

Semiophonic Treatment of Developmental Dyslexia

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SUMMARY

Psycho-linguistic and cognitive roots of the semiophonic method, a new treatment of the developmental language disorders. The semiophonic method uses a device called a "lexiphone", which allows a direct training - without systematic pedagogical interventions - of the automatic language impairments concerning these symptoms.*

Key words: Language developmental disorders — Phonological awareness — Basic automatisms of language — Fundamental frequency — Parametric sound

Over the last few years, psycholinguists have written a considerable number of articles and books on language developmental disorders. The relatively recent success of cognitive sciences and research on the respective roles of linguistic competence and cognitive capacities in the development of intelligence in children is far from being the only explanation of this sudden interest.

In fact, since Roman Jakobson, child language pathology has traditionally been one of the privileged fields linguists have used to support their hypotheses on the process of language acquisition.

Problems dealing with learning to read are among the developmental symptoms the most often studied, because of the high number of dyslexics (5 to 10% of school age children according to recent statistics) and to the role failure in school plays in the western world's cultural and pedagogical crisis.

To this is added the linguistic interest of understanding the different structural elements common to diverse language symptoms both oral (dysphasia) and written (dyslexia). Therefore the inherent nature of the language itself is confronted by the heterogeneity of its oral and written functions.

However, faced with such a mass of research, it is surprising to note that few authors are interested in the treatment of these disorders, as if the study of behavior and of clinical results did not lead to any research perspectives. Why don't any studies of different methods of treatment follow predictive or epidemiological studies that so interest our scientists? Does the medical field

* The semiophonic method is used to-day by many speech and educational therapists (hospitals, centers, private practices) in France, Belgium, Switzerland and Israel.

illness or a syndrome and scorn the results of therapeutic studies based on this research ?

With such a perspective, the study of the conceptions and the results of semiophonic treatment* (31) becomes even more interesting. Dr. Messerschmitt's double-blind study concludes that the results of the semiophonic method are "superior to traditional methods" and it confirms the basic hypothesis of psycholinguistic work on dyslexia, namely that the symptom is a revelation of more general language acquisition disorders. Twenty years ago we said that dyslexia, which hadn't yet been called developmental, should really be considered "lexical dysphasia" (10).

This hypothesis, which still doesn't appear explicitly, comes from the specificity of developmental dyslexia or, in other words, from the difference between dyslexia and simply problems in reading acquisition (22). For psycholinguists, aetiological analyses from different sciences involved in the study of developmental language pathology are concerned with the pathology of the symptom (visual or auditive disorders and malfunctions of a biological, physiological or psychological etc. origin) and not with the symptom itself. They thereby do not form one valid aetiology but a system of multiple heterogeneous causes on different epistemological levels. Linguists or cognitivists only mention them in passing but that doesn't change the premise of their thesis.

All speech therapists know from experience that aetiologies put forward to explain dyslexia are interchangeable. It depends on the school of thought. In some cases they fall back on biological causes which seem to invade the clinical field and in other cases psychological or relational causes, which in turn...etc.

And when Pierre Lecoq incriminates the "*articulatory feedback loop*" in the formation of the symptoms of dyslexia (24), care must be taken to conserve the linguistic "*readability*" of the phenomenon. This position implies, in particular, that the language and its pathology should not be reduced to one of its structural components and that the psychophysiological content which is linked to the co-articulation phenomenon must be defined first. It can be added that cognitive experiments have proven the purely linguistic character of dyslexia. The results of tests of "*immediate memory*" are normal when non-linguistic sounds are used (music, noise, etc.) but drop when linguistic sequences are used whether these sequences are significant or not (which, on a pure neurologic point of view, allows to infer the role of the two hemispheres in the language organisation).

PHONOLOGICAL AWARENESS

An anthology of articles on reading acquisition and the difficulties of this process goes in the same direction (37). The authors are mostly from American universities (with the exception of Alegria and Morais who are Belgian and Sprenger-Charolles who is French) (40). It is interesting to note that aside from very specialized differences of opinion which are minimal from a theoretical stand point (at least for a practitioner) concerning the

* Cf. the blind experiment done by Dr. Paul Messerschmitt at the Trousseau Hospital of Paris in 1992 and 1993 (in the Psychopathology and Adolescent ward) with two groups of twenty two dyslexics (semiophonic therapy vs traditional therapy). See his article published in ANAE, 1993, 5, Paris, France.

different stages of reading acquisition, the authors all agree to accuse the immaturity of a patient's *phonological awareness* (known under different terminology as "phonic awareness", "phonological sensitivity", "phonemic knowledge", "phonological skills", "segmental awareness"...) in the appearance of dyslexic disorders irrespective of the clinical form of the symptom. The studies refute the fundamentals of Boder's classifications (12) of dyseidetic dyslexics and dysphonetic dyslexics which are still popular. For Olson, for example (34), the difference between semantic dyslexics and phonological dyslexics is in reality an error in perspective : the first type seems to be the result of semantic- contextual anticipations. But the basis of the symptom remains for both types phonological : the ability to understand is not directly challenged.

For psycholinguists, the existence of the specificity of dyslexical disorders in the origin of a delay in reading acquisition does not seem to be doubted. Predictive tests which evaluate the level of maturity of phonological awareness of five-year-olds who haven't begun to learn to read are very revealing of what must be considered a language disorder. They test the ability to synthesize or segment words from phonemic or syllabic elements (phonemic awareness), sensitivity to sonority, rhymes and alliterations (phonetic awareness), sensitivity to rhythm and to phonological sequences (prosodic awareness), and all other "awarenesses" that make up so called *phonic* or *phonological awareness*. It has been confirmed that these disorders are independent of the child's intellectual level which is often excellent. In other words, the longitudinal tests called "predictive"* prove that these children, who have a *a priori* normal oral expression capacities and high level intellectual development, have linguistic disorders which are forerunners of the difficulties that are waiting for them when they try to learn how to read (10).

It would seem that such an approach would hold back any evolution in treatment techniques and in particular perfecting the semiophonic method. With this method the hypothesis of reconstruction — in the Piaget meaning of the term — of the linguistic capacities of the subject is highly feasible, whatever the aetiological processes implied to explain the lack of phonetic awareness.

The semiophonic method proposes to directly treat, without systematic pedagogical intervention, what can be qualified, in reference to certain studies, as the *automatic* processes of language as opposed to the *attentional* processes (39).

In order to do this we use an audio-phonatory device known as the *lexiphone* that works with a headphone equipped with a built-in microphone. Through this device we are able to intervene at the patient's audio-phonatory and audito-verbal loop (audio-phonatory feedback)* .

* In fact the "predictive" notion has to be nuanced. Many linguists question, in fact, how much phonological awareness is precisely due to the effort of the child to learn how to read - which implies that phonetic awareness develops simultaneously with learning how to read. This so called awareness is divided then into two periods: computational phonetic awareness which is done very early and is subconscious and is a prerequisite for the development of reflective awareness (the real phonemic awareness) which is not subconscious and develops at the same time as learning how to read and how to write the alphabet. (cf Stanovich, "Representation and awareness during reading learning" in "L'apprenti lecteur" *ibid*)

* The semiophonic method is not the first one to use audiophonatory equipment. Except for the verbotal method which was developed in accordance with Professor Guberina's

The semiophonic method is designed based on the structural principle that the roots of language developmental disorders are not found in linguistic or cognitive superstructures (called top down processes) but are found in insufficiencies in one or several basic capacities (called bottom up processes) of which a breakdown in phonological awareness is the principle sign. Intonative forms, the elements of syntagmatic rupture, and the "quantums of signification distinctions" (17) are found in these linguistic foundations. They allow diffracted aspects of meaning to come together in a linguistic flow which like a river follows the bed of speech sound sensitivity (38).

It is necessary to *automatise* these structural beginnings of speech because any effort on the part of the subject to voluntarily master one or more of these elements which make up basic linguistic capacities, implies a deviation of varying importance of the cognitive functions devoted to managing higher order meaning whether spoken or written.

DE-SEMANTISIZING LANGUAGE

From this our idea developed to find a method of treatment which allows the subject to temporarily escape from language "superstructures", or in other words, from meaning itself (this from a purely constructivist point of view and therefore by definition biased). There is always the possibility in traditional treatment that any signification, even the most elementary, could become a paradoxical means for a subject to avoid the occasion to return to the fundamental linguistic cause of difficulties. We feel that this is precisely why numerous speech therapy treatments fail through the resistance to the re-education process itself ! But that question which played an important role in the origin of the method, should be treated at greater length than this article would permit.

More briefly, we have tried to induce a "desemantisation" of language if such a paradoxical neologism is possible. In so doing, we seem to confirm the intuition of numerous therapists who are ill at ease in the systematic contradiction that forces them to work both as an authority and a therapist. The authority knows everything about the form and the orthography of the patient's theoretical linguistic level. The therapist tries to work on the structural meaning but not on the patient's language deficits, the "malformations" of which plunge it into its biological and psychological past.

Although the semiophonic method was originally based on hypotheses which are more different in their form than in their substance — such as the role of *auditivo-verbal perception* disorders in dysphasia which are dear to

very interesting studies at the University of Zagreb on the use of audiophonatory filters in teaching the deaf how to speak, this type of equipment has often interested the press. Therapists with little scientific or clinical justification claim it does wonders in the treatment of patients and symptoms which have little in common other than the most extreme eclectism. Leaving controversy aside as it would lead at the very least to making sure that these hypotheses and affirmations be scientifically and systematically proven, we would like to specify that the semiophonic method is only a method for language therapy. It is not a method of reeducation of the brain, the ears or the emotions using sounds which have powers that are all the more magical because they cannot be tested.

Ajuriaguerra (15) — we can say that psycho-linguistic discoveries over the last few years have confirmed the hypothesis on which the semiophonic method is based. Today most authors agree that developmental dyslexia is characterized by the difficulty of finding phonological information inherent in the written message.

This disorder is reflected in word recognition experiments, the lower speed indicating difficulties in accessing the mental lexicon. Four types of operations are used in naming exercises : visual perceptive encoding, focalisation of attention, organisation of semantic memory and finally phonological treatment of the words. Dyslexics only have difficulties with the last one as shown by a specific slowness in the recuperation in memory of symbolic information by phonetic encoding (26).

Dyslexia is also linked to a lower performance in mnemonic span encoding which measures the capacity to store information in immediate memory (27). The cognitive psychologist Baddeley (8) considers this the main axis of *working memory*. One of the functions of working memory is to treat grapho-phonological characters and to compare them with elements taken from long term memory monitored by a central process that controls attention and executes strategies. In this perspective, Baddeley imagines the existence of a device to maintain auditory information (*internal acoustic image*) linked to an *articulatory loop* which allows written material to be converted into phonetico-phonological material and to reactivate the traces in stock when they weaken (function of maintenance of the so called *interior voice*). As its name implies, the *articulatory loop* is linked to a more or less complete "mentalisation" — see for example the role of subvocalisation in silent reading — of the audio-phonatory loop which is activated during infant babbling and marked by the production of both types of babbling (solitary and proto language or interaction with others). In this perspective, Baddeley shows the existence of a relationship between the mnemonic span and the speed of articulation (implying, for example, that increasing a child's mnemonic span is directly linked to increasing the speed of articulation) (9). These results have been confirmed by numerous other scientists.

In summary, the role of the *articulatory loop* in dyslexic decoding difficulties — pinpointed by a lower memory span of linguistic elements — is essential.

In other words, the grapho-phonological developmental deficit comes from a disorder in the audio-phonatory sphere — *auditivo-verbal perception*. This disorder, that started from the first months of infancy, is either innate or linked to the subject's personal history and always comes from one of these two origins. This is because the evolution of a child's language is organically linked to a series of mandatory stages (cognitivists' *temporal windows* (30)) by which the early innate forms of neuro-anatomic and neuro-physiological organisation interact with the language environment (but also the psychological, relational and affective etc. environments) and take on a quasi definitive form.

LEARNING THROUGH CUES

Having reaffirmed the central role of phonological awareness disorders in developmental dyslexia and in the theory behind the semiophonic method,

other elements contributing to the theoretical basis of the semiophonic method have to be discussed.

Any learning process requires what Piaget calls *decentering*, a process which enables the subject to shift attention from the content of the schema to use an element outside this schema. That ability, as far as reading acquisition is concerned, seems to us to correspond to the necessity for the subject to shift attention from the content of the message to the language characteristics used to transmit this message. An illustration of this point is found, in our opinion, in Gough's identification through cues (36). Gough proves that for a young reading beginner, words are learned in associated pairs. For example, the number 4 is arbitrarily linked to the word "table", the number 5 to "chair", etc. Find the number and the beginner remembers the word. The number which is purely arbitrary serves as a decentering referent.

The experiment with fingerprints is even more explicit. Thirty-two children between the ages of 4 and 5 are asked to read a word off of four different cards. One of the cards has a fingerprint on the lower left-hand corner. The cards are shown to the children until they are able to identify all the words 2 times in a row. The results show that all the children learn the word on the card with the fingerprint faster than the three others. Very few are able to recognize the word if the fingerprint is removed. However, almost all of them can remember the correct word if they are shown the card with only the fingerprint on it. In conclusion it has been shown that the children learned the word by choosing an external purely visual cue and by neglecting the word itself (*external cue*). The experiment was continued and it was shown that at the next stage children will choose a part of the word as the cue (*internal cue*). They are thus able, for example, to recognize the second half of the word and not the first. Gough calls this passage from the external towards the internal cues, from an arbitrary mark to a letter (or group of letters) learning how to *cipher*. Once children learn how to cipher, they establish once and for all a precise and definitive correspondance between a letter and a sound. It is from their ability to cipher that children learn little by little to read (by *selective associations*).

Linnea Ehri adds a new step to this system of cues (29). She believes there is an intermediary phase between reading with visual cues and reading through decoding. During this *phonetic cue phase*, children use as their cues, one or several letters for which the written and the pronounced word closely correspond. This extra step explains semantic errors produced when, for example, children choose initial or final letters as cues and neglect the letters in the middle. At this step Gough's cipher hasn't yet been established. The children are still using a primitive decoding technique.

The epistemological value of the concept of cues in reading acquisition seems extremely interesting. The whole difficulty is to learn how learning — especially language learning — can function with itself as a cue ! In that perspective we must look into present ideas about the complexity of automatic or involuntary systems. The hypothesis can be made that while *temporal windows* are opening (referred to earlier), a temporal doubling is being organized where a part of the energy invested in memory is being used but with a lag in time (as in epistemological model of Watt's steam engine, for example). In other words a respite or a lag in time is created in the systems named "*temporal autocorrelations*" which allow retroactions or retroprogramming called *parallel distributed processing* (14).

BABBLING AND PROTOLANGUAGE

In this way, the beginnings of a child's language should be considered as the process of mastering the notion of temporality. Babbling (7 - 24 months) corresponds to the setting up of both a forward and a backward *temporal autocorrection* system. Children learn this through playing with their voices in babbling explorations or in interactions with the people around them (proto-language).

Jakobson thought that there was sometimes a short period when children were mute between the time when children give up flourishing and unprovoked playing or "spontaneous babbling" which is rich in prelinguistic elements and the time when they begin language (18). The linguistic phase is characterized by the appearance of phonological elements (syllabifications) and the attention of the child is irrevocably turned towards the segmental organization of language. In this perspective it was considered for a long time that ~~maintaining~~ maintaining arbitrary intonation productions was a sign of immaturity which could perturb the articulatory development of the child and necessary precision (21). That is why up to the last few years, intonation (melody, rhythm, and accentuation of language) was thought to have a secondary role. It was not considered to be of linguistic value and even less of phonetic value. It seems as if that position has since evolved. Today — even since the middle of the seventies (33) — most scientists are convinced that babbling plays a major role in the way a child begins a linguistic phase. The intonational organisation (fundamental frequency of the voice, melody and rhythm) has become a prerequisite for language (19). By eight months babbling has adapted to the rhythm and to the melody of linguistic productions. It is more particularly adapted to the mother's language which has a greater influence on metaphonological traits than on segmental properties of the child's language. Intonation curves correspond for the most part to those of adults (7). By 16 months there is no longer any suprasegmental discontinuity between babbling and first language. The intonation curves are organized in the same way as in adult language (phonologically, demarcatively and structurally(28)). In a word, the passage from babbling to the first language is characterized by mastering prosodic patterns which are linked either to tonal curves or to production tempos.

In an article published in 1987, Nicole Bacri, a psycholinguist at the CNRS, compared temporal and rhythmic regularities of early productions (before phonological structuring) of young children who had a severe hearing impairment with those who had normal hearing. She was able to define two *tempos* which make up two axes that permit the creation of intonational organisation (1).

1. The *articulatory tempo* which depends on motor coordination of the pronunciation of sound elements. This tempo corresponds to the creation of intrinsic phonetic differences which are reinforced by local kinesthetic feedback as early as in the first six months. As a child develops its sensori-motor capacities, it learns to synchronize productions with those of the people around it, using both hearing and seeing. By three or four months, a child becomes sensitive to the temporal structure of the mother's voice and synchronizes it with the child's own voice (kinesthetic synchronisation). This is the first stage of linguistic elaboration which is an indication of the child's innate capacity to distinguish speech from non-speech. In spite of their hearing deficiencies, those with hearing impairment have no trouble with the maturation of their articulatory and vocal sensori-motor system thanks to visual and proprioceptive information (observation of articulatory movements of those around them).

2. The *relative tempo* which corresponds to the capacity of children to control temporal rhythms of different linguistic sequences beyond one word and to set up intonative forms of language (extrinsic differences). This capacity requires, in particular, that children discriminate among successive sound events and distinguish their forms. This "*implies a recoding, a storing of information and comparison of successive information which implies, in production, an anticipation of the form to be produced.*" (2) But unlike the *articulatory tempo*, the *relative tempo* is acquired only through auditive feedback. In French, for example, the syllables preceding pauses are usually accentuated and are two times longer than syllables at the beginning of sequences (oxytonic rhythm). This capacity appears around fourteen months thanks to the help of "*cognitive processes that regulate vocal motricity over a long period. They allow anticipation of a complex form and they make up representational systems which combine phonetic information and lexical and syntactic information. Children's speech which has the rhythmic and temporal structure of the language is intelligible for the adult*" (3).

Therefore the *articulatory tempo* is tributary only to local sensori-motor coordination — without the child having to call up elaborate cognitive structures (all pertinent phonetic contrasts are acquired before the age of six months) — unlike the *relative tempo* and prosodic rhythm which require the capacity to anticipate the forms which allow phonetic information to be combined with the lexical and syntactic information of the language. If the production of syllables or even short words implies mastering *articulatory tempo*, the production of a longer utterance implies *relative tempo* and rhythm.

People with a hearing impairment are therefore obliged to make a considerable effort to control the speed of their speech to make it conform to the norm for language use which is extremely difficult to acquire. For children with a hearing impairment, mastering the *articulatory tempo* at an early age is paradoxically an obstacle to the development of the *relative tempo* which is organized only through learned knowledge. This is because they can then get around the difficulty of the absence of auditive patterns. This organization in two tempos corresponds to what we have "macroscopically" called the acquisition of "automatisms" necessary to the normal development of a child's linguistic capacities. In this way, the difficulties of a child with a hearing impairment correspond to those of a dyslexic. They are both obliged to mobilize part of their cognitive capacities usually used for "attentional processes". They are missing the auditive pattern that would have allowed them a satisfactory "automization" of linguistic tempos. The French hearing impaired know, for example, that they have to lengthen the last syllable of an utterance, but they stop this lengthening after a certain amount of time whatever the tempo of their speech. In this case the acceleration of "*the time will be carried out by decreasing pauses between words and not by modifying intrasyllabic length*" (4). Hearing deficiencies thus become a cognitive as well as a physiological and/or psychological handicap.

Over the years, numerous studies on language development have touched on these two tempos which correspond to the fundamental epistemological divisions in linguistics (diachronic/synchronic, paradigmatic/syntagmatic, phonologic/semantic, metonymique/metaphorique, etc.) The *articulatory tempo* which is the most archaic, brings to mind what Ombredane called in his time "*pneumo-laryngo-buccal gesticulation*". This concerns the infant babbling period which is at the same time as infants acquire the capacity to

differentiate which is an approach to signification "*significant gesticulations*" (35). The child uses this pneumo-laryngo-buccal language "organ" to develop linguistic capacities and to discover a capacity to differentiate and to assemble sounds. The articulatory tempo makes up the first temporal window, the first Jakobson stage of language.

Research over the last few years has greatly amplified Jakobson's hypothesis whereby metaphonological production makes up the first stage of language even though Jakobson denies its role in the appearance of segmentation capacity.

Since then it has been established that :

- prosodic elements (tempos, accentuation, rhythm) determine the conditions of existence, both from a diachronic and a synchronic point of view, of the capacities of both lexical and syllabic segmentation and, under the influences of reading acquisition, phonemic.
- among these elements, the first stage (the "original core") is created, as Nicole Bacri has shown, by the articulatory tempo which must be clearly distinguished from the relative tempo.

LANGUAGE GAMES

Perhaps the following metaphor will lead to a better understanding of these tempos.

Imagine that an expert basketball player is asked to play with a strange ball. The player would only need a few minutes to get used to the ball's characteristics : its strength, its rhythm, its bounce depending on its inertia, its elasticity, its volume, etc. Thanks to experience acquired — the psychomotor capacities learned through years of training — the expert player discovers rapidly and intuitively the intrinsic tempo which is the result of the sum of the physical characteristics of the ball. Therefore the player will be able to rapidly produce a sufficiently adapted dribble to be able to concentrate on the game.

On the other hand, a beginner who is placed in the same conditions would have a lot of difficulty controlling the bounce of the ball. Even though the beginner tried as hard as possible — harder than the expert player — the dribble would be off balance and the beginner would have a tendency of losing the ball, etc. The beginner's attention would be almost entirely focused on just getting the dribble right and thus would have more and more difficulty playing the game.

Within the limits of such a metaphor, we would say that for someone with a hearing deficiency, the language "organ" is off balance. It has been formed thanks to kinesthetic and visual feedback which are the origins of articulatory tempo which is of an almost normal quality. However it has been formed by an inadequate relative tempo and rhythm acquired through substitution strategies. Language use becomes difficult because of the impossibility for the subject to apprehend linguistic forms which do not correspond to phonetic contrasts : melodic curves, pitch, rhythm, and accentuation in which the auditive pattern plays a central role. Therefore the acquisition of the relative tempo which is an indication of the child's capacity to anticipate a significant chain — that we designate above by analogy as the temporal autocorrection system which takes into account the backward and forward programs necessary to understanding speech —

requires a "construction" which calls upon elaborate "high" compensatory cognitive faculties.

A debate on whether or not capacities inherent for the acquisition of linguistic "automatizations" are innate would lead nowhere. It is worth noting, however, that these structural roots require that innate precapacities (organizational preforms) come in contact with linguistic events which depend on the child's environment just as sensorial, motor, psychological, affective, etc. events shape these capacities. This is another way of putting Jakobson's "development by stages". Historically "*initial structures are covered over by those that follow*". On the other hand, we know that in aphasia, for example, which acts as a sort of "geological slice" of the linguistic "terrain", "*disintegration first affects the highest strata as Jackson showed us with his law of regression from the most complex to the simplest or the most primitive*". (16)

Through the semiophonic method we have therefore decided to approach the treatment of developmental dyslexia by trying to find out if it were possible to intervene directly at the roots of the symptom as we have tried to explain with this short analysis of psycholinguistic studies over the last few years.

THE SEMIOPHONIC METHOD

Our intention is to analyse the fundamental points of the method corresponding to the theoretical points developed above which therefore imply finding a means of intervening directly on the "elementary automatizations of language". We will finish by a rapid description of the stages of the treatment, an exhaustive analysis of which will be the object of another article.

The semiophonic method is a complete process of treatment consisting of several chronological stages. Borrowing from Jakobson's metaphor, we can say that the patients pass through the different stages of language at the same time as they go through the treatment process.

In general a session lasts one hour — less if the child is very young — and is divided into two parts, a half hour each.

The treatment is carried out with the help of a device called a *lexiphone* which consists of an amplifier, a tape recorder and headphones with a built-in microphone. The device (amplifier and tape recorder) enables the subject to hear both pre-recorded cassettes and what the subject himself says in the microphone (feedback audiophonatoire). The therapist can hear what the patient hears through another set of headphones. The therapist can then more accurately tune the device or intervene in the re-education cycle.

Besides this audiophonatory amplification-restitution function, the *lexiphone* has several other specific functions.

1. "Parametric Sound"

The device is capable of producing a "white sound" called a "parametric sound" (or "parametry") since it is a pure electronic sound with

predetermined and adjusted parameters. This sound can modulate according to the sound reaching the amplifier which is called "modulating sound" in opposition to "parametric sound". This "modulating sound" (or "modulation") comes from either the tape recorder playing a pre-recorded tape or the microphone in front of the patient's mouth.

Without a "modulating" sound — when no sound reaches the amplifier — the "parametric sound" produced by the *lexiphone* is situated in the ultrasound zone. On a frequency/time diagram, it looks like a horizontal line situated slightly above the ultrasound limit or above 15,000 Hz for most people as the height is adjustable. (figure 1) This simply means that it should be inaudible. In order for it to be heard by the patient, the "parametric sound" must modulate, or in other words it must go down towards the bass and cross the ultrasound limit. This is exactly what happens when a "modulating sound" reaches the amplifier.

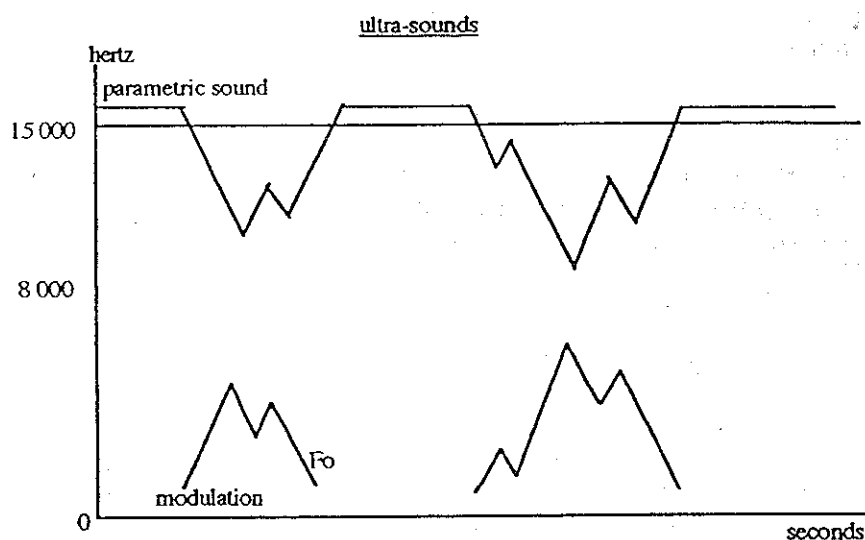


Figure 1

Parametric sound is linear at 16,000 Hz. The modulation created by the modulating sound makes it modulate down to 8,000 Hz. Therefore each inflection of the fundamental frequency of the "modulating sound" — each rise and fall of the F_0 — provokes a mirror modulation of the "parametric sound". When the F_0 goes up, the parametric sound goes down. When the F_0 goes down, the parametric sound goes up until it disappears again in the ultrasound level with each pause in the so called "modulation".

This means in particular that when the parametric sound produced by a recorded text is injected in the headphones — in modulating sound position — the subject only hears the modulations of a high pitched electronic sound broken by brief silences. (It sounds like a bird singing). This is because the zone between 4,000 and 15,000 Hz where the parametric sound is situated very rarely contains sound of a linguistic nature except for the high points at 8,000 Hz of some constrictives.

In fact, changes in the amplitude of the voice making up the modulating sound — intensity changes — intervene also in the shape that the parametric sound modulations take, but this time in the same direction. This is so that the

modulations which result from the sum of the two parameters ("frequency" and "amplitude") characterize the intonative shape of the language reaching the amplifier — the rhythm and the shape of the high points having already been determined.

Therefore parametric sound makes up the *intonative signature* of the language (pitch, rhythm and amplitude).

2. The First Phase of the Re-education

At the beginning of the re-education process, one of the objectives of the parametric sound is to focus the subject's attention on this intonative shape.

This objective is reached in several ways.

During the first part of the session which lasts a half hour, the patient only listens to the parametric sound produced by a pre-recorded cassette with the microphone switched off. During this time, the patient is asked to play, draw or do any other activity that doesn't imply reading or writing.

During the second part, the second half hour, patients discover that they have the possibility of producing a parametric sound with their own voices. At this time the microphone is left on so that with the slightest cough, exclamation, etc. the patients hear the parametric sound produced by their voices. In other words, subjects discover that "parametry" maintains a close relationship with their own vocal productions of which there isn't any exterior (exogène) auditive perception — except for the parametric sound — but only kinesthetic perception. At the same time, during this second phase, a patient hears recorded music and the parametric sound which it produces. The parametric sound follows the melodic form.

Thus during this first phase, patients discover that "parametry" has the characteristic of following the melodic inflections of the "modulating sound" whether it is produced by music or by their own verbal productions. In other words, in their headphones they hear music — and not their voices — as well as the two parametric sounds modulated by both the music and by their voices.

To complete this didactic (but not pedagogical) phase, subjects hear their own voices after two sessions which then allows them to confirm that "parametry" follows their own voices in the same way as it follows the music.

To summarize, the first phase is made up of a series of session during which subjects hear:

- during half a session : parametric sound produced by a recorded text but without the text being audible.
- during the other half of the session :
 - at the same time, both audible music and parametric sound which is produced both by the music and by their own voices. Their own voices are not heard.
 - later, under the same set up, their voices are audible.

Thus in a few sessions, subjects have discovered an artificial sound the modulations of which have the characteristic of following the inflections and changes in the rhythm of the music, the recorded text or even their own voices. The patients can make this discovery by themselves without the therapist necessarily commenting at all. Explanations concerning the

content of the system of re-education are only given when patients ask for them and according to their ability to comprehend. Metaphors are usually used to explain. In fact, for the patient, the discovery should be more intuitive than a rationalisation.

This system allows subjects to be directly confronted with one of the fundamental linguistic dimensions which from the beginning of their lives has been "subconscious". By "subconscious" we mean, as we have already said, the process which allows an elementary dynamic form to go from the "attentional" domain to that of the "automatic" (as in Stanovich's "computational subconscious knowledge"):

In any therapy, it has to be determined how can the "primitive stages" concerned by language developmental disorders be reached when with the therapist has to use the "vehicles" of language coming from more elaborate stages of this same language. This is why all therapies use a top down process which, we have seen, does not correspond to a developmental logic of language — and thus to the symptom. Sometimes we have the impression that the therapist is like an architect who, having learned that the foundations of a building are faulty, finds that the only means available to work on the construction is to use a telephone !

Unlike traditional methods, the semiophonic process is a bottom up process.

There is another paradox in the same line, characteristic of traditional methods, which the semiophonic method can solve. Educational therapists are in a position to do therapy because of their training and because they can speak, write and read well. This is why both the society and the families consider them speech therapists but it is also why therapy is often inseparable from pedagogy. In some countries (the USA, Great Britain etc.) therapists of language developmental disorders are part of the school system. The therapeutic part of the re-education process is secondary to the pedagogical part even if the therapist would have it differently. The determining factor is inevitably the situation of the family, the society and the school.

The results of this are that the therapy is considered by patients — and are they always wrong ? — as a continuation of multiple pedagogical re-education operations that have preceded it and have failed. This is sufficient to make the next attempt fail or even to reinforce the symptom.

This problem can be avoided (11) thanks to the strategic flexibility of semiophonic therapy (32), which allows the therapist to be more or less freed from the technical aspect of the re-education as opposed to the therapeutic aspect which can be more fully developed.

Thus at the beginning of the re-education process, we have subjects whose attention has probably for the first time been focused directly and exclusively on the prosody of language thanks to the intervention of a series of strategems.

It must be remembered that, as early as by the tenth month, thanks to the attention very young infants devote to the voices of their mothers, infants are able to form the intonative shape of their own voices — the basic form (Fo). This intonative form continues to develop at the same time as the child's language. Studies have shown that for children with hearing impairments, voice alterations go hand in hand with language development delays (20).

It is the strategum of parametric sound which paradoxically is the element which plays the principle role in re-education. Gough's experiments on learning through cues or through associated pairs are a good example. The cues used to teach in the beginning are arbitrary, allowing little by little the formation of a structural relationship with the linguistic items that have to be memorized. First a child uses arbitrary external visual cues then internal phonetic cues and then progressively uses *ciphers*. In this process of "interiorisation" — and of symbolisation —, the arbitrary disappears and not the strategum. It could be said that the relationship to learning of the associated pairs is "parametric" as in the case of mnemotechniques used by students to remember key words for a test. Another example would be multiplication tables that children used to learn by chanting. This "music" obviously played a role in the memorisation of the tables just like it does in nursery rhymes.

What is the role of the arbitrary cue, the fingerprint in Gough's experiments? How can arbitrariness play a role in what seems to be a necessity ?

From this point the hypothesis must be formulated that this cue which seems to be "primary" is in fact "secondary" and that it is the evidence of a pre-existing means of operation. By the effect of decentering, the visual cue allows children to find within themselves, let's say in the atavistic memory, the original structural links that have allowed language to become an autonomous capacity and to link elements which are *a priori* totally heterogeneous (voice, respiration, cognitive data, etc).

The acquisition of language and afterwards of writing confirms a pre-existing unity — and yet one that is developing —, linking these elements which are *a priori* radically heterogenous such as the articulatory feedback loop and memory or such as "phonological awareness" and reading.

The visual arbitrary cue is only the image of a means of operation or a unity which already exists. It gets its meaning from foreseeing what is necessary to memorize. In this way, its "interiorisation" that is transformed into an internal cue (in the circumstances a phonetic cue) is only the after-the-fact confirmation of a potentially pre-existing state. If the opposite were true, no cue would be able to play the role that is attributed to it.

We sometimes call this process² the highlighter effect ! Even though it is purely artificial — especially because it is artificial — the fluorescent line of a highlighter that students draw over a selected few sentences of their notes enable them to memorize the meaning. But this line only works if the length of the line corresponds exactly to that of the sentence — or to the syntactic segment of the sentence — which has to be memorized. Otherwise the highlighter effect works poorly or not at all. Because the strategum stops where the parameter starts working : by creating a relationship, even a minimal one — even abstract — between the line and the language. For this example it is the length of the sentence. It is measured in a fraction of an inch and fosters the "support" effect of the "associated pair". The parameter is thus the reflection of a structural association that was already created and is only necessary to "activate".

This is how parametric sound works inside language itself.

3. The second phase of re-education

The second phase allows us to intervene at the level that we have called, according to Nicole Bacri's studies, the articulation between the *articulatory tempo* and the *relative tempo*. This is another manner of explaining the paradigmatic and syntagmatic dimension of the developing language. At this stage our objective is to help the two temporal axis of language to reconstruct and to resume their relationship.

The articulatory tempo is linked to intrinsic differences between consonantal and vocal phonemes which imply that the flow of the motor stimulation is segmented into distinct units. Its maturation depends on sensory-motor coordinations : we have seen that all pertinent phonetic contrasts are acquired before six months (5). By eighteen months, the time it takes to articulate both consonants and vowels is the same as that of adults. In other words, in French, it is the capacity to pronounce five to six syllables per second.

Let's go back to the metaphor of the basketball player. Children learn to play at the same time as they comprehend the definitive configuration of the ball. The prosodic patterns are acquired before complete control of phonemic duration. In French the temporal increase of the final syllable — or before a pause — as well as the accentuations of the intonative curve, appear on the same segments and will facilitate phonemic and syllabic segmentation (6). The intelligibility of child speech to adults thus depends on the presence of a strong contrast between the duration of the initial syllable and the final syllable. This contrast is absent from productions that are judged to be incomprehensible because the capacity of the child to modulate the relative duration of vowels inside of a sequence is necessary for intelligibility. A change in duration varies from 21% to 40% in intelligible productions whereas it only varies from 1 to 8% in unintelligible verbal productions making discrimination impossible.

The development of the linguistic capacities of the child is conditioned by the domination of these two deliveries — verbal and articulatory — and their articulation.

The lexiphone has the possibility of breaking up the voice that is sent to the patient's headphones at adjustable regular intervals (between 1/10th of a second and 2 seconds). This possibility is called "alternation". Patients hear the same cassette as in the beginning: a text read in their language without any interruption. However, in their headphones they hear the modulating sound in broken speech — an alternation between blanks and the recorded voice — to which is added the parametric sound which is not heard in alternation.

As the diagram (figure 2) shows, the break up of the sound between blanks and modulations is not systematically in accordance with the syllabic articulation point. But this is of little importance because alternation is perceived in much the same way as parametric sound. Parametric sound refers the subjects back to their own perception and memorisation of the intonative forms of their language and they rediscover them "without thinking about it". Alternation enables them to rediscover a deep interior perception of syllabic forms. In this way, the alternation system is as parametric as the preceding system, returning the subject to the invariance of the phoneme (the *quantum* of distinction of signification).

The subject drifts between the two sounds, the continual parametric sound and the broken modulating sound renewing, putting back together and going back over the two dimensions of language.

Alternation thus goes through three stages : syllabic segmentation, then phonemetic (corresponding to the phonetic tempo : (the.. two... ry... peo... are... fa...)) and finally lexical, the patient being confronted for the first time with the beginning of signification: "These two very old people are the father..."

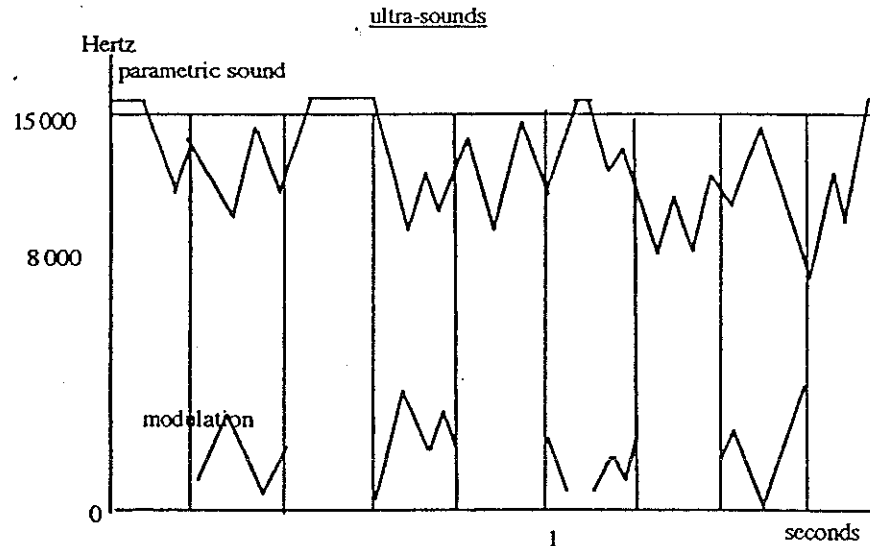


Figure 2

The recording is incomprehensible as is the case in the first stage. However, this time the patient knows that it is listening to a recording of spoken language because the segments are recognizable (syllabic segments if the alternance works at a rhythm of about 1/5th of a second : "Once ...on...time..was...lit...girl...")

4. The other Stages of Re-education

The "active" phase of the therapy begins. Until now patients only listened to that strange series of sounds in their headphones at the same time as they performed non-linguistic activities.

However the therapist hasn't been inactive during this first phase. Besides fine tuning the technical side of the therapy and the support it implies (explanations, comments, etc.), the therapist has touched on subjects concerning the patient's psychological and affective life (school, family, etc.) as well as talking about the results of the patient's non-linguistic activities (drawings, clay objects, etc.). The second period leads to a more direct form of therapy.

As in all re-education methods, the semiophonic method proceeds by repetitions until near the end when reading and writing are introduced.

In order to do this, half hour cassettes were recorded, some of them with a list of words, others with lists of double words and still others with sentences taken from passages in a book. All of these recordings have blank spaces during which the patient must repeat the recording into the microphone.

The general tendency that can be noticed is that patients imitate the voice that they hear in the headphones (diction, intonative form, syntactic construction, etc.) according to the principle of "the least effort". It is easier

to imitate what is heard than to conserve the characteristics of our own productions. Under these circumstances anything that resists this imitation can be of symptomatic nature other than characteristics that are of a sociocultural nature (accent, etc.). The quality of the recordings made by professional actors plays an important role. In that perspective, any audiophonatory repetition is already a form of re-education.

The parametric sound continues to be present during the different stages of re-education except at the end when the patient goes back to a normal "audiophonatory feedback loop".

Patients thus hear the parametric sound which conforms to both recorded items and those that they repeat. It is possible for their attention to wander from linguistic significations which is the problem in "active" re-education methods. By habit, they sometimes focalise their attention on the parametric sound which accompanies their verbal productions. In other words they lose sight of the signification of the utterance to focus on the intonative form. It is in this way that even when their minds wander, they practically never leave the different linguistic levels involved in the therapy. The parametric sound plays the role of curbing or guiding patients, recovering them when their attention wanders from the signification of the utterance. Unlike what happens in traditional therapy, their waning attention is welcome because it fosters a "subconscious" recapitulation of the linguistic therapy which they continue to carry out.

All the stages that follow are made up of half sessions : half a session of word repetition, followed by half a session of text repetition, etc.

The first stage of the active period involves *word repetition*. Patients repeat words that they hear in their headphones, the list of which — typed out vertically on a page — is given them. But they do not have to look at the list and they certainly don't have to look up any words.

Although on some lists the words were chosen at random, they all have a minimum of two syllables but there is no theoretical systematisation (frequency of certain syllables, identifying phonetic faults, etc.) The patients are left with their own "subconscious" choice of the linguistic levels on which they work.

In other cases, the lists are in accordance with systematic linguistic characteristics such as syllabic, phonetic, etc. characteristics. The decision, of course, is up to the therapist.

Structural separations — which go back to the "artificial" separation of the two structural processes (the two "tempos") that we have studied — are underlined by dichotic listening. The words (even the double words will be used) are heard in the right ear, corresponding to the left hemisphere of the brain, the center of auditive and auditivoverbal gnosis. The parametric sound is heard in the left ear corresponding to the right hemisphere and to prosodic treatment of language.

While repeating, patients often end up saying the words as if they were pseudo-words without any meaning, until they come upon a particular word that reminds them of some personal signification ... This desired effect corresponds to a technique which attempts to foster lapses of attention on one level, maintaining the focus on the re-education process. This is helped by the nonlinguistic tasks the children continue to perform: drawing, playing with puzzles and lego, etc.

The next step is the *double word repetition* sessions which are identical to those of single words: repetition, vertical columns of words typed out on a page, dichotic listening...The double words can correspond to collocations such as "wishful thinking" or "capital punishment" or just the opposite, arbitrary associations — "step stool" or "puff pastry", etc. In a way at this stage children go back to the first period of elaboration of meaning and syntax.

Then next step is *text repetition*. This time they work with a passage from a book, the sentences of which have been broken into phrases corresponding to syntactic groups (*There was a table ... set out under a tree... in front of the house... and the March Hare... and the Hatter... were having tea at it...*). At this stage patients have the possibility of identifying with the characters at the same time as they rediscover the relationship between "rhythmic groups" and "breathing groups" which allows them to completely reintegrate the meaning of the sentence. Dichotic listening has been completely eliminated.

Guided reading. The children are given the books from which the recorded passages of the preceding period have been taken. For the first time they are asked to stop all manual activity. This is also the first time they have a book in their hands.

Patients read at the same time as they repeat the corresponding recordings. The segments of the sentences are marked on the page by brightly colored vertical slashes. (*There was a table // set out under a tree // in front of the house // and the March Hare // and the Hatter // were having tea at it...*).

Example : a young child reads a text following the lines with a finger, the first time to listen to the recorded phrase, the second time to repeat it. But with the help of the therapist, the child can choose to read only the first time or only the second time.

Starting to read can be a critical point. There is always the risk that for a dyslexic the traumatic experiences discussed above are brought back. When this happens, the child only perceives reading as a formal and segmental structure made up of and broken down into more or less long elements without much signification because they are not linked by intonation. This is where the function of the audiophonatory repetition becomes evident: it is a form of technical assistance which allows the therapist to use all the strategies available. The therapist has the freedom to negotiate this assistance in the way that will be the most adequate for the patient. It must be remembered that parametric sound is still being heard and continues to play its role of paradigmatic guide.

At the end of this phase the patient is asked to work on a series of cassettes which correspond to recordings of whole books.

Free reading. This time recorded voices are completely eliminated. Patients read books that can be found at each session out loud into the microphone. Their voices are accompanied by the parametric sound until the last ten sessions when it completely disappears.

The technical autonomy of the subject is now complete. The assistance of the re-educator has evidently been successful. This is the last phase of the re-education process. It is sometimes followed by a half session of spelling work.

Written repetition. This phase concerns spelling disorders called "dysorthography", a study of which was done by Corinne Caillère, speech therapist in a well received thesis (13). Originally this phase was created to consolidate re-education of dyslexia. However, it has been shown to be fruitful for treatment of dysorthography.

In fact no one will be surprised to hear that dysorthography is a hybrid symptom in which dyslexia — which is seen in phonetic mistakes — plays an inhibitory role in learning how to spell or in other words in syntax and usage mistakes.

With semiophonic therapy, we think that spelling should improve once dyslexia has been treated. Therefore we have recommended for years traditional education/re-education after the end of semiophonic therapy. The evolution of tests seems to bear this out : those taken at the end of semiophonic therapy have often shown a marked improvement in phonology and reading level with very little evolution in spelling. However, the same tests taken one year later, without any new therapy, show that the spelling level has gone up to the reading level. Therefore the improvement in spelling seems to be linked to learning in school which has become efficient thanks to the decrease or the disappearance of dyslexia.

Then because we wished to add a time for writing to semiophonic therapy, we ended up creating a phase called " writing repetition".

This time we recorded fragments of phrases separated by "sound blanks" which are much longer than those the patient had until now so that there would be time to write, and not just repeat into the microphone. The cassette recordings were done in a more didactic way — slower, more articulated, etc., similar to when a teacher gives a dictation in school. In the choice of the cassette it is evident that we took into consideration the patient's supposed level in spelling. The dictations last from ten to twelve minutes followed by a faster reading with repetition then with all twenty fragments read without a pause.

The patient writes the fragments of the sentences one below the other, skipping a line between each one after having repeated them in the microphone. When the dictation is over, the patient re-reads the text with the recording and then corrects it. The patient is then given ten to fifteen minutes to find mistakes by referring directly to the book.

The patient has three occasions to make a correction, changing colors each time, so that the therapist can see when and where mistakes were noticed by the patient. The therapist can also add up the number of mistakes that are left and analyse the types of mistakes. Finally as the child does the same dictation several times (for example once or twice a month), it is also possible to follow the evolution of the mistakes (number, type, etc.) as well as their corrections according to the effect of what is being learned.

This on-going study seems to be particularly promising. Already it can be said that in semiophonic therapy, spelling correction of phonetic-type errors is extremely rapid and seems to be definitely acquired. This is not the case for syntactic and usage errors which seem to be tributary to a pedagogical type of learning.

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