ALFRED TOMATIS

THE EAR AND LEARNING

TRANSLATED

from

Oreille et difficultés d'apprentissage

(a lecture given to the Association Québécoise pour des enfants présentant des troubles d'apprentissage, Montreal, Canada, 23 March 1979)

BY

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TRANSLATOR'S NOTE AND ACKNOWLEDGEMENTS

I have striven always to render his meaning exactly, in the first place. In the second, I have tried to make this as comprehensible as possible to speakers of the English language; this has meant using English idioms instead of transliterating, and that I have opted for American rather than English spelling. Also, words and phrases which require explanation appear in the Glossary, and these are indicated in the text by an asterisk. References to texts alluded to in this lecture will also be found in the Glossary. Thirdly, I hope I will have been able to convey a little of the excitement and beauty of the French text, which can be very condensed and yet, or perhaps because of this expresses original concepts in a poetic language.

The translator wishes to thank especially Professor Tomatis himself for trusting her with the preparation of the glossary, and Judith Dressayre, Beulah Levinson and Jacques Vilain, who first encouraged her to undertake the translation.

She also gratefully acknowledges help from Christina Bener-Helmstein, Judith Bloch, Henri Declève, Alec Foucard, Audrey Foucard, Rosemarie Gabler, Andrew Laird, Ann Sealy, Meredith Squires, Andrè Van der Stricht, and, though last in alphabetical order, by no means least, Monique Van der Stricht.

On the threshold of the twenty-first century, which is being made ready by the rising generation, may I, in this, The Year of the Child, give special thanks to children everywhere for having, by their presence, suggested this Congress; the interest in which is plainly to be seen here.

Indeed, there is hardly a public gathering which could, in a world plunged in disarray, express a more timely chorus of hope. Who was the instigator of this Congress? Who started it? Could it be that the child himself is dictating, in the depths of our conscience, what our conduct towards him should be? At a time when everything is legally organized for the destruction of life, could it even be his heartrending cry to us for his right to *existence? If so, then may that essential property of life be praised, since our heartstrings can still be touched by such solicitation.

In any event, whatever the origin of the initiative, may the organizers of this Congress be warmly congratulated, and may they be assured of our most willing co-operation in the movement which they have just launched in this year dedicated to the child.

INTRODUCTORY SURVEY

I have been asked to speak to you today about the part played by the ear in difficulties of learning. If ever there were a subject, which affects each one of us, this must surely be it, so true is it that we are all confronted, though some more than others, by problems of integration. And we are hampered, as can be verified, to the extent that our capacity to listen remains impoverished.

The immense scope of the undertaking becomes clear once we decide to place the ear and learning difficulties in apposition. And the scope is the greater when is becomes a question of making evident a relationship between the two terms which is not contingent but fundamental, and which I consider to be crucial to the subject under discussion.

Before defining these terms, as they deserve to be defined, it seems opportune to give you a bird's-eye view of an experiment lived through since the year 1954/55, that is experienced for almost a quarter of a century. I noticed at that time that any auditory modification (brought about experimentally through headphones and by means of amplifiers and filters) produced a manifest change in the subject's mode of reading. These results were all the more striking in that they were obtained while I was busy studying two kinds of client, seemingly very different. But nevertheless, when using the very same means, the audiophonological reactions were shown to be identical whether the subjects in question were professional singers, actors or speakers on the one hand, or people suffering from various speech difficulties, such as stuttering, on the other.

Already familiar with these positive results in the above-mentioned cases, I felt entitled to ask myself whether the same procedures could not be used to improve reading, and to correct bad spelling. I even stretched my imagination further and supposed that it might be possible to attain by this manoeuvre a means of correcting learning difficulties in general.

I am aware of the extreme boldness of such a point of view. Nevertheless, in matters of research it seems necessary to stretch ourselves to the utmost, if only to test a given hypothesis, whilst at the same time preserving a spirit of sufficient critical detachment to be able to throw out whatever is untenable.

