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Touch and go: Learning to read Braille

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This single case study investigates over a 2½-year period some of the problems that a young child who is congenitally blind may encounter when starting to read Braille. In particular, attention is focused on the early phases and skills in reading acquisition in sighted children. Among sighted children, phonological skill has been closely linked with early reading success (Bryant & Bradley, 1985); in fact, phonological awareness and segmentation abilities seem to be crucial. However, two phases appear to characterise the early reading strategies, namely the logographic and alphabetic phases (Frith, 1985). There is converging evidence that the first phase is one where the child recognises words as a whole on the basis of visual appearance (Barron & Baron, 1977; Gathercole & Baddeley, 1989; Seymour & Elder, 1986; Snowling & Frith, 1981). Still, even at this early stage, the child already takes account of several salient features of a written word, such as word length and doubled letters, as well as noting if the individual letters such as *t* or *f* go above or below the line (Seymour & Elder, 1986). For example, a child may recognise a word because it has a double *l* in the middle of the string, without having taken in the identity of the letters on either side. Certainly there is evidence that children begin to read without a firm knowledge of letter-sound correspondence (Goswami & Bryant, 1990).

It is in the second, alphabetic, stage that it becomes clear to a child that letters represent sounds, and, what is more, that these sounds bear a significant relationship to the way the word is spoken. There has been increasing evidence for a critical phase in reading development that depends crucially on such an understanding, and problems with this can be a significant obstacle to reading success (Frith, 1985; Liberman, Shankweiler, Liberman, Fowler, & Fischer, 1978).

Three issues are raised here: the possible effects on these phases of reading development of (a) blindness per se, (b) the use of a different modality (i.e., touch instead of sight), and (c) a different script (i.e., Braille and not print).

Literary knowledge is available to sighted children from their earliest perceptual experiences. "Visible language," as Frith (1985) has termed it, is as much if not more a part of the visual environment than other visual input. Yet this is one crucially important feature that contrasts an infant who is totally blind with a sighted counterpart. Generally speaking, a child who is blind does not feel written words until they are introduced at school. Stories read to visually handicapped children only rarely have tangible pictures. The child who is blind experiences language as an auditory phenomenon in a much more exclusive way than a sighted child ever does. Cornflake packet logos, stop signs at road junctions, labels on nursery friezes, etc., are not available if a child cannot see. Thus, though there is a wealth of tactual experience for a child who is blind, such experience does not tend to be literary.

From a practical viewpoint there is a certain amount of research that has investigated Braille reading (Lowenfeld, Abel, & Hatlen, 1969). Children who are blind begin their reading readiness activities with tactual discrimination games and exercises so they will develop the skill to discriminate the dot patterns within a Braille cell, much the way children who are sighted participate in activities to develop their visual discrimination skills for print reading. Letters and symbols in Braille reading material consist of different numerical and spatial permutations of six embossed dots, arranged in two columns and three rows. Figure 1 shows some examples of Braille letters (not embossed) along with common letter identification errors. Each letter in the alphabet has a different configuration. In many circumstances, letter clusters like *ed* or *tion* are presented as just one, or at the most two, symbols. Such contractions are taught from

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THERE HAVE been very few investigations of children who are congenitally blind learning to read Braille. In this case study, the author reports on a 2 1/2-year follow-up of a young girl who was congenitally, totally blind as she learned this embossed script. The aim was to evaluate the relevance of models of reading acquisition developed for sighted children to the learning of Braille by a child who is blind. The results suggest that (a) even without word or letter experience, phonological awareness can be well developed; (b) the logographic phase of reading can be bypassed in favour of an alphabetic phase; and (c) a strong emphasis on this alphabetic strategy might influence the reading process. In spite of differences in learning, the level of reading skill which is finally obtained is very similar to that of sighted children at a similar stage of development.

Toucher et aller de l'avant: l'apprentissage de la lecture en braille

IL EXISTE très peu de recherches consacrées à l'apprentissage de la lecture en braille chez des enfants aveugles congénitalement. Dans cette étude de cas, l'auteur rend compte du suivi pendant deux ans et demi de l'apprentissage de l'écriture en relief d'une fillette totalement aveugle congénitalement. La recherche avait pour but d'évaluer, dans le cas de l'apprentissage de la lecture d'un enfant aveugle, la pertinence des modèles d'apprentissage de la lecture développés pour les enfants voyants. Les résultats suggèrent que a) la conscience phonologique peut être bien développée, même en l'absence d'expérience du mot ou de la lettre; b) la phase logographique de la lecture peut être négligée au bénéfice d'une phase alphabétique; et c) mettre fortement l'accent sur cette stratégie alphabétique pourrait influencer le processus de lecture. Malgré les différences d'apprentissage, le niveau de savoir lire acquis finalement est très semblable à celui des enfants voyants de niveau de développement voisin.

Toca y avanza: Aprendiendo a leer Braille

EXISTEN POCAS investigaciones sobre el aprendizaje de la lectura en Braille en niños ciegos congénitos. En este estudio de caso, la autora presenta una investigación sobre el aprendizaje de esta escritura en relieve, que se realizó mediante el seguimiento durante dos años de una niña ciega de nacimiento. El objetivo fue evaluar la relevancia de los modelos de adquisición de la lectura, desarrollados para niños videntes, en el aprendizaje del Braille. Los resultados sugieren que: a) la conciencia fonológica se desarrolla bien, aún sin tener experiencia con palabras escritas y letras, b) la fase logográfica de la lectura puede soslayarse favoreciendo el desarrollo de la fase alfabética y c) el hecho de poner el énfasis en las estrategias alfabéticas podría influenciar el proceso de lectura. A pesar de las diferencias en el aprendizaje, el nivel de habilidad en lectura que se obtiene es muy similar al nivel de los niños videntes que están en una etapa similar del desarrollo.

Tasten und Anfangen: Brailleschrift lernen

ES EXISTIEREN nur sehr wenige Untersuchungen über von Geburt an blinde Kinder, die Brailleschrift lernen. In dieser Fallstudie beschäftigt sich der Autor mit den zweieinhalbjährigen Verbesserungsleistungen eines jungen geburtsblinden Mädchens, das diese Reliefschrift lernte. Das Ziel war, die Relevanz von Leselernmodellen sehfähiger Kinder für das Lesen von Brailleschrift von blinden Kindern zu erproben. Die Resultate legen nahe, daß (a) auch ohne Buchstaben- oder Wortkenntnisse phonologische Fähigkeiten entwickelt werden können, (b) die Wortzeichenphase des Lesens umgangen werden kann zugunsten einer alphabetischen Phase, und (c) ein starker Einfluß auf diese alphabetische Phase den Leselernprozeß beeinflussen kann. Trotz Lernunterschieden ist die Ebene der letztendlich erlangten Lesefähigkeit sehr ähnlich der der sehfähigen Kinder in einem vergleichbaren Entwicklungsstadium.

Figure 1 Some Braille letters that can be confused

i		e	
p		v	
d		f	
h		j	

the outset; for example, *and* in the word *candy* is contracted. Contractions can cut across phonological boundaries as well; for example, in the word *honey* it is the three letters *one* that are depicted in a shortened form. There are also many instances where a single symbol can represent a word; for example, *have* is represented by the letter *h*. Such word signs and contractions are often taught right from the beginning and help to increase the speed of reading (see Appendix A for examples). Braille and print orthography are not completely equivalent, and an understanding of the internal characteristics of the Braille code can be crucial for clarity in teaching (Hamp & Caton, 1984).

There is a wide range in Braille reading speed; some readers are rather fast, averaging about half the speed of the sighted, say 150 words per minute, but many read much more slowly than this, i.e., below 40 words per minute. Often writing in Braille is introduced at almost the same time as reading. A writing machine known as the Perkins Brailler allows the user to produce Braille. Reading tuition is most important and can indeed make the difference for the child between success and failure (Harley, Truan, & Sanford, 1987); for instance, the child who is blind may not approach the task with the same enthusiasm as a sighted child, and therefore it is important to pay attention to motivational factors (Spungin, 1989). Spungin underlines the fact that failure to use Braille is usually not due to some inherent difficulty of the task but rather to more practical considerations.

In the U.K. the system most emphasised is a phonic approach in which the sounds of individual letters are learnt and used as a sequential decoding device. However, more important still for reading success than phonic ability is the readiness of the child to handle the tactual perceptual discrimination demands of Braille (Pring, 1992). The first letters introduced are ones that differ in the number of dots the Braille cell contains, and progress occurs gradually through the introduction of new letters once others have been thoroughly learnt. When the whole-word method of teaching reading was popular, the contractions in Braille were introduced at the outset of reading instruction. Even now they are likely to be taught at an early stage. Harley, Henderson, & Truan (1979) argue that the Braille learner builds up an equivalent to a sight vocabulary of words that do not need analysis but can be recognised instantly. Yet Nolan and Kederis (1969) found little evidence for the use of context to help Braille decoding, which suggests that such automatic recognition may not usually occur. However, the important point here is that the level of competence of the children tested is crucial, because fast recognition for Braille words may only occur after a certain level of Braille competence has been achieved (Pring, 1984).

The ways in which Braille and print reading differ can be summarised as (a) encoding strategy—with Braille, tactual input tends to be successive while with print, visual encoding of several letters may take place almost simultaneously; (b) accuracy—tactual acuity is

significantly lower than that of vision and can resemble "blurred vision" (Apkarian-Stielau & Loomis, 1974); (c) redundancy—because of the characteristics of the script, there is little redundancy in the Braille orthography, and therefore it is harder to read and requires more attention to the letter recognition processes than print reading (Pring, 1984); and (d) contractions—both Braille and print use the alphabet, but in Braille shortened forms of letter clusters are employed to overcome the very real problems of reading speed. However, in spite of these differences, by the time a visually handicapped child has a reading age of around 10 years, the differences between the efficiency of Braille and of print reading are surprisingly few (Nolan & Kederis, 1969; Pring, 1982, 1984).

In the study of Braille reading acquisition reported here, a young girl called Becky, who was congenitally totally blind, was the focus of the investigation, starting from her first weeks at school and continuing until the beginning of her third year. I adopted a single case study approach for several reasons. My first aim was to centre the investigation on a child who was congenitally totally blind with no other physical handicaps, and such cases are relatively rare. Second, I thought it preferable to obtain a considerable amount of data from one child rather than more limited information from several cases. Finally, I intended to follow up the learning process of Braille reading over an extended period, and for practical reasons such extended testing and observations are very difficult to organise when they involve several children. Thus, in spite of the obvious limitations of a single case study, I hope that investigating reading acquisition from the very beginning will provide some useful information.

There were several questions that I singled out for special attention. The first was whether or not the absence of visible language experience with letters and words would have any influence on the phonological awareness and segmentation abilities of a blind child. Certainly phonological knowledge and phonological memory are based on auditory analysis, and in this sense it is likely that the differences between sighted and visually handicapped children would be small (though see Mills, 1983). However, it has been suggested that the ability to read and to spell may enhance phonological awareness (Morais, Cary, Alegria, & Bertelson, 1979), and even letter-sound connections that a preschooler might make have an important influence on later reading success (Stuart & Coltheart, 1988). One way of taking a first look at this would be to ask what level of phonological skill is, or is not, developed in a young child who is blind prior to reading tuition. A second question was: Would Becky show evidence of whole-word reading as had been noted by those early Braille teachers mentioned by Harley et al. (1979)? Third, would an alphabetic phase of reading development have the same characteristics for her as for a sighted child? Would it be equally easy for Becky to pick up letter-sound correspondences and blending procedures where individual sounds are combined in Braille as for a sighted counterpart with print?

Becky attended a school for the visually handicapped but was the only child in her class who was totally and congenitally blind. There is a well-documented literature on the special difficulties for such children in comparison with those who become blind only after having experienced the visual world (see Fraiberg, 1977). Becky was rather a suitable subject for study because she suffered from no other mental or physical handicaps, and she and her teacher were happy to let us visit quite often and watch her progress.

Becky was the eldest of three daughters and the only one with a handicap. She was diagnosed as having retinopathy of prematurity (a condition often arising as a result of high oxygen levels given to premature babies). Developmental milestones were delayed, which is not at all unusual in such cases. Language development was particularly slow, and echolalia was prominent during her preschool years; at the age of 3 she had two-word utterances. However, by the time she started school she had caught up and her language was good. As is sometimes found with children who are blind, Becky's early development showed some of the characteristics of children who are autistic (Minter, Hobson, & Pring, 1991); the parents reported that Becky was emotionally and socially very withdrawn in infancy, possibly a factor in her language delay. However, her cognitive ability allowed her to catch up rapidly once these difficulties were overcome. Becky entered full-time education at the age of 4 years, 11 months. Her teachers considered her to be an articulate and clever child. Her scores on a number of language and ability tests are provided in Appendix B.

The method of instruction used by Becky's teacher involved tactile discrimination practice and the careful introduction of individual letters. Only later were single words, including some contracted words, introduced. Becky was first taught the letters *a, b, l,* and *g,* which consist of one, two, three, and four dots respectively. She also learnt her own name, and once she had mastered several letters, short words consisting of these letters were introduced. Becky had a store of Braille letters and words that she tried to increase as time went on. She had a reader that was designed to gradually introduce more letters and words as her skill increased.

Method

Becky was seen and tested by the author or an assistant on a regular basis, beginning in the first 2 weeks of school and thereafter generally every 6 weeks or so during term times, for a period of 2½ years. On one occasion Becky's teacher helped with testing the words Becky could read and spell. The first year at school was taken up with a familiarization program to Braille letters, but by the time Becky was 5½ years old tests of word reading could be administered effectively. The phonological awareness tests were given around Becky's 5th birthday. The tests of logographic reading proceeded during her 6th year, and the tests of alphabetic reading continued on until just before she was 7 years old.

Procedure and results

Phonological awareness

The first series of tests were aimed at testing Becky's phonological awareness. For this she was first asked to repeat 12 spoken real words, e.g., *table* and *goat,* and 12 spoken nonsense words such as *slint* and *gron,* matched for phonological difficulty. A high level of phonological awareness would lead one to expect a good performance not only on the words but also on the nonwords. Becky scored 11/12 for words and 9/12 for nonwords. Such a score is age appropriate and reflects a relatively high level of competency. In the second test of phonological awareness Becky was asked to recite nursery rhymes and to produce rhyming words on request (e.g., *hot-cot, bat-hat, tree-he, chair-hair,* target and response respectively). On this she also did well, showing no problems in producing rhymes. She was also asked to judge whether two words did or did not rhyme, but with this task she did not do well; her scores were essentially at chance level.

Phonological segmentation was tested in three ways. First, Becky was given a set of 15 spoken words, ranging in length from one to three syllables. As she heard each word, she could repeat it and was asked to tap with her finger at each syllable. She did this perfectly (15/15), as do most sighted 5 year olds. Next she was asked to tap out phonemes in the same way as she had done with the syllables, but the words were all single-syllable words. For example, *church* has three phonemes (ch-ur-ch). Becky was poor at tapping out phonemes in single-syllable words, getting none of the words wholly correct. However, her errors revealed that she could often segment the first two or three sounds correctly, failing only on the final phoneme. She was then given a test of auditory organization, where she was asked to detect the odd one out of four spoken words. This tests awareness of initial sounds, medial sounds, and final sounds (e.g., *fan-cat-hat-mat, lick-lid-miss-lip*). On this test Becky performed quite well; she was 70% correct on initial sounds and 50% correct with medial phonemes, but virtually at chance, 30%, on final phonemes. On both these phoneme tests her performance was similar to that of sighted 5 year olds.

The logographic phase

It needs to be made clear that Becky did not simply sit down and learn her Braille letters as a sighted child might with print. It took her close on 1 year to be able to distinguish the different Braille characters, one from another, and label them with the correct letter names and sounds. Indeed, her teacher focused more on the sounds that each letter represented than the letter names.

The first component of reading ability proper that was tested concerned logographic reading. For this Becky was presented with some simple short words to read aloud. Would she do that wholistically, that is, feeling the whole word and then pronouncing it, or would that stage of sighted reading development prove unsuitable in learning to read Braille?

In fact Becky always used the same strategy of sounding out aloud each letter in sequence and then blending them. She used this strategy even with her own name. Many sighted children, seeing a written word starting with a certain letter, will automatically respond with a word familiar to them that starts with the same letter. The response may, on some occasions, be unrelated to the length of the word, for example, "television" may be the response to the written word *tail,* the *t* in this case being the dominant salient feature (see Seymour & Elder, 1986). Becky never made such errors. Her reading errors fell into two categories: letters incorrectly identified because she misperceived the dot position within a Braille cell, and blending errors, where after the correct sounds had been identified separately they could not be joined accurately. Thus in Becky's reading acquisition the logographic phase was nonexistent.

The alphabetic phase

The next stage of investigating the reading process was concerned with the alphabetic phase of development, where children introduce their spoken language knowledge and connect sounds to letters. This process is also important for spelling skills, and it is within the alphabetic phase that spelling knowledge begins to influence the reading strategy because it makes explicit the connections between letters and sounds.

Becky was given several lists of letter strings to read aloud on two separate occasions; the words were chosen so as not to include contracted forms. Some strings were words and some nonwords. The strings were three and four letters in length, and Becky read correctly 29/34 words, while for the nonwords she scored 19/20. Clearly her letter-sound skills were excellent. Another approach to studying whether reading is alphabetically governed is to investigate the regularity effect. This effect is evident when regular words that have consistent letter-sound correspondences show some advantage for reading over frequency-matched irregular words that have exceptional letter-sound correspondences. Examples of regular words would be *black* or *boat* and of irregular words *yacht* or *have* (which should actually rhyme with *wave*). To investigate Becky's use of letter-sound rules further, she was asked to read lists of 12 regular and 12 irregular words matched on frequency, again on two occasions. She read 9 regular and 2 irregular words correctly, producing a marked regularity effect. Her errors were not in sounding out, but in either refusals or regularization errors. For example, she responded /tal/ to *tall*, /cal/ to *call*, and *post* was pronounced to rhyme with *lost*. These errors show a strong reliance on regular sound-letter correspondences.

Spelling performance demands that the child make explicit all the letters in a word, while reading performance contrasts with this because correct reading can occur when a child has only a partial internal representation of the printed word. One can obtain some understanding of the internal representation of words which mediate reading by comparing reading with spelling performance. Becky was asked to read and then write (with a Perkins Brailler) 40 words. These were divided into 20 three-letter words and 20 four-letter words. Half were known words from Becky's reader, and half were unknown words not yet contained in her reader. She read 17/20 known words correctly. She also spelled 17/20 of these words correctly. Of the unknown words she read 9/20 and spelled 12/20 correctly. These results indicate that alphabetic abilities were well developed and showed that Becky's spelling skill matched her reading skills. That she could cope with even a fair number of words hitherto unknown to her testifies to the fact that her sound-letter and letter-sound coding abilities were equally good and being used effectively.

Discussion

This appears to be the first long-term follow-up report of reading development in a young child who is congenitally blind. It was asked whether her reading strategies would mirror the stages identified in the processing of print by young sighted readers: phonological awareness, the initial logographic phase, and finally alphabetic reading.

Turning first to phonology, the relevant results simply showed that Becky was a competent phonetician for her age. Thus within the limitations of a single case study the present results indicate that congenital blindness has no effect on phonological segmentation and awareness. This was important to establish at the outset, because Bryant and Bradley (1985) as well as others (Gathercole & Baddeley, 1989) have highlighted the possibly causal relationship between phonological awareness and reading acquisition. The only surprising exception to Becky's phonological competence was that she found it hard to decide whether two words rhymed or not. This was in spite of her ability to produce rhymes to cues. Every effort was made to make the requirements of the task clear to the child, and she seemed interested and motivated. It thus appears from these findings that copying sounds is easier than judging between them. In any case, Becky started her reading of Braille with her phonological skills in place.

The most marked difference between early reading strategies found in sighted children and those used by Becky was the apparently total absence, in her case, of a logographic phase. Becky never appeared to explore a total word pattern and then recognise the whole word, nor did she guess on the basis of a couple of salient features the identity of the word. She always sounded out each letter aloud in sequence and then blended the sounds. There are three possible explanations for this difference in her reading strategy when compared with that of young sighted readers, and these may not be mutually exclusive but may interact with each other. Possible factors include a difference in the sensory modality used for reading, differences in the characteristics of print and Braille scripts, and the absence of a processing strategy derived from earlier visual experience.

Turning first to modality differences, we note that vision is a sense in which the relative emphasis is on the immediate integration of features into a wholistic configuration. In touch, this process tends to proceed much more gradually, and the successive stages of the process are much more distinct. Therefore, tactual reading may by its very nature lend itself to letter-by-letter processing. However, this modality difference alone appears to be an insufficient explanation for the present findings. For instance, neither when the child's own name appeared nor when only short two-letter words were presented was there any indication of logographic reading. In both these instances such a reading strategy could have been usefully employed, since in the case of one's name or another very familiar word guessing may occur with

sighted children. Also, two letters can be felt almost simultaneously and could therefore be perceived as a unit. Thus the Braille symbols used to represent common words such as *is, am, mother* (contracted form), *go,* and so forth could be learnt as a unit to correspond with meaning without the recourse of segmenting them into their constituent parts. This, however, did not occur, but there is some evidence that such a process may occur at a later stage when reading proficiency has progressed further.

Regarding the Braille script itself, the embossed dots do indeed make acuity difficult, and the dot pattern in a Braille cell also has contingent redundancy problems. There is no doubt that a child dealing with Braille, even if it were visible, would have to concentrate on, and attend to, the sensory input to a far greater extent than is necessary for print, where differences in letter configurations are much more distinctive. Nevertheless, it is not easy to see how this could be a satisfactory explanation of the absence of a logographic phase of development so commonly found in the reading of print by the sighted.

A third possible interpretation of the present results, and probably the most likely one, is that congenital blindness structures stimulus processing in quite distinct ways. Visible language, in which symbols correspond to meanings, and signs to things, surrounds sighted children long before they begin to read. There is a close equivalence between signs and that which they signify. The sighted child builds up a large internal set of representations based on logographs well before even any letters have been distinguished. Indeed, sighted children early on connect images with words in a way that few children who are blind have the opportunity to do until they begin school. Little wonder then that the logographic phase might be dispensed with by the young reader who is blind. The recognition of groups of letters without the sequential processing of each letter may not occur until much later on, when the word recognition units internalised by the advanced reader can be activated directly (Pring, 1984).

For Becky the alphabetic stage is the natural first phase of Braille reading and thus dominates her early acquisition process. Consequently, in contrast to sighted children, she reads nonwords as well as she reads words and relies strongly on the regularity of letter-sound correspondences. Also, she spells as well as she reads in spite of the fact that spelling demands far more accurate internal letter representations than does reading. So here Becky's reliance on a rapid acquisition of a transcoding skill gives her an advantage over some sighted readers. It compensates for the inherent difficulties of reading acquisition experienced by children who are blind and enables her to achieve a similar level of reading competence at age 7 to that obtained by many sighted children.

Thus, regardless of the manner in which Becky was instructed and the difference in reading acquisition strategies she used, the difficulties she encountered through her congenital blindness did not, in the long run, impede her progress towards literacy.

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AUTHOR NOTES

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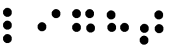
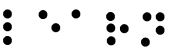
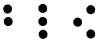
APPENDIX A

Examples of some contracted words

	Contracted	Uncontracted
mother		
light		
learn		
blow		
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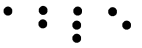
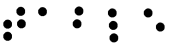
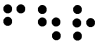
able		
table		
four		
even		

APPENDIX B
Cognitive profile

At 4 years, 5 months Becky obtained an IQ score of 111 on the Intelligence Test for Children with Defective Vision (1956). She had a forward digit span of 6 and a backward digit span of 2 items (WISC-R Subtest). She was tested on a modified version of the British Ability Scales Immediate Visual Recall Test (1979), in which she was given a series of raised-line drawings to feel, told the name of each drawing at the time of study, and after 2 minutes asked to recall the pictures she had felt. Her recall was excellent; she scored 16/20 items. These results show that she was well able to tactually discriminate the drawings and that she related to their names much as a sighted child would have (see also Pring, 1992). On the Williams Vocabulary Test, Becky performed at the level of 7 years, 5 months and some 2 years above her chronological age. In a listening comprehension task (modified from the Neale test analysis of reading ability), her understanding of the test was at the 7 years, 4 months age level. She thus represented a picture of at least average and in some respects superior cognitive functioning when compared with sighted children of the same age.