Research

Lexiphone therapy -
an auditory intervention approach to treating dyslexia

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This article reports the results of a study to test the efficacy of a new method of treating dyslexia developed in France by Dr Isi Beller, a psychiatrist in Paris. The method takes a phonological approach and uses a special device called a lexiphone which produces acoustically modified auditory input that is received via headphones. It is designed to re-educate auditory attention and speech awareness during selected listening, speaking, reading and writing activities. In a controlled study with 18 children from the north west of England, most of whom had been diagnosed by the Dyslexia Institute, it was found that a significant improvement took place in the measures of reading and spelling taken (WORD and Neale). This was the case both with respect to changes before and after treatment and in comparison with controls. There were also clear improvements for all children in phonological awareness as measured by the Phonological Assessment Battery (PhAB).

BACKGROUND

As a practising child psychiatrist in Paris in the 1970s, Dr Isi Beller became increasingly aware that many of the children presenting had problems that were underpinned by difficulties in reading and writing. He became convinced that if he could address this issue it would have beneficial effects on the child's self-esteem, emotional relationships and general behaviour as well as the self-evident benefits on educational attainment. His own theoretical background led him to look at the root of the problem which he saw as the way in which children first attend to the speech that is around them. In conjunction with an electronic engineer, Boris Fradin, he invented a special device – the lexiphone – which was designed to remedy the problem of a failure to engage in the necessary automatic and selective processing of speech which is the basis on which language development takes place and, subsequently, reading and writing. The lexiphone became a tool that was incorporated into a systematic programme known as the semiophonic method of auditory re-education (outlined below) for treating dyslexic children. It is widely used in the Francophone world, that is Belgium, Switzerland and throughout France. There ate more than 200 speech therapists using the approach in Europe and Dr Beller and his team in Paris have treated approximately 2,200 children.

It was a logical step to attempt to adapt the approach to other languages, English being the obvious choice. Accordingly, trials have taken place in the USA and UK with feasibility studies being originally carried out in Sheffield and Boston. These indicated that the approach could work for English speaking children. The first proper validation study, one that has made every effort to follow the approach used in Dr Beller's clinic in Paris, has recently concluded in Manchester in a project supported by the ESRC. This article reports the results of that study after first describing the essential features of the approach.

The Semiophonic Method of Auditory Re-education (Lexiphone)

Auditory re-education uses a special device – the lexiphone – to produce acoustically modified auditory input (via headp which is designed to re-educate structural elements of language, that is, the detection and processing of acoustic s at the intrasyllabic (phoneme) and intersyllabic (word) The device affects prosodic (patterns of rhythm and s sensitivity by highlighting acoustic differences at the sy level.

The lexiphone essentially does two things:

1. It acoustically highlights the melodic contour of speec something known as parametric sound which trans variations in amplitude and pitch to produce a high p warbling tone.
2. By a process known as alternation, it draws attenti phonemic, morphologic and word level segments of s through periodic use of an intermittent speech signal.

These structural elements of early language acquisition a perceptual deficiencies implicated in the child with dyslex the rehabilitative focus of this method. It seeks to re-e auditory attention and speech awareness during se listening, speaking, reading and writing activities. Therap graduated process with a recommended minimum of 80 one hour sessions.

The method has a number of other features that arise Dr Beller's experience as a child psychiatrist:

1. It is regarded as necessary to take the dyslexic individua to the point where language first became a signi influence in order to encourage the patient to pe language in the way that s/he did as an infant.
2. He recognised that the dyslexic child, with a history of obliged to engage in activity that he or she increasingly repellent, needs to be removed from the confrontationa that even the most enlightened teacher-therapist w perceived as adopting. In other words, on the socio-emo plane the dyslexic is frequently suspicious, embarrasse therefore negative to any further attempts to expose the of major weakness.
3. He appreciated the importance of the fact that the mec of reading must be regarded as an automatic process then frees up the cognitive system to attend to thing meaning, style and occasionally grammatical errors incl spelling and punctuation. Even these, however, are auto most of the time and it is comprehension that is important. The dyslexic's problem is that they never a the required level of automaticity. Reading remains a l effortful process – decoding the grapheme – which little cognitive space for determining meaning.
4. He realised that the way into remediation for dyslexi via the auditory route. Although reading is a visual acti looking at marks on a page – Beller is in line with

current thinking in believing that it is the sounds of language (the phonology) that hold the key to reading. If you cannot segment the acoustic stream effectively then it is unlikely that you will ever learn to read properly and you will probably have impaired language as well.