From the above work it appeared

(1) that the two ears did not have the same capacity for discrimination, i.e. for auditory analysis with regard to the controlling feedback mechanisms; and this was true for both reading and writing;

(2) that the right ear singled itself out to such a degree that I was able to denominate it "l'oreille directrice", i.e. the leading or polarizing ear; attaining as it did a level of specialization which the left ear seemed never able to reach;

and

(3) that the desire to listen is superimposed on the simple fact of hearing, as though a new dimension had been added to the function to have been observed first.

Those were my conclusions at the time. In order to confirm them, I had a choice of two paths of research:

(1) to establish proof of the hypothesis by experimental means,

(2) a laborious decoding of those nervous mechanisms involved which would give rise to the results which had been thus obtained.

Experimental investigation which lasted six years confirmed my hypothesis in so positive and constant a manner that I was led to transpose the undertaking into a means of cure, and then into a system of education.

As to the longest lap - that of understanding the how and why of the phenomena which had become manifest - that ended a few years later and led to the convictions which I am about to communicate.

THE EAR: ITS *PHYLOGENESIS

Of the two terms of the subject matter in hand, it is the ear to which I intend to give priority, persuaded as I am that in the light of a better understanding of its functioning, a hundred and one questions posed by learning difficulties will find their explanation.

It stands to reason that if one remains fixated to the usual method of broaching the subject of audition, it is difficult to conceive that such a function could have any repercussion or influence on learning difficulties. But certain authors have nevertheless outlined the idea that in these difficulties the role of the ear should be incriminated; as, for example, has *Orton on several occasions.

The major role which I assign to the ear certainly risks shaking the accepted view to its foundations. However, to be somewhat over-zealous is not to be deprecated if it succeeds in arresting attention and thereby in arousing interest.

At the present time we know quite a lot about the function of hearing. The preceding decades have enriched our knowledge in many different ways. Nevertheless that which remains obstinately hidden seems to indicate that it is our methodology which is steeped in error. In order to succeed, instead of concentrating on the physiology of the ear alone, we should rather embark on the whole field it influences.

It is self-evident that the simplistic view, which sees the ear as an external pinna linked through the middle ear to the internal ear, should be abandoned. That restricted anatomical concept corresponds in hardly anything, or in so little, to that with which it could be credited. I believe the ear to comprise, beyond and together with, the parts already mentioned, those parts of the *nervous system which it is said to control. Looked at carefully, that domain is enormous; and if only the trouble be taken to explore it, it becomes more a question of where to stop. Indeed one is led to uncover its operation at every level of the nervous system.

This global approach is made possible, it is true, only if one chooses to set aside another unfortunate habit, that of always separating the ear into two systems: the vestibular and the cochlear. For though their present-day functions may seem to confirm the view of bipartition, when looked at phylogenetically, it is a question of one and the same organ which, in the course of its evolution, has maintained its own faculty holistically by having enlisted auxiliaries; the latest recruit being the *cochlea.

So whereas the cochlea has to detect infinitesimally small movements, the vestibulum is still able to confine itself to the perception of shifts of greater amplitude. Modern physiology also, moreover, tends to take a more integrated view of the whole, and to see it as one.

From now on, whenever the ear is mentioned, it is the cochleovestibular system which is intended. Considered in this way, it assumes an altogether greater importance. And this importance is the more striking in that I am fully convinced that it acts as an *organizer (in the embryological sense of the word), which by *induction persuades the whole nervous system to become what it is.

Everything takes place, so it seems, as though the function of language had enticed Man into attaining the stature of his ultimate prerogative: that which urges him to put into words whatsoever the universe may reveal to him. Seen in this way, the nervous system in its entirety becomes a pivotal vessel in which the world is reflected.

In plain language, the nervous system can be said to be bombarded by an infinity of stimulating distractions which keep it awake, hold it spellbound, and thus enable it to take an active share in; to have, not only metaphorically but literally, a speaking part in, that environmental world which is unveiled to it.

THE EAR: ITS PRIMAL FUNCTIONS: ENERGY AND HARMONY

But to go back and start from scratch, it is at the opposite end of the scale, in the most primitive elements of nerve tissue, that the most basic, as well as the most archaic, function of the labyrinthine cochleovestibular apparatus is to be found: its energising, literally dynamising, function. The phylogenetic evolution of the apparatus makes this manifest all along the line, but obscures itself whenever, and to the extent that, we become obsessed by its more recently acquired functions in the course of its evolutionary history. So that this phenomenon, so well-known to zoologists, since they study *primitive species, and, when seen in the simplest of organisms, the truth of which is self-evident, seems little by little to sink back and to be effaced under the sedimenting strata of other later functions, to such an extent as to be totally ignored at the level of human physiology.

And yet this energising of matter is but an initial rough draft of dialogue, which can still be seen, in a more sophisticated version, in the membranous labyrinth throughout its evolution. In effect, stimulation brings the prototypal nervous system to life. And it responds, within the organism, in a coordinated, harmonious manner. Thus can it be said that the function of equilibrium is also the province of one and the same organ throughout its evolution, and that it now, additionally, also controls muscular tone. Seen thus, it is but a more elaborate antiphony of a similar interchange.

On the other hand, seen from the point of view of the whole, one knows that all movements sort themselves out with regard to one another, and that this requires a harmonious distribution, both homo- and heterolaterally, of whatever tonicity is present. This applies whether in integrated kinetic actions or simply in postural stances. From that moment, (as requests and replies, or stimulation and reaction, grow more complex), a blueprint is set up which will firmly structure *automatic reflex action, whilst at the same time a pristine glimmer of body image appears.

Such a system, although tailoring its individual requirements, does so nevertheless within the appearance of a unitary scheme of things. An overall neurological concept for it has been introduced ad hoc and in order that it may the more readily be grasped, namely that of the vestibular or *somatic integrator. Under this term are included the utricle both with its attendant semicircular ducts and with its attendant saccule, together with the whole of that part of the nervous system which corresponds to them. I think it merits both description and to be shown in diagram (fig.1).

After the gathering up of the utricular, ampullary and saccular nerves, which takes place at the level of the *ganglion of Scarpa, they become redistributed into four nuclei in the *medulla oblongata and the *pons. These four nuclei are those of Deiters (lateral), Roller (inferior or spinal), Schwalbe (medial or triangular) and Bechterew (superior). They behave as though they were primitive or archaic brains. From them each and every anterior [i.e. motor] nerve root of the spinal cord receives messages as from a primal brain mechanism.

These come via the vestibulospinal nerve tracts - the lateral vestibulospinal tract proceeds directly (i.e. homolaterally) from the nucleus of Deiters, whereas the medial vestibulospinal tract is crossed (i.e. it proceeds heterolaterally) from the nucleus of Roller. Every muscle in the body is thus dependent on them. Besides, liaison is also made with the cerebellar relay station: ascending nerve fibers going towards the archeocerebellum (also called the vestibulocerebellum) and the fastigial nucleus; as well as descending fibers returning from them to the vestibular nuclei. With this the possibility of a more sophisticated muscular play is established. It is an organization all the more elaborate in that automatic *proprioceptive perception is also now made possible via sensory nerve bundles whose returning responses reveal instantly the spatial and positional distribution of bone and articulation; of tendon and muscle. The tracts of *Flechsig and Gowers bring in this information from the body to the paleocerebellum (also called the spinocerebellum). The latter also receives the *projection or itinerant vestibulocerebellar fibers (which have been mentioned above) via the network of nerves disposed on the surface of the *cerebellum. Thence another more refined control is added at body level by the cerebellum's links with the *olive and the *red nucleus, and from them back via the olivospinal and rubrospinal tracts.

THE VISUAL INTEGRATOR: A SUBLIMINAL SELF IMAGE

The somatic integrator thus extends its field of action to the whole body. There is no muscle whose tone, balance and position relative to the body as a whole does not depend on the vestibulum. This is true even of the ascending vestibulomesencephalic nerves, which control the muscles of the eye, and which obey the same rules; and thus eye movements too have the benefit of vestibular regulation. In fact, the second organizational level, which I call the visual integrator (fig.2) is both served by the vestibular integrator and at the same time makes use of it to mobilize the body in its environmental space, which it can thus gain and know, monitor and master. That it succeeds in so doing is thanks to that aforesaid previously established existential body image, which now at this stage makes possible the notion of a subliminal self image. This latter is, in fact, realized through the mediation of the visual integrator, which exploits the *tectospinal tracts, which (together with the vestibulospinal tracts) terminate once again at the level of the anterior (motor) roots of the spinal cord. From now on, too, the outside world is present. And face to face with this outside world, not only position and posture, but also movement and mobility, are assured.

THE COCHLEAR INTEGRATOR

But this is not the whole story. Indeed, the automaton, so to speak, on the assembly-line, is now arrayed and crowned in a complementary suit of clothing, which completes and perfects it: the cochlear integrator. I would gladly call it the linguistic integrator. Before describing it, and seeing it in diagram, let me explain precisely what I understand by an integrator. It comprises all the motor, sensory and sense nerve fibers belonging to one and the same system. It is a matter of a single vision which unites in one and the same functional field a host of apparently disparate activities, which are nevertheless in fact co-ordinated in the execution of an act. It can be seen besides that included in such a system are the vast fields of sensory activity, called *analyzers by *Polyakov, and which were taken up again by Aleksandr *Luria. This expanded neuropsychological view seems to give a broader vision of the different steps of phylogenetic evolution, as though each of them both extended and included the preceding system in order to reach a definitive structure in Man.

The third integrator is shown in fig.3. The cochlear division of cranial nerve VIII meets its first relay in a dorsal and a ventral nucleus; the nerve bundles from these two nuclei are then gathered together in order eventually to deliver messages to the temporal area of the *cerebral cortex. This information arrives first at *Heschl's girus (*Brodmann's areas 41 and 42) and thence proceeds to the *extrapyramidal motor area which is contiguous with the auditory center and subjacent to it (Brodmann's area 22). Here the circuit redescends via the temporopontic tract of *Turck-Meynert as far as the pontine nuclei, from which pontocerebellar fibers reach the cerebellum. From there, connexions are made with vestibular analyzers via the cerebellar surface network, whilst a return route to the cortex (frontal and parietal)

is assured via the dentothalamic tract and the thalamocortical projections. Based on this overall scaffolding, further closed circuits are established via frontopontine and parietopontine fibers. Furthermore, this maze of circuitry sends off a branch from the dentothalamic tract and the thalamocortical tract to the red nucleus; and through this intermediary a functional cochlear component is added to that of the vestibular influence, again at the level of the anterior (motor) roots of the spinal cord.

It can be seen that once these mechanisms are in place, the organization of the automatic control of movement is ensured. Voluntary movement is not yet possible: it will be supplied by the *pyramidal system.

THE LINGUISTIC PYRAMID: LANGUAGE

Looked at closely, the corticospinal tract (responsible for voluntary movement), is the axis of what I call the linguistic pyramid, the base of which is provided by the cerebral hemispheres. And I like to regard this pyramid as the major inductor which, step by step, mutation by mutation, leads the nervous system to the realization of its human potential. The nervous system appears all the better adapted to language, in as much as it is language which has fashioned it. This expresses the degree to which I regard the nervous system and language to be linked, need and fulfilment becoming functionally identical. If it is true that there can be no language without a nervous system, it is no less true that the nervous system is really only repaying it in kind. Without the never-ending call of language, subtended by a puissant and ever-present Logos, the nervous system would have had no reason to be.

LEARNING: THE NERVOUS SYSTEM'S RESPONSE TO LANGUAