠑⠺
*pueue pew

Combinations of spelling errors within one word are possible and are classified as *accumulated spelling errors*. The two spelling errors in (13a) consist of a letter insertion, the geminate <d>, plus the permutation of the target sequence <el> to <le>.

(13) a. *⠍⠕⠲⠇⠑ a'. ⠍⠕⠙⠑⠇
*moDDle model

The spelling errors listed in the section *other* are mainly morphological errors. In (14a) the homophone **past* is used instead of past tense form *passed*. In (14b) the plural suffix -*s* is substituted for by the genitive inflection *'s*.

(14) a. *⠏⠁⠎⠞ a'. ⠏⠁⠎⠎⠫
*past passED
passed

b. *⠞⠑⠁⠄⠎ b'. ⠞⠂⠎
*tea's tEAs
teas

Spelling error by underlying process

Following the classification by form, the underlying cause of the error is identified. Most spelling errors are either gemination errors as in (15) or instances of phonetic spelling as in (16). The gemination error in *leisure* in (15a) is an insertion of <s>, whereas in *assignments* in (15b) the <s> is omitted.

(15) a. *⠇⠑⠊⠎⠎⠥⠗⠑
*leissure

a'. ⠇⠑⠊⠎⠥⠗⠑
leisure

b. *⠁⠎⠊⠛⠝⠰⠞⠎
*asignMENTs

b'. ⠁⠎⠎⠊⠛⠝⠰⠞⠎
assignMENTs
assignments

There are several causes for instances of phonetic spelling. One is the mapping of dialect forms as in *story* in example (8). Another is giving a regular phoneme grapheme correspondence to an irregular low-frequency word as in the highly irregular *yacht* in (16a) where the string <ach> is substituted for by <o>. Another cause is the representation of unstressed short vowels. In *spinach* in (16b) the underlying /ɪ/ is represented by <i> instead of <a>. The last group consists of homophones such as *sought* in (16c), where the homophone *sort* is used instead, resulting in the more regular representation of the underlying /sɔːt/.

(16) a. *⠽⠕⠞
*yot

a'. ⠽⠁⠡⠞
yaCHt
yacht

b. *⠎⠏⠔⠊⠡
*spINiCH

b'. ⠎⠏⠔⠁⠡
spINaCH
spinach

c. *⠎⠕⠗⠞
*sort

c'. ⠎⠐⠳
sOUGHT
sought

To sum up, spelling errors are classified according to two specifications. Firstly, they are assigned unambiguously to an error category by form: insertion of a grapheme, omission of a grapheme, grapheme transposition, grapheme substitution, complex substitution and accumulated spelling error. The second specification identifies the underlying process that caused the error: consonant gemination, phonetic spelling, representation of an unstressed syllable or erroneous selection of a homophone.

7.2.4 Braille code errors

Braille code errors are particular to contracted braille and do not have an equivalent in Standard English Orthography. The results are in accordance with Standard English Orthography but violate the rules of contracted braille discussed in chapter 4. All braille code errors are classified according to the form of the output. I will first argue that reversals are a distinctive element of braille without being braille code errors.

Braille code errors are divided into *zero realisations of contractions* and *wrong choice of contractions*.

Reversals

Young children reverse the direction of writing and the letter direction in the very early stages of writing acquisition in print (Kress 2000:67). Legibility is usually not impaired because there are only the two sets of lower case letters in the Roman alphabet in (17) which can be generated by transformations such as shape rotation or reflecting the shape.[94]

(17) a. { b, d, p, q }

b. { n, u}

For upper case letters, which are usually produced first in early writing, such a transformation never results in an ambiguous form. Almost half of the reversals are symmetrical in themselves and thus not sensitive to reflection, see (18a). The other set in (18b) does not change into a different letter by transformations such as shape rotation or reflection.

(18) a. {A, H, I, M, O, T, U, V, W, X, Y}

b. {B, C, D, F, G, J, K, L, N, P, Q, R, S, Z}

In braille this is different. The matrix of a braille cell leaves no room for redundancy. Every change in the amount or order of dots within a braille cell results in a different sign. The sets of possible transformations which have alphabet letters as both their input and output are given in (19a) to (19g). If additionally all groupsigns are taken into account the sets in (19a') to (19g') are generated.

[94] The set {m,w} is also possible in handwriting; in the set {f, t} the horizontal stroke is left in a wrong position, a transformation is therefore not possible for this set.

(19) a. {⠙ ⠋ ⠓ ⠚}
d f h j

a'. {⠙ ⠋ ⠓ ⠚ ⠲ ⠖ ⠦ ⠴}
d f h j DIS TO HIS WAS

b. {⠃ ⠉}
b c

b'. {⠃ ⠉ ⠆ ⠒ ⠤}
b c BE CON COM

c. {⠑ ⠊}
e i

c'. {⠑ ⠊ ⠢ ⠔}
e i EN IN

d. {⠍ ⠥}
m u

d'. {⠍ ⠥ ⠩ ⠬}
m u SH ING

e. {⠺ ⠗}
w r

f. {⠏ ⠧}
p v

f'. {⠏ ⠧ ⠹ ⠼}
p v TH BLE

g. {⠝ ⠵}
n z

g'. {⠝ ⠵ ⠫ ⠮}
n z ED THE

In addition, (20) lists all those sets which have a letter as input and a groupsign as output.

(20) a. {⠁ ⠂}
a EA

b. {⠛ ⠶}
g GG

c. {⠕ ⠪}
o OW

d. {⠟ ⠻ ⠷ ⠾}
q ER OF WITH

e. {⠎ ⠱ ⠣ ⠜}
s WH GH AR

f. {⠞ ⠳}
t OU

g. {⠽ ⠯}
y AND

This leaves only the letters <k> in (21a) and <l> in (21b) without a corresponding letter or groupsign generated by transformation. However, both letters have corresponding indicator signs.

(21) a. {⠅ ⠨}
k indicator sign

b. {⠇ ⠸}
l indicator sign

One last set is given in (22a). These upper groupsigns are not related to a letter in the alphabet.

(22) a. {⠌ ⠡}
ST CH

Reversals are a braille-specific error type. There are four types of reversals. Left-right reversals, shape rotations and shape transpositions and single column permutations.

The most frequent reversals are the result of typing with the right hand what belongs to the left one and vice versa. This results in an exchange of the left and right column within the braille cell independent of the type of target sign, as illustrated in (23). I will call this type of reversal left-right reversal (L-R reversal). The type of sign need not be affected, as in (23a), where the L-R reversal results in an exchange of the upper groupsign ⠾, *WITH*, with the upper groupsign ⠷, *OF* in *without*. In (23b) the L-R reversal results in the transformation of the lower groupsign ⠔, *IN*, into the lower groupsign ⠢, *EN*, in *drink*. In (23c) the L-R reversal changes the upper groupsign ⠩, *SH*, into the letter ⠍, <m>, in *shadow*. Finally, the letter ⠏, <p>, is changed into the upper groupsign ⠹, *TH*, by the L-R reversal in (23d). All examples have in common that their occurrence is not predictable. Furthermore, they show that the right contractions are targeted even though they have the wrong orientation. If the use of the contraction were a problem they would have used more braille cells.

(23) a. *⠷⠳⠞
*OF/OUt

a'. ⠾⠳⠞
WITH/OUt
without

b. *⠙⠗⠢⠅
*drENk

b'. ⠙⠗⠔⠅
drINk
drink

c. *⠍⠁⠙⠪
*madOW

c'. ⠩⠁⠙⠪
SHadOW
shadow

d. *⠓⠑⠇⠹
*helTH

d'. ⠓⠑⠇⠏
help

The second subgroup of reversals are shape rotations in which the target shape is rotated within the braille cell. In (24a) the reversal is the result of a 90° rotation of the target shape ⠚, in (24b) it is a 180° rotation of the target ⠷, and in (24c) a 270° rotation of ⠓.

(24) a. *⠙⠕⠽⠰⠇
*doy<u>FUL</u>

a'. ⠚⠕⠽⠰⠇
joy<u>FUL</u>
joyful

b. *⠻⠋⠻⠎
*ERfERs

b'. ⠷⠋⠻⠎
OFfers
offers

c. *⠋⠁⠏⠏⠽
*fappy

c'. ⠓⠁⠏⠏⠽
happy

A further type of reversal is the transposition of shapes, which is generated within a 2x2 matrix, one of the letters <a> to <j>. These shapes have the correct orientation but the wrong vertical location. In (25a) the targeted lower wordsign *his* has the right shape but appears as an upper sign, thus in the wrong vertical location.

(25) a. *⠓

a'. ⠦
HIS
his

Finally, the last type of reversal is the single column permutation. These are created by shifting a dot within one column of a cell, as illustrated in (26), in Koenig's terms, a misplaced dot, see Figure 7.2.

(26) a. *⠒
*CC

a'. ⠊
I

Thus, reversals are a distinctive element of braille, the corpus data indicates that they are subject-specific and neither consistently used nor predictable. In addition, their occurrence cannot be linked to proficiency in braille. Although they are an unalienable part of braille, I assume that reversals are not braille code errors.

Zero Realisations

Zero realisations of contractions are found for all types and functions of contracted forms. Instead of using a contraction, the sequence is spelled out in full. This is a violation of rule 8.8.1, [use least space]. In (27a) the upper groupsign ⠷, *OF* is not realised as an arbitrary part of the root *hoof*. In (27b) the upper groupsign ⠾, *WITH*, remains unrealised. In (27c) the upper wordsign ⠮, *THE*, is not realised; instead the word is spelled out in full.

(27) a. *⠓⠕⠕⠋   a'. ⠓⠕⠷
*hoof   hoOF
hoof

b. *⠺⠊⠹⠳⠞   b'. ⠾⠳⠞
*wiTH/OUt   WITH/OUt
without

c. *⠞⠓⠑   c'. ⠮
*the   THE
the

Lower groupsigns are affected likewise: the zero realisation of the lower groupsign ⠔, *IN*, in the root *sin*, (28a), the omission of the prefix ⠔, *IN*, in *increase* in (28b), and the full spelling of *was* in (28c).

(28) a. *⠎⠊⠝   a'. ⠎⠔
*sin   sIN
sin

b. *⠊⠝⠉⠗⠂⠎⠑   b'. ⠔⠉⠗⠂⠎⠑
*incrEAse   INcrEAse
increase

c. *⠺⠁⠎   c'. ⠴
*was   WAS
was

Similarly, composite groupsigns can remain unrealised. In (29a) the composite groupsign ⠐⠕, ONE, is not realised within the root *done*. In (29b) the root itself is affected: the composite groupsign ⠐⠺ *WORK* remains unrealised in *workers*, in (29c) the suffix *-ful* is not realised by the corresponding composite groupsign ⠰⠇, *FUL*. Finally, the composite wordsign ⠘⠺, *WORD*, is not used in *word* in (29d).

(29) a. *⠙⠕⠝⠑   a'. ⠙⠐⠕
*done   dONE
done

b. *⠺⠕⠗⠅⠻⠎   b'. ⠐⠺⠻⠎
*workERs   WORK/ERs
workers

c. *⠚⠕⠽⠋⠥⠇   c'. ⠚⠕⠽⠰⠇
*joyful   joyFUL
joyful

d. *⠺⠕⠗⠙
*word

d'. ⠐⠺
WORD
word

The last set are shortforms. The example in (30a) shows a realisation of *below* that ignores the fact that it should be realised by a shortform but otherwise obeys the rules of both Standard English Orthography and braille.

(30) a. *⠆⠇⠪
*BElOW

a'. ⠆⠇
BEl
below

Incorrect use of contractions

The omissions in the previous section are all violations of rule 8.8.1 [use least space], the improper choices of contractions can violate a wider range of the generalisations and restrictions given in chapter 4.

The examples in (31) both use an incorrect upper groupsign. In *authentic* in (31a) this is the choice of the upper groupsign ⠹, *TH*, over ⠮, *THE*. In (31b) the upper groupsign ⠻, *ER*, is used instead of the upper wordsign ⠑, *EVERY*. Both substitutions result in a violation of 8.8.1 [use least space]. These alternatives are only possible because the respective targets remain unrealised. In order to determine whether there are braille code interferences to spelling, I will look at the secondary error specifications, underlying linguistic units. Therefore it is not necessary to create a third error category *dependent incorrect use of contractions*. Thus braille code errors that have the structure in (31) are classified as zero realisations, as this only enables the wrong use of the contraction.

(31) a. *⠁⠥⠹⠑⠝⠞⠊⠉
*auTHentic

a'. ⠁⠥⠮⠝⠞⠊⠉
auTHEntic
authentic

b. *⠑⠧⠻⠽
*evERy

b'. ⠑
EVERY
every

Due to the emphasis in *British Braille* on the use of upper groupsigns, it is virtually impossible to find an incorrect use of an upper groupsign.

Erroneous uses of lower groupsigns are also extremely rare. They are usually due to violations of the restrictions to the positions in which lower groupsigns may appear. Thus in (32a) *egg* may not use ⠶, *GG*, as this is only allowed in word-medial position.

Similarly in *disconnect* in (32b) only ⠲, *DIS*, may be used, as ⠒, *CON*, is restricted to word-initial position and may be used in *connect* but not in *disconnect*.

(32) a. *⠑⠶⠶ — *eGG   a'. ⠑⠛⠛ — egg

b. *⠲⠒⠝⠑⠉⠞ — *DIS/CONnect   b'. ⠲⠉⠕⠝⠝⠑⠉⠞ — DISconnect, disconnect

Within the group of composite contractions, errors can affect either the cell containing the functional sign or the cell containing the letter. In *disagreement* in (33a) ⠰⠞, <u>*MENT*</u>, contains a wrong indicator sign.

(33) a. *⠲⠁⠛⠗⠑⠑⠨⠞ — *DISagree-dot4-6-t   a'. ⠲⠁⠛⠗⠑⠑⠰⠞ — DISagree<u>MENT</u>, disagreement

Two instances of a wrong use of upper wordsigns are given in (34). In (34a) the upper wordsign ⠙, *DO*, is erroneously used to represent *did*, and the upper wordsign ⠞, *THAT*, has been exchanged for the lower wordsign ⠖, *TO* in (34b).

(34) a. *⠙ — *did   a'. ⠙⠊⠙ — did

b. *⠞ — *to   b'. ⠖ — TO, to

The second source of incorrect uses of upper wordsigns are the sequencing prescriptions for the upper wordsigns ⠯, *AND*, ⠿, *FOR*, ⠷, *OF*, ⠮, *THE*, ⠾, *WITH*, and the indefinite article ⠁, *a*. In (35a) there is a wrong space in the sequence conjunction *and* plus indefinite article, ⠯⠁. In (35b) the sequence of the preposition *with* plus the definite article is not written unspaced.

(35) a. *⠯ ⠁ — *AND a   a'. ⠯⠁ — AND/a, and a

b. *⠾ ⠮ — *WITH THE   b'. ⠾⠮ — WITH/THE, with the

An example for a wrong use of a lower wordsign is given in (36a) where *he* is contracted inappropriately by ⠦.

(36) a. *⠦ — *HE   a'. ⠓⠑ — he

Errors in the use of composite wordsigns are either errors in assigning a wordsign to a contraction or in the structure of the wordsign. In (37a) *which* is inappropriately represented by ⠐⠱. In *world* in (37b) the functional cell of the target is correct but in the second cell the final letter is used, like in a composite groupsign.

(37) a. *⠐⠱
*WHICH

a'. ⠱
WHICH
which

b. *⠸⠙
*world

b'. ⠸⠺
<u>WORLD</u>
world

Finally, the errors occurring in the use of shortforms are given in (38). The most frequent type of error for a shortform is that it is not realised at all. Wrong uses of shortforms consist either of a wrong set of constituent letters, as *receiving* in (38a), or of the assignment of a different letter sequence to an existing shortform, as in (38b), where signs of the shortform *because* are used for *become*.

(38) a. ⠗⠉⠧⠬
rcvING

a'. ⠗⠉⠧⠛
rcvg
receiving

b. *⠆⠉
*BEcome

b'. ⠆⠉⠕⠍⠑
BEcome
become

Due to this classification of braille code error most braille code errors occur in the structure of composite groupsigns and wordsigns and in the assignment of letter sequences to wordsigns and shortforms.

7.2.5 Complex errors

The classification of errors into mechanical errors, spelling errors and braille code errors by form is not sufficiently precise, as a braille code error can co-occur with a spelling error within one word. I use the category *complex error* for this combination.

There are two categories of complex errors: dependent and independent complex errors. Independent complex errors are a sequence of spelling error and braille code error within one word such as **buffy* in (39a). The spelling error in this string is a grapheme substitution, the target ⠑⠞, <et> is substituted for by ⠽, <y>. The braille code error in (40a) is the zero realisation of the lower groupsign ⠖, *FF*, the errors are in a linear sequence and occur independent of each other.

(39) a. *⠃⠥⠋⠋⠽ — *buffy
a′. ⠃⠥⠖⠑⠞ — buFFet — buffet

A dependent complex error is a combination of spelling error and braille code error in which the spelling error produces an incorrect sequence which would require a braille contraction. One such example is *legislation* in (40a). The underlying spelling error is the insertion of <d> which creates the sequence <ed>. This sequence then ought to be represented by the upper groupsign ⠫, *ED*. Therefore the occurrence of the braille code error in this example is dependent on the spelling error.

(40) a. *⠇⠑⠙⠛⠊⠎⠇⠰⠝ — *ledgisl<u>ATION</u>
a′. ⠇⠑⠛⠊⠎⠇⠰⠝ — legislATION — legislation

If a mechanical error occurs together with either a code error or a spelling error in one word, these combinations are classified as spelling error and code error respectively. Thus the combination of spelling error and mechanical error in (41a) is classified as a spelling error in which the letter ⠕, <o>, is expressed by the sequence ⠥⠁, <ua>. In addition there is an omission of dot 2 in the first cell, resulting in ⠡, *CH*, instead of ⠣, *GH*. In (41b) the braille code error leaves the upper wordsign *go* unrealised. The accompanying mechanical error, + R_3, is the extra dot 6 in the erroneous target <o>.

(41) a. *⠡⠥⠁⠌ — *CHuast
a′. ⠣⠕⠌ — GHoST — ghost

b. *⠛⠵ — *gz
b′. ⠛ — GO — go

If a word contains a mechanical error this has no influence on its classification. Complex errors are exclusively combinations of braille code errors and spelling errors within one word. The different error types may be dependent on each other but need not.

7.2.6 Ambiguous errors

Ambiguous errors are errors that can be analysed in more than one way even if the context and the subject's individual error profile are taken into account. There are three possibilities in which such an error can be ambiguous; mechanical error or spelling error, mechanical error or code error, and spelling error or code error.

The first ambiguity, mechanical error versus spelling error, is given in (42a). The example can be interpreted as a mechanical error or as a code error. The target is *canoe*. If analysed as a mechanical error, it is a typo consisting of a superfluous dot 3, (+ L_3) which is part of the immediate preceding environment. If analysed as a spelling error, it is a grapheme substitution expressing phonetic spelling in following the regular correspondence of /uː/ and <oo>. In (42b) the ambiguity is in the contrast of mechanical error versus code error. If it is interpreted as a mechanical error it is a typo, leaving out dot 5 (- R_2). Looking at it as a braille code error implies a false use of the composite groupsign ⠰⠛, <u>*ONG*</u>. Finally, (42c) can be interpreted as a spelling error or as a code error. If it is regarded as a spelling error, the target letter <e> has been substituted by <i>. If analysed as a code error, it is a L-R reversal substituting the target ⠑ by its mirror image ⠊.

(42) a. *⠉⠁⠝⠕⠕ *canoo — a'. ⠉⠁⠝⠕⠑ canoe

b. *⠁⠍⠠⠛ *am-dot6-g — b'. ⠁⠍⠰⠛ am<u>ONG</u> among

c. *⠛⠁⠇⠇⠊⠕⠝ *gallion — c'. ⠛⠁⠇⠇⠑⠕⠝ galleon

Due to the lack of redundancy within braille it is not always possible to unambiguously classify an error type to a given form.

7.2.7 Unclassified errors

In contrast to Koenig and Ashcroft's *illegible word*, I labelled a string of braille cells which defies analysis *unclassified error*. This is due to the structure of the study. The choice of words is derived from a very narrow context. In contrast to free writing samples, as for example in an essay, there are only very few strings of braille cells which cannot be identified in the study. Thus some of the data cannot be analysed due to the amount or complexity of errors, even though the target word may be known.

In (43a) the target is *happy*. The sequence produced there is possibly a sequence of three typing errors; + R_1, an extra dot 4, in ⠁ giving ⠉ and twice - R_1, an omitted dot 4, in the following ⠏ giving ⠇. In (43b) the target *pew* in task 6 does not contain a contraction. It is not clear how this target can be associated with the form in (43b).

(43) a. *⠓⠉⠇⠇⠽ — *hclly   a.' ⠓⠁⠏⠏⠽ — happy

b. *⠏⠽⠵⠑ — *pyze   b'. ⠏⠑⠺ — pew

The examples in (44) are taken from task 5, the combined mismatch and association task. The target word cannot be reconstructed in either example. In (44a) the braille form names the mismatch in the set {head, hoof, chest, thigh} and in (44b) it describes a part of the face.

(44) a. *⠗⠁ — *ra

b. *⠳⠗⠫⠑⠓⠁ — *OUrEDeha

Even in the highly controlled contexts of this study it is possible to receive data that cannot be associated with any of the target words.

7.2.8 Summary

My classification system is based on the NFER classification of spelling errors and Koenig's (1993) classification of braille code errors. The objective of my braille study is to investigate whether the system of contracted braille contains elements which might interfere with spelling performance and whether errors which do not contain elements specific to braille have a similar pattern to the spelling errors found in the control group of print users. Therefore all types of individual and accidental errors such as mechanical errors, perception errors and test errors have been disregarded. The remaining errors are classified into spelling errors, braille code errors, complex errors and ambiguous errors. Example (45) repeats spelling errors according to form: insertion, (45a), omission, (45b), substitution, (45c) and complex substitution, (45d).

(45) a. ⠃⠁⠝⠝⠁⠝⠁ — *bannana   a'. ⠃⠁⠝⠁⠝⠁ — banana

b. *⠉⠝⠕⠑ — *cnoe   b'. ⠉⠁⠝⠕⠑ — canoe

c. *⠹⠊⠍⠑ — *THime   c'. ⠹⠽⠍⠑ — THyme, thyme

d. ⠽⠕⠞ — *yot   d'. ⠽⠁⠡⠞ — yaCHt, yacht

Code errors are classified according to zero realisations and erroneous realisations of contractions and by the form of the contraction under consideration. *Hoof* in (46a) is an example of an unrealised upper groupsign that represents an arbitrary part of the root. In *below* in (46b) the shortform remains unrealised.

(46) a. *⠓⠕⠕⠋ — *hoof   a'. ⠓⠕⠷ — hoOF, hoof

b. *⠆⠇⠪ — *BElOW   b. ⠆⠇ — BEl, below

For both groups of braille code errors, zero realisations of contractions and inconsistent use of contractions, there ought to be a significant decrease in error frequency that correlates with a decrease in complexity from upper groupsigns to lower groupsigns to composite groupsigns.

Complex errors are an accumulation of spelling error and braille code error within one word; ambiguous errors can be analysed either as braille code error or as spelling error even though the context and the subject's individual error profile is taken into account. Finally, unclassified errors are strings of braille cells which bear no resemblance with the targeted form.

8 Results

This section summarises the results of the study, listing choices in tasks 1, and 3 to 5 (section 8.1), general spelling errors (section 8.2) and braille code errors (section 8.3). The data presented in this section are errors that either are produced by several braillists or, in the case of spelling errors, are paralleled in the control group. Complex errors, ambiguous errors, unclassified errors and reversals are individual errors.[95] They are summarised in Table 8.1 but will not be discussed in detail.

Table 8.1: Summary of individual errors

	task 1	task 2	task 3&4	task 5	task 6	task 7	task 8	task 9
Complex errors	1	26	6	3	4	15	1	0
Ambiguous errors	3	16	6	4	2	1	2	3
Unclassified errors	1	4	2	6	1	1	0	0
Reversals	8	27	5	1	3	0	0	2

Mechanical errors, perception errors and test errors have been disregarded as they do not contribute information on literacy competence either.

Four of the nine parts of the study allow for personal variation. Section 8.1 presents these individual choices. Spelling errors that occur among several braillists or that are paralleled by members of the control group are listed in Section 8.2. In section 8.3 those braille code errors are presented that occur in the data of several braillists.

8.1 Variation

Individual replies are possible in the questionnaire, the mismatch and association tasks. The dictation and the entire second part of the study do not allow for personal variation. In this section I give an overview of the choices made by the subjects in tasks 1 and 3-5.

Task 1: Questionnaire

The questionnaire provides some personal background information and functions as a general warm up. The contributions total 1367 words, varying from 34 words to 135 words (average 72 words) per subject. All questions are open questions and I expected to get partial overlaps in the answers. The overall choice of targets of Table 6.8 is repeated here as Table 8.2.

[95] Reversals are a distinctive element of braille, yet the patterns obtained indicate that they are caused subject specific, and cannot be predicted by the written environment. In addition, young print writing children also produce reversals of letters when they start writing (Kress: 2000).

Table 8.2: Task 1: List of target items

sentence	item 1	item 2	item 3	item 4	item 5
1	WAS	INtroducED	TO/BRAILLE		
2	HAVE	usED	BRAILLE	FOR	yeARs
3	prINt	BEFORE	ST/ARtED	BRAILLE	
4	DO	writtEN			
5	prefERrED	gettING	IN/FORmATION		
6	prefER	TO/liSTEN	TO/a	TO/rEAd	

Example (1) shows the range of answers obtained for the first question. The answers of the types in (1a) to (1e) which contain all target words in bold are considered accurate.

(1) *Question* At which age were you introduced to braille?
Answers
a. I **was introduced to braille** at age five.
b I **was** first **introduced to braille** at the age of five.
c. I **was introduced to braille** when I was about four or three years old.
d. I **was** about five when I was **introduced to braille**.
e. I **was** three years old when I was **introduced to braille**.
f. I started learning **braille** when I **was** three.
g. I **was** age 12.
h. I started at five.

A summary of the subjects' choices is given in Table 8.3. Best matches are achieved for *was* in the first sentence, *years* in the second sentence and *print* in the third sentence where each target is selected by 16 of the 19 subjects.

Table 8.3: Task 1: Choice of target items

sentence	item 1	item 2	item 3	item 4	item 5
1	16	14	15		
2	15	13	15	13	16
3	16	10	10	12	
4	11	11			
5	6	3	12		
6	11	12	12	15	

Task 3: Mismatch task

Table 8.4 is a summary of Table 6.13, listing the material that is presented to the subjects in the order of presentation. All targets are marked in italics.[96]

[96] There are 18 participants in tasks 3 to 5. One subject could not take part in this section due to scheduling problems.

Table 8.4: Task 3: Order of presentation

	item 1	item 2	item 3	item 4
1.	*pEA/CH*	cARrot	swEDe	spINaCH
2.	sOFt	*liGHt*	hARd	rOU/GH
3.	WHiskERs	beARd	frINGe	*CH/IN*
4.	*coaCH*	freiGHtER	fERry	yaCHt
5.	pARsley	*cARnATION*	lemon balm	coriAND/ER
6.	SHip	SHeet	SHALL	*CHILD*
7.	sigh	STab	sEAt	*SH/ARk*
8.	SHip	CHip	CHeER	*jeER*
9.	*SHadOW*	ruSTle	jINGle	craSH
10.	*host*	CHop	maSH	STir

Table 8.5 gives an overview of the subjects' choices. The target items are marked by italics. The best correspondences are achieved in sets 2 and 9 with 17 selections of the target item, the fewest matches are obtained in sets 7 (8 matches) and 8 which contained 7 selections of the target item.

Table 8.5: Task 3: Overview of choices

	item 1	item 2	item 3	item 4
1.	*16*	0	0	2
2.	1	*17*	0	0
3.	3	0	3	*12*
4.	*14*	1	1	2
5.	2	*11*	4	1
6.	1	0	4	*13*
7.	6	1	3	*8*
8.	5	3	3	*7*
9.	*17*	0	0	1
10.	*16*	0	0	2

Task 4: association task

All target items in set 1 to 4 of task 4 are listed in Table 8.6 in the order of presentation. Set 5 had no equivalent in task 3 and is thus not listed.[97]

Table 8.6: Task 4: list of target items

	target 1	target 2	target 3
1.	cARrot	swede	spINaCH
2.	CHop	maSH	STir
3.	freiGHtER	fERry	yaCHt
4.	pARsley	lemon balm	coriAND/ER

The most frequent targets are *apple* with 15 occurrences in set 5 and *carrot* with 14 occurrences in the first set, as shown in Table 8.7. The last two columns show the two most frequent choices that are not part of the target set.

[97] The last set has a double function, to finish the association task with an easy exercise and to provide a link to the combined mismatch and association task, where the set of the pre-test is {mandarin, nectarine, cherry, feather}.

The pilot study showed that the items of the mismatch task are no longer salient in the following association task. This result is confirmed in the braille study. Only four of the 12 items of the previous task were chosen by at least half of the subjects. The choices seem to be prototypical representatives of the hypernyms. These are *carrot* as a prototypical vegetable in the first set which was chosen by 14 of 18 subjects. *Cook* and *wash* are prototypical activities to do in the kitchen and are chosen by 13 and 12 subjects respectively. In the last set, prototypical fruits are *apple* and *banana* with 15 and 11 choices.

The high frequency of *thyme* is exceptional. It is not an item of the target list in Table 8.6, yet it has been chosen by 12 subjects. The reason for the unusual salience of *thyme* in set 4 is due to the prompt given to those subjects who had difficulties calling three herbs to mind. They were asked to think of the song *Scarborough Fair* by Simon and Garfunkel. The text lists the herbs *parsley, sage*, *rosemary and thyme* in the first verse. In contrast, three items of task 3 are not selected at all: *mash* in set 2, *freighter* in set 3 and *coriander* in set 4.

Table 8.7: Task 4: overview of choices

	item 1	item 2	item 3	most frequent different selection	second frequent different selection
1.	14	4	1	8: potato	6: pea
2.	2	0	4	13: cook	12: waSH
3.	0	8	10	5: dINGhy	4: canoe; 4: SHip
4.	9	5	0	12: THyme	7: sage
5.	∅	∅	∅	15: apple	11: banana

Task 5: Combined Mismatch and Association task

This task is a combination of the preceding mismatch and association tasks. The list of targeted items is given in Table 8.8. The hypernyms are listed in the last column. The targets of the mismatch section are in the first column followed by the co-hyponyms, which are part of the association section of the task, in columns 3 to 5.

Table 8.8: Task 5: target list

	target	item 1	item 2	item 3	hypernym
1.	spARrOW	goldfiSH	canARy	hamSTER	pets
2.	<u>CHARACTER</u>	<u>MOTHER</u>	<u>FATHER</u>	siST/ER	family
3.	hoOF	hEAd	CHeST	THiGH	body parts
4.	FOReARm	FORehEAd	eyebrOW	CHeekb<u>ONE</u>	face
5.	CH/IN	livER	braIN	heARt	organs
6.	re<u>ALLY</u>	n<u>EVER</u>	<u>SOMETIME</u>s	usu<u>ALLY</u>	frequency adverb
7.	SHellfiSH	haDDock	sEA trOUt	mackERel	fish

The distribution of the choices obtained in the association task are listed in Table 8.9. As expected, the prototypical pets *cat* and *dog* were selected very frequently, each in 14 of 18 choices. Of the choices in the last two columns, only *arm* in row 3 and *always* and *often* in row 5 contain contractions.

Table 8.9: Task 5: distribution of choices

	target	item 1	item 2	item 3	most frequent different selection	second frequent different selection
1.	8	9	4	7	cat: 14; dog: 14	
2.	18	10	11	6	uncle: 8; aunt: 8	
3.	17	7	4	1	leg: 9; ARm: 9	
4.	11	2	7	4	nose: 13	eye: 11
5.	18	7	5	16[98]	lungs: 12	kidneys :9
6.	15	13	13	5	OFtEN: 9	ALWAYS: 5
7.	10	8	13	5	cod: 8	plaice: 5

The invariant tasks: Task 2 and tasks 6 to 9

In Task 2 there are 11 sentences totalling 135 words. Due to the fact that six subjects left out single sentences the dictation totals 2507 words instead of 2565 words. Word choice is controlled for in all tasks of the second part. There are only very few individual deviations where an individual subject may have added another item.

8.2 Spelling errors

Table 8.10 gives an overview of all spelling errors produced by the braillists, classified by form. Most errors are grapheme substitutions, 30%, followed by complex substitutions 24.0%.

Table 8.10: Braillists: Spelling errors by form

distribution of spelling errors	insertion	omission	grapheme substitution	complex substitution	transposition	accumulated spelling error	other
task1 (n = 10)	2	2	3	3	0	0	0
task 2 (n = 118)	5	22	41	25	1	16	8
task 3,4 (n = 51)	1	1	20	18	5	6	0
task 5 (n = 32)	2	9	11	6	1	3	0
task 6 (n = 14)	0	2	4	5	0	3	0
task 7 (n = 13)	0	4	0	5	0	4	0
task 8 (n = 9)	8	0	0	1	0	0	0
task 9 (n = 16)	0	13	0	0	0	2	1
total (n = 263)	18	53	79	63	7	34	9
percentage	6.8 %	20.2 %	30.0 %	24.0 %	2.7 %	12.9 %	3.4 %

[98] *Heart* is a prototypical organ and only one of the 18 choices showed a braille code error. This subject consistently uses EA in the string <ear> which is in accordance with an earlier version of *British Braille*.

The errors of the control group are listed in Table 8.11. In comparison to the braillists, there is a more even error distribution among insertions, omissions and grapheme substitutions which are all approximately 20%. Among the braillists, grapheme substitutions and complex substitutions (see 7.2.3) are the most frequent spelling errors. The section *other* is significantly larger in the control group, it contains predominantly capitalisation errors such as a sentence-medial capital or the omission of a sentence-initial capital which are part of Standard English orthography. Capitals are optional in *British Braille*. As a consequence there are no omitted sentence-initial capitals in braille. Furthermore, none of the braillists produced a sentence-medial capital.

Table 8.11: Control group: Spelling errors by form

distribution of spelling errors	insertion	omission	grapheme substitution	complex substitution	transposition	accumulated spelling error	other
task 2 (n = 158)	26	27	42	26	1	9	27
task 3,4 (n = 58)	20	10	13	6	2	4	3
task 5 (n = 21)	6	4	5	4	0	2	0
task 6 (n = 21)	1	15	2	3	0	0	0
task 7 (n = 29)	12	8	1	6	0	2	0
task 8 (n = 1)	0	0	1	0	0	0	0
task 9 (n = 19)	3	0	2	2	0	0	12
total (n = 307)	68	64	66	47	3	17	42
percentage	22.1%	20.8%	21.5%	15.3%	1.0%	5.5%	13.7 %

The spelling errors in the following section are listed by formal error type to ensure an unambiguous classification. The data presented here is limited to systematic errors, i.e. errors that are either produced by several subjects or that are paralleled in the control group. All data is presented in the order of the columns in Table 8.10 and 8.11. In each subgroup, examples containing errors in both groups are presented first. The second specification of the spelling errors is by underlying causes, concentrating on the two major ones, gemination errors and errors due to phonetic spelling.

Insertion

All insertions in (2) are gemination errors which occur in both groups. The extra <r> in *coriander* in (2a) is written by one braillist and 5 members of the control group.[99] In *co-operation* in (2b) one braillist and 2 controls produced an extra <p>. One braillist and one member of the control group put an extra <t> in *carrots* in (2c).

[99] In the sections discussing spelling errors, all references to graphemes are given in angle brackets without their braille equivalents in order to facilitate reading. All controls produced print copies, nevertheless, their data is not given separately as their print versions correspond to the transcriptions.

(2) a. *⠉⠕⠗⠗⠊⠯⠻ a'. ⠉⠕⠗⠊⠯⠻
*corriAND/ER coriAND/ER
coriander

b. *⠉⠕⠤⠕⠏⠏⠻⠰⠝ b'. ⠉⠕⠤⠕⠏⠻⠰⠝
*co-oppER/ATION co-opER/ATION
co-operation

c. *⠉⠜⠗⠕⠞⠞⠎ c'. ⠉⠜⠗⠕⠞⠎
*cARrotts cARrots
carrots

The insertion in (3a) is caused by phonetic spelling. Segmenting the affricate /dʒ/ into its constituent plosive [d] and fricative [ʃ] in the underlying phonemic form /ˌledʒˈəsˈleɪʃən/, an extra <d> is inserted into *legislation* by one braillist and 2 controls.

(3) a. *⠇⠫⠛⠊⠎⠇⠰⠝ a'. ⠇⠑⠛⠊⠎⠇⠰⠝
* lEDgislATION legislATION
legislation

Seven braillists produced a gemination error by adding an extra <m> in *comet* in (4a).

(4) a. *⠤⠍⠑⠞ a'. ⠤⠑⠞
*COMmet COMet
comet

Within the set of braille code errors that occur in the data of several braillists gemination errors are the most frequent.

Omission

The gemination errors in (5) all result in a letter omission and occur in both groups. The errors are listed in order of frequency. The gemination of <m> in *recommendations* in (5a) is omitted by 6 braillists and 6 controls. In *marvellous* in (5b) 4 subjects and 2 controls left the geminate <l> unrealised. Two subjects and 2 controls omitted the gemination of <l> in both *really* and *joyfully* in (5c) and (5d). In *normally* in (5e) the gemination of <l> remains unrealised by one braillist and one member of the control group. In *necessity* in (5f) and *haddock* in (5g) the geminate <s> and <d> remain unrealised by one braillist and one member of the control group in either example.

(5) a. *⠗⠑⠉⠕⠍⠢⠙⠰⠝⠎ a'. ⠗⠑⠉⠕⠍⠍⠢⠙⠰⠝⠎
*recomENdATIONs recommENdATIONs
recommendations

b. *⠍⠜⠧⠑⠇⠳⠎ b'. ⠍⠜⠧⠑⠇⠇⠳⠎
*mARvelOUs mARvellOUs
marvellous

c. *⠗⠂⠇⠽
*rEAly

c'. ⠗⠑⠠⠽
re<u>ALLY</u>
really

d. *⠚⠕⠽⠰⠇⠽
*joyFULy

d'. ⠚⠕⠽⠰⠇⠇⠽
joyfully
joyfully

e. *⠝⠕⠗⠍⠁⠇⠽
*normaly

e'. ⠝⠕⠗⠍⠠⠽
norm<u>ALLY</u>
normally

f. *⠝⠑⠉⠑⠎⠰⠽
*neces<u>ITY</u>

f'. ⠝⠑⠉⠑⠎⠎⠰⠽
necess<u>ITY</u>
necessity

g. *⠓⠁⠙⠕⠉⠅
*hadock

g'. ⠓⠁⠲⠕⠉⠅
haDDock
haddock

Phonetic spelling is the cause of the errors in (6). Two braillists and 4 controls produced the phonemic form of *government* /ˈgʌvəment/ in (6a), leaving <n> unrealised. In (6b) the final <e> is left out by one subject and 2 members of the control group. I interpret the omission of <r> in *marshmallow* in (6c) as a result of dialect spelling. It occurred in the data of one braillist and one member of the control group, both from the South-West of England. This is predominantly a non-rhotic dialect area, which means that <r> is solely realised in a pre-vocalic environment.

(6) a. *⠛⠕⠧⠻⠝⠰⠞⠎
*govER/MENTs

a'. ⠛⠕⠧⠻⠝⠰⠞⠎
govERn<u>MENT</u>s
governments

b. *⠒⠤⠃⠔
* COMbIN

b'. ⠤⠃⠔⠑
COMbINe
combine

c. *⠍⠁⠩⠍⠁⠇⠇⠪
* maSHmallOW

c'. ⠍⠜⠩⠍⠁⠇⠇⠪
mAR/SHmallOW
marshmallow

The gemination errors in (7) have no corresponding forms in the control group. In (7a) and (7b) the <f> is not doubled. The corresponding plural forms in (7b) are produced by the same 4 braillists who produced the singular forms in (7a). The gemination of <r> in *carrot* in (7c) and of <p> in *topped* in (7d) are both unrealised by 2 braillists.

(7) a. *⠑⠿⠞ a'. ⠑⠋⠿⠞
*eFORt efFORt
effort

b. *⠑⠿⠞⠎ b'. ⠑⠋⠿⠞⠎
*eFORts efFORts
efforts

c. *⠉⠜⠕⠞⠎ c'. ⠉⠜⠗⠕⠞⠎
* cARots cARrots
carrots

d. *⠞⠕⠏⠫ d'. ⠞⠕⠏⠏⠫
*topED toppED
topped

The letter omission in (8) is caused by phonetic spelling. Two braillists left out the <e> in *forearm*, an omission that does not occur in the control group.

(8) a. *⠿⠜⠍ a'. ⠿⠑⠜⠍
* FOR/ARm FOReARm
forearm

As in the section on insertion, the most frequent cause of errors is consonant gemination.

Grapheme substitution

The grapheme substitutions in examples (9) to (11) are all paralleled in the control group. They are caused by various triggers such as short vowels in unstressed syllables, the preference of another grapheme that has the same correspondence to the underlying phoneme, homophones or dialect spellings.

All errors in (9) are caused by phonetic spellings of unstressed underlying vowels. Eleven subjects wrote <i> instead of <e> in the second syllable of *delegation*, /ˌdel$^{ɪ}_{ə}$ˈgeɪʃən/, in (9a). In this syllable schwa and /ɪ/ are in free variation. As none of these braillists are prone to producing LR-reversals and because 10 controls produced the same error, I classified it as a spelling error. In *spinach* in (9b) the underlying /ɪ/ is represented by <i> instead of <a> by one braillist and one member of the control group.

(9) a. *⠙⠑⠇⠊⠛⠠⠝ a'. ⠙⠑⠇⠑⠛⠠⠝
*deligATION delegATION
delegation

b. *⠎⠏⠔⠊⠡ b'. ⠎⠏⠔⠁⠡
* spINiCH spINaCH
spinach

Three subjects and one member of the control group produced the grapheme substitution in *host* in (10a) where the underlying diphthong /əʊ/ is represented by <oa> instead of <o>. In *congenial* in (10b) the more regular grapheme <ea> is used by one braillist and one member of the control group instead of <e> to represent the underlying stressed /iː/. *Buffet* in (10c) is a French borrowing. The form <*buFFey> is produced by a grapheme substitution in accordance with English phoneme grapheme correspondences by one braillist and one member of the control group. One braillist and one member of the control group substituted the target <ea> by <ee>, creating the homophone *meet* in the first part of the compound *meatloaf* in (10d).

(10) a. *⠓⠕⠁⠌ a'. ⠓⠕⠌
*hoaST hoST
host

b. *⠒⠛⠂⠝⠊⠁⠇ b'. ⠒⠛⠢⠊⠁⠇
*CONgEAnial CONgENial
congenial

c. *⠃⠥⠖⠑⠽ c'. ⠃⠥⠖⠑⠞
*buFFey buFFet
buffet

d. *⠍⠑⠑⠞⠇⠕⠁⠋ d'. ⠍⠂⠞⠇⠕⠁⠋
*meetloaf mEAtloaf
meatloaf

The underlying form of the print digraph <th> in *thyme* is /t/. The regular correspondence of phoneme and grapheme in (11a) results in the use of <t> instead of <th>. This substitution is made by 3 braillists and one member of the control group.

(11) a. *⠞⠽⠍⠑ a'. ⠹⠽⠍⠑
*tyme THyme
thyme

The grapheme substitutions in example (12) only occur among the braillists. In *marshmallow* in (12a) 12 braillists represented the underlying /æ/ by <e> instead of <a>. I consider dialect spelling to cause the grapheme substitution in (12b). Similar to the omission of <r> in *marshmallow* in (6c) I interpret the use of <r> instead of <l> by 2 braillists in *lemon balm* as a result of dialect spelling, i.e. as a sign for sensitivity in a non-rhotic accent for the presence of <r> in Standard English after a long vowel such as /ɑː/ in *lemon balm* in (12b). Three subjects produced the grapheme substitution in (12c). The use of the upper groupsign ⠬, *ING*, in *dinghy* is not in accordance with word segmentation. It splits the digraph <gh>. As a consequence 3 braillists substituted <gh> with <g>.

(12) a. *⠍⠜⠩⠍⠑⠇⠇⠪
*mAR/SHmellOW

a'. ⠍⠜⠩⠍⠁⠇⠇⠪
mAR/SHmallOW
marshmallow

b. *⠇⠑⠍⠕⠝⠃⠜⠍
*lemonbARm

b'. ⠇⠑⠍⠕⠝ ⠃⠁⠇⠍
lemon balm

c. *⠙⠬⠽
* dINGy

c'. ⠙⠬⠣⠽
dINGhy
dinghy

In the class of grapheme substitution, errors caused by phonetic spelling are the most frequent error type.

Complex substitution

The complex substitutions in (13) are gemination errors which occur in both groups. In (13a) 3 braillists and one member of the control group target the wrong consonant for gemination. Instead of <m>, <c> is doubled. The same happens in *professional* in (13b) by 3 braillists and 2 controls and *professionally* in (13c) by 2 braillists and 2 controls. There <f> is doubled instead of <s>.

(13) a. *⠗⠑⠒⠕⠍⠢⠙⠠⠝⠎
*reCComENdATIONs

a'. ⠗⠑⠉⠕⠍⠍⠢⠙⠠⠝⠎
recommENdATIONs
recommendations

b. *⠏⠗⠷⠋⠑⠨⠝⠁⠇
*prOFfeSIONal

b'. ⠏⠗⠷⠑⠎⠨⠝⠁⠇
prOFesSIONal
professional

c. *⠏⠗⠷⠋⠑⠨⠝⠠⠽
*prOFfeSION/ALLY

c'. ⠏⠗⠷⠑⠎⠨⠝⠠⠽
prOFesSION/ALLY
professional

Six braillists and 5 controls substituted the target form *sought* with the homophone *sort* in (14a). This version results in the more regular representation of /sɔːt/. The second complex substitution by a homophone is given in (14b). One braillist and one member of the control group used *pair* instead of *pear*.

(14) a. *⠎⠕⠗⠞
*sort

a'. ⠎⠐⠕
sOUGHT
sought

b. *⠏⠁⠊⠗
*pair

b'. ⠏⠑⠜
peAR
pear

Seven subjects and 2 controls produced a complex substitution targeting the highly irregular *yacht*. In (15a) <o> is used instead of the string <ach>. Two braillists and 4 controls produced phonetic spelling in *authentic* in (15b). The string <or> is used instead of <au> to represented the underlying form /ɔːˈθentɪk/.

(15) a. *⠽⠕⠞ — *yot
a'. ⠽⠁⠡⠞ — yaCHt — yacht

b. *⠕⠗⠮⠢⠞⠊⠉ — * orTHEntic
b'. ⠁⠥⠮⠢⠞⠊⠉ — auTHEntic — authentic

There are two types of morphological errors in (16). In (16a) two braillists and 6 controls use **past* instead of the appropriate past tense form *passed*. The morphological errors in (16b) and (16c) are substitutions of the plural suffix *-s* with the genitive inflection *'s*. Two braillists and 6 controls produced this error in *teas* in (16b), one braillist and one member of the control group in *grandmothers* in (16c).[100]

(16) a. *⠏⠁⠌ — * past
a'. ⠏⠁⠎⠎⠫ — passED — passed

b. *⠞⠑⠁⠄⠎ — * tea's
b'. ⠞⠂⠎ — tEAs — teas

c. *⠛⠗⠯⠐⠍⠄⠎ — *grAND/<u>MOTHER</u>'s
c'. ⠛⠗⠯⠐⠍⠎ — grAND/<u>MOTHER</u>s — grandmothers

The complex substitutions in (17) and (18) are unparalleled by the control group. The most frequently occurring complex substitution is shown in (17a). Five braillists used the composite wordsign ⠐⠞, <u>*TIME*</u>, instead of the homophonous target *thyme*. I assume

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[100] Two members of the control group were much more susceptible to this error than the braillists. They produced a total of 11 genitive forms instead of plurals, such as those in (i).

(i) a. disagreement's — a'. disagreements
b. effort's — b'. efforts
c. egg's — c'. eggs
d. idea's — d'. ideas
e. offer's — e'. offers
f. Whale's — f'. whales
g. eggs' — g'. eggs
h. ideas' — h'. ideas

Another complex substitution occurs in the control group only. Six members of the control group used the homophone *of* to represent *have*.

that this form is biased by the existence of the composite wordsign ⠐⠞, *TIME*, and the practice of the braille code to use letter strings independent of their meanings. In addition, *British Braille* requests that the composite groupsign ⠐⠞, *TIME*, is used when "the letters it represents are pronounced as the word 'time'." *British Braille* (2004:8.5.10). Being a print to braille transcription manual *British Braille* does not consider homophones, it is restricted to the representation of letter strings.

(17) a. *⠐⠞   a'. ⠹⠽⠍⠑
*TIME   THyme
thyme

There is one complex substitution which occurs in the data of 4 subjects where the underlying /juː/ is realised as <ue> instead of the more regular <ew> in *pew* in (18a), cf. Venezky (1999:82). In the highly irregular *yacht* in (18b) three subjects use the string <augh> instead of the sequence <ach>.

(18) a. *⠏⠥⠑   a'. ⠏⠑⠺
*pue   pew

b. *⠽⠁⠥⠣⠞   b'. ⠽⠁⠡⠞
*yauGHt   yaCHt
yacht

As in grapheme substitution, the most frequent cause for errors is phonetic spelling among the braillists. In the control group the underlying cause is different; they produce many more morphological errors than the braillists. These errors primarily affect homophones.

Letter transposition

There is just one letter transposition which occurs more than once. In *swede* in (19a) two braillists exchange the string <de> for <ed> to produce the complex grapheme <ee> in analogy with *sweet*.

(19) a. *⠎⠺⠑⠫   a'. ⠎⠺⠫⠑
*sweED   swEDe
swede

Table 8.12 gives a summary of the 116 of the 261 spelling errors that occur in the data of more than one braillist or that are paralleled in the control group.[101]

[101] There are 307 spelling errors in the data of the control group. After excluding individual errors, there are 162 errors that follow general patterns. Errors patterns that only occur in the control group have been disregarded in the examples. One such example is a gemination error in *banana*. There are 7 instances in which the control group produced **bannana*.

Table 8.12: Summary of spelling errors by form

summary of spelling errors	braillists n = 116	%
insertion	11	9.5
omission	34	29.3
grapheme substitution	38	32.8
complex substitution	31	26.7
transposition	2	2.3

Comparing the errors of braille subjects and members of the control group, the patterns that are shared most frequently among the groups are gemination errors and errors in the representation of underlying weak vowels, especially the representation of schwa in an unstressed syllable. The groups diverge in the production of errors caused by phonetic spelling and inappropriate homophones, which occur much more frequently in the braillists' data. Individuals in both groups produced errors, which did not have counterparts in the other group. Most importantly, none of the braillists produced deviant spellings, which are incompatible with orthographic word segmentation.[102]

For both groups the spelling errors are listed by their underlying cause in Table 8.14. Errors which occur in several subjects tend to be gemination errors in the control group, whereas errors caused by phonetic spelling are generally individual errors, unless they are representations of short vowels in unstressed syllables or caused by dialect spellings.

Table 8.13: Spelling errors by process

distribution of spelling errors	braillists n = 116	%
gemination error	45	38.8
representation of short vowel	11	9.5
phonetic spelling	14	12.1
homophone	13	11.2
dialect spelling	3	2.6
morphological error	5	4.3
other	25	21.6

The words that elicited most spelling errors are listed in Table 8.14. The three words in which the braillists produced most spelling errors are *marshmallow* (15), *delegation* (14) and *recommendations* (14). In the control group they are *braille* (13), an unfamiliar word for the control group, *delegation* (12) and *legislation* (11). *Necessity* and *legislation* show very few pure spelling errors among the braillists. Both contractions ⠰⠽, ITY, and ⠰⠝, ATION, are error-prone. Therefore these items also occur containing braille code errors or complex errors.

[102] On the contrary: In *dinghy* which is used by 5 subjects the use of the upper groupsign ⠬, *ING*, is not in accordance with orthographic word segmentation. It splits the digraph <gh>. None of the braillists produced a correct form.

Table 8.14: Most frequent erroneous words in alphabetical order

	spelling error	braillists	control group
1.	BRAILLE	0	13
2.	COMet	8	0
3.	CONgENial	4	7
4.	coriAND/ER	9	8
5.	delegATION	14	12
6.	govERnMENTs	5	6
7.	legislATION	2	11
8.	mAR/SHmallOW	15	2
9.	mARvellOUs	7	6
10.	necessITY	5	10
11.	prOFesSIONal	8	7
12.	recommENdATIONs	14	9
13.	sOUGHT	9	6
14.	tEAs	2	7
15.	THyme	9	2
16.	yaCHt	7	5

To sum up, due to their nature gemination errors usually result in grapheme insertions or omissions. In contrast, instances of phonetic spelling usually produce grapheme substitutions or complex substitutions.

8.3 Braille code errors

This section gives a summary of braille code errors which follow general patterns. The 224 braille code errors are summarised in Table 8.15. The patterns found in spelling errors and in braille code errors are discussed in Section 9.1 and 9.2, individual error patterns are discussed in Section 9.3.

There are very few instances of incorrect uses of contractions. Most braille code errors are due to a groupsign remaining unacknowledged. My data shows that generally, if a contraction is known it is used as long as the targeted words are high in frequency or do not contain a contraction incompatible with word segmentation. In task 5 all braille code errors are zero-realisations. This is provoked by aiming at targets containing contractions which are incompatible with word segmentation such as *heARt*, *hoOF*, *braIN*, *reALLY*; cf. Table 6.18. Task 6 is designed to achieve a maximum of change in the use of braille contractions for each pair of words. In addition, eight groupsigns realised arbitrary contractions. There are no contractions containing groupsigns incompatible with word segmentation in the target list of this task. In task 7 most errors occurred in *professionally*, the target containing two composite groupsigns compatible with word segmentation and one upper groupsign ⠷, *OF*, not compatible with word segmentation.

Table 8.15: Summary of the distribution of braille code errors

	task 1 n =20	task 2 n = 90	task 3,4 n =6	task 5 n = 24	task 6 n =30	task 7 n = 16	task 8 n =24	task 9 n = 24	total n = 224	%
zero realisation										
upper groupsign	2	4	1	12	2	3	1	16	41	18.3
lower groupsign	1	23	1	4	3	2	10	7	51	22.8
composite groupsign	2	15	0	5	10	7	0	0	39	17.4
upper wordsign	0	0	4	0	3	0	7	0	14	6.3
lower wordsign	4	17	0	0	1	0	0	0	22	9.8
composite wordsign	1	0	0	3	6	0	0	0	10	4.5
shortform	2	1	0	0	3	0	0	0	6	2.7
incorrect use										
upper groupsign	1	8	0	0	0	0	4	0	13	5.8
lower groupsign	0	0	0	0	0	0	0	1	1	0.4
composite groupsign	0	1	0	0	0	0	0	0	1	0.4
upper wordsign	2	15	0	0	0	0	0	0	17	7.6
lower wordsign	2	4	0	0	0	0	0	0	6	2.7
composite wordsign	0	2	0	0	1	4	2	0	9	4.0
shortform	3	0	0	0	1	0	0	0	4	1.8

All braille code errors are sorted by form. Omissions of upper groupsigns are presented in (20) to (23). Seven of the 19 subjects produced the sequence of the upper groupsign ⠹, *TH*, and the lower groupsign ⠢, *EN*, in (20a), to represent the letter string <then> in *authentic* instead of using the appropriate upper groupsign ⠮, *THE*, followed by <n>. There are 4 instances of omissions of the upper groupsign ⠮, *THE* in *bathe* in (20b). The letter string <the> is represented by ⠹⠑, *THe*, instead of ⠮, *THE*. The example *stand* in (20c) shows the zero-realisations of ⠌, *ST*, by 2 braillists.

(20) a. *⠁⠥⠹⠢⠞⠊⠉
*auTH/ENtic

a'. ⠁⠥⠮⠝⠞⠊⠉
auTHEntic
authentic

b. *⠃⠁⠹⠑
*baTHe

b'. ⠃⠁⠮
baTHE
bathe

c. *⠎⠞⠯
*stAND

c'. ⠌⠯
ST/AND
stand

The letter sequence <ffor> in *effort* in (21a) and in *efforts* in (21b) can be interpreted as containing the complex grapheme <ff>. In both examples 4 former print readers contract this sequence with the lower groupsign ⠖, *FF*, representing the geminate instead of the appropriate arbitrary sequence <for> by ⠿, *FOR*. The same pattern is found in *offer* in (21c) and *offers* in (21d) where the lower groupsign ⠖, *FF*, representing the geminate is used in preference to the upper groupsign ⠷, *OF*, by 2 of the former print readers who also preferred the geminate <ff> in (21a) and (21b). They are the same braillists who also leave out the upper groupsign ⠜, *AR*, in *sparrow* in (21e).

(21) a. *⠑⠖⠕⠗⠞
*eFFort

a'. ⠑⠋⠿⠞
efFORt
effort

b. *⠑⠖⠕⠗⠞⠎
*eFForts

b'. ⠑⠋⠿⠞⠎
efFORts
efforts

c. *⠕⠖⠻
*oFF/ER

c'. ⠷⠋⠻
OFfER
offer

d. *⠕⠖⠻⠎
*oFF/ERs

d'. ⠷⠋⠻⠎
OFfERs
offers

e. *⠎⠏⠁⠗⠗⠪
*sparrOW

e'. ⠎⠏⠜⠗⠪
spARrOW
sparrow

The upper groupsign ⠷, *OF*, remains unrealised by 2 former print readers in *often* in (22a).

(22) a. *⠕⠋⠞⠢
*oftEN

a'. ⠷⠞⠢
OFtEN
often

In the examples in (23) the use of the upper groupsigns are incompatible with print word segmentation. The most frequent error is the omission of the upper groupsign ⠷, *OF*, in *hoof*, in (23a) which remains unrealised in the data of 5 braillists. Similarly, there are 3 zero realisations of the upper groupsign ⠷, *OF*, which is not compatible with word segmentation in *professionally* in (23b).

(23) a. *⠓⠕⠕⠋
*hoof

a'. ⠓⠕⠷
hoOF
hoof

b. *⠏⠗⠕⠋⠑⠎⠰⠝⠰⠽
*profesSION/ALLY

b'. ⠏⠗⠷⠑⠎⠰⠝⠰⠽
prOFesSION/ALLY
professionally

Examples of unrealised lower groupsigns are given in (24) to (27). The most frequent zero realisation is encountered in roots ending in a letter sequence which could be contracted by a lower groupsign were it not for its word-final position. In (24) all roots end in the string <ea>. They can only be contracted by the lower groupsign ⠂, *EA*, in word-medial position, here before the plural suffix *–s*. There are 8 omissions of ⠂ in *teas*, 5 in *ideas* and 4 in *peas* in (24).

(24) a. *⠞⠑⠁⠎ a'. ⠞⠂⠎
*teas tEAs
teas

b. *⠊⠙⠑⠁⠎ a'. ⠊⠙⠂⠎
*ideas idEAs

*⠏⠑⠁⠎ b'. ⠏⠂⠎
*peas pEAs
peas

The second group of omissions of lower groupsigns is related to gemination. Lower groupsigns are used to represent geminate letters in order to facilitate reading, see section 4.3.7. In both *eggs* and *eggplant* in (25a) and (25b) the sequence <gg> is spelled out in full by 2 braillists. Instead of using the appropriate lower groupsign ⠶, *GG*, they use ⠛⠛, <gg>. The same is true of the sequence <ff> in *fluffy* in (25c) and *buffet* in (25d). Two braillists leave the appropriate lower groupsign ⠖, *FF*, unrealised in *fluffy* and 3 in *buffet*.

(25) a. *⠑⠛⠛⠎ a'. ⠑⠶⠎
*eggs eGGs

b. *⠑⠛⠛⠏⠇⠁⠝⠞ b'. ⠑⠶⠏⠇⠁⠝⠞
*eggplant eGGplant
eggplant

c. *⠋⠇⠥⠋⠋⠽ c'. ⠋⠇⠥⠖⠽
*fluffy fluFFy
fluffy

d. *⠃⠥⠋⠋⠑⠞ d'. ⠃⠥⠖⠑⠞
*buffet buFFet
buffet

The lower groupsign ⠤, *COM* remains unrealised in 4 instances in *come* in (26a) and 2 braillists leave the lower groupsign ⠔, *IN*, in *spin* unrealised in (26b).

(26) a. *⠉⠕⠍⠑ a'. ⠤⠑
*come COMe
come

b. *⠎⠏⠊⠝ b'. ⠎⠏⠔
*spin spIN
spin

There are two examples for which the use of the appropriate lower groupsigns ⠔, *IN*, and ⠤, *COM*, results in incompatible word segmentation. Both ⠔, *IN*, in *finally* in (27a) and ⠤, *COM*, in *comet* in (27b) remain unrealised by 3 braillists.

(27) a. *⠋⠊⠝⠠⠽ a'. ⠋⠔⠠⠽
*fin<u>ALLY</u> fIN/<u>ALLY</u>
finally

b. *⠉⠕⠍⠑⠞ b'. ⠤⠑⠞
*comet COMet
comet

Frequent omissions of composite groupsigns are listed in (28) and (29). The largest number of zero-realisations in composite groupsigns is obtained for *bright* in (28a). ⠐⠗, *<u>RIGHT</u>*, remains unrealised on 6 occasions in *bright*, and on 4 occasions in *fright*, (28b). Both forms use the composite groupsign ⠐⠗, *<u>RIGHT</u>*, as an arbitrary contraction which is compatible with orthographic word segmentation. The four subjects who did not realise ⠐⠗, *<u>RIGHT</u>*, in *fright*, did not use it in *bright* either. Yet, all four subjects used the upper groupsign ⠣, *GH*, in the string <right>. In *department* in (28c) three different subjects prefer the upper groupsign ⠜, *AR*, over the composite groupsign ⠐⠏, *<u>PART</u>*. In (28d), three subjects used the string <evER> instead of the composite groupsign ⠐⠑, *<u>EVER</u>*.

(28) a. *⠃⠗⠊⠣⠞ a'. ⠃⠐⠗
*briGHt b<u>RIGHT</u>
bright

b. *⠋⠗⠊⠣⠞ b'. ⠋⠐⠗
*friGHt f<u>RIGHT</u>
fright

c. *⠙⠑⠏⠜⠞⠰⠞ c'. ⠙⠑⠐⠏⠰⠞
*depARt<u>MENT</u> de<u>PART</u>/<u>MENT</u>
department

d. *⠎⠑⠧⠻⠁⠇ d'. ⠎⠐⠑⠁⠇
*sevERal s<u>EVER</u>al
several

In contrast to the arbitrary strings in (28), the unrealised composite groupsigns ⠰⠎, *LESS*, in (29a) and ⠰⠇, *FUL*, in (29b) each represent a morpheme. In *carelessly*, ⠰⠎, *LESS*, is left unrealised by 3 braillists, in *joyful*, 2 braillists spelled <ful> out in full instead of using the composite groupsign ⠰⠇, *FUL*.

(29) a. *⠉⠜⠑⠇⠑⠎⠎⠇⠽
*cARelessly

a'. ⠉⠜⠑⠰⠎⠇⠽
cAReLESSly
carelessly

b. *⠚⠕⠽⠋⠥⠇
*joyful

b'. ⠚⠕⠽⠰⠇
joyFUL
joyful

There are two instances in which the same upper wordsign is spelled out by 2 braillists. In (30a) *go* is spelled out in full and in (30b) the upper groupsign ⠹, *TH*, in *this* is used without realising that it also functions as the upper wordsign ⠹, *THIS*. Similarly, the upper wordsign *shall* in (30c) is spelled out by 3 subjects, who used the corresponding upper groupsigns for these letter strings correctly.

(30) a. *⠛⠕
*go

a'. ⠛
GO
go

b. *⠹⠊⠎
*THis

b'. ⠹
THIS
this

c. *⠩⠁⠇⠇
*SHall

c'. ⠩
SHALL
shall

There are only two systematic omissions of lower wordsigns in the data, *enough* in (31a) and *by* in (32a). Both examples are highly artificial and constructed to access the purely algorithmic part of the code, i.e. in order to type these examples correctly it is essential to recognise and know the relevant braille code rule. Six subjects replaced the lower wordsign ⠢, *ENOUGH* in the string <enough's> with the sequence of groupsigns ⠢, *EN*, ⠳, *OU*, and ⠣, *GH*, in (31a).

(31) a. *⠢⠳⠣⠄⠎
* EN/OU/GH's

a'. ⠢⠄⠎
ENOUGH's
enough's

The constituent boundary between *pass by* and *from* which ought to be bridged in *Cows passed by from time to time*, is respected by 7 braillists. Instead of following the algorithm and write *by* adjacent to *from*, they spelled *by* out in full in (32a). For the most proficient braillist (30:9) in the group, a very enthusiastic braille reader, this was the only braille code error she produced.

(32) a. *⠏⠁⠎⠎⠫ ⠃⠽ ⠋ — *passED by FROM

a'. ⠏⠁⠎⠎⠫ ⠴⠋ — passED BY/FROM — passed by from

There is just one instance of a composite wordsign that is unrealised by several braillists. Three subjects did not use the composite groupsign ⠐⠗, *RIGHT*, in (33a), two of which already left it unrealised as an arbitrary string in (28).

(33) a. *⠗⠊⠣⠞ — *riGHt

a'. ⠐⠗ — RIGHT — right

There are 10 instances of incorrect sequencing of functional upper wordsigns. In (34) a sequence of the upper wordsigns ⠯, *AND*, ⠿, *FOR*, ⠷, *OF*, ⠮, *THE*, ⠾, *WITH*, and the indefinite article ⠁, *a*, is not adjoined to each other. Five of these violations occur in the sequence of the conjunction *and* plus the indefinite article, ⠯⠁ in (34a). In addition, there are three errors affecting the sequence of the preposition *with* plus article in (34b) and (34c) and two affecting *of* plus article in (34d) and (34e).

(34) a. *⠯ ⠁ — *AND a

a'. ⠯⠁ — AND/a — and a

b. *⠾ ⠮ — *WITH THE

b'. ⠾⠮ — WITH/THE — with the

c. *⠾ ⠁ — *WITH a

c'. ⠾⠁ — WITH/a — with a

d. *⠷ ⠁ — *OF a

d'. ⠷⠁ — OF/a — of a

e. *⠷ ⠮ — *OF THE

e'. ⠷⠮ — OF THE — of the

There is one other type of incorrect use of upper wordsigns in (35). In *without* in (35a) the upper wordsign ⠳, *OUT*, is used wrongly by 3 subjects.

(35) a. *⠾⠳ — *WITH/OU

a'. ⠾⠳⠞ — WITH/OUt — without

In two instances the lower wordsign ⠢, *ENOUGH*, in (36a) is adjacent to the punctuation sign.

(36) a. *⠢⠲ a'. ⠢⠳⠣⠲
*ENOUGH. EN/OU/GH.
Enough.

Due to my definition of zero realisation which focuses on the intended outcome, not on alternative solutions, there are very few instances of erroneous uses of contractions. Zero realisations which are not individual omissions are caused by strings which can be contracted in more than one way. Several subjects then use the deviant alternatives. Table 8.16 summarises the systematic errors found in the braille data.

Table 8.16: Systematic errors of the braille data

	n = 132	%
zero realisation		
upper groupsign	36	27.3
lower groupsign	37	28.0
composite groupsign	21	15.9
upper wordsign	8	6.1
lower wordsign	13	9.8
composite wordsign	2	1.5
incorrect use		
upper groupsign	13	9.8
lower groupsign	2	1.5
composite groupsign	0	0
upper wordsign	0	0
lower wordsign	0	0
composite wordsign	0	0

Generally, systematic errors are found in those examples which require the knowledge of the relevant braille code rule. They can be attributed to the algorithmic characteristics of the braille code, where it is necessary to recognise arbitrary letter sequences in order to apply the relevant rule if these forms are not lexicalised.

9 Discussion

My study shows that there are no structural elements of *British Braille* that inhibit writing performance because they interfere with language processes or Universal Grammar. The interpretation of the data is based on two fundamental assumptions. Firstly, just as there are logographic, alphabetic and orthographic strategies in use for Standard English Orthography, there is more than one strategy for producing contracted braille. Secondly, former print users have different spelling strategies, as the print forms of words are already established in their orthographic lexicon.

As part of my error analysis, I will show that onset of blindness and handedness are relevant factors in determining patterns within the group of braillists. Following the error classification of chapter 7, I will analyse spelling errors and braille code errors separately.

Millar (1997) showed that incompatible word segmentation caused by contractions has no effect on reading for experienced braillists. I will investigate whether the same is true for writing performance. Both sections focus on patterns found for spelling errors and braille code errors which are listed in chapter 8. I have limited the analysis to this data in order to counterbalance the small group sizes, to emphasise joint processes and to avoid too much influence from individual error patterns such as consistently leaving out one particular contraction irrespective of its function within a word.

All subjects are proficient braillists and have been braille users for at least the past 3 years. Their braille experience ranges from 3 to 25 years. Seven braillists have been former print readers and 12 braillists have never been print readers. In order to be able to isolate error patterns particular to braille, there are two filters. Firstly. the data of all braillists who are not native speakers of English, have an additional impairment such as a hearing impairment or a learning difficulty has been excluded. The remaining 19 braillists produced 651 errors with a grand mean of 34.4 errors and a standard deviation of 24.1 errors. The best braillist produced two errors, whereas the weakest braillist produced 82 errors. This, together with a standard deviation of 24.1, shows that the group is very heterogeneous and justifies restricting the data to errors that occur in several subjects in order to separate recurrent error patterns from errors made by an individual subject.

Table 9.1 gives an overview of all errors. To see whether previous knowledge of print is reflected in the distribution of error types, the group is divided into congenitally blind braillists, who have no experience with print, and adventitiously blind braillists, who are former print users. The latter have knowledge and experience with Standard English Orthography and have used this system functionally.

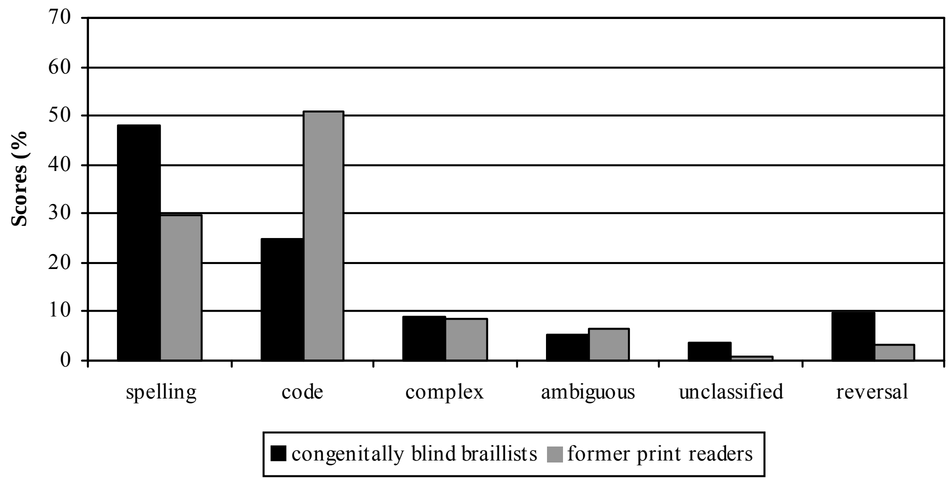
Table 9.1: Distribution of error types

	all braillists n = 19		congenitally blind braillists n = 12		former print readers n = 7	
spelling error	263	40.4%	181	48.1%	82	29.8%
braille code error	233	36.0%	93	24.7%	140	50.9%
complex error	57	8.8%	33	8.8%	24	8.7%
ambiguous error	37	5.7%	19	5.1%	18	6.5%
unclassified error	15	2.3%	13	3.5%	2	0.7%
reversal	46	7.1%	37	9.8%	9	3.3%
total	651		376		275	

The overall distribution of errors in these groups is illustrated in Figure 9.1. At first sight, the braillists produced about the same amount of spelling errors and braille code errors. Dividing the group into congenitally blind braillists and former print readers, yields a very different result. Congenitally blind braillists produce about twice as many spelling errors (48%) as braille code errors (25%), whereas former print readers show almost the opposite pattern with 30% spelling errors and 51% braille code errors. This shows that previous knowledge of print is a relevant factor in the production of braille.

The differences in the production of *complex errors* and *ambiguous errors* are very small and hence negligible. In the categories *unclassified error* and *reversal* the difference in distribution is due to one subject. She produced 12 of the 15 unclassified errors and 32 of the 46 reversals. For a discussion of her data, see section 9.3.

Figure 9.1: Distribution of error types by onset of blindness



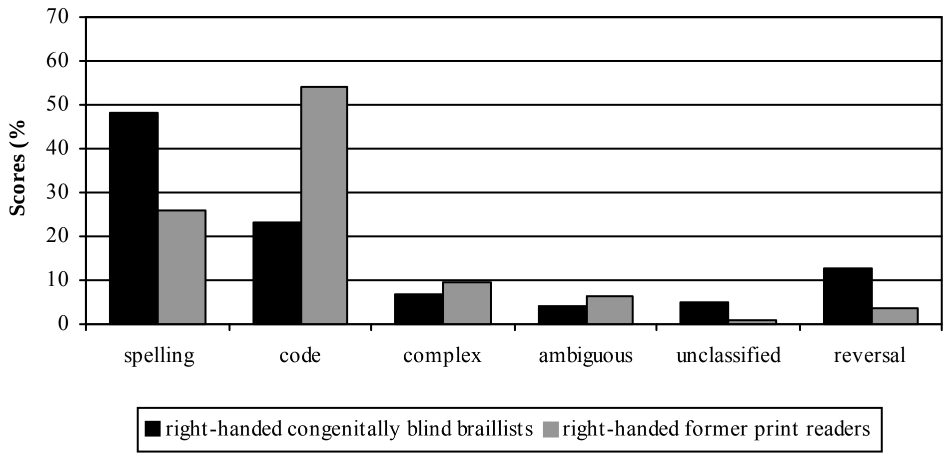
As the comparison of the two subgroups shows, previous functional print use is a relevant factor in the production of errors. To determine whether handedness has an additional influence on this distribution, the performance of the group of all braillists is contrasted with the data obtained by the 9 right-handed congenitally blind braillists and by the 6 right-handed former print readers in Table 9.2.[103] The data of three ambidextrous braillists in the group of congenitally blind braillists and the data of one left-handed braillist in the group of former print readers are therefore excluded.

Table 9.2: Distribution of error types by handedness and onset of blindness

	right-handed congenitally blind braillists n = 9		right-handed former print readers n = 6	
spelling error	123	48.4%	63	25.7%
braille code error	59	23.2%	132	53.9%
complex error	17	6.7%	23	9.4%
ambiguous error	10	3.9%	16	6.5%
unclassified error	13	5.1%	2	0.8%
reversal	32	12.6%	9	3.7%
total	254		245	

Restricting the data to that of right-handed braillists only has polarised the divergent distribution patterns of spelling errors and braille code errors in both groups. The congenitally blind right-handed braillists produced almost 50% spelling errors, whereas the former print readers produced over 50% braille code errors, as shown in Figure 9.2.

Figure 9.2: Distribution of error types by handedness and onset of blindness



To sum up, in total the braille data superficially looks like an even distribution of spelling errors and braille code errors. Yet, this is the result of the combination of two

[103] The onset of blindness is used in this context to determine whether a braillist is a former print reader or whether they used braille as their primary means of literacy from the very beginning.

opposite patterns which produce a level average. Whereas congenitally blind braillists produced most spelling errors, former print users produced most braille code errors.

Starting with spelling errors in section 9.1, I will compare the error patterns found in the group of braillists to those of the control group. In section 9.2, I will analyse braille code errors which follow general patterns to see whether there are correlations of form and performance or function and performance.

As onset of blindness and handedness have been shown to be influential characteristics in the distribution of error types, I will consistently analyse spelling errors and braille code errors with respect to the performance of subgroups by taking these two characteristics into account.

9.1 General patterns in spelling errors

The form of the spelling errors follows the classification by the *National Foundation of Educational Research* (NFER) introduced in chapter 7. Table 9.3 shows the distribution of spelling errors which occur simultaneously in the data of different braillists. It is an expansion of Table 8.12 in the previous chapter as it also contains the error patterns found in the control group. The braillists produced a total of 263 spelling errors, 131 of which are found in more than one braillist or are also found in the control group. There is only one set of transposition errors in the data; the form **sweed* instead of *swede* is produced by two braillists. This is not enough to justify the separate error category *transposition error*.[104] Transposition errors are included in the category *other* which contains mainly morphological errors in the group of braillists. In the control group capitalisation errors are included in this category too, as in contrast to braille capitalisation is not optional in Standard English Orthography.[105]

Table 9.3: Summary of spelling errors by form

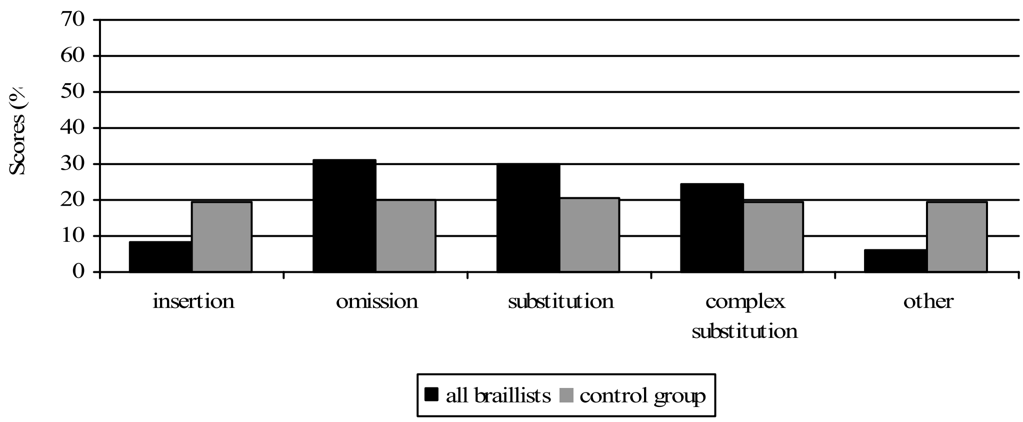
	braillists n = 19		control group n = 20	
insertion	11	8.4%	34	19.7%
omission	41	31.3%	35	20.2%
grapheme substitution	39	29.8%	36	20.8%
complex substitution	32	24.2%	34	19.7%
other	8	6.1%	34	19.7%
total	131		173	

[104] Transposition errors are more likely to be found in typed work, especially when one hand is faster than the other producing forms like **abotu* instead of *about* or **taht* instead of *that*. Although braille is typed rather than handwritten, this error type is unlikely to occur on a brailler due to the fact that every single letter is formed by one to six keys, not represented by an individual key like on a QUERTY keyboard.

[105] There is only one left-handed subject in the control group. He did not produce a single spelling error.

All *NFER* error types are attested in the group of braillists and in the control group. Their data differs with respect to distribution. Whereas all error types are approximately of equal frequency in the control group, the braillists produce mainly substitution errors and omissions, as shown in Figure 9.3.

Figure 9.3: Patterns of spelling errors



In the previous section I have shown that congenitally blind braillists and former print readers produce differing error patterns. Therefore, I will subdivide the group of braillists according to this characteristic in order to be able to determine whether the same diverging behaviour can be found in the different types of spelling errors.

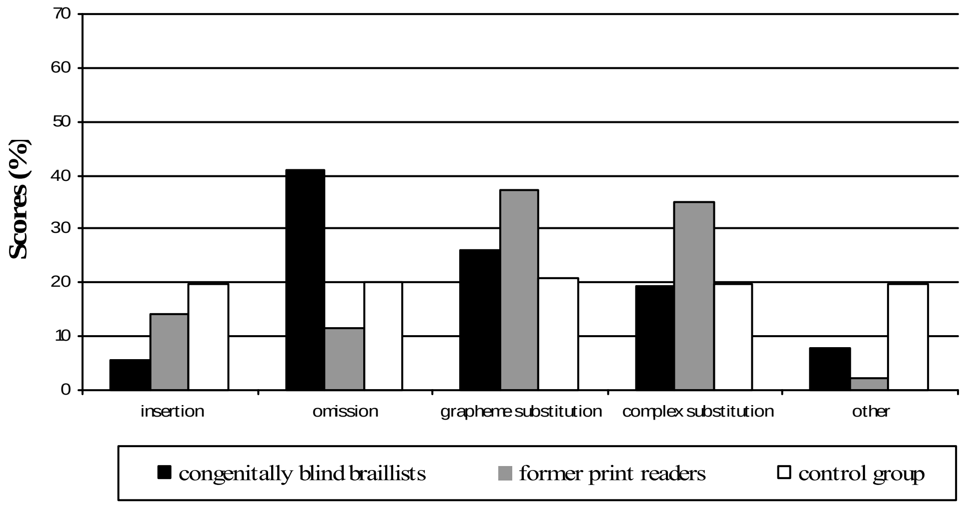
Dividing the braillists according to the onset of blindness, Table 9.4 shows that their error distribution differs significantly with respect to the form of the error. In contrast to the control group neither group of braillists shows an even error distribution.

Table 9.4: Summary of spelling errors by onset of blindness

	congenitally blind braillists n = 12		former print readers n = 7		control group n = 20	
insertion	5	5.7%	6	14%	34	19.7%
omission	36	40.9%	5	11.6%	35	20.2%
grapheme substitution	23	26.1%	16	37.2%	36	20.8%
complex substitution	17	19.3%	15	34.9%	34	19.7%
other	7	8.0%	1	2.3%	34	19.7%
total	88		43		173	

Congenitally blind braillists produce mainly *omissions* (41%). Former print readers produce mainly substitutions: Their spelling errors contain 37% grapheme substitution and 35% complex substitution, a number which differs significantly from the 26% grapheme substitution and 19% complex substitution of the congenitally blind braillists.

Figure 9.4: Adventitiously blind brailllists and congenitally blind braillists: patterns of spelling errors by form



The next step is to analyse the data with respect to underlying processes that trigger these errors and to establish a relationship with these errors. A summary of spelling errors by process is given in Table 9.5 for the complete group of braillists and for the control group. The category *phonetic spelling* includes 13 homophones and 12 erroneous representations of unstressed short vowels in the group of braillists. The latter are a major problem, for example the second <e> in *delegation* caused 10 spelling errors among the braillists and 11 spelling errors in the control group, see chapter 8 example (9a). Furthermore, both groups produced erroneous homophone forms and similar morphological errors.

Handedness was shown to be a polarising factor considering the distribution of error types. Therefore, I will compare the data of right-handed subjects in Table 9.5

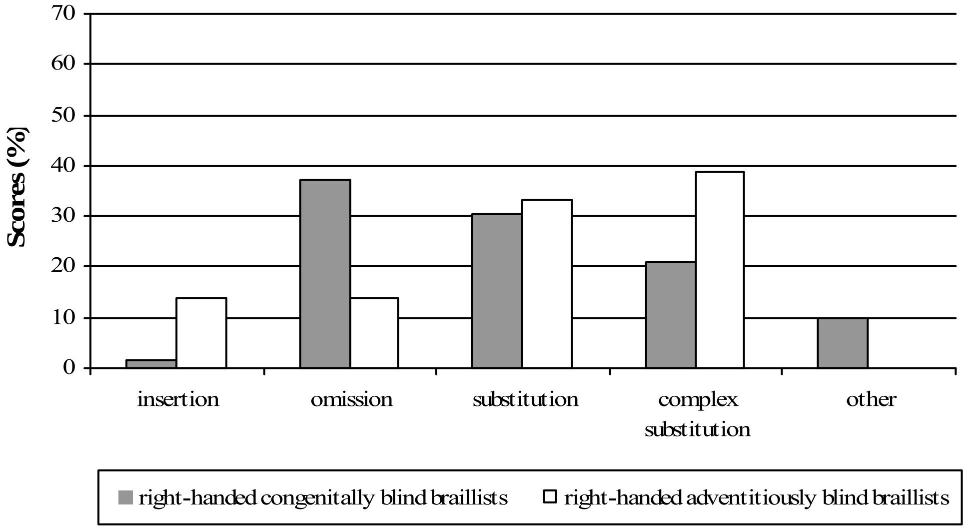
Table 9.5: Summary of spelling errors by onset of blindness

	right-handed congenitally blind braillists n = 9		right-handed former print readers n = 6		control group n = 20	
insertion	1	1.6	5	13.9	34	19.7%
omission	23	37.1	5	13.9	35	20.2%
grapheme substitution	19	30.6	12	33.3	36	20.8%
complex substitution	13	21	14	38.9	34	19.7%
other	6	9.7	0	0	34	19.7%
total	62		36		173	

Figure 9.5 shows the error distribution of right-handed congenitally blind braillists and right-handed former print readers. The same polarising effect can be observed again.

With the exception of grapheme substitutions, the differences in distributions have become larger.

Figure 9.5: Right-handed adventitiously blind brailllists and congenitally blind braillists: patterns of spelling errors by form



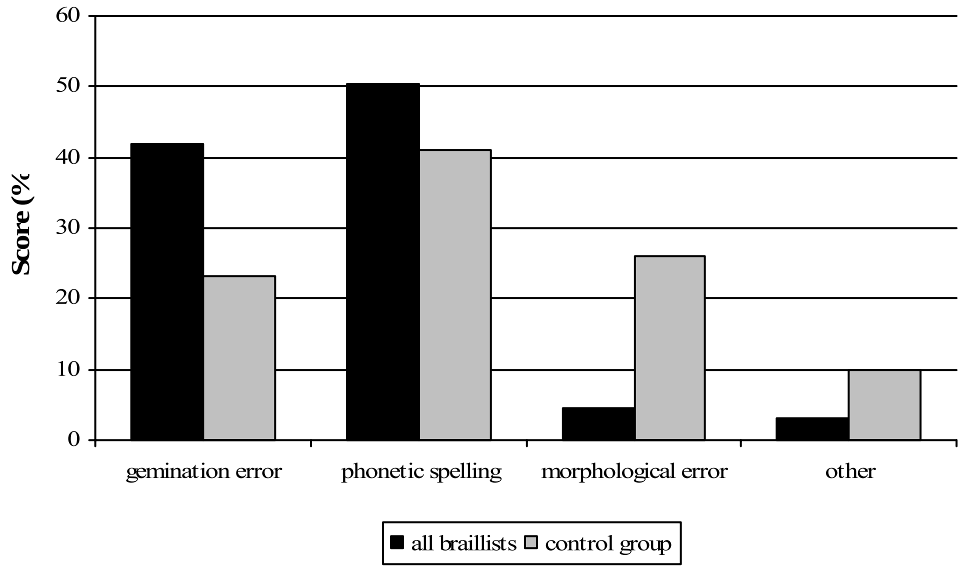
The following section turns from the differences in the distribution of spelling errors by form to the distribution of spelling errors by process, starting with a comparison of all braillists and the control group in Table 9.6.

Table 9.6: Spelling errors by process

	all braillists n = 19		control group n = 20	
gemination error	55	42.0%	40	23.1%
phonetic spelling	66	50.4%	71	41.0%
morphological error	6	4.6%	45	26.0%
other	4	3.0%	17	9.8%
total	131		173	

Gemination errors occur nearly twice as often among the braillists than in the control group. Errors due to phonetic spelling are also more frequent among the braillists. The control group produces many more morphological errors, such as interchanging the genitive *'s* and the plural suffix *-s*, even in a context in which the plural form is explicitly requested (e.g. in Task 9). Figure 9.6 illustrates the differences between the braillists and the control group.

Figure 9.6: Patterns of spelling errors by process



The next step takes the onset of blindness into account. Table 9.7 gives a summary of spelling errors by process. The result is, again, a diverging pattern within the group of braillists. In contrast to the control group, the group of congenitally blind braillists produced more gemination errors (49%) than instances of phonetic spelling (42%). The former print readers resemble the control group in producing the reverse pattern. They produce 28% gemination errors and 63% errors caused by phonetic spelling. In the category *morphological error*, both groups congenitally blind braillists (6%) and former print readers (2%) perform significantly better than the control group (26%).

Table 9.7: Summary of spelling errors by process and by onset of blindness

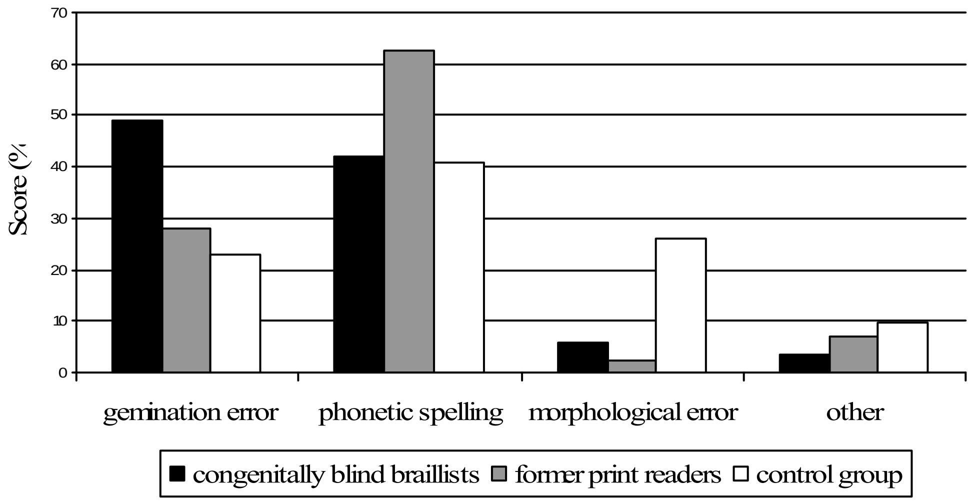
	congenitally blind braillists n = 12		former print readers n = 7		control group n = 20	
gemination error	43	48.9%	12	27.9%	40	23.1%
phonetic spelling	37	42.0%	27	62.8%	71	41.0%
morphological error	5	5.7%	1	2.3%	45	26.0%
other	3	3.4%	3	7.0%	17	9.8%
total	88		43		173	

Comparing the two groups of braillists shows a significant difference in the processes that cause their errors. Congenitally blind braillists create approximately twice as many gemination errors (49%) as former print readers (28%) or the control group (23%).[106]

[106] Weingarten et al. (2004) take the fact that the second consonant of a pair of geminate consonants is typed faster than in a different environment as evidence, that they are planned as one unit in processing. It would be interesting to see how congenitally blind braillists performed on a QWERTY keyboard compared to sighted typists.

On the other hand, former print readers produce many more errors due to phonetic spelling (63%) than either the congenitally blind braillists (42%) or the control group (41%). This is shown in Figure 9.7.

Figure 9.7: Congenitally blind braillists and adventitiously blind braillists: Patterns of spelling errors by process



Both groups of braillists produced spelling errors which are identical to those produced in the control group, as for example the gemination error of inserting an extra <t> in *carrot* or an extra <r> in *coriander* (see chapter 8, example 2). Nevertheless the distribution of their errors is different.

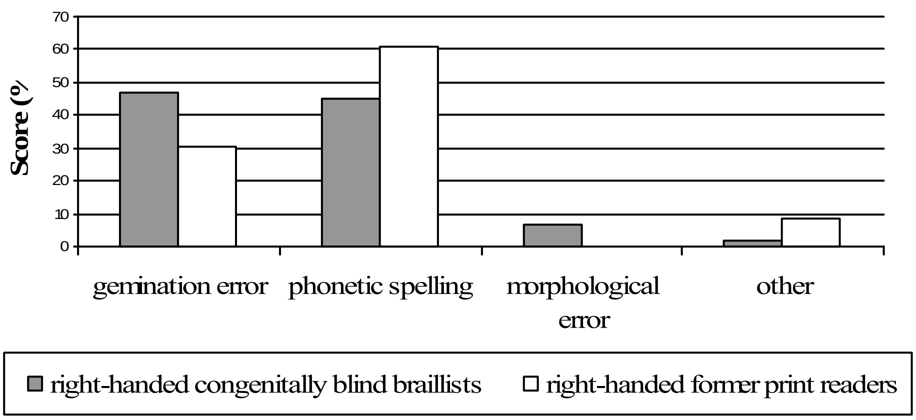
Next I will investigate the influence of handedness on the spelling processes as handedness was shown to be an influential factor in the distribution of error types. The data of the subgroups is contrasted in Table 9.7.

Table 9.7: Spelling errors by process, onset of blindness and handedness

	right-handed congenitally blind braillists n = 9		right-handed former print readers n = 6	
gemination error	29	46.7%	11	30.6%
phonetic spelling	28	45.2%	22	61.1%
morphological error	4	6.5%	0	0%
other	1	1.6%	3	8.3%
total	62		36	

The groups of right-handed congenitally blind braillists and right-handed former print readers are similar in their experience with braille, the average being 13:3 years in the first and 12:5 in the second group. The differences within the group of congenitally blind braillists mainly concern gemination errors and errors caused by phonetic spelling. The data of the 3 ambidextrous congenitally blind braillists is polarizing, their exclusion shows that for right-handed congenitally blind braillists both processes are balanced. Similarly, in the group of right-handed former print readers, the exclusion of the data of the one left-handed former print reader shows a convergence in the remaining group.[107] This is illustrated in Figure 9.8.

Figure 9.8: Spelling errors by process, onset of blindness and handedness



To summarize, the group of braillists and the control group produced the same error patterns regarding form and processes. With respect to both categories, the subgroups of former print readers and congenitally blind braillists show divergent patterns.

Regarding the underlying processes, both groups show most errors in the categories *gemination error* and *phonetic spelling.* Whereas the distribution within these two categories is almost level for the group of adventitiously blind braillists, the errors of the former print readers diverge. Concentrating on right-handed subjects minimizes the deviation but does not change the pattern. In this data previous experience with print has an influence on the distribution of error patterns. It deviates notably from subjects who have never been print users. Thus knowledge of print is a relevant factor in braille production.

[107] Since this is just one person, the difference may also be attributed to some unknown other characteristic of this braillist; nevertheless, his data is excluded due to handedness.

9.2 General patterns on braille code errors

Millar (1997) showed that contractions which resulted in incompatible word segmentation have no effect on reading for experienced braillists. I will investigate whether the error patterns of congenitally blind braillists and former print readers differ in a similar way in braille writing.

9.2.1 General patterns by contraction type

The emphasis of the study is on the interaction of contractions with linguistic units, therefore the majority of contractions are groupsigns. The data of all braillists contains a total of 233 braille code errors. I will concentrate on those errors which occur simultaneously in the data of at least two braillists in order to obtain general patterns and exclude interference from individualized braille coding habits. This leaves 161 braille code errors. An overview of these 161 braille code errors is given in Table 9.9.

Table 9.9: Patterns by form in braille code errors

	n = 161	%
upper groupsigns	46	28.6
lower groupsigns	43	26.7
composite groupsigns	30	18.6
upper wordsigns	14	8.7
lower wordsigns	22	13.7
composite wordsigns	3	1.9
shortforms	3	1.9

Wordsigns and shortforms form a closed set. There are 70 wordsigns and 76 shortforms in *British Braille*. Therefore, errors in the realisation of wordsigns and shortforms are usually individual errors. I assume wordsigns and shortforms are lexicalised and a subject either knows them or they don't. The data contains 7 zero realisations of the lower wordsign ⠴, *WAS*. Six of these zero realisations are produced by one subject who did not acknowledge *was* as a wordsign. I will now concentrate on the error frequencies of groupsigns.

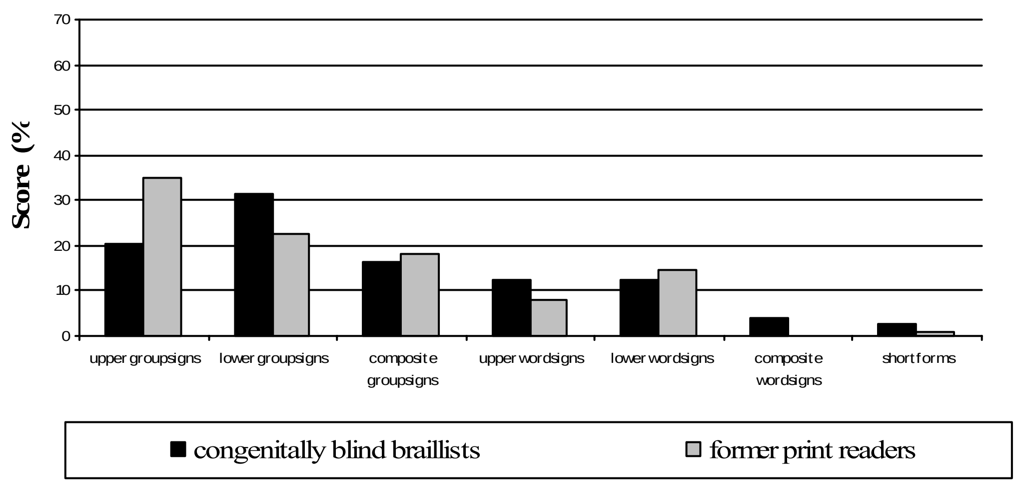
As in Section 9.1. braillists are divided into congenitally blind braillists and former print readers to determine whether this distinction is also significant for braille code errors. Their respective data is given Table 9.10.

Table 9.10: Braille code errors by form and onset of blindness

	congenitally blind braillists n = 12		former print readers n = 7	
upper groupsigns	15	20.5%	31	35.2%
lower groupsigns	23	31.5%	20	22.7%
composite groupsigns	12	16.4%	16	18.2%
upper wordsigns	9	12.3%	7	8.0%
lower wordsigns	9	12.3%	13	14.8%
composite wordsigns	3	4.1%	0	0%
shortforms	2	2.7%	1	1.1%
total	73		88	

Figure 9.9 illustrates the different behaviours of the subgroups. The strongest discrepancy in the data of congenitally blind braillists and former print readers is obtained for errors in upper groupsigns and lower groupsigns. The frequency of braille code errors is 15% higher for upper groupsigns and 9% for lower groupsigns in the data of former print readers compared to congenitally blind braillists.

Figure 9.9: Error frequencies by onset of blindness



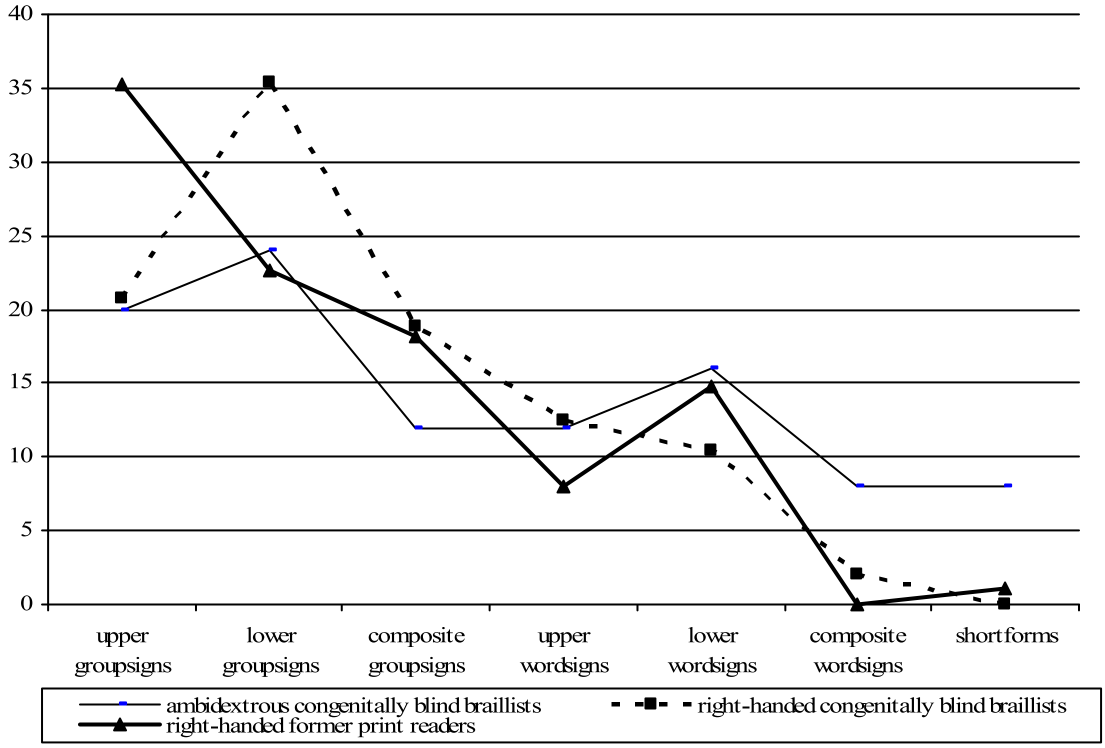
As handedness is a relevant factor in the error patterns of spelling errors, I also use this criterion for the analysis of braille code errors. Table 9.11 lists braille code error taking handedness as well as onset of blindness into account. Incidentally, only the left-handed braillist did not produce braille code errors that occurred in the data of any of the other braillists. Therefore all errors by former print readers, which occur at least in the data of one other braillist, are all made by right-handed braillists.

Table 9.11: Patterns of braille code errors by handedness and onset of blindness.

	right-handed congenitally blind braillists n = 9	%	right-handed former print readers n = 6	%
upper groupsigns	10	20.8	31	35.2
lower groupsigns	17	35.4	20	22.7
composite groupsigns	9	18.8	16	18.2
upper wordsigns	6	12.5	7	8.0
lower wordsigns	5	10.4	13	14.8
composite wordsigns	1	2.1	0	0
shortforms	0	0	1	1.1
	48		88	

Taking handedness into account clearly shows that the data of the ambidextrous braillists has a levelling effect on the patterns in the group of congenitally blind braillists. For some reason their error patterns correspond to the error patterns of former print readers.

Figure 9.10: Error frequencies by handedness and onset of blindness



Focusing on the graphs of right-handed former print readers and right-handed congenitally blind braillists shows two diverging graphs that confirm the observation that former print experience is relevant to the production of braille.

9.2.2 General patterns by function

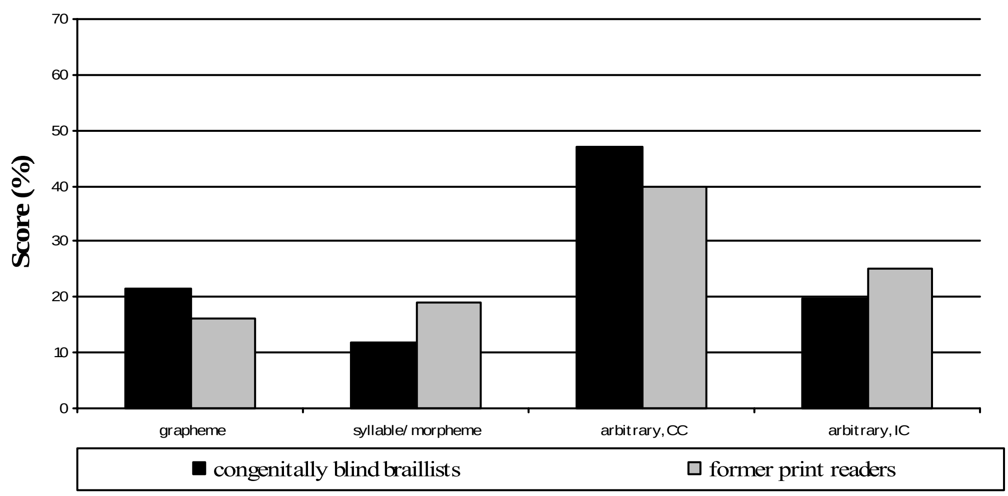
There are 119 erroneous uses of groupsigns which occur in the data of at least two braillists. They are listed in Table 9.12 according to the linguistic units they affect. This table shows an unexpected high percentage of grapheme errors, 18.5%. In addition, they are more frequent among the group of congenitally blind braillists. The reasons for this are discussed in (1) below.

Table 9.12: Error patterns by linguistic function of the contraction

	congenitally blind braillists n = 12		former print readers n = 7	
grapheme	11	21.6%	11	16.2%
syllable or morpheme	6	11.8%	13	19.1%
arbitrary, compatible with orthographic word segmentation	24	47.1%	27	39.7%
arbitrary, incompatible with orthographic word segmentation	10	19.6%	17	25%
total	51		68	

The correlation of frequency of a contraction to the errors obtained in the data is illustrated in Figure 9.11. The error frequency of the largest subgroup, arbitrary contractions that are compatible with word segmentation, correlates to the largest group of errors. In general, the performance is always better when the contractions correspond to linguistic units, graphemes, syllables and morphemes reflecting a connection to the language faculty. Within the language module, congenitally blind braillists are more sensitive to syllables and morphemes whereas former print readers are more sensitive to graphemes with respect to arbitrary contractions.

Figure 9.11: Error frequencies by function of the contraction



In the following I will look in detail at the relation of contractions and the linguistic units with which they interact.

Contractions representing graphemes

Among the groupsigns those which represent graphemes are special. The set of upper groupsigns and the lower groupsign ⠂, *EA*, in (1a) have been designed to use one braille sign where print uses a complex grapheme. The set of lower groupsigns in (1b) represents geminate consonants.

(1) a.

⠡	⠣	⠩	⠹	⠱	⠳	⠪	⠂
CH	GH	SH	TH	WH	OU	OW	EA

b.

⠆	⠒	⠲	⠖	⠶
BB	CC	DD	FF	GG

Contractions representing graphemes are the least error-prone set. The only patterns to be found are given in (2), where lower contractions remain unrealised in root changes due to the additional requirement that they may only be used in word-medial position. For those graphemes represented by upper groupsigns, there are no patterns in the braille code errors.[108]

Twenty-two lower groupsigns remained unrealised in the targets *ideas*, *teas*, *peas* and *eggs* in (2). The affixation puts the grapheme <ea> and geminates <gg> and <ff> in word-medial position. They have in common that the use of the lower groupsigns is only possible because of the presence of a suffix which puts these strings into word-medial position. The lower groupsign ⠂, *EA*, represents the complex grapheme <ea> in *ideas*, *teas* and *peas*. It is more often not realised than the lower groupsigns ⠶, GG, and

---

[108] There are two instances in the data in which a complex grapheme was not realised by the corresponding upper groupsign. Two former print readers produced these errors, one had 3 and the other 23 years of braille experience. In (ia) one of 233 braille code errors is the individual zero realisation of the upper groupsign ⠳, *OU*, in *marvellous*, which also contains a typing error, - L_2, in the third braille cell. The second one is the zero realisation of ⠪, *OW*, in *marshmallow* in (ib). This is one of 57 complex errors which also contains the substitution of the target <a> by <e> as a result of phonetic spelling in the representation of /ˌmɑːʃˈmæləʊ/.

(i) a. *⠍⠜⠥⠑⠇⠇⠕⠥⠎
*mARuellous

a.' ⠍⠜⠧⠑⠇⠇⠳⠎
mARvellOUs
marvellous

b. *⠍⠜⠩⠍⠑⠇⠇⠕⠺
*mAR/SHmellow

b.' ⠍⠜⠩⠍⠁⠇⠇⠪
mAR/SHmallOW
marshmallow

⠖, *FF* which represent geminate consonants. *British Braille* allows this root change especially with regard to the dual function of ⠂, *EA*. Consisting of just dot 2, this contraction not only saves space but also facilitates reading as its presence can interrupt sequences of dense cells and render adjacent braille characters more easily recognisable (Lorimer 1982:Vol.I:22).

(2) a. *⠊⠙⠑⠁⠎
*ideas

a'. ⠊⠙⠂⠎
idEAs
ideas

b. *⠞⠑⠁⠎
*teas

b'. ⠞⠂⠎
tEAs
teas

c. *⠏⠑⠁⠎
*peas

c'. ⠏⠂⠎
pEAs
peas

d. *⠑⠛⠛⠎
*eggs

d'. ⠑⠶⠎
eGGs
eggs

e. *⠋⠇⠥⠋⠋⠽
*fluffy

e'. ⠋⠇⠥⠖⠽
fluFFy
fluffy

The root change is ignored by both groups of braillists and produced by 4 congenitally blind braillists and 4 former print readers. Whereas the congenitally blind braillists miss out contractions at random, former print readers show a pattern in their omissions: they tend to leave out all contractions of one type.

Contractions representing a morpheme

All three types of groupsigns can represent a morpheme. Due to their design these are usually the past tense morpheme *-ed*, *-ing* and the agentive/instrumental suffix *-er* for upper groupsigns, and the derivational prefixes *in-* and *dis-*. The suffixes *-sion*, *-less*, *-ful*, *-tion*, *-ness*, *-ment* and *-ity* are included in the set of composite groupsigns. As a result of the increase in complexity, strings represented by composite groupsigns are more error-prone.

Accordingly, the 9 morphological errors obtained in the data target two suffixes, *-less* in (3a) and *-ful* in (3b).

(3) a. ⠉⠜⠑⠨⠎
cAReLESS
careless

b. ⠚⠕⠽⠰⠇
joy<u>FUL</u>
joyful

The corresponding composite groupsigns for these suffixes are spelled out in full, show a wrong indicator sign or a wrong letter in the groupsign.

Contractions representing a syllable

The pattern found for omitted groupsigns which represent syllables is similar. The data contains 10 omissions of groupsigns which represent a syllable. These omissions are triggered by the three targets *department* in (4a) and *offer* in (4b). In *department*, 2 adventitiously and 2 congenitally blind braillists use the upper groupsign ⠜, *AR*, in the second ortho-syllable *part* instead of the composite groupsign ⠐⠏, *<u>PART</u>*. In *offer* 2 former print readers and one congenitally blind braillist use the inappropriate lower groupsign ⠖, *FF*, instead of the upper groupsign ⠷, *OF*, for the ortho-syllable *of*. They all use the same root for the plural forms.

(4) a. *⠙⠑⠏⠜⠞⠰⠞
*depARtMENT

a'. ⠙⠑⠐⠏⠰⠞
de<u>PART</u>/<u>MENT</u>
department

b. *⠕⠖⠻
*oFF/ER

b'. ⠷⠋⠻
OFfER
offer

This pattern of giving preference to a contraction representing consonant gemination as in *offer* is discussed in the following section in example (7).

Arbitrary contractions compatible with orthographic word segmentation

In the group of targets which require an arbitrary contraction compatible with orthographic word segmentation, the most frequently unrealised groupsigns are the lower groupsign ⠤, *COM*, in *come* in (5a) and in *comet* in (5b) and the composite groupsign ⠐⠗, *<u>RIGHT</u>*, in *bright* in (5c) and *fright* in (5d). All four examples consist of an arbitrary letter string within a root. These examples show no correlation between the onset of blindness and the realisation of the contractions.

(5) a. *⠉⠕⠍⠑
*come

a'. ⠤⠑
COMe
come

b. *⠉⠕⠍⠑⠞
*comet

b'. ⠤⠑⠞
COMet
comet

c. *⠃⠗⠊⠣⠞
*briGHt

c'. ⠃⠐⠗
b<u>RIGHT</u>
bright

d. *⠋⠗⠊⠣⠞
*friGHt

d'. ⠋⠐⠗
f<u>RIGHT</u>
fright

The single most frequently occurring error is the zero realisation of the upper groupsign ⠮, *THE*, in *authentic* in (6a). Given the fact that this is an upper groupsign, the least complex contraction in the whole system of *British Braille*, this is a rather surprising result. The devious form is produced by eight subjects, six of them are congenitally blind braillists. As in (5), they prefer to contract the letter sequence <then>, sacrificing the global generalisation 2 [the fewest contractions shall be used] in order to produce a form that not only respects orthographic word segmentation, but identifies <th> as a separate grapheme.

(6) a. *⠁⠥⠹⠢⠞⠊⠉
*auTH/ENtic

b'. ⠁⠥⠮⠝⠞⠊⠉
auTHEntic
authentic

Assuming that *authentic* is a word of lower frequency, this behaviour agrees with Millar's (1997) observation that phonetic spelling strategies operate in low frequency words and is a further piece of evidence that linguistic units are relevant for written braille production. Thus the segmentation isolating the phoneme <th> in (6a) is used instead of the arbitrary upper groupsign ⠮, *THE* in (6b).

All examples in (7) ought to use upper groupsigns which are arbitrary but in accordance with orthographic word segmentation. They remain unrealised as preference is given to the lower groupsign ⠖, *FF*, in *offer* in (7a) and *effort* in (7b). In *carrot* and *sparrow* the upper groupsign ⠜, *AR*, remains unrealised in order not to split the gemination of <r>. This pattern is found in the data of 6 of the 19 braillists. It produced 18 braille code errors, 6 for *offer*, 8 for *effort* and 2 each for *carrot* and *sparrow*. Fifteen of these errors are produced by former print readers. They seem to have a system which gives preference to geminate contractions over arbitrary, yet high frequency, contractions.

(7) a. *⠕⠖⠻
*oFF/ER

a'. ⠷⠋⠻
OFfER
offer

b. *⠑⠖⠕⠗⠞
*eFFort

b'. ⠑⠋⠿⠞
efFORt
effort

c. *⠎⠏⠁⠗⠗⠪
*sparrOW

c'. ⠎⠏⠜⠗⠪
spARrOW
sparrow

d. *⠉⠁⠗⠗⠕⠞⠎
*carrots

d'. ⠉⠜⠗⠕⠞⠎
cARrots
carrots

The preference for keeping geminate consonants as a unit is stronger in these examples than the contractions which arbitrarily represent a string that is also created in syllabification. The identical pattern is found in example (8) where the requirements of *British Braille* cause a disruption of complex graphemes which is incompatible with word segmentation.

Arbitrary contractions incompatible with orthographic word segmentation

The study elicited 27 braille code errors in contractions which are not compatible with orthographic word segmentation as they disrupt a grapheme as in the examples in (8) or because they bridge two segments as in (9).

Vowel graphemes are disrupted in all targets in (8). Four former print readers and one ambidextrous congenitally blind braillist avoided a disruption of the complex grapheme <oo> in (8a) and spelled *hoof* out in full instead of using the upper groupsign ⠷, *OF*. Two congenitally blind braillists and 2 former print readers avoided a disruption of the discontinuous vowel grapheme <a…e> in *bathe* in (8b) by giving preference to the upper groupsign ⠹, *TH*, representing the complex consonant grapheme <th> and leaving the upper groupsign ⠮, *THE*, unrealised. In *appeared* in (8c) and *heart* in (8d) preference is given to the lower groupsign ⠂, *EA*, which corresponds to the complex vowel grapheme <ea> instead of using the appropriate upper groupsign ⠜, *AR*, which disrupts the complex grapheme. In this particular example, the age of this subject may be relevant as the forms in (8c) and (8d) are in accordance with an earlier version of *British Braille* (Lorimer et al 1982:II:3). In the context of changes to *British Braille* in

1960, 90 of 301 braillists stated that the proposed change of contracting the string <ear> from ⠂⠗, *EAr*, to ⠑⠜, *eAR*, did not make any difference to them while 159 opposed this change.

(8) a. *⠓⠕⠕⠋
*hoof

a'. ⠓⠕⠯
hoOF
hoof

b. *⠃⠁⠹⠑
*baTHe

b'. ⠃⠁⠮
baTHE
bathe

c. *⠁⠏⠏⠂⠗⠫
*appEArED

c'. ⠁⠏⠏⠑⠜⠫
appeAR/ED
appeared

d. *⠓⠂⠗⠞
*hEArt

d'. ⠓⠑⠜⠞
heARt
heart

The remaining errors which are incompatible with word segmentation occur in all categories of groupsigns. The error distribution among the lower groupsigns confirms that former print readers are more sensitive to units of Standard English Orthography than congenitally blind braillists. In *buffet* in (9a) the lower groupsign ⠖, *FF*, which represents the consonant gemination, is not realised by two congenitally blind braillists and one former print reader. In (9b) the lower groupsign ⠔, *IN*, is arbitrary and not realised by two former print readers and one ambidextrous congenitally blind braillists.

(9) a. *⠃⠥⠋⠋⠑⠞
*buffet

a'. ⠃⠥⠖⠑⠞
buFFet
buffet

b. *⠋⠊⠝⠠⠽
*finALLY

b'. ⠋⠔⠠⠽
fIN/ALLY
finally

Several in (10a) and *never* in (10b) target the same composite groupsign ⠐⠑, EVER. As this contraction is an arbitrary part of a root in both examples, it should show the same distribution among both groups of braillists. This is true for the use of ⠐⠑, EVER, in *several* in (10a) but not for *never* in (10b). *Never* is a target in the combined mismatch and association task where it has been chosen by 5 former print readers and 8 congenitally blind braillists. One former print reader produced the erroneous form in (10b). Another zero realisation of ⠐⠑, EVER, originates from the questionnaire and is produced by the same braillist who, consistently, also left this groupsign unrealised in *several*.

(10) a. *⠎⠑⠧⠻⠁⠇
*sevERal

a'. ⠎⠐⠑⠁⠇
s<u>EVER</u>al
several

b. *⠝⠑⠧⠻
*nevER

b'. ⠝⠐⠑
n<u>EVER</u>
never

In one instance, an upper groupsign that spans orthosyllables and remains unrealised is not a reflex of individual braille skills but occurs in the data of 3 braillists. *Professionally* was a challenge to both groups of braillists and the control group. Eight braillists and 7 members of the control group produced a spelling error in this target, due to difficulties with gemination. Three braillists produced the braille code error in (11a), leaving the incompatible upper groupsign ⠷, *OF*, unrealised, yet showing no difficulties with the gemination patterns or the composite groupsign ⠨⠝, *SION* which is solely by its structure rated more difficult than an upper groupsign, without taking the consonant gemination <ss> into account.

(11) a. *⠏⠗⠕⠋⠑⠎⠨⠝⠠⠽
* profes<u>SION</u>/<u>ALLY</u>

a'. ⠏⠗⠷⠑⠎⠨⠝⠠⠽
prOFes<u>SION</u>/<u>ALLY</u>
professionally

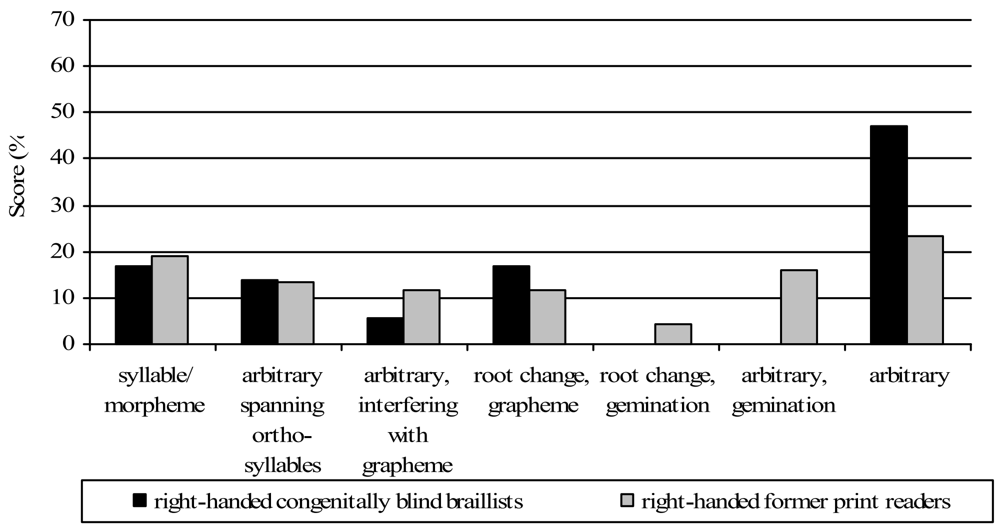
To summarize, both groups are sensitive to the spanning of ortho-syllables. This data supports my claim that previous experience with print creates different error patterns in braille code errors. In contrast to former print readers, braillists who have never used print show hardly any errors when complex graphemes and geminate consonants are separated by braille contractions. Table 9.13 summarizes these findings taking handedness and onset of blindness into account in order to obtain least interferences from those two factors. Right-handed congenitally blind braillists and right-handed former print readers behave alike with respect to contractions affecting syllables or morphemes and arbitrary contractions spanning orthosyllables. They diverge most when the use of a contraction affects consonant gemination or is arbitrary and in accordance with orthographic word segmentation.

Table 9.13: Error patterns by refined function

	right-handed congenitally blind braillists n = 9		right-handed former print readers n = 6	
syllable or morpheme	6	16.7%	13	19.1%
arbitrary, spanning ortho-syllables	5	13.9%	9	13.2%
arbitrary, interfering with grapheme	2	5.6%	8	11.8%
root change, grapheme	6	16.7%	8	11.8%
root change, gemination	0	0	3	4.4%
arbitrary, gemination	0	0	11	16.2%
arbitrary	17	47.2%	16	23.5%
total	36		68	

Figure 9.13 shows that the error patterns of right-handed former print readers are more evenly distributed, whereas right-handed congenitally blind braillists have a very clear peak in the realisation of arbitrary groupsigns, which are compatible with orthographic word segmentation.

Figure 9.13: Error frequencies by function, onset of blindness and handedness



The analysis of this data leads to the following conclusion: print and braille operate with the same processes but use different underlying units. Congenitally blind braillists and former print readers show the same patterns in error frequency when contractions represent syllables or morphemes. When they span ortho-syllables, they are indifferent and show an error frequency corresponding to the frequency of contractions with these functions.

They show a significant difference between error frequency and frequency in the use of contractions at the sub-syllabic level. Both groups of braillists are highly sensitive to graphemes, producing not a single systematic error when a contraction represented a grapheme. If a contraction interferes with a complex grapheme former print readers produce approximately twice as many errors (12%) as congenitally blind braillists (6%). The root changes in (2a) to (2c) which affected graphemes are particular to lower medial groupsigns in braille. In comparison to the few targets presented, the error rate is extremely high. If this change affected arbitrary consonant gemination, congenitally blind braillists showed no errors at all whereas former print readers are disturbed by this feature of braille.

Congenitally blind braillists are not sensitive to interferences from Standard English Orthography. They show the highest frequency rate for arbitrary errors in words where the use of the contraction is compatible with word segmentation. This indicates that the spelling of a word is either known or not. If it is known this knowledge includes the use of the contraction, if not it is assembled phonetically. This accounts for the choice of contraction of ⠹, *TH*, instead of ⠮, *THE*, in *authentic* in example (6) which produces a string in accordance with the rules of Standard English Orthography but contains a braille code error. Under the assumption that a braillist who knows the code has to make choices regarding the use of a contraction, this choice clearly failed here. If this form were assembled via a cognitive process the appropriate contraction should have been chosen.

Furthermore, congenitally blind braillists show no interference from consonant gemination at all, whether compatible or incompatible with orthographic word segmentation. The group of former print readers shows interference from Standard English Orthography and produce 21% of their errors in these categories.

As linguistic processes are operating in writing (Weingarten 1998, 2003, 2004; Cossu 1999), yet at the same time the correct form could be generated by an algorithm, I understand this behaviour as confirmation that linguistic units are relevant for written braille production. In addition, I take it as a shibboleth which confirms that linguistic units are stronger than cognitive processes, as the corresponding algorithm for the use of these contractions solely requires the identification of a letter string and its substitution by a certain contraction.

To summarize, although there is a wide scope for individual variation within the data, there are error patterns in the category *braille code error*, which are generated by the interaction of elements of contracted braille. These have the structure of an algorithm. The resulting braille code errors show that print and braille operate with the same processes but use different underlying units at a subsyllabic level. Only former print readers are sensitive to characteristics of Standard English Orthography. Yet, both groups congenitally blind braillists and former print readers produce errors that show a stronger sensitivity for linguistic than for cognitive processes which firmly places braille writing in control of the language faculty.

9.3 Individual patterns

In this section I will discuss typical results of individual braillists. In the two previous sections I compared percentages due to differing reference sets. Therefore I will examine the data of a few exceptional braillists in this section. I will start with the error patterns in extraordinary good performances, followed by the error patterns of braillists who produced the most errors and those braillists who show a highly idiosyncratic use of braille.

Error patterns in excellent performances

The three best results are achieved by three congenitally blind braillists, producing a total of 2, 9 and 11 errors. The best braillist produced the two errors in (12). In (12a) *British Braille* requires that in *Cows passed by from time to time* the constituent boundary between *pass by* and *from* is bridged. This is the most extreme divergence between the linguistic structure of the target and the cognitive execution of an algorithm required by the rules of *British Braille*. This subject respected the constituent boundary instead of following the algorithm and sequence *by* and *from* unspaced. As a result, she spelled *by* out in full. She also produced one phonetically conditioned spelling error, the inappropriate gemination of <l> in *mackerel* in (12b).

(12) a. *⠏⠁⠎⠎⠫ ⠃⠽ ⠋
*passED by FROM

a'. ⠏⠁⠎⠎⠫ ⠴⠋
passED BY/FROM
passed by from

b *⠍⠁⠉⠅⠻⠑⠇⠇
* mackERell

b'. ⠍⠁⠉⠅⠻⠑⠇
mackERel
mackerel

The data of the two braillists who produced the second and third best results share this pattern, i.e. their errors are limited to spelling errors and braille code errors too. Their errors are process-related, not idiosyncratic. Individual errors are only found among braille code errors where a random wordsign or shortform remains unrealised.

Table 9.14: Best overall results achieved in the study

	age	dominant hand	former print reader	years of braille use	error total	spelling error	braille code error
S 14	30:9	R	no	25	2	1	1
S 30	17:9	R	no	13	9	5	4
S 34	18:11	LR	no	14	11	2	9

Error patterns of weaker braillists

In contrast to the braillists that performed extremely well, the errors of weaker braillists are not restricted to spelling errors and braille code errors. They produce at least 20% of complex, ambiguous and unclassified errors which is illustrated in Table 9.15.

Table 9.15: Error distribution in the data of weaker braillists

	age	dominant hand	former print reader	years of braille use	total	spelling error	braille code error	Complex errors	Ambigu-ous errors	Unclas -sified errors
S 15	42:7	R	yes	20	61	16,4%	63,9%	8,2%	9,8%	1,6%
S 23	11:10	LR	no	7	75	52%	24%	17,3%	6,7%	0%
S 19	18:4	R	yes	11	80	22,5%	53,8%	16,3%	6,3%	1,3%

In addition, there are very few patterns in spelling errors, which coincide with those of the control group. Their spelling errors contain numerous instances of individual phonetic spelling such as *caught* in (13a). In addition, their braille code errors show many zero realisations in the most frequent group, upper groupsigns, such as ⠫, *ED*, in *medical* in (13b).

(13) a. *⠉⠁⠥⠞⠑
*caute

a'. ⠉⠁⠥⠣⠞
cauGHt
caught

b. *⠍⠑⠙⠊⠉⠁⠇
*medical

b'. ⠍⠫⠊⠉⠁⠇
mEDical
medical

There is a correlation of overall performance and the frequency of complex errors. The more errors a subject produced the higher the proportion of complex errors. The data contains 55 complex errors. Forty-two of these are independent complex errors, words that just happen to contain a braille code error and a spelling error, as in *normally* in (14a), where the spelling error consists of a grapheme substitution caused by phonetic spelling; <u> is used instead of <o>. The braille code error is independent of the substitution, it is the zero realisation of the composite groupsign ⠠⠽, *ALLY*.

(14) a. *⠝⠥⠗⠍⠁⠇⠇⠽
*nurmally

a'. ⠝⠕⠗⠍⠠⠽
normALLY
normally

The remaining 13 complex errors are interdependent complex errors where either the letter string produced by the spelling error feeds the braille code error or vice versa. There are 8 instances in which the spelling error causes a zero realisation and an upper or a lower groupsign as in *legislation* in (15a). The insertion of <d> produces the sequence <ed>. This sequence ought to be represented by the upper groupsign ⠫, *ED*. Thus the braille code error is a consequence of the spelling error. With the exception of two errors these are caused by the weakest braillists. In the remaining 5 interdependent complex errors a braille code error causes a spelling error, as in (20b) where the lower wordsign ⠢, *ENOUGH*, remains unrealised and in the full form the grapheme <ph> is used instead of <gh> due to phonetic spelling. These 5 errors are exclusively produced by the 3 weakest braillists.

(15) a. *⠇⠑⠙⠛⠊⠎⠇⠠⠝
*ledgisl<u>ATION</u>

a'. ⠇⠑⠛⠊⠎⠇⠠⠝
legislATION
legislation

b. *⠑⠝⠳⠏⠓
*enOUph

b'. ⠢
ENOUGH
enough

Individual differences

Two braillists showed very idiosyncratic patterns in their use of braille. Both are congenitally blind braillists. The first left out the lower groupsign ⠔, *IN*, consistently, regardless of its function. Thus it remained unrealised not only as a contraction interfering with a complex grapheme in *brain* in (16a) but also in the monosyllabic roots *spin*, *sin* and *chin* in (16b) to (16d). He does not show the same behaviour for the very similar lower groupsign ⠢, *EN*, nor does he have difficulties with the use of composite groupsigns or with wordsigns.

(16) a. *⠃⠗⠁⠊⠝
*brain

a'. ⠃⠗⠁⠔
braIN
brain

b. *⠎⠏⠊⠝
*spin

b'. ⠎⠏⠔
spIN
spin

c. *⠎⠊⠝
*sin

c'. ⠎⠔
sIN
sin

d. *⠡⠊⠝
*CHin

d'. ⠡⠔
CH/IN
chin

The other braillist who showed a highly idiosyncratic pattern produced 28 reversals which are predominantly LR-reversals. Apart from the extensive production of reversals, there are no problems related to the code. Four of her braille code errors in (17a) to (17d) are among those found in the data of several other braillists, see section 9.1.

(17) a. *⠃⠁⠹⠑
*baTHe

a'. ⠃⠁⠮⠑
baTHE
bathe

b. *⠊⠙⠑⠎
*ideas

b'. ⠊⠙⠂⠎
idEAs
ideas

c. *⠙⠑⠏⠜⠞⠰⠞
*depARtMENT

c'. ⠙⠑⠂⠏⠰⠞
de<u>PART</u>/<u>MENT</u>
department

d. *⠉⠜⠑⠰⠑
*cARe<u>ENCE</u>

d'. ⠉⠜⠑⠨⠎
cARe<u>LESS</u>
careless

The remaining two braille code errors affect the formation of wordsigns. In (18a) she uses the upper wordsign ⠙, *DO*, to represent *did*, and in (18b) she uses the composite wordsign ⠸⠓, *HAD*, to represent *have*. In both errors, she stays within the lexeme she intended to use.

(18) a. *⠙
*DO

a'. ⠙⠊⠙
did

b. *⠸⠓
*HAD

b'. ⠓
HAVE
have

She is not a strong speller, producing many instances of phonetic spelling. This in combination with the many reversals and the characteristic of braille to have no redundancies in the shape of its characters causes the high rate of 20% unclassified errors.

To sum up, within this small sample group of braillists congenitally blind braillists show a performance of braille writing different from that of former print readers, even if those have been braillists for a similar amount of time. In addition, some subjects show a highly idiosyncratic use of braille that need not necessarily be exclusively related to the code.

9.4 Summary

The main question the study ought to answer is whether there are structural elements of *British Braille* that inhibit writing performance because they interfere with language processes and thus indicate whether there are interferences between *British Braille* and Universal Grammar.

Firstly, I showed that subjects who are former print readers show different error patterns with respect to both spelling errors and braille code errors than subjects who have no former functional use of print. Secondly handedness was also shown to have an effect on error patterns. Therefore the two groups that were contrasted are right-handed former print readers and right-handed congenitally blind braillists.

Regarding spelling errors, both groups produced errors in the same categories and with the same processes as the control group. They exceeded the control group in the sensitivity to the morphological structure of words. Regarding the underlying processes, both groups of braillists show most errors in the categories *gemination error* and *phonetic spelling.* Whereas these errors are of equal frequency among the congenitally blind braillists, former print readers follow the pattern of the control group and produce approximately twice as many errors by phonetic spelling (61%) than gemination errors (31%). The differing patterns in the group of spelling errors indicate that former knowledge of Standard English Orthography is a relevant factor in braille production.

Former print readers have already established an orthographic system, which may interfere with contracted braille. Although there is a wide scope for individual variation within the data, some error patterns obtained in the data can only be explained as interference of those parts of *British Braille* which require an algorithmic process if the form is not already lexicalised. The resulting braille code errors show that print and braille operate with the same processes but use different underlying units at a subsyllabic level.

Only former print readers are sensitive to characteristics of Standard English Orthography which strongly supports the assumption that although historically dependent on print, braille is a writing system in its own right. Thus there is an interference but not between Universal Grammar and braille but between two orthographic systems: Standard English Orthography and contracted braille.

Both congenitally blind braillists and former print readers produce errors that show a stronger sensitivity for linguistic than for cognitive processes which firmly places braille writing in control of the language faculty.

10 Concluding remarks

The central question under investigation was whether there are structural elements of *British Braille* that are in conflict with language processes, i.e. whether the system of *British Braille* can be held responsible for poor spelling performance.

In a detailed analysis of *British Braille* I have shown that it is a seemingly arbitrary compilation of rules sensitive to language processes and that this compilation of arbitrary *British Braille* rules can be restructured by the underlying implicit use it makes of word structure, most importantly the segmentation of ortho-syllables as postulated by Primus (2003) and Weingarten (2004).

My study showed that former print readers produce different error patterns with respect to both spelling errors and braille code errors than subjects who have no former functional use of print. Regarding the underlying linguistic processes, both groups of braillists show most errors in the categories *gemination error* and *phonetic spelling.* Whereas these errors are of equal frequency among the congenitally blind braillists, former print readers follow the pattern of the control group and produce approximately twice as many errors by phonetic spelling than gemination errors. The differing patterns regarding spelling errors indicate that former knowledge of Standard English Orthography is a relevant factor in braille production. Former print readers have already established an orthographic system, which may interfere with contracted braille. Although there is a wide scope for individual variation within the data, some error patterns obtained in the data can only be explained as interference of those parts of *British Braille* which require an algorithmic process if the form is not already lexicalised. The resulting braille code errors show that print and braille operate with the same processes but use different underlying units at a subsyllabic level.

Only former print readers are sensitive to characteristics of Standard English Orthography which is an indicator that braille is a writing system in its own right. However, both congenitally blind braillists and former print readers produce errors that show a stronger sensitivity for linguistic than for cognitive processes which firmly places braille writing in control of the language faculty contradicting the old saying that you need to be clever to learn braille!

Both the analysis of *British Braille* and the study confirmed that there is an independent unit *syllable* in the writing system. Furthermore, braille and braillists are more sensitive to this unit than to phonological syllables and morphemes.

Questioning the compatibility of braille and Universal Grammar, both the code analysis and the study show that braille takes linguistic units into account. There are very few instances in which braille prescribes rules that can only be accessed via cognitive processes. These rules tend to be ignored in favour of a form consistent with the linguistic structure of the target just as print reading children are insensitive to prescriptive rules in orthography (Weingarten 2004). Yet, there is an interference but it is not between linguistic principles and braille but between two orthographic systems: Standard English Orthography and contracted braille

Questions for further research

- Is there a minimum input threshold for braille production in the language system?
- To what extent is the presence or absence of visual feedback important and how does it tie in with kinaesthetic feedback?
- Are there other factors interfering with spelling such as, the absence of an individual representation, as there is no equivalent to handwriting in braille.
- To what extent may speech software interfere with spelling? Is there a difference in spelling competence in children who primarily use speech software[109] in word processing to children who work with a refreshable braille display? [110]
- What is the nature of reversals?
- Are the error patterns of braillists of different countries who share their native language but who have different default systems for using braille identical? For example, Spain uses uncontracted braille whereas Mexico uses contracted braille.
- How do contracted braille and full spelling interact?
- Do braille teaching strategies for former print readers need to be altered?
- Under the assumption that adventitiously blind subjects have the advantage of already knowing the print writing system, they should perform better in typing than in tasks containing contracted braille. It remains to be seen whether having known print is an advantage for adventitiously blind learners of braille and whether former print habits persist if there is no more print input, or whether there is an analogy to the loss of clarity in speech in adventitiously deaf people.

[109] Speech software in this context is adaptive technology which reads text on a computer screen. It is also possible to have auditive feedback for every key pressed and/or for every whole word typed. One problem is that the speech output may easily sound distorted.

[110] A refreshable braille display is a piece of special equipment which gets connected to a computer instead of or in addition to a monitor to read the text that the computer sends to the monitor. It is refreshable as the text changes while being read, similar to electronically displayed adverts in buses.

Abstract

The central question of this work is to investigate whether there are structural elements of *British Braille* that are in conflict with language processes, i.e. whether the system of *British Braille* can be held responsible for poor spelling performance.

Especially from the point of view of a print reader braille is a secondary system which requires many extra rules that have to be learnt. Thus it is easily considered more difficult. I do not wish to question the value of braille, whether it is used in contracted or uncontracted form.

A detailed analysis of *British Braille* has shown that it is a seemingly arbitrary compilation of rules that is sensitive to language processes, the most important unit being the ortho-syllable as postulated by Primus (2003) and Weingarten (2004).

In chapter 4 I have shown that the apparent compilation of arbitrary *British Braille* rules be restructured by the underlying implicit use it makes of word structure, most importantly the segmentation of ortho-syllables. This system is not a mere compilation of rules and lists that have to be learnt by rote. The analysis supports the assumption that cognitive processes are not the only possible route to contracted braille and that the way in which the rules of contracted braille have been compiled is far more problematic than the underlying system itself.

Many braillists receive a dual education, learning to read and write contracted braille and use full spelling on computer keyboards. Millar (1997) argues that having two orthographic representations for the same letter groups may increase memory load in retrieval. This might indeed make spelling more difficult for braillists. I will focus on possible interferences from contracted braille with natural language without the additional difficulty of mastering full spelling on a computer keyboard. I adopt Millar's (1997) axiom that print and braille are identical in linguistics. Thus models and findings for print can be used for testing hypotheses in braille.[111]

Further support for access to language processes comes from a study on braille which I have developed to investigate whether there are structural elements of *British Braille* that inhibit writing performance. Thus the study is designed to reveal the interaction of braille contractions with natural language, in particular to investigate whether the

[111] There are two major differences between print and braille. Firstly, there is no redundancy in braille. All signs differ from each other in the presence or absence of at least one dot irrespective of their unit size, i.e. whether they are letters or contractions. Secondly, print is read during pauses of eye movement whereas braille is read by movement.

bridging of syllable or morpheme boundaries by arbitrary contractions influences spelling performance.

My study shows that former print readers have different error patterns with respect to both spelling errors and braille code errors than subjects who have no former functional use of print. Regarding the underlying linguistic processes, both groups of braillists show most errors in the categories *gemination error* and *phonetic spelling.* Whereas these errors are of equal frequency among the congenitally blind braillists, former print readers follow the pattern of the control group and produce approximately twice as many errors by phonetic spelling than gemination errors. The differing patterns in the group of spelling errors indicate that former knowledge of Standard English Orthography is a relevant factor in braille production.

Former print readers have already established an orthographic system, which may interfere with contracted braille. Although there is a wide scope for individual variation within the data, some error patterns obtained in the data can only be explained as interference of those parts of *British Braille* which require an algorithmic process if the form is not already lexicalised. The resulting braille code errors show that print and braille operate with the same processes but use different underlying units at a subsyllabic level.

Only former print readers are sensitive to characteristics of Standard English Orthography. However, both congenitally blind braillists and former print readers produce errors that show a stronger sensitivity for linguistic than for cognitive processes which contradicts the old saying that you need to be clever to learn braille!

Both parts, the analysis of *British Braille* and the study, confirmed that there is an independent unit *syllable* in the writing system. Furthermore, braille and braillists are more sensitive to this unit than to phonological syllables and morphemes.

Questioning the compatibility of braille and Universal Grammar, both the code analysis and the study show that braille takes linguistic units into account. There are very few instances in which braille prescribes rules that can only be accessed via cognitive processes. These rules tend to be ignored in favour of a form consistent with the linguistic structure of the target just as print reading children are insensitive to prescriptive rules in orthography (Weingarten 2004). Yet, there is an interference but it is not between linguistic principles and braille but between two orthographic systems: Standard English Orthography and contracted braille

Zusammenfassung

Die zentrale Fragestellung dieser Arbeit ist die Untersuchung, ob die Regeln in *British Braille*, dem Regelwerk für Blindenkurzschrift in Großbritannien, so formuliert sind, dass sie mit sprachlichen Prozessen in Konflikt geraten können und somit die geringe Rechtschreibkompetenz, die blinden Schülern zum Teil nachgesagt wird, direkt mit dem System der Blindenkurzschrift zusammen hängt.

Aus der Sichtweise eines Schwarzschrift Lesenden ist Punktschrift ein sekundäres System, das über die Standardorthographie hinaus viele Regeln benötigt, die extra gelernt werden müssen. Daraus wird schnell der Schluss gezogen, dass Punktschrift als schwieriger anzusehen ist.

Eine detaillierte Analyse des englischen Regelwerks ergab, dass diese offenbar willkürlich zusammengestellte Sammlung ebenso willkürlicher Regeln dennoch von sprachlichen Prozessen geleitet wird. Die wesentliche Einheit dabei ist die von Primus (2003) und Weingarten (2004) postulierte Schreibsilbe.

In Kapitel 4 habe ich gezeigt, dass sich viele der anscheinlich willkürlichen Regeln auf der Basis der Schreibsilben generalisieren lassen und dass diese gleichzeitig einen stärkeren Einfluss als Phoneme und Morpheme haben. Dies unterstützt meine Hypothese, dass kognitive Prozesse zwar ein möglicher Weg zum Schreiben der Blindenkurzschrift, nicht jedoch der einzige sind. Die Art, in der das Regelwerk *British Braille* zusammengestellt ist, ist weit problematischer als das System selbst, denn das Regelwerk ist eine Überlagerung gesammelter präskriptiver Regeln und nicht als Einheit konzipiert.

Es gibt noch einen zweiten Weg zum Erlernen der Blindenkurzschrift durch sprachliche Prozesse im Rahmen des Schriftspracherwerbs. Viele blinde Kinder erhalten eine Ausbildung in der Blindenkurzschrift und Schreiben an der Schreibmaschine, bzw. am Computer nach dem Zehnfingersystem parallel erlernt werden. Millar (1997) sieht darin eine gesteigerte Anforderung an das Gedächtnis, jeweils die richtige, gerade benötigte Form abzurufen, was dann Schreiben für blind Kinder schwieriger mache.

Meine Arbeit hat sich auf Interferenzen zwischen sprachlichen Einheiten und den Einheiten der Blindenkurzschrift konzentriert. Dabei habe ich Millars (1997) Axiom, dass Schwarzschrift und Blindenkurzschrift linguistisch identisch sind angenommen.

Daraus ergibt sich, dass Modelle aus dem regulären Schriftspracherwerb zum Testen von Modellen zum Erwerb der Blindenkurzschrift übernommen werden können.

Meine Studie zum Gebrauch der Blindenkurzschrift, durchgeführt im Oktober 2004 in Großbritannien, untersucht, ob Elemente der englischen Blindenkurzschrift die Schreibleistung negativ beeinflussen können. Die Studie ist aufgebaut, die Interaktionen der Brailleschrift mit natürlicher Sprache zu testen. Dabei stehen Silben- und Morphemgrenzen im Mittelpunkt der Untersuchung.

Es zeigte sich, dass die Probanden, die vor ihrer Erblindung Schwarzschrift benutz hatten, im Bezug auf Rechtschreibung die gleichen Fehlermuster produzierten wie die sehende Kontrollgruppe; Fehler die sich deutlich von denen der Gruppe unterschieden, die nie Erfahrungen mit Schwarzschrift gesammelt hatte. Betrachtet man die zugrunde liegenden linguistischen Prozesse, treten die häufigsten Fehler in beiden Gruppen bei der Konsonantengemination und bei beim lautsprachlichen Schreiben auf. Bei Blinden ohne Schwarzschrifterfahrung sind die Fehler in beiden Gruppen gleich verteilt, in der anderen Gruppe überwiegen Fehler in der Konsonantengemination, wie auch in der Kontrollgruppe. Dies legt den Schluss nahe, dass vorangegangene Erfahrungen mit Schwarzschrift prägend sind, da diese bereits ein orthographisches Bewusstsein geschult haben. Nur diejenigen Probanden, die bereits funktionelle Leser waren, zeigten eine Sensibilisierung für Eigenschaften der Schwarzschrift. Es gibt jedoch in beiden Gruppen von Probanden eine ganz klare Präferenz für linguistische Prozesse, sollten diese bei der Wahl einer Kürzung mit kognitiven Prozessen in Konflikt geraten.

Die beiden großen Teile meiner Arbeit, die strukturelle Analyse von *British Braille* und die Ergebnisse des Testes belegen, dass es im Schriftsystem eine unabhängige Schreibsilbe gibt. Dazu kommt dass alle Probanden mehr Sensibilität gegenüber dieser Einheit als gegenüber Silben und Morphemen zeigten.

Trotz der Möglichkeit Braille über kognitive Leistungen zu produzieren kann der Erwerb der Brailleschrift als Zweitspracherwerb, wie der reguläre Schriftspracherwerb, angesehen werden und damit seinen Platz im System der Universalgrammatik finden, ohne dieser entgegenzustehen. Die einzige auftretende Interferenz tritt zwischen der Standardorthographie und der Blindenkurzschrift bei Probanden, die früher funktionelle Schwarzschriftleser waren, auf.

Appendix A: *British Braille* Rules used in Chapter 4

8 USE OF CONTRACTIONS

8.2 SIMPLE UPPER WORDSIGNS

8.2.7 The words AND, FOR, OF, THE, WITH, a should generally follow one another without a space if occurring on the same line of braille, even when a sense break or a natural pause is present.

Examples: He is WITH/THE OFficER OF/THE watCH; THE ENd OFa pERfect DAY; He lookED grim AND/OF/a sad DISposiTION; Him we TH/INk OF/AND love; THE/WITH prOFits sCHeme

8.3 SIMPLE UPPER GROUPSIGNS

8.3.5 [BLE and ING] may not be used at the beginning of a word. However, they may generally be used in the middle or at the end of a word wherever the letters they represent occur.

Examples: blemiSH [not BLEmiSH], dINGhy, em-BLEm (divided at the braille line), INgle [not INGle], INgram [not INGram], sINGe.

8.3.6 The contraction for ING should be used whether the *g* is pronounced hard or soft.

Examples: crING/ING, gING/ER, niGHtINGale, sING/ING

8.3.7 The contraction for BLE may not generally be used before the letters *a* or *n*.

Examples: pitCHblENde [not pitCH/BLEnde], tablEAu [not taBLEau]

8.4 LOWER CONTRACTIONS

8.4.1 Any number of lower contractions and punctuation signs may follow one another without an intervening space, provided that the string includes an upper sign and that all other rules are observed.

8.4.5 The lower wordsigns TO, INTO and BY should be written unspaced from a word which follows on the same braille line, even when a sense break or natural pause is present.

Examples: BY/AND BYhe wENt TOsCHool BYbus. HIS pay WAS NOT INcrEAsED BY/AS muCH AS THAT. BY/AND lARge SHe STood BY/hER deciSION. C/OWs passED BY/FROM TIME TO/TIME.

8.4.14 BE, WERE, HIS and WAS may be preceded by the italic sign. They may not be used in con-junction with any other sign. The signs for WERE, HIS and WAS may not be used as parts of words.

Examples: He *WAS* plEAsED. AS YOU wERe! IT may be! IT wasn't a wERewolf.

8.4.16 The contractions for BE, CON and DIS may be used at the beginning of a word or after a hyphen in a hyphenated compound word, provided the letters they represent constitute a syllable, and in the case of BE it must be an unstressed syllable. They may not be used elsewhere in a word.

Examples: BEcome, BEnign, bENefit, CONnect, DISconnect, DIStINct, INdiST/INct, conCH, disc, diSHevellED, self-DISciplINe.

Note, however the following exceptions in which the contraction BE should be used:

Examples: BE/ING, BEin'

8.4.19 The contraction for COM may only be used at the beginning of a word, but it need not form a syllable.

Examples: COMa, COMb, COMe, COM/FORt, BY/COMpARison, TO/COME

But it must not be used when the letters <co> are added to a complete word to give a word of cognate meaning.

Examples: comates, comingle

8.4.22 The lower contractions for EN and IN should generally be used wherever the letters they represent occur.

Examples: B/EN/ENdEN, ENgINe, femIN/INe, fINal, pEN/INsula.

8.4.25 The contractions for EA, BB, CC, DD, FF and GG may only be used when these letters occur between letters or contractions in the same word written in one braille line. They must not begin or end a braille line.

Examples: aDDs, bEAt, daGG/ER; but: add [not aDD], easy [not EAsy].

8.4.27 In general the EA contraction should be used whenever EA occurs within a word.

Examples: acrEAge, AR/EAs, CHangEAbilITY, crEAte, crEAtivITY, delIN/EAte, EuropEAn, FORseEAbly, idEAliSTic, idEAs, laurEAte, likEABLe, lIN/EAge, lIN/EAl, mallEA/BLE, milEAge, miscrEAnt, nausEAtING, ocEAnic, pagEAnt, pEAcEA/BLE, pERmEA/BLE, pERmEAte, ratEA/BLE, rEAlITY, rosEAte, sEAs.

8.4.28 In an unhyphenated compound word, when the first element ends or the second element begins with EA, the EA should be contracted.

Examples: AR/EAway, moTH/EAtEN, norTH/EA/ST, sEAman, spEAkEAsy, sprEAdEAgle, tEA/TIME

8.4.29 The contraction for EA should not be used when the letters belong to two distinct syllables and the <a> does not begin a suffix, *or* when the form of a root word would be excessively distorted.

Examples: aurora borealis [not *aurora borEAlis], BEatific [not *bEAtific], gENealogy [not *gEN/EAlogy], habeas corpus [not *habEAs corpus], hanseatic [not *hansEAtic], Neapolitan [not *N/EApolitan], orgeat [not *orgEAt], pancreas [not *pancrEAs], pINeapple [not *pIN/EApple]

8.5 COMPOSITE WORDSIGNS

Dot 4-5 Contractions

8.5.1 The contraction for WORD should be used wherever the letters it represents occur.

Examples: FOReWORD, sWORD, WORDiNESS, WORDsworTH.

However, the contractions for UPON, THESE, THOSE and WHOSE should only be used where they retain their meanings as whole words.

Examples: HERE/UPON, WHERE/UPON, WHOSEsoEVER; but cOUpon [not coUPON], hypoTHEses [not hypoTHESEs], THoseby [not THOSEby]

Dots 4-5-6-Contractions

8.5.2 The following contractions should generally be used wherever the letters they represent occur: CANNOT, MANY, SPIRIT, WORLD, THEIR.

Examples: diSPIRIT/ED, G/ER/MANY, RoMANY, THEIRs, WORLDly.

The contraction HAD may generally be used when the *a* is short, unless the preference Rule (8.8.5.) directs otherwise.

Examples: HADn't; but haDDock [not HADdock].

Dot 5 Contractions

8.5.3 In general the following dot 5 contractions should be used wherever the letters they represent occur: DAY, FATHER, KNOW, LORD, MOTHER, QUESTION, RIGHT, WORK, YOUNG, CHARACTER, THROUGH, OUGHT.

Examples: acKNOWledge, aRIGHT, bOUGHT, CHARACTERize, FATHERly, midDAY, playwRIGHT, QUESTIONnaire, RIGHTeous, sMOTHER, WORK/SHop, YOUNG/ER.

8.5.4. The contraction for EVER may only be used when the stress is on the first <e> and the letter group in not preceded by an <e> or <i>.

Examples: lEVER, fEVER, nEVER, sEVER, sEVERal; but: BElievER [not BEliEVER], pERsevERe [not pERsEVERe], revERbERate [not rEVERbERate], revERe [not rEVERe], sevERe [not sEVERe], sevER/ITY [not sEVER/ITY]

8.5.5 The contraction for HERE may only be used when the letters it represents are pronounced as one syllable.

Examples: adHERE, HEREto, HERE/WITH, spHERE, but: hEResy [not HEREsy]

8.5.6 The contraction for NAME may only be used when the letters it represents are pronounced as one syllable.

Examples: NAMEly, NAMEr, NAMEsake, unNAMEd; but ENamel [not eNAMEl], ornaMENT [not orNAMEnt], unamENdED [not uNAMEndED]

8.5.7 The contraction for ONE should in general only be used when all three letters it represents are pronounced as one syllable. In addition, the contraction should be used in the word ending "oney".

Examples: alONE, bONE, dONE, gONE, hONEy, lONEly, mONEy, phONEy, ST/ONE, telephONE; but: anemone [not anemONE], bayonet, [not bayONEt], colonel [not colONEl], phonetic [not phONEtic], sooneST [not soONE/ST]

However, note the following exceptions.

Examples: hONE/ST, mONEtARy

8.5.8. The contraction for PART should generally be used wherever the letters it represents occur.

Examples: aPARTheid, PART/ERre, PARTial, PARTiculAR, PARTook, rePARTee, sPARTan.

However, the TH or THE contractions should be used in preference in words where TH is pronounced as a single sound.

Examples: P/AR/THian, P/AR/THEnon

8.5.9 The contraction for SOME should be used wherever the letters it represents form a definite syllable of the basic word.

Examples: CHromoSOME, hAND/SOME, hAND/SOMEr, hAND/SOME/ST; but blossomED [not blosSOMEd], gasometER, ransomED [not ranSOMEd], somERsault [not SOMErsault].

8.5.10 The contraction for TIME may only be used when the letters it represents are pronounced as one syllable.

Examples: mariTIME, SOME/TIMEs, TIMEr, TIMEx, but cENtime [not cEN/TIME], cENtimetre [not cEN/TIMEtre], multimEDia [not mulTIMEdia].

8.5.11 The contraction for UNDER should be used except when the letters it represents are immediately preceded by the vowels *a* or *o*.

Examples: blUNDER, fUNDER, TH/UNDER, UNDERtake; but bOUndER [not boUNDER], laundER [not laUNDER]

In addition, it should not be used when only the *un* is a prefix.

Example: undERivED [not UNDERivED]

8.5.12 The contraction for THERE may only be used in words of which the word "there" forms a component part.

Examples: THERE/ABOUTs, THERE/AFTER, THEREfrom, but eTHErEAl [not eTHEREal], smiTHEreENs [not smiTHERE/ENs].

8.5.13 The contraction for WHERE should generally be used wherever the letters it represents occur.

Examples: noWHERE, WHERE/UPON, but WH/ER/EVER [not WHEREvER]

8.6 COMPOSITE GROUPSIGNS

8.6.1 Contractions formed with dots 4-6, 5-6 and 6 should generally be used wherever the letters they represent occur except at the beginning of a word.

Examples: bLESS/ING, cANCEl, dANCEr, ENhANCEd, mOUNTaIN, sOUND, wOUND/ED, basTION, ceMENT, GuiNESS, INcONGruOUs, INfIN/ITY, laITY, mONGoose, sIN/FUL/NESS, spONGe, TH/ENCE, creATION, rATION/ALLY, reALLY, rotATION, squALLY

8.6.5 The contraction for NESS may be used in feminine endings except when preceded by e or i, in which case the contractions for EN and IN should be used.

Examples: bARoNESS, govER/NESS, lioNESS, mAR/CHioNESS; but: CHieftaINess, citizENess.

8.6.6 The contraction for ITY should not be used in words like the following

Examples: biscuity [not biscuITY], fruity [not fruITY], hoity-toity [not hoITY-toITY], raBBity [not raBB/ITY].

8.7 SHORTFORMS

8.7.1. Shortforms can in general be used wherever they occur as whole words, whatever their meaning.

Examples: according (agreeing, granting); letter (epistle, one who lets, etc.); must (obligation, mould, new wine, etc); quick (alive, fast).

8.7.2. They may be preceded and followed by additions provided there is no interference with spelling, the basic word retains its original meaning, and the resultant word could not be mistaken for another word.

Examples: children's; get-together; goodies; greateST; letter/ED; but: BEfriENdED; [not BE/friend/ED → BEfrED]; blINdED [not blind/ED → blED]; declAR/ATION [not declare/ATION], muST/ARd [not must/ARd], SH/OUldER [not should/ER].

8.7.3 Shortforms composed of the first letters of a word (e.g. after, blind, friend) may not be used before a vowel when the resulting combination of letters could be mistakenly pronounced as a word.

Examples: aftEReFFects [not after/effects → afeFFects]; BEfriENdED [not BE/friend/ED → BEfrED]; blINdING [not blind/ING → blING]; but blindfold

8.8 PREFERENCE

8.8.1 Preference should normally be given to contractions which cause a word to occupy fewer cells, unless this would result in serious distortion.

Examples: advANCEd [not *advancED], aRIGHT [not *ARiGHt], basTION [not *baSTion], dANCEr [not *dancER], happiNESS [not *happINess], meAND/ER [not *mEAndER], NAMEd [not *namED], TIMEr [not *timER], vENgeANCE [not *vENgEAnce], WITH/ER not *wiTHEr], but tablEAu [not *taBLEau]

8.8.2 The contractions for AND, FOR, OF, THE, WITH should be used in preference to other contractions, provided their use does not waste space.

Examples: baTHEd [not *baTH/ED], efFORt [not *eFFort], OFfER [not *oFF/ER], oTHEr [not *oTH/ER], THEatre [not *TH/EAtre], THEn [not *TH/EN], but TH/ENCE [not *THEnce]

8.8.3 Simple upper groupsigns should be used in preference to simple lower groupsigns, provided their use does not waste space.

Examples: afFORd [not *aFFord], cobBLEr [not *coBBlER], feAR [not *fEAr], gabbled [not *gaBBlED], neARly [not *nEArly], nucleAR [not *nuclEAr], rabBLE [not *raBBle], sacCH/AR/INe [not *saCChAR/INe], wEDdING [not *weDD/ING], *BUT* DIStINct [not *diST/INct], DISturbED [not *diSTurbED].

8.8.5 Simple groupsigns should generally be preferred to composite contractions, provided their use does not waste space.

Examples: adhER/ENt [not *adHEREnt], adhER/ER [not *adHEREr], cohER/ED [not *coHEREd], COMmENcED [not *COMmENCEd], COMponENt[not *COMpONEnt], CONgo [not *cONGo], CONgratulate [not *cONGratulate],CONgruITY [not *cONGruITY], eFFulgENt [not *efFULgENt], expERiENcED [not *expERiENCEd], fENcED [not *fENCEd], gaTHErED [not *gaTHEREd], haDDock [not *HADdock], hER/ED/ITY [not *HEREdITY], INfluENcEA/BLE [not *INfluENCEaBLE], poisonED [not *poisONEd], SHadOW[not *sHAD/OW],silENcER [not *silENCEr], sliTHErED [not *sliTHEREd], SpENcER [not *SpENCEr], telephonED [not *telephONEd], tonER [not *tONEr], wEA/THErED [not *wEA/THEREd].

However, if the form of the word would otherwise be distorted, composite contractions should be used.

Examples: cONEy [not *CONey], limbLESS [not *limBLEss], midDAY [not *miDDay], STrONGhold, [not *STronGHold], WHEREas [not *WH/ER/EAs]

8.8.6. Contractions should not be used which would upset the usual pronunciation of words.

Examples: asTHma not aSThma, creATION not crEA/TION, diSHevellED not DIShevellED, gINGham, not gIN/GHam, isTHmus not iSThums, poSThumOUs not posTHumOUs

8.9 BRIDGING

Prefixes

8.9.1. In general, contractions which bridge a prefix and the remainder of a word are permissible unless their use would make the word hard to assimilate by the reader. In particular the contractions ED, EN, ER, OF and ST are permissible. Note however, the second paragraph of 8.8.3., whereby a lower contraction may be used in preference to one of these upper contractions to avoid bridging.

Examples: dEDuce, dEN/ATIONalise, dENominator, dENote, dERail, dERange, EDict, miSTake, miST/ERm, prEDeST/INe, prEDicaMENT, prEDicTION, prEDomINate, prERogative, prOFile, prOF/OUND, prOFuSION, rED/OU/BLE, rENew
But: aERofoil [not *aER/OFoil], BEratED [not *bERatED], comate [not *COMate], deactivate [not *dEActivate], disulphide [not *DISulphide], INessENtial [not *iNESS/ENtial], kilowatt [not *kilOWatt], misheAR [not *miSHeAR], react [not *rEAct], sublet [not *suBLEt]

8.9.2 Except in the case of the contraction for EA it is usually not advisable to take advantage of a prefix in order to use a contraction which could not have been used in the original word.

Examples: DIS/INgENiOUs [not *DIS/ING/ENiOUs], electroencephalogram [not *electroENCEphalogram], unblemiSH/ED [not *unBLEmiSH/ED], unfulfillED [not *unFULfillED], unlessonED [not *unLESSonED]; but DIS/EAse, unEAtaBLE.

Suffixes

8.9.3 Generally speaking, a contraction may bridge a word and its suffix.

Examples: borEDom, dukEDom, freEDom, orangERy, savagERy

However, bridging contractions should be avoided when aspirated *h* is preceded by *c*, *g*, *s*, *t*, or *w*, and in certain other cases.

Examples: Cunnyngham [not *CunnynGHam], kniGHthood [not *kniGH/THood], biscuity [not *biscuITY], orangeade [not *orangEAde].

Compound Words

8.9.4 Contractions should not be used to bridge elements of compound words.

Examples: bottleneck [not *bottlENeck], hEAddress [not *hEA/DDress], hideaway [not *hidEAway], IndiaruBB/ER [not *INdiARuBB/ER], INsofAR [not *INsOF/AR], kettledrum [not *kettlEDrum], paINstakING [not *paIN/STakING], STateroom [not *STatERoom].

8.9.5 The contractions for CH, GH, SH, TH, THE, WH should not be used when the *h* is aspirated at the beginning of a clearly marked syllable.

Examples: cARthorse, cOWhERd, eGGhEAd, grasshoppER, lONGhAND, rawhide, STrONGhold, sweetheARt

Diphthongs

8.9.6 The contraction for EA should not be used when the *e* or *a* forms part of the diphthong ae, whether printed as such [i.e. æ] or not.

Examples: Judaean [not *JudaEAn], Liliaceae [not *LiliacEAe]

Appendix B: Error Patterns

A Spelling errors

	data	target	error type	specification1	specification 2	task	subject[112]
1.	* *mARvelOUs	mARvellOUs marvellous	spelling error also in control group	omission	gemination error	2	S 12-0
2.	* *mARvelOUs	mARvellOUs marvellous	spelling error also in control group	omission	gemination error	2	S 28-0
3.	* *mARvelOUs	mARvellOUs marvellous	spelling error also in control group	omission	gemination error	2	S 19-1
4.	* * mARvolOUs	mARvellOUs marvellous	spelling error also in control group	omission	gemination error	2	S 35-1
5.	* *joy<u>FUL</u>y	joy<u>FUL</u>ly joyfully	spelling error also in control group	omission	gemination error	7	S 28-0
6.	* *joy<u>FUL</u>y	joy<u>FUL</u>ly joyfully	spelling error also in control group	omission	gemination error	7	S 30-0
7.	* * cARrotts	cARrots carrots	spelling error, also in control group	insertion	gemination error	2	S 15-1
8.	* * co-oppER/<u>ATION</u>	co-opER/<u>ATION</u> co-operation	spelling error, also in control group	insertion	gemination error	2	S 35-1

[112] The subject code includes the number, whether they are former print readers "-1" or not "-0". Handedness is indicated by –L for *lefthanded* and LR for ambidextrous but braillists. Thus S 23-0-LR is by subject 23 who is a congenitally blind ambidextrous braillist.

	data	target	error type	specification1	specification2	task	subject
9.	*⠉⠕⠗⠗⠊⠯⠻ *corriAND/ER	⠉⠕⠗⠊⠯⠻ coriAND/ER coriander	spelling error, also in control group	insertion	gemination error	4	S 33-1
10.	*⠓⠁⠙⠕⠉⠅ *hadock	⠓⠁⠲⠕⠉⠅ haDDock haddock	spelling error also in control group	omission	gemination error	5	S 29-0-LR
11.	*⠝⠑⠉⠑⠎⠰⠽ *necesITY	⠝⠑⠉⠑⠎⠎⠰⠽ necessITY necessity	spelling error also in control group	omission	gemination error	2	S 12-0
12.	*⠝⠑⠉⠑⠎⠰⠽ *necesITY	⠝⠑⠉⠑⠎⠎⠰⠽ necessITY necessity	spelling error also in control group	omission	gemination error	2	S 30-0
13.	*⠝⠑⠎⠎⠑⠎⠎⠰⠽ *nessessITY	⠝⠑⠉⠑⠎⠎⠰⠽ necessITY necessity	spelling error, also in control group	grapheme substitution	gemination error	2	S 25-0-LR
14.	*⠝⠕⠗⠍⠁⠇⠽ *normaly	⠝⠕⠗⠍⠠⠽ normALLY normally	spelling error also in control group	omission	gemination error	7	S 23-0-LR
15.	*⠏⠗⠷⠋⠑⠨⠝⠠⠽ *prOFfeSION/ALLY	⠏⠗⠷⠑⠎⠨⠝⠠⠽ prOFesSION/ALLY professionally	spelling error, also in control group	complex substitution	gemination error	7	S 18-0
16.	*⠏⠗⠷⠋⠑⠨⠝⠠⠽ *prOFfeSION/ALLY	⠏⠗⠷⠑⠎⠨⠝⠠⠽ prOFesSION/ALLY professionally	spelling error, also in control group	complex substitution	gemination error	7	S 33-1
17.	*⠏⠗⠷⠋⠑⠨⠝⠁⠇ *prOFfeSIONal	⠏⠗⠷⠑⠎⠨⠝⠁⠇ prOFesSIONal professional	spelling error, also in control group	complex substitution	gemination error	7	S 10-0
18.	*⠏⠗⠷⠋⠑⠨⠝⠁⠇ *prOFfeSIONal	⠏⠗⠷⠑⠎⠨⠝⠁⠇ prOFesSIONal professional	spelling error, also in control group	complex substitution	gemination error	7	S 12-0

	data	target	error type	specification 1	specification 2	task	subject
19.	*⠏⠗⠷⠋⠑⠨⠝⠁⠇ *prOFfeSIONal	⠏⠗⠷⠑⠎⠨⠝⠁⠇ prOFesSIONal professional	spelling error, also in control group	complex substitution	gemination error	7	S 18-0
20.	*⠗⠂⠇⠽ *rEAly	⠗⠑⠠⠽ reALLY really	spelling error also in control group	omission	gemination error	5	S 23-0-LR
21.	*⠗⠂⠇⠽ *rEAly	⠗⠑⠠⠽ reALLY really	spelling error also in control group	omission	gemination error	7	S 23-0-LR
22.	*⠗⠑⠉⠕⠍⠢⠙⠠⠝⠎ *recomENdATIONs	⠗⠑⠉⠕⠍⠍⠢⠙⠠⠝⠎ recommENdATIONs recommendations	spelling error also in control group	omission	gemination error	2	S 12-0
23.	*⠗⠑⠉⠕⠍⠢⠙⠠⠝⠎ *recomENdATIONs	⠗⠑⠉⠕⠍⠍⠢⠙⠠⠝⠎ recommENdATIONs recommendations	spelling error also in control group	omission	gemination error	2	S 18-0
24.	*⠗⠑⠉⠕⠍⠢⠙⠠⠝⠎ *recomENdATIONs	⠗⠑⠉⠕⠍⠍⠢⠙⠠⠝⠎ recommENdATIONs recommendations	spelling error also in control group	omission	gemination error	2	S 23-0-LR
25.	*⠗⠑⠉⠕⠍⠢⠙⠠⠝⠎ *recomENdATIONs	⠗⠑⠉⠕⠍⠍⠢⠙⠠⠝⠎ recommENdATIONs recommendations	spelling error also in control group	omission	gemination error	2	S 25-0-LR
	*⠗⠑⠉⠕⠍⠢⠙⠠⠝⠎ *recomENdATIONs	⠗⠑⠉⠕⠍⠍⠢⠙⠠⠝⠎ recommENdATIONs recommendations	spelling error also in control group	omission	gemination error	2	S 28-0
26.	*⠗⠑⠉⠕⠍⠢⠙⠠⠝⠎ *recomENdATIONs	⠗⠑⠉⠕⠍⠍⠢⠙⠠⠝⠎ recommENdATIONs recommendations	spelling error also in control group	omission	gemination error	2	S 30-0
27.	*⠗⠑⠉⠕⠍⠢⠙⠠⠝⠎ *recomENdATIONs	⠗⠑⠉⠕⠍⠍⠢⠙⠠⠝⠎ recommENdATIONs recommendations	spelling error also in control group	omission	gemination error	2	S 35-1

	data	target	error type	specification 1	specification 2	task	subject
28.	*⠗⠑⠒⠕⠍⠢⠙⠠⠝⠎ reCComENdATIONs	⠗⠑⠉⠕⠍⠍⠢⠙⠠⠝⠎ recommENdATIONs recommendations	spelling error, also in control group	complex substitution	gemination error	2	S 2-0
29.	*⠗⠑⠒⠕⠍⠢⠙⠠⠝⠎ reCComENdATIONs	⠗⠑⠉⠕⠍⠍⠢⠙⠠⠝⠎ recommENdATIONs recommendations	spelling error, also in control group	complex substitution	gemination error	2	S 29-0
30.	*⠗⠕⠒⠕⠍⠢⠙⠠⠝⠎ *roCComENdATIONs	⠗⠑⠉⠕⠍⠍⠢⠙⠠⠝⠎ recommENdATIONs recommendations	spelling error, also in control group	complex substitution	gemination error	2	S 8-1
31.	*⠓⠕⠁⠌ *hoaST	⠓⠕⠌ hoST host	spelling error, also in control group	grapheme substitution	phonetic spelling	3	S 2-0
32.	*⠓⠕⠁⠌ *hoaST	⠓⠕⠌ hoST host	spelling error, also in control group	grapheme substitution	phonetic spelling	3	S 22-1-L
33.	*⠓⠕⠁⠌ *hoaST	⠓⠕⠌ hoST host	spelling error, also in control group	grapheme substitution	phonetic spelling	3	S 24-0
34.	*⠛⠕⠧⠻⠝⠰⠞⠎ *govER/MENTs	⠛⠕⠧⠻⠝⠰⠞⠎ govERnMENTs governments	spelling error also in control group	omission	phonetic spelling	2	S 33-1
35.	*⠛⠕⠧⠻⠝⠰⠞⠎ *govER/MENTs	⠛⠕⠧⠻⠝⠰⠞⠎ govERnMENTs governments	spelling error also in control group	omission	phonetic spelling	2	S 23-0-LR
36.	*⠕⠗⠮⠝⠞⠊⠉ * orTHEntic	⠁⠥⠮⠝⠞⠊⠉ auTHEntic authentic	spelling error, also in control group	complex substitution	phonetic spelling	2	S 8-1
37.	*⠕⠗⠮⠝⠞⠊⠉ * orTHEntic	⠁⠥⠮⠝⠞⠊⠉ auTHEntic authentic	spelling error, also in control group	complex substitution	phonetic spelling	2	S 33-1

	data	target	error type	specification 1	specification 2	task	subject
38.	*⠒⠛⠂⠝⠊⠁⠇ *CONgEAnial	⠒⠛⠢⠊⠁⠇ CONgENial congenial	spelling error, also in control group	grapheme substitution	phonetic spelling	2	S 35-1
39.	*⠃⠥⠖⠑⠽ * buFFey	⠃⠥⠖⠑⠞ buFFet buffet	spelling error, also in control group	grapheme substitution	phonetic spelling	2	S 22-1-L
40.	*⠇⠫⠛⠊⠎⠇⠠⠝ *lEDgisl<u>ATION</u>	⠇⠑⠛⠊⠎⠇⠠⠝ legisl<u>ATION</u> legislation	spelling error, also in control group	insertion	phonetic spelling	2	S 25-0-LR
41.	*⠍⠁⠩⠍⠁⠇⠇⠪ * maSHmallOWxxx	⠍⠜⠩⠍⠁⠇⠇⠪ mAR/SHmallOW marshmallow	spelling error also in control group	omission	phonetic spelling	2	S 9-0
42.	*⠽⠕⠞ *yot	⠽⠁⠡⠞ yaCHt yacht	spelling error, also in control group	complex substitution	phonetic spelling	3	<u>S 2-0</u>
43.	*⠽⠕⠞ *yot	⠽⠁⠡⠞ yaCHt yacht	spelling error, also in control group	complex substitution	phonetic spelling	4	S 23-0-LR
44.	*⠽⠕⠞ *yot	⠽⠁⠡⠞ yaCHt yacht	spelling error, also in control group	complex substitution	phonetic spelling	4	S 29-0
45.	*⠙⠑⠇⠊⠛⠠⠝ *deligATION	⠙⠑⠇⠑⠛⠠⠝ deleg<u>ATION</u> delegation	spelling error, also in control group	grapheme substitution	representation of short vowel	2	S 35-1
46.	*⠙⠑⠇⠊⠛⠠⠝ *deligATION	⠙⠑⠇⠑⠛⠠⠝ deleg<u>ATION</u> delegation	spelling error, also in control group	grapheme substitution	representation of unstressed short vowel	2	S 8-1
47.	*⠙⠑⠇⠊⠛⠠⠝ *deligATION	⠙⠑⠇⠑⠛⠠⠝ deleg<u>ATION</u> delegation	spelling error, also in control group	grapheme substitution	representation of unstressed short vowel	2	S 10-1

	data	target	error type	specification 1	specification 2	task	subject
48.	*⠙⠑⠇⠊⠛⠠⠝ *deligATION	⠙⠑⠇⠑⠛⠠⠝ delegATION delegation	spelling error, also in control group	grapheme substitution	representation of unstressed short vowel	2	S 12-0
49.	*⠙⠑⠇⠊⠛⠠⠝ *deligATION	⠙⠑⠇⠑⠛⠠⠝ delegATION delegation	spelling error, also in control group	grapheme substitution	representation of unstressed short vowel	2	S 18-0
50.	*⠙⠑⠇⠊⠛⠠⠝ *deligATION	⠙⠑⠇⠑⠛⠠⠝ delegATION delegation	spelling error, also in control group	grapheme substitution	representation of unstressed short vowel	2	S 22-1-L
51.	*⠙⠑⠇⠊⠛⠠⠝ *deligATION	⠙⠑⠇⠑⠛⠠⠝ delegATION delegation	spelling error, also in control group	grapheme substitution	representation of unstressed short vowel	2	S 23-0-LR
52.	*⠙⠑⠇⠊⠛⠠⠝ *deligATION	⠙⠑⠇⠑⠛⠠⠝ delegATION delegation	spelling error, also in control group	grapheme substitution	representation of unstressed short vowel	2	S 24-0
53.	*⠙⠑⠇⠊⠛⠠⠝ *deligATION	⠙⠑⠇⠑⠛⠠⠝ delegATION delegation	spelling error, also in control group	grapheme substitution	representation of unstressed short vowel	2	S 25-0-LR
54.	*⠙⠑⠇⠊⠛⠠⠝ *deligATION	⠙⠑⠇⠑⠛⠠⠝ delegATION delegation	spelling error, also in control group	grapheme substitution	representation of unstressed short vowel	2	S 28-0
55.	*⠙⠑⠇⠊⠛⠠⠝ *deligATION	⠙⠑⠇⠑⠛⠠⠝ delegATION delegation	spelling error, also in control group	grapheme substitution	representation of unstressed short vowel	2	S 30-0
56.	*⠎⠏⠔⠊⠡ *spINiCH	⠎⠏⠔⠁⠡ spINaCH spinach	spelling error, also in control group	grapheme substitution	representation of unstressed short vowel	4	S 29-0
57.	*⠍⠑⠑⠞⠇⠕⠁⠋ * meetloaf	⠍⠂⠞⠇⠕⠁⠋ mEAtloaf meatloaf	spelling error, also in control group	grapheme substitution	homophone	2	S 12-0

	data	target	error type	specification 1	specification 2	task	subject
58.	*⠏⠁⠊⠗ *pair	⠏⠑⠜ peAR pear	spelling error, also in control group	complex substitution	homophone	3	S 28-0
59.	*⠎⠕⠗⠞ *sort	⠎⠐⠳ sOUGHT sought	spelling error, also in control group	complex substitution	homophone	2	S 24-0
60.	*⠎⠕⠗⠞ *sort	⠎⠐⠳ sOUGHT sought	spelling error, also in control group	complex substitution	homophone	2	S 25-0-LR
61.	*⠎⠕⠗⠞ *sort	⠎⠐⠳ sOUGHT sought	spelling error, also in control group	complex substitution	homophone	2	S 28-0
62.	*⠎⠕⠗⠞ *sort	⠎⠐⠳ sOUGHT sought	spelling error, also in control group	complex substitution	homophone	2	S 29-0
63.	*⠎⠕⠗⠞ *sort	⠎⠐⠳ sOUGHT sought	spelling error, also in control group	complex substitution	homophone	2	S 8-1
64.	*⠎⠕⠗⠞ *sort	⠎⠐⠳ sOUGHT sought	spelling error, also in control group	complex substitution	homophone	2	S 15-1
65.	*⠛⠗⠯⠐⠍⠄⠎ *grAND/MOTHER's	⠛⠗⠯⠐⠍⠎ grAND/MOTHERs grandmothers	spelling error	other	morphological error	9	S 23-0-LR
66.	*⠏⠁⠌ *past	⠏⠁⠎⠎⠫ passED passed	spelling error, also in control group	other	morphological error	2	S 2-0
67.	*⠏⠁⠌ *past	⠏⠁⠎⠎⠫ passED passed	spelling error, also in control group	other	morphological error	2	S 9-0

	data	target	error type	specification 1	specification 2	task	subject
68.	*⠏⠁⠌ *past	⠏⠁⠎⠎⠫ passED passed	spelling error, also in control group	other	morphological error	2	S 29-0
	*⠞⠑⠁⠄⠎ *tea's	⠞⠂⠎ tEAs teas	spelling error, also in control group	other	morphological error	2	S 12-0
69.	*⠞⠑⠁⠄⠎ *tea's	⠞⠂⠎ tEAs teas	spelling error, also in control group	other	morphological error	2	S 22-1-L
70.	*⠒⠤⠃⠔ *COMbIN	⠤⠃⠔⠑ COMbINe combine	spelling error, also in control group	grapheme substitution		2	S 2-0

Error patterns not paralleled in the control group

	data	target	error type	specification1	specification 2	task	subject
1.	*⠤⠍⠑⠞ *COMmet	⠤⠑⠞ COMet comet	spelling error	insertion	gemination error	8	S 18-0
2.	*⠤⠍⠑⠞ *COMmet	⠤⠑⠞ COMet comet	spelling error	insertion	gemination error	8	S 24-0
3.	*⠤⠍⠑⠞ *COMmet	⠤⠑⠞ COMet comet	spelling error	insertion	gemination error	8	S 25-0-LR
4.	*⠤⠍⠑⠞ *COMmet	⠤⠑⠞ COMet comet	spelling error	insertion	gemination error	8	S 34-0-LR
5.	*⠤⠍⠑⠞ *COMmet	⠤⠑⠞ COMet comet	spelling error	insertion	gemination error	8	S 10-1

	data	target	error type	specification1	specification 2	task	subject
6.	*⠤⠍⠑⠞ *COMmet	⠤⠑⠞ COMet comet	spelling error	insertion	gemination error	8	S 15-1
7.	*⠤⠍⠑⠞ *COMmet	⠤⠑⠞ COMet comet	spelling error	insertion	gemination error	8	S 22-1-L
8.	*⠑⠿⠞ *eFORt	⠑⠋⠿⠞ efFORt effort	spelling error	omission	gemination error	9	S 9-0
9.	*⠑⠿⠞⠎ *eFORts	⠑⠋⠿⠞⠎ efFORts efforts	spelling error	omission	gemination error	9	S 9-0
10.	*⠑⠿⠞ *eFORt	⠑⠋⠿⠞ efFORt effort	spelling error	omission	gemination error	9	S 23-0-LR
11.	*⠑⠿⠞⠎ *eFORts	⠑⠋⠿⠞⠎ efFORts efforts	spelling error	omission	gemination error	9	S 23-0-LR
12.	*⠑⠿⠞ *eFORt	⠑⠋⠿⠞ efFORt effort	spelling error	omission	gemination error	9	S 24-0
13.	*⠑⠿⠞⠎ *eFORts	⠑⠋⠿⠞⠎ efFORts efforts	spelling error	omission	gemination error	9	S 24-0
14.	*⠑⠿⠞ *eFORt	⠑⠋⠿⠞ efFORt effort	spelling error	omission	gemination error	9	S-29-0
15.	*⠑⠿⠞⠎ *eFORts	⠑⠋⠿⠞⠎ efFORts efforts	spelling error	omission	gemination error	9	S-29-0

	data	target	error type	specification 1	specification 2	task	subject
16.	*⠉⠜⠕⠞ *cARot	⠉⠜⠗⠕⠞ cARrot carrot	spelling error	omission	gemination error	3	<u>S 2-0</u>
17.	*⠉⠜⠕⠞⠎ *cARots	⠉⠜⠗⠕⠞⠎ cARrots carrots	spelling error	omission	gemination error	2	S 23-0-LR
18.	*⠉⠜⠕⠞⠎ *cARots	⠉⠜⠗⠕⠞⠎ cARrots carrots	spelling error	omission	gemination error	2	S 28-0
19.	*⠞⠕⠏⠫ *topED	⠞⠕⠏⠏⠫ toppED topped	spelling error	omission	gemination error	2	S 9-0
20.	*⠞⠕⠏⠫ *topED	⠞⠕⠏⠏⠫ toppED topped	spelling error	omission	gemination error	2	S 23-0-LR
21.	*⠷⠻ *OF/ER	⠷⠋⠻ OFfER offer	spelling error	omission	gemination error	9	S 23-0-LR
22.	*⠷⠻⠎ *OF/ERs	⠷⠋⠻⠎ OFfERs offers	spelling error	omission	gemination error	9	S 23-0-LR
23.	*⠑⠛ *eg	⠑⠛⠛ egg	spelling error	omission	gemination error	9	S 12-0
24.	*⠑⠛⠎ *egs	⠑⠶⠎ eGGs eggs	spelling error	omission	gemination error	9	S 12-0
25.	*⠿⠜⠍ *FOR/ARm	⠿⠑⠜⠍ FOReARm forearm	spelling error	omission	phonetic spelling	5	S 8-1

	data	target	error type	specification1	specification2	task	subject
26.	*FOR/ARm	FOReARm forearm	spelling error	omission	phonetic spelling	5	S 23-0-LR
27.	*mAR/SH mellOW	mAR/SHmallOW marshmallow	spelling error	grapheme substitution	phonetic spelling	2	S 10-1
28.	*mAR/SHmellOW	mAR/SHmallOW marshmallow	spelling error	grapheme substitution	phonetic spelling	2	S 15-1
29.	*mAR/SHmellOW	mAR/SHmallOW marshmallow	spelling error	grapheme substitution	phonetic spelling	2	S 19-1
30.	*mAR/SHmellOW	mAR/SHmallOW marshmallow	spelling error	grapheme substitution	phonetic spelling	2	S 22-1
31.	*mAR/SHmellOW	mAR/SHmallOW marshmallow	spelling error	grapheme substitution	phonetic spelling	2	S 33-1
32.	*mST/SHmellOW	mAR/SHmallOW marshmallow	spelling error	grapheme substitution	phonetic spelling	2	S 35-1
33.	*mAR/SHmellOW	mAR/SHmallOW marshmallow	spelling error	grapheme substitution	phonetic spelling	2	S 18-0
34.	*mAR/SHmellOW	mAR/SHmallOW marshmallow	spelling error	grapheme substitution	phonetic spelling	2	S 23-0-LR
35.	*mAR/SHmellOW	mAR/SHmallOW marshmallow	spelling error	grapheme substitution	phonetic spelling	2	S 24-0

	data	target	error type	specification 1	specification 2	task	subject
36.	* *mAR/SHmellOW	mAR/SHmallOW marshmallow	spelling error	grapheme substitution	phonetic spelling	2	S 28-0
37.	* *mAR/SHmellOW	mAR/SHmallOW marshmallow	spelling error	grapheme substitution	phonetic spelling	2	S 29-0
38.	* *mAR/SHmellOW	mAR/SHmallOW marshmallow	spelling error	grapheme substitution	phonetic spelling	2	S 12-0
39.	* *dINGy	dINGhy dinghy	spelling error	grapheme substitution	phonetic spelling	4	S 10-1
40.	* *dINGy	dINGhy dinghy	spelling error	grapheme substitution	phonetic spelling	4	S 18-0
41.	* *dINGy	dINGhy dinghy	spelling error	grapheme substitution	phonetic spelling	4	S 22-1-L
42.	* * guvERnMENTs	govERnMENTs governments	spelling error	grapheme substitution	phonetic spelling	2	S 19-1
43.	* * bguvERnMENT	govERnMENTs governments	spelling error	grapheme substitution	phonetic spelling	2	S 9-0
44.	* *lemonbARm	lemon balm	spelling error	grapheme substitution	dialect spelling	4	S 12-0
45.	* *lemonbARm	lemon balm	spelling error	grapheme substitution	dialect spelling	4	S 25-0-LR

	data	target	error type	specification 1	specification 2	task	subject
46.	*⠐⠞ *TIME	⠹⠽⠍⠑ THyme thyme	spelling error	complex substitution	homophone	4	S 2-0
47.	*⠐⠞ *TIME	⠹⠽⠍⠑ THyme thyme	spelling error	complex substitution	homophone	4	S 25-0-LR
48.	*⠐⠞ *TIME	⠹⠽⠍⠑ THyme thyme	spelling error	complex substitution	homophone	4	S 19-1
	*⠐⠞⠓⠁⠞ *TIME	⠹⠽⠍⠑ THyme thyme	spelling error	complex substitution	homophone	4	S 22-1-L
49.	*⠐⠞ *TIME	⠹⠽⠍⠑ THyme thyme	spelling error	complex substitution	homophone	4	S 33-1
50.	*⠏⠥⠑ *pue	⠏⠑⠺ pew	spelling error	complex substitution	phonetic spelling	6	S 9-0
51.	*⠏⠥⠑ *pue	⠏⠑⠺ pew	spelling error	complex substitution	phonetic spelling	6	S 25-0-LR
52.	*⠏⠥⠑ *pue	⠏⠑⠺ pew	spelling error	complex substitution	phonetic spelling	6	S 10-1
53.	*⠏⠥⠑ *pue	⠏⠑⠺ pew	spelling error	complex substitution	phonetic spelling	6	S 19-1
54.	*⠽⠁⠥⠣⠞ *yauGHt	⠽⠁⠡⠞ yaCHt yacht	spelling error	complex substitution		3	S 10-1

	data	target	error type	specification 1	specification 2	task	subject
55.	*⠽⠁⠥⠣⠞ *yauGHt	⠽⠁⠡⠞ yaCHt yacht	spelling error	complex substitution		4	S 19-1
56.	*⠽⠁⠥⠣⠞ *yauGHt	⠽⠁⠡⠞ yaCHt yacht	spelling error	complex substitution		4	S 33-1
57.	*⠎⠺⠑⠫ *sweED	⠎⠺⠫⠑ swEDe swede	spelling error	transposition	phonetic spelling	4	S 12-0
58.	*⠎⠺⠑⠫ *sweED	⠎⠺⠫⠑ swEDe swede	spelling error	transposition	phonetic spelling	4	S 24-0

B Braille code errors

	data	target	error type	specification1	specification2	task	subject
1.	*⠓⠕⠕⠋ *hoof	⠓⠕⠷ hoOF hoof	braille code error	0-ugs[113]	IC[114]	5	S 23-0-LR
2.	*⠓⠕⠕⠋ *hoof	⠓⠕⠷ hoOF hoof	braille code error	0-ugs	IC	5	S 8-1
3.	*⠓⠕⠕⠋ *hoof	⠓⠕⠷ hoOF hoof	braille code error	0-ugs	IC	5	S 15-1
4.	*⠓⠕⠕⠋ *hoof	⠓⠕⠷ hoOF hoof	braille code error	0-ugs	IC	5	S 19-1

113 Zero realisation of upper groupsign
114 Incompatible with word segmentation

	data	target	error type	specification1	specification2	task	subject
5.	*⠓⠕⠕⠋ *hoof	⠓⠕⠷ hoOF hoof	braille code error	0-ugs	IC	5	S 33-1
6.	*⠏⠗⠕⠋⠑⠎⠨⠝⠁⠇ *profesSIONal	⠏⠗⠷⠑⠎⠨⠝⠁⠇ prOFesSIONal professional	braille code error	0-ugs	IC	7	S 24-0
7.	*⠏⠗⠕⠋⠑⠎⠨⠝⠠⠽ * profesSION/ALLY	⠏⠗⠷⠑⠎⠨⠝⠠⠽ prOFesSION/ALLY professionally	braille code error	0-ugs	IC	7	S 24-0
8.	*⠏⠗⠕⠋⠑⠎⠨⠝⠠⠽ * profesSION/ALLY	⠏⠗⠷⠑⠎⠨⠝⠠⠽ prOFesSION/ALLY professionally	braille code error	0-ugs	IC	7	S 35-1
9.	*⠏⠗⠕⠋⠑⠎⠰⠝⠠⠽ *profesTION/ALLY	⠏⠗⠷⠑⠎⠨⠝⠠⠽ prOFesSION/ALLY professionally	braille code error	0-ugs	IC, f-cgs[115]	7	S 15-1
10.	*⠋⠊⠝⠠⠽ *finALLY	⠋⠔⠠⠽ fIN/ALLY finally	braille code error	0-lgs[116]	IC	2	S 33-1
11.	*⠋⠊⠝⠠⠽ *finALLY	⠋⠔⠠⠽ fIN/ALLY finally	braille code error	0-lgs	IC	7	S 8-1
12.	*⠋⠊⠝⠠⠽ *finALLY	⠋⠔⠠⠽ fIN/ALLY finally	braille code error	0-lgs	IC	7	S 23-0-LR
13.	*⠓⠂⠗⠞ *hEArt	⠓⠑⠜⠞ heARt heart	braille code error	0-ugs	IC	5	S 15-1

[115] Wrong use of composite groupsign
[116] Zero realisation of lower groupsign

	data	target	error type	specification1	specification2	task	subject
14.	* *appEArED	appear/ED appeared	braille code error	0-lgs	IC	2	S 15-1
15.	* *brain	braIN brain	braille code error	0-lgs	IC	5	S 18-0
16.	* *passED by FROM	passED BY/FROM passed by from	braille code error	0-lws[117]	IC	2	S 14-0
17.	* *passED by FROM	passED BY/FROM passed by from	braille code error	0-lws	IC	2	S 18-0
18.	* *passED by FROM	passED BY/FROM passed by from	braille code error	0-lws	IC	2	S 23-0-LR
19.	* *passED by FROM	passED BY/FROM passed by from	braille code error	0-lws	IC	2	S 34-0-LR
20.	* *passED by FROM	passED BY/FROM passed by from	braille code error	0-lws	IC	2	S 8-1
21.	* *passED by FROM	passED BY/FROM passed by from	braille code error	0-lws	IC	2	S 10-1
22.	* *passED by FROM	passED BY/FROM passed by from	braille code error	0-lws	IC	2	S 35-1

[117] Zero realisation of lower wordsign

	data	target	error type	specification1	specification2	task	subject
23.	*⠁⠹⠢⠞⠊⠉ *auTH/ENtic	⠁⠥⠮⠝⠞⠊⠉ auTHEntic authentic	braille code error	0-ugs		2	S 10-1
24.	*⠁⠹⠢⠞⠊⠉ *auTH/ENtic	⠁⠥⠮⠝⠞⠊⠉ auTHEntic authentic	braille code error	0-ugs		2	S 12-0
25.	*⠁⠹⠢⠞⠊⠉ *auTH/ENtic	⠁⠥⠮⠝⠞⠊⠉ auTHEntic authentic	braille code error	0-ugs		2	S 18-0
26.	*⠁⠹⠢⠞⠊⠉ *auTH/ENtic	⠁⠥⠮⠝⠞⠊⠉ auTHEntic authentic	braille code error	0-ugs		2	S 24-0
27.	*⠁⠹⠢⠞⠊⠉ *auTH/ENtic	⠁⠥⠮⠝⠞⠊⠉ auTHEntic authentic	braille code error	0-ugs		2	S 25-0-LR
28.	*⠁⠹⠢⠞⠊⠉ *auTH/ENtic	⠁⠥⠮⠝⠞⠊⠉ auTHEntic authentic	braille code error	0-ugs		2	S 30-0
29.	*⠁⠹⠢⠞⠊⠉ *auTH/ENtic	⠁⠥⠮⠝⠞⠊⠉ auTHEntic authentic	braille code error	0-ugs		2	S 35-1
30.	*⠁⠥⠹⠑⠝⠞⠊⠉ *auTHentic	⠁⠥⠮⠝⠞⠊⠉ auTHEntic authentic	braille code error	0-ugs		2	S 23-0-LR
31.	*⠃⠁⠹⠑ *baTHe	⠃⠁⠮ baTHE bathe	braille code error	0-ugs	⠮ IC	8	S 9-0
32.	*⠃⠁⠹⠑ *baTHe	⠃⠁⠮ baTHE bathe	braille code error	0-ugs	⠮ IC	8	S 12-0

	data	target	error type	specification1	specification2	task	subject
33.	*⠃⠁⠹⠑ *baTHe	⠃⠁⠮ baTHE bathe	braille code error	0-ugs	⠮ IC	8	S 15-1
34.	*⠃⠁⠹⠑ *baTHe	⠃⠁⠮ baTHE bathe	braille code error	0-ugs	⠮ IC	8	S 35-1
35.	*⠑⠖⠕⠗⠞ *eFFort	⠑⠋⠿⠞ efFORt effort	braille code error	0-ugs	gemination	9	S 15-1
36.	*⠑⠖⠕⠗⠞⠎ *eFForts	⠑⠋⠿⠞⠎ efFORts efforts	braille code error	0-ugs	gemination	9	S 15-1
37.	*⠑⠖⠕⠗⠞ *eFFort	⠑⠋⠿⠞ efFORt effort	braille code error	0-ugs	gemination	9	S 19-1
38.	*⠑⠖⠕⠗⠞⠎ *eFForts	⠑⠋⠿⠞⠎ efFORts efforts	braille code error	0-ugs	⠿ gemination	9	S 19-1
39.	*⠑⠖⠕⠗⠞ *eFFort	⠑⠋⠿⠞ efFORt effort	braille code error	0-ugs	⠿ gemination	9	S 33-1
40.	*⠑⠖⠕⠗⠞⠎ *eFForts	⠑⠋⠿⠞⠎ efFORts efforts	braille code error	0-ugs	⠿ gemination	9	S 33-1
41.	*⠑⠖⠕⠗⠞ *eFFort	⠑⠋⠿⠞ efFORt effort	braille code error	0-ugs	⠿ gemination	9	S 35-1
42.	*⠑⠖⠕⠗⠞⠎ *eFForts	⠑⠋⠿⠞⠎ efFORts efforts	braille code error	0-ugs	⠿ gemination	9	S 35-1

	data	target	error type	specification1	specification2	task	subject
43.	*⠕⠋⠋⠻ *offER	⠷⠋⠻ OFfER offer	braille code error	0-ugs	⠷gemination	9	S 2-0
44.	*⠕⠋⠋⠻⠎ *offERs	⠷⠋⠻⠎ OFfERs offers	braille code error	0-ugs	⠷mm	9	S 2-0
45.	*⠕⠖⠻ *oFF/ER	⠷⠋⠻ OFfER offer	braille code error	0-ugs	⠷mm	9	S 15-1
46.	*⠕⠖⠻⠎ *oFF/ERs	⠷⠋⠻⠎ OFfERs offers	braille code error	0-ugs	⠷mm	9	S 15-1
47.	*⠕⠖⠻ *oFF/ER	⠷⠋⠻ OFfER offer	braille code error	0-ugs	⠷gemination	9	S 19-1
48.	*⠕⠖⠻⠎ *oFF/ERs	⠷⠋⠻⠎ OFfERs offers	braille code error	0-ugs	⠷gemination	9	S 19-1
49.	*⠕⠋⠞⠢ *oftEN	⠷⠞⠢ OFtEN often	braille code error	0-ugs	⠷	5	S 8-1
50.	*⠕⠋⠞⠢ *oftEN	⠷⠞⠢ OFtEN often	braille code error	0-ugs	⠷	5	S 15-1
51.	*⠉⠁⠗⠗⠕⠞⠎ *carrots	⠉⠜⠗⠕⠞⠎ cARrots carrots	braille code error	0-ugs	⠜ mm	2	S 35-1
52.	*⠉⠁⠗⠗⠕⠞ *carrot	⠉⠜⠗⠕⠞ cARrot carrot	braille code error	0-ugs	⠜ mm	4	S 34-0-LR

	data	target	error type	specification1	specification2	task	subject
53.	* *sparrOW	spARrOW sparrow	braille code error	0-ugs	mm	5	S 15-1
54.	* *sparrOW	spARrOW sparrow	braille code error	0-ugs	mm	5	S 19-1
55.	* *stAND	ST/AND stand	braille code error	0-ugs		6	S 19-1
56.	* *stAND	ST/AND stand	braille code error	0-ugs		6	S 23-0-LR
57.	* *grandMOTHERs	grAND/MOTHERs grandmothers	braille code error	0-ugs		9	S 35-1
58.	* *grandMOTHER	grAND/MOTHER grandmother	braille code error	0-ugs	, + L_2	9	S 35-1
59.	* *teas	tEAs teas	braille code error	0-lgs		2	S 10-1
60.	* *peas	pEAs peas	braille code error	0-lgs		2	S 10-1
61.	* *ideas	idEAs ideas	braille code error	0-lgs		9	S 10-1
62.	* *teas	tEAs teas	braille code error	0-lgs		2	S 18-0

	data	target	error type	specification1	specification2	task	subject
63.	*⠏⠑⠁⠎⠑ *peas	⠏⠂⠎ pEAs peas	braille code error	0-lgs	⠂	2	S 19-1
64.	*⠊⠙⠑⠁⠎ *ideas	⠊⠙⠂⠎ idEAs ideas	braille code error	0-lgs	⠂	9	S 19-1
65.	*⠞⠑⠁⠎ *teas	⠞⠂⠎ tEAs teas	braille code error	0-lgs	⠂	2	S 23-0-LR
66.	*⠊⠙⠑⠁⠎ *ideas	⠊⠙⠂⠎ idEAs ideas	braille code error	0-lgs	⠂	9	S 23-0-LR
67.	*⠞⠑⠁⠎ *teas	⠞⠂⠎ tEAs teas	braille code error	0-lgs	⠂	2	S 24-0
68.	*⠏⠑⠁⠎ *peas	⠏⠂⠎ pEAs peas	braille code error	0-lgs	⠂	2	S 24-0
69.	*⠞⠑⠁⠎ *teas	⠞⠂⠎ tEAs teas	braille code error	0-lgs	⠂	2	S 25-0-LR
70.	*⠞⠑⠁⠎ *teas	⠞⠂⠎ tEAs teas	braille code error	0-lgs	⠂	2	S 30-0
71.	*⠏⠑⠁⠎ *peas	⠏⠂⠎ pEAs peas	braille code error	0-lgs	⠂	2	S 30-0
72.	*⠞⠑⠁⠎ *teas	⠞⠂⠎ tEAs teas	braille code error	0-lgs	⠂	2	S 33-1

	data	target	error type	specification1	specification2	task	subject
73.	*⠞⠑⠁⠎ *teas	⠞⠂⠎ tEAs teas	braille code error	0-lgs	⠂	2	S 35-1
74.	*⠊⠙⠑⠁⠎ *ideas	⠊⠙⠂⠎ idEAs ideas	braille code error	0-lgs	⠂	9	S 35-1
75.	*⠊⠙⠑⠁⠎ *ideas	⠊⠙⠂⠎ idEAs ideas	braille code error	0-lgs	⠂	9	S 9-0
76.	*⠉⠕⠍⠑ *come	⠤⠑ COMe come	braille code error	0-lgs	⠤	8	S 12-0
77.	*⠉⠕⠍⠑⠞ *comet	⠤⠑⠞ COMet comet	braille code error	0-lgs	⠤	8	S 12-0
78.	*⠉⠕⠍⠑ *come	⠤⠑ COMe come	braille code error	0-lgs	⠤	8	S 15-1
79.	*⠉⠕⠍⠑ *come	⠤⠑ COMe come	braille code error	0-lgs	⠤	8	S 19-1
80.	*⠉⠕⠍⠑⠞ *comet	⠤⠑⠞ COMet comet	braille code error	0-lgs	⠤	8	S 28-0
81.	*⠉⠕⠍⠑ *come	⠤⠑ COMe come	braille code error	0-lgs	⠤	8	S 29-0
82.	*⠉⠕⠍⠑⠞ *comet	⠤⠑⠞ COMet comet	braille code error	0-lgs	⠤	8	S 29-0

	data	target	error type	specification1	specification2	task	subject
83.	*⠉⠍⠍⠑⠞ *cmmet	⠤⠑⠞ COMet comet	braille code error	0-lgs	⠤	8	S 35-1
84.	*⠃⠥⠋⠋⠊⠞ *buffet	⠃⠥⠖⠑⠞ buFFet buffet	braille code error	0-lgs	⠖ gemination	2	S 12-0
85.	*⠋⠇⠥⠋⠋⠽ *fluffy	⠋⠇⠥⠖⠽ fluFFy fluffy	braille code error	0-lgs	⠖ gemination	2	S 19-1
86.	*⠋⠇⠥⠋⠋⠽ *fluffy	⠋⠇⠥⠖⠽ fluFFy fluffy	braille code error	0-lgs	⠖ gemination	2	S 23-0-LR
87.	*⠃⠥⠋⠋⠊⠞ *buffet	⠃⠥⠖⠑⠞ buFFet buffet	braille code error	0-lgs	⠖ gemination	2	S 28-0
88.	*⠃⠥⠋⠋⠊⠞ *buffet	⠃⠥⠖⠑⠞ buFFet buffet	braille code error	0-lgs	⠖ gemination	2	S 35-1
89.	*⠑⠛⠛⠏⠇⠁⠝⠞ *eggplant	⠑⠶⠏⠇⠁⠝⠞ eGGplant eggplant	braille code error	0-lgs	⠶ gemination	2	S 8-1
90.	*⠑⠛⠛⠏⠇⠁⠝⠞ *eggplant	⠑⠶⠏⠇⠁⠝⠞ eGGplant eggplant	braille code error	0-lgs	⠶ gemination	2	S 25-0-LR
91.	*⠑⠛⠛⠎ *eggs	⠑⠶⠎ eGGs eggs	braille code error	0-lgs	⠶ gemination	9	S 33-1
92.	*⠑⠛⠛⠎ *eggs	⠑⠶⠎ eGGs eggs	braille code error	0-lgs	⠶ gemination	9	S 35-1

	data	target	error type	specification1	specification2	task	subject
93.	*⠎⠊⠝ *sin	⠎⠔ sIN sin	braille code error	0-lgs	⠔	6	S 18-0
94.	*⠎⠊⠝ *sin	⠎⠔ sIN sin	braille code error	0-lgs	⠔	8	S 18-0
95.	*⠎⠏⠊⠝ *spin	⠎⠏⠔ spIN spin	braille code error	0-lgs	⠔	6	S 18-0
96.	*⠎⠏⠊⠝ *spin	⠎⠏⠔ spIN spin	braille code error	0-lgs	⠔	6	S 35-1
97.	*⠃⠗⠊⠣⠞ *briGHt	⠃⠐⠗ bRIGHT bright	braille code error	0-cgs[118]	⠐⠗	6	S 12-0
98.	*⠃⠗⠊⠣⠞ *briGHt	⠃⠐⠗ bRIGHT bright	braille code error	0-cgs	⠐⠗	6	S 25-0-LR
99.	*⠃⠗⠊⠣⠞ *briGHt	⠃⠐⠗ bRIGHT bright	braille code error	0-cgs	⠐⠗	6	S 28-0
100.	*⠃⠗⠊⠣⠞⠓⠁⠞ *briGHt	⠃⠐⠗ bRIGHT bright	braille code error	0-cgs	⠐⠗	6	S 29-0
101.	*⠃⠗⠊⠳⠞ *briOUt	⠃⠐⠗ bRIGHT bright	braille code error	0-cgs	⠐⠗, + R_2	6	S 23-0-LR

[118] Zero realisation of composite groupsign

	data	target	error type	specification1	specification2	task	subject
102.	*⠃⠗⠊⠣⠞⠓⠁⠞ *briGHt	⠃⠐⠗ b<u>RIGHT</u> bright	braille code error	0-cgs	⠐⠗	6	S 19-1
103.	*⠋⠗⠊⠣⠞ *friGHt	⠋⠐⠗ f<u>RIGHT</u> fright	braille code error	0-cgs	⠐⠗	6	S 12-0
104.	*⠋⠗⠊⠣⠞ *friGHt	⠋⠐⠗ f<u>RIGHT</u> fright	braille code error	0-cgs	⠐⠗	6	S 25-0-LR
105.	*⠋⠗⠊⠣⠞ *friGHt	⠋⠐⠗ f<u>RIGHT</u> fright	braille code error	0-cgs	⠐⠗	6	S 29-0
106.	*⠋⠗⠊⠣⠞ *friGHt	⠋⠐⠗ f<u>RIGHT</u> fright	braille code error	0-cgs	⠐⠗	6	S 19-1
107.	*⠉⠜⠑⠇⠑⠎⠎⠇⠽ *cARelessly	⠉⠜⠑⠨⠎⠇⠽ cARe<u>LESS</u>ly carelessly	braille code error	0-cgs	⠨⠎	7	S 12-0
	*⠉⠜⠑⠇⠑⠎⠎⠇⠽ *cARelessly	⠉⠜⠑⠨⠎⠇⠽ cARe<u>LESS</u>ly carelessly	braille code error	0-cgs	⠨⠎	7	S 15-1
108.	*⠉⠜⠑⠇⠑⠎⠎⠇⠽ *cARelessly	⠉⠜⠑⠨⠎⠇⠽ cARe<u>LESS</u>ly carelessly	braille code error	0-cgs	⠨⠎	7	S 19-1
109.	*⠙⠑⠏⠜⠞⠰⠞ *depARt<u>MENT</u>	⠙⠑⠂⠏⠰⠞ de<u>PART</u>/<u>MENT</u> department	braille code error	0-cgs	⠨⠎	2	S 2-0
110.	*⠙⠑⠏⠜⠞⠰⠞ *depARt<u>MENT</u>	⠙⠑⠂⠏⠰⠞ de<u>PART</u>/<u>MENT</u> department	braille code error	0-cgs	⠂⠏	2	S 9-0

	data	target	error type	specification1	specification2	task	subject
111.	*⠙⠑⠏⠜⠞⠰⠞ *depARtMENT	⠙⠑⠐⠏⠰⠞ dePART/MENT department	braille code error	0-cgs	⠐⠏	2	S 35-1
112.	*⠙⠑⠏⠜⠞⠉⠢⠞ *depARtcENt	⠙⠑⠐⠏⠰⠞ dePART/MENT department	braille code error	0-cgs	⠐⠏, - L_3	2	S 15-1
113.	*⠚⠕⠽⠋⠥⠇ *joyful	⠚⠕⠽⠰⠇ joyFUL joyful	braille code error	0-cgs	⠰⠇	7	S 15-1
114.	*⠚⠕⠽⠋⠥⠇ *joyful	⠚⠕⠽⠰⠇ joyFUL joyful	braille code error	0-cgs	⠰⠇	7	S 35-1
115.	*⠚⠕⠽⠋⠥⠇⠇⠽ *joyfully	⠚⠕⠽⠰⠇⠇⠽ joyFULly joyfully	braille code error	0-cgs	⠰⠇	7	S 15-1
116.	*⠎⠑⠧⠻⠁⠇ *sevERal	⠎⠐⠑⠁⠇ sEVERal several	braille code error	0-cgs	⠐⠑	2	S 2-0
117.	*⠎⠑⠧⠻⠁⠇ *sevERal	⠎⠐⠑⠁⠇ sEVERal several	braille code error	0-cgs	⠐⠑	2	S 19-1
118.	*⠎⠑⠧⠻⠁⠇ *sevERal	⠎⠐⠑⠁⠇ sEVERal several	braille code error	0-cgs	⠐⠑	2	S 35-1
119.	*⠝⠑⠧⠻ *nevER	⠝⠐⠑ nEVER never	braille code error	0-cgs	⠐⠑	1	S 19-1
120.	*⠝⠑⠧⠻ *nevER	⠝⠐⠑ nEVER never	braille code error	0-cgs	⠐⠑	5	S 19-1

	data	target	error type	specification1	specification2	task	subject
121.	*⠁⠍⠕⠝⠛ *among	⠁⠍⠰⠛ amONG among	braille code error	0-cgs	⠰⠛	2	S 35-1
122.	*⠁⠍⠕⠝⠛ *among	⠁⠍⠰⠛ amONG among	braille code error	0-cgs	⠰⠛	2	S 35-1
123.	*⠺⠁⠎ *was	⠴ WAS was	braille code error	0-lws	⠴	1	S 19-1
124.	*⠺⠁⠎ *was	⠴ WAS was	braille code error	0-lws	⠴	1	S 19-1
125.	*⠺⠁⠎ *was	⠴ WAS was	braille code error	0-lws	⠴	1	S 19-1
126.	*⠺⠁⠎ *was	⠴ WAS was	braille code error	0-lws	⠴	2	S 19-1
127.	*⠺⠁⠎ *was	⠴ WAS was	braille code error	0-lws	⠴	2	S 19-1
128.	*⠺⠁⠎ *was	⠴ WAS was	braille code error	0-lws	⠴	6	S 19-1
129.	*⠺⠁⠎ *was	⠴ WAS was	braille code error	0-lws	⠴	1	S 34-0-LR
130.	*⠢⠳⠣⠄⠎ *EN/OU/GH's	⠢⠄⠎ ENOUGH's enough's	braille code error	0-lws	⠢	2	S 2-0

	data	target	error type	specification1	specification2	task	subject
131.	*EN/OU/GH's	ENOUGH's enough's	braille code error	0-lws		2	S 10-1
132.	*EN/OU/GH's	ENOUGH's enough's	braille code error	0-lws		2	S 28-0
133.	*EN/OU/GH's	ENOUGH's enough's	braille code error	0-lws		2	S 30-0
134.	*EN/OU/GH's	ENOUGH's enough's	braille code error	0-lws		2	S 34-0-LR
135.	*EN/OU/GH's	ENOUGH's enough's	braille code error	0-lws		2	S 33-1
136.	*by THE	BY/THE by the	braille code error	0-lws		2	S 15-1
137.	*by a	BY/a by a	braille code error	0-lws		2	S 15-1
138.	*riGHt	<u>RIGHT</u> right	braille code error	0-cws[119]		6	S 23-0-LR
139.	*riGHt	<u>RIGHT</u> right	braille code error	0-cws		6	S 25-0-LR

[119] Zero realisation of composite wordsign

	data	target	error type	specification 1	specification 2	task	subject
140.	*⠗⠊⠣⠞⠓⠁⠞ *riGHt	⠐⠗ RIGHT right	braille code error	0-cws	⠐⠗	6	S 12-0
141.	*⠉⠜⠑⠐⠎ *cAReSOME	⠉⠜⠑⠨⠎ cAReLESS careless	braille code error	f-cgs	⠨⠎	7	S 15-1
142.	*⠉⠜⠑⠰⠑ *cAReENCE	⠉⠜⠑⠨⠎ cAReLESS careless	braille code error	f-cgs	⠨⠎	7	S 9-0
143.	*⠉⠜⠑⠰⠇ *cAReFUL	⠉⠜⠑⠨⠎ cAReLESS careless	braille code error	f-cgs	⠨⠎	7	S 19-1
144.	*⠷ ⠁ *OF a	⠷⠁ OF/a of a	braille code error	f-uws[120]		2	S 2-0
145.	*⠾ ⠮ *WITH THE	⠾⠮ WITH/THE with the	braille code error	f-uws		2	S 2-0
146.	*⠿ ⠮ *FOR THE	⠿⠮ FOR/THE for the	braille code error	f-uws		1	S 2-0
147.	*⠷ ⠮ *OF THE	⠾⠮ OF THE of the	braille code error	f-uws		2	S 23-0-LR
148.	*⠾ ⠮ *WITH THE	⠾⠮ WITH/THE with the	braille code error	f-uws		2	S 23-0-LR

[120] Wrong use of upper wordsign

	data	target	error type	specification1	specification2	task	subject
149.	* *AND a	AND/a and a	braille code error	f-uws		2	S 12-0
150.	* *AND a	AND/a and a	braille code error	f-uws		2	S 23-0-LR
151.	* *AND a	AND/a and a	braille code error	f-uws		2	S 8-1
152.	* *AND a	AND/a and a	braille code error	f-uws		2	S 33-1
153.	* *AND a	AND/a and a	braille code error	f-uws		2	S 35-1
154.	* *WITH a	WITH/a with a	braille code error	f-uws		2	S 19-1
155.	* *WITH/OU	WITH/OUt without	braille code error	f-uws		2	S 12-0
156.	* *WITH/OU	WITH/OUt without	braille code error	f-uws		2	S 15-1
157.	* *WITH/OU	WITH/OUt without	braille code error	f-uws		2	S 24-0
158.	* *commet	COMet comet	independent complex error	insertion, gemination error	0-lgs	8	S 2-0

	data	target	error type	specification1	specification2	task	subject
159.	* *commet	COMet comet	independent complex error	insertion, gemination error	0-lgs	8	S 19-1
160.	* *profeSIONal	prOFesSIONal professional	independent complex error	omission, gemination error	IC 0-ugs mm	7	S 35-1
161.	* *profeSIONal	prOFesSIONal professional	independent complex error	omission, gemination error	IC 0-ugs mm	7	S 35-1
162.	* *profesionally	prOFesSION/ALLY professionally	independent complex error	omission, gemination error	IC 0-ugs, 0-cgs, 0-cgs mm	7	S 19-1
163.	* *prOFfesSIONally	prOFesSION/ALLY professionally	independent complex error	omission, gemination error	IC 0-cgs	7	S 12-0
164.	* *parot	pARrot parrot	independent complex error	omission, gemination error	0-ugs	6	S 23-0-LR
165.	* *parot	pARrot parrot	independent complex error	omission, gemination error	0-ugs	6	S 35-1
166.	* * buffe	buFFet buffet	independent complex error	omission, phonetic spelling	0-lgs	2	S 24-0
167.	* *dINgy	dINGhy dinghy	independent complex error	omission, phonetic spelling	0-ugs	4	S 33-1
168.	* *mAR/SHmellow	mAR/SHmallOW marshmallow	independent complex error	grapheme substitution	0-ugs	2	S 8-1

	data	target	error type	specification1	specification2	task	subject
169.	*prOFfeTION/ALLY	prOFesSION/ALLY professionally	independent complex error	complex substitution, gemination error	IC 0-ugs mm	7	S 25-0-LR
170.	*profeSH/EA/ALLY	prOFesSION/ALLY professionally	independent complex error	complex substitution, phonetic spelling	IC 0-ugs	7	S 9-0
171.	*popeSH/ENally	prOFesSION/ALLY professionally	independent complex error	complex substitution, phonetic spelling	IC 0-ugs, 0-cgs	7	S 23-0-LR
172.	*pofessanal	prOFesSIONal professional	independent complex error	complex substitution, phonetic spelling	IC 0-ugs	7	S 19-1
173.	*profeSHonal	prOFesSIONal professional	independent complex error	complex substitution, phonetic spelling	IC 0-ugs	7	S 2-0
174.	*proceSHanal	prOFesSIONal professional	independent complex error	complex substitution, phonetic spelling	IC 0-ugs	7	S 9-0
175.	*buffa	buFFet buffet	independent complex error	complex substitution	0-lgs	2	S 23-0-LR
176.	*buffy	buFFet buffet	independent complex error	complex substitution	0-lgs	2	S 19-1
177.	*prOFfeTION	prOFesSIONal professional	independent complex error	accumulated spelling error	f-cgs gemination	7	S 25-0-LR
178.	*proFFeTION	prOFesSIONal professional	independent complex error	accumulated spelling error	0-ugs, f-cgs gemination	7	S 15-1

	data	target	error type	specification1	specification2	task	subject
179.	*profeSH/EN	prOFesSIONal professional	independent complex error	accumulated spelling error	IC 0-ugs	7	S 23-0-LR
180.	*lEDgislATION	legislATION legislation	interdependent complex error	insertion, phonetic spelling	0-ugs	2	S 28-0
181.	*dedgislaTION	legislATION legislation	interdependent complex error	insertion, phonetic spelling	0-ugs	2	S 23-0-LR
182.	*CONjeneal	CONgENial congenial	interdependent complex error	grapheme substitution	0-lgs	2	S 23-0-LR
183.	*legistaTION	legislATION legislation	interdependent complex error	grapheme substitutions	0-cgs	2	S 19-1
184.	*delogATION	delegATION delegation	ambiguous error	typing error, + L_3	grapheme substitution, vowel in unstressed syllable	2	S 33-1
185.	*lessure	leisure	ambiguous error	typing error, +L_3	spelling error: grapheme substitution , phonetic spelling	1	S 22-1-L
186.	*mARvollOUs	mARvellOUs marvellous	ambiguous error	typing error, + L_3	grapheme substitution, vowel in unstressed syllable	2	S 33-1
187.	*DISagredot4-5-6t	DISagreeMENT disagreement	ambiguous error	typing error, +R_1	f-cgs	9	S 19-1
188.	*DISagredot6s	DISagreeMENTs disagreements	ambiguous error	typing error, -R_2	f-cgs	9	S 15-1

	data	target	error type	specification1	specification2	task	subject
189.	*govERn6ts	govERnMENT government	ambiguous error	typing error, - R_2	f-cgs	2	S 15-1
190.	*SHaDD/OW	SHadOW shadow	ambiguous error	spelling error, insertion, gemination error	braille code error	3	S 10-1
191.	*SHaDD/OW	SHadOW shadow	ambiguous error	spelling error, insertion, gemination error	braille code error	3	S 15-1
192.	*flufy	fluFFy fluffy	ambiguous error	spelling error, omission, gemination error	transposition	2	S 2-0
193.	*flufy	fluFFy fluffy	ambiguous error	spelling error, omission, gemination error	transposition	2	S 9-0
194.	*flufy	fluFFy fluffy	ambiguous error	spelling error, omission, gemination error	transposition	2	S 24-0
195.	*flufy	fluFFy fluffy	ambiguous error	spelling error, omission, gemination error	transposition	2	S 29-0
196.	*diPART/MENT	dePART/MENT department	ambiguous error	LR-reversal	grapheme substitution, V in unstressed syllable	2	S 23-0-LR
197.	*CONgINial	CONgENial congenial	ambiguous error	LR-reversal	grapheme substitution, V in unstressed syllable	2	S 25-0-LR

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