How Beller incorporated these ideas into his method

1. It is known that from a very early age babies will respond to particular sounds in their mother's voice such as rising pitch, changes in volume and stress. Babies can also discriminate between speech sounds such as *ba* and *pa* (voiced and unvoiced phonemes) long before they have any language at their disposal. It is also known that the way in which adults talk to babies (whether their parents or not) is special. So-called 'baby talk' has properties which seem to assist the child's acquisition of language; it is slower, higher, has exaggerated intonation, etc. Beller has used this knowledge and attempted to capture it in his auditory re-education through the mediums of **parametric sound** and **alternance** (segmentation).

2. Beller tackled the socio-emotional, interpersonal problems that many dyslexic children have in an ingenious way. If the issue is an unwillingness to engage in something that exposes you as a failure, then remove the figure who constantly reminds you of that fact. The therapist is a tangential rather than central figure in Beller's approach. Remediation is predominantly in the hands of the participants themselves. Sitting in the private worlds of their lexiphone cubicles, wearing a very acceptable form of contemporary culture (the Walkman!), they are apparently in charge of their destiny. They work at the pace they prefer in the way that they want such as choosing what they play with and what they read. Of course, the therapist is there but s/he is largely an unobtrusive figure who communicates mainly via the headphones Thus, the learning experience and expectations are very different from those usually encountered by the child.

3. The crucial automatic aspect of reading is addressed by deliberately discouraging children from attending to the auditory re-education process especially during the early stages. Instead subjects are encouraged to engage in quite different activities such as puzzles, lego and drawing while they are listening to the tapes. The aim here, therefore, is to establish the 'primitive' elements of language processing at a level that does not impinge on focal attention. This allows the cognitive system to function effectively when it is required in activities like imitating sounds and reading.

4. Beller's route into the auditory system is principally via his invention of the lexiphone. At an early stage in his work he recognised the significance of the phenomenon later known as phonological awareness and saw it as one of the keys to unlocking reading difficulties. Parametric sound serves to mark the critical features of language (or music) by high lighting them through what happens to the sound form. But, because this acoustic input carries no meaning it is absorbed unconsciously. The claim is that it provides the substrate which the child needs to relate language to the written form. Later, through the medium known as alternance, the child is alerted to the important similarities and differences between words and their structure. In this way phonological awareness, a concept common to most contemporary theories of reading, is re-educated.

Dr Beller's approach, therefore, is grounded in scientific and educational principles. An essential assumption is that any one or two of the features described is insufficient. It is the whole package that is important and that represents the unique nature of the semiophonic method of auditory re-education.

Phases of the Re-education Process

The recommended 100 sessions are divided into two parts, each lasting approximately 30 minutes. Seven phases are involved.

First phase

- Parametric sound (1st half hour)

The child hears the variations of the parametric sound produced by a story on the cassette which sounds like bird song. This directs the child's processing system to the rhythm of language but without their focal attention being drawn to it. While listening the children do puzzles, draw or engage in any preferred activities.

- Music and parametric sound (2nd half hour)

The child listens to music accompanied and highlighted by parametric sound. At intervals the microphone attached to the headphones is switched on. Any speech or sound produced by the child is relayed via the lexiphone to create parametric sound in the child's headphones. Children will discover that parametric sound follows the modulation of the music as well as the human voice.

Second phase

- Syllabic alternance (1st half hour)

The objective is to re-introduce the phonological element of language but still without the interference of meaning. This is achieved by using fragmented language in which verbal components are removed in a regular but random manner. For example, the child might hear:

the la en her co bis

In this example every other syllable has been removed from the sentence: The old lady enjoyed her chocolate biscuit. Parametric sound accompanies the alternance and is not subject to editing. It serves to continue training in language prosody. During this phase the child works progressively on different tempos of segmentation: syllabic, phonemic and later lexical and syntactic segmentation.

- Word repetition (2nd half hour)

From the beginning of the second phase, the child will begin the active phase of the re-education process, starting with word repetition and continuing with double word repetition, text and book repetition, 'free' reading (the child reads alone, no tape is involved) and finally spelling. Parametric sound is continually present systematically accompanying the voice on the cassette and the voice of the child.

Word repetition is done from a list of words (followed by blanks for repetition) that have been recorded on cassette. The same principle holds for double word and text repetition. Working with an audio-phonatory loop encourages self-correction by the child. The general rule is for the therapist not to correct the child.

At the second phase the meaning of words is not important. The therapy creates a natural tendency for children to imitate the pronunciation, rhythm and intonation of what they hear. The fact that the child's attention is often on their manual activity causes them to repeat words in an automatic manner which puts a premium on the intonative contours and rhythm of words.

Third phase

- Phonemic or lexical alternance (1st half hour)
- Double word repetition (2nd half hour)

Double word repetition is the same as word repetition with two words being presented together. It marks the beginning of language and a steady move towards meaning.

Fourth phase

- Single word or double word repetition (1st half hour)
- Text repetition (2nd half hour)

Extracts from books have been recorded with silent spaces between phrases (segmented according to syntax). A wide range of stories is available to maintain motivation. Repetition of phases, using the auditory loop and parametric sound, helps the child's memory (verbal short-term memory is typically poor in dyslexics). Children can work at their own pace and select texts to repeat as preferred.

Fifth phase

- Text repetition (1st half hour)
- Guided reading (2nd half hour)

For the first time in the re-education process, the child is confronted with a book. Guided reading is a gentle way to re-introduce reading. The procedure is similar to text repetition but follows the text in a book with highlighted segments of phrases that are to be repeated.

Sixth phase

- Guided reading (1st half hour)
- Free reading (2nd half hour)

The child is asked to read aloud a chosen book into the microphone with the child's voice still accompanied by parametric sound.

Seventh phase

- Free reading (1st half hour)
- Written repetition (2nd half hour)

The child listens to a recording of a poem, segmented according to syntax. Initially the child is presented with the poem on paper but with a number of blanks which the child must try to fill in. Over time the number of blanks increases until finally they write the whole poem. The child is encouraged to re-read what they have written and to self correct. Correction and guidance are also provided by the therapist.

UK (Manchester) Validation Project

Method

Participants. 18 children, 10 males and 8 females, aged between 7:0 (7 years 0 months) and 10:4 years (average age 8:1 years) living in the North West region of England, were recruited. These came from a total of 23 children who were interviewed. Sixteen of the children had been assessed by the Dyslexia Institute and two were referred via their local educa authority who were aware of the project.

Diagnostic tests and screening. Before intervention all chil were given the Wechsler Intelligence Scale for Children (W IIIUK), the Wechsler Objective Reading Dimensions (WOF the Phonological Assessment Battery (PhAB) (Frederick Frith and Reason, 1997), the Neale Test of Reading Ab (Revised British Edition,1989) and The Dyslexia Screening (Fawcett and Nicholson, 1996). All children and their par were interviewed and completed a clinical and educati history questionnaire. Children were selected for the progra according to their performance on the above tests, having b diagnosed as having moderate or severe dyslexia. IQ sc ranged from 88 to 118 with a mean of 102 (SD 10.33). Ele of the children had three or more highlighted scores on PhAB where highlighted scores reflect 'at risk' in the area of l guage and literacy. Reading ages were, on average, 2:1 y below chronological age (Neale) and 1:6 below, on average, WORD.

Intervention procedure It was made clear to parents that part pation in the lexiphone auditory re-education programme wa major commitment involving two visits a week to the cen over 10 months. At the same time it was also pointed out t children could withdraw from the programme at any time. the event, all children remained for the duration of the thera

The physical set-up consisted of a large room with f individual 'cubicles' at one end of the room containing a ta and chair. These were each linked via audio headphones t remote lexiphone. The lexiphones were under the control of t therapist who was at a desk in another part of the room and v also able to monitor, by headphones, what individual child were listening and responding to. The therapy room was w equipped with books, games, drawing and modelling materi and attractively decorated. It also contained over 100 casse tapes used in the lexiphone therapy programme. T intervention followed the programme used in Dr Beller's cli in Paris as faithfully as possible. The phases have already be outlined.

Design. Following the practice of Dr Beller, measures of readi and spelling ability were taken only at the start and finish extended therapy. The exception was phonological ability sir the PhAB test was administered half way through therapy well as at the end. A comparison group of dyslexic child matched for age, sex, geographic region, IQ, and reading a spelling ability was tested on the same measures as the tre ment group over the same time period. The comparison gro had all been assessed by the Dyslexia Institute and w receiving varieties of 'standard' intervention as recommended the Institute. It proved possible to obtain good matches for of the 18 children in the treatment group.

Results

Two sets of data are reported. The gains (or losses) on t various reading and phonetic measures between Time 1 (start treatment) and Time 2 (end of treatment) are first presente This period was approximately 10 months and involved 1 sessions of lexiphone therapy. The second set of data compri comparisons between the Lexiphone group and the match group of dyslexic children.

Changes in reading scores during the course of treatment

Table 1.

Composite scores on WORD reading test for Lexiphone treatment group (n=18) for beginning (Time 1) and end of therapy (Time 2).

WORD COMPOSITE SCORE	MEAN	STANDARD DEVIATION
Time 1	77.39	11.75
Time 2	82.89	15.51

There is an increase in the WORD composite score of 5.5 standard points between Time 1 and Time 2 (see Table 1). This difference is significant (t = 2.36, p = .031) and shows that there is a substantive gain in reading ability during the period of treatment. The breakdown of scores for the three components of the WORD test is shown in Table 2. The difference of 2.56 standard points between T1 and T2 for reading just failed to reach significance (t = -1.87, p = .08). The increase in spelling score (4.11) was not significant while that for comprehension (6.89) was (t = -2.54 , p = .021).

Table 2.

WORD standard scores (Time 1 and Time 2) for Reading, Spelling and Comprehension.

TEST		MEAN STANDARD	DEVIATION
Reading:	T1	82.83	10.65
	T2	85.39	11.35
Change		2.56	
Spelling:	T1	80.72	9.35
	T2	84.83	12.69
Change		4.11	
Comprehension:	T1	80.83	11.97
	T2	87.72	16.68
Change		6.89	

Table 3.

WORD reading ages (Time 1 and Time 2) for Reading, Spelling and Comprehension

TEST		MEAN STANDARD	DEVIATION
Reading:	T1	80.12	11.61
	T2	91.51	18.75
Change		11.39	
Spelling:	T1	80.84	8.44
	T2	92.23	18.96
Change		11.39	
Comprehension:	T1	79.74	10.09
	T2	92.07	21.35
Change		12.33	

When expressed in reading ages (Table 3) all the increases are significant: reading (11.4 months, t = -4.58, p = .000), spelling (11.4 months, t = -3.61, p = .002), comprehension (12.3 months, t = -3.99, p = .001).

The data for the Neale test in Table 4 show that the mean increase in reading age on all three measures was at 12 months or better. The changes were all significant: Accuracy, t = -4.33, p = .000; Rate, t = -3.36, p = .004; Comprehension, t = -7.17, p = .000.

Table 4.

Reading age scores (in months) on the Neale reading test for Time 1 and Time 2.

TEST		MEAN STANDARD	DEVIATION
Accuracy:	T1	71.50	14.06
	T2	83.50	19.26
Change		12.00	
Rate:	T1	73.68	17.36
	T2	86.29	24.96
Change		12.61	
Comprehension:	T1	75.00	13.26
	T2	90.00	20.00
Change		15.00	

Phonological measures

The Phonological Assessment Battery (PhAB) was administered at the start of the project, halfway through treatment and at the termination of the therapy. It was found that the number of areas in which the child has recorded a score that puts it in the 'at risk' category, that is, demonstrating moderate or severe delay with respect to the standardised norm, had reduced from 3 to 1.33 by the end of the treatment. This difference is significant (t = 5.15, p = .000) which indicates that one of the effects of the lexiphone treatment was to raise the level of phonological awareness, a recognised critical component of literacy. Six of the eight relevant components showed significantly increased scores (Alliteration, Rhyme, Spoonerisms, Naming Speed Pictures, Naming Speed Digits and Rhyme Fluency). This again, allows us to confidently assert that the lexiphone treatment is having a significant and positive effect on phonological awareness. It should also be noted that these effects were apparent at the midpoint of the treatment.

Lexiphone group and matched controls compared

Table 5.

Mean differences between time 1 and time 2 for reading standard scores and age equivalents (WORD test) for the Lexiphone therapy (n = 18) and dyslexic comparison group (n = 11).

TEST – WORD	LEXIPHONE GROUP (18)	CONTROL GROUP (11)
Reading (standard scores)	2.6	-4.6
Spelling (standard scores)	3.8	-5.1
Comprehension (standard scores)	6.9	-5.4
Reading Age (months)	11.4	6.8
Spelling Age (months)	11.4	4.9
Comprehension Age (months)	12.3	2.2

The effect of the lexiphone therapy can be further assessed by comparing the results of the lexiphone group with a group of matched controls referred to as the Comparison Group. Table 5 provides a breakdown of the three subtests that comprise the WORD test: reading, spelling and comprehension. It can be

seen that on standard scores, the group which had lexiphone therapy improved by between 2 and 4 standard scores, on average, in reading and spelling and by nearly 7 standard points in comprehension. In contrast the comparison group suffered a drop in score of between 4 and 6 standard scores. This means that the difference between the two groups at the end of the treatment period was 7.11 standard scores on reading, 8.87 standard scores on spelling and 12.3 on comprehension. These differences are all significant (Reading, $t = 3.51$, $p = .002$; Spelling, $t = 2.41$, $p = .023$; Comprehension, $t = 3.16$, $p = .004$).

A similar picture is apparent on reading age where the differences are respectively: 4.6 months (reading); 6.5 months (spelling) and 10.1 months (comprehension). Only the latter of these differences is significant ($t = 2.41$, $p = .023$).

Table 6.

Mean differences between time 1 and time 2 for reading standard scores, reading ages, spelling standard scores and spelling ages (WORD test) for the Lexiphone therapy (n = 11) and dyslexic comparison groups.

WORD TEST	LEXIPHONE GROUP (11)	CONTROL GROUP (11)
Reading (standard scores)	3.6	-4.6
Spelling (standard scores)	4.3	-5.1
Comprehension (standard scores)	7.1	-5.4
Reading Age (months)	14.9	6.8
Spelling Age (months)	13.6	4.9
Comprehension Age (months)	15.0	2.2

Table 6 presents the data for the eleven children from the Lexiphone treatment group that had exact matches in the Manchester dyslexic comparison group. Larger differences between the groups, from T1 to T2, are now demonstrated. The difference in reading standard scores is 8.2 standard points ($t = 3.3$, $p = .004$), for spelling it is 9.4 points ($t = 2.2$, $p = .038$) and for comprehension, 12.5 points ($t = 2.69$, $p = .014$). As indicated all these differences in standard score points are significant. The reading age differences are 8.2 months in reading age, 8.7 months in spelling age and 12.8 months in comprehension which is also a significant difference ($t = 2.54$, $p = .019$).

INDIVIDUAL DIFFERENCES

The results reported tell only part of the story. The effects on individual children are also important. There is not space here to go into detail but it is possible to give a flavour of the findings. Children were classified on the basis of their changes in performance on the standardised reading tests using the reading, spelling and comprehension measures. Altogether nine measures were used and it was found that all of the children made some improvement but that the rate of improvement varied. Six of the children made improvements on one-third of the measures and eleven made improvement on more than two-thirds of the measures, the average for this group being an improver rate of 84%. One child was in the middle with an improver rating on four out of the nine measures. This means, therefore, that nearly two-thirds of children can be said to have derived considerable benefit from the therapy and one-third to have achieved moderate or slight improvement. This 'rate' of success compares very favourably with all other intervention procedures of which we are aware.

CONCLUSIONS

The semiophonic method of auditory re-education has been give to a group of young dyslexic children and cleat benefi demonstrated. Gains in reading and spelling, as measured c standardised tests, were three times those of the matched control In addition, large and significant improvements in phonologic awareness were found. The commitment of parents and childre was shown by the total absence of any attrition during the stud and all participants reported substantial improvement in sel esteem and in educational attainment. Many questions remai concerning the explanation for change and the precis mechanisms that account for it. It is also premature to evalua Dr Beller's claims for rehabilitation in the absence of long-ter follow-up data. Nevertheless, the findings show promise an support the setting up of a unit that can administer the therap and allow further monitoring of results to take place.

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Maureen Wheeler of the Wilmslow Dyslexia Institute supplied t following information regarding the comparison group:

'Some were getting basic support from school, some saw a local tut weekly and some were not really getting any extra help at all – a fe maybe 2 or 3 were about to start D.I. lessons.'

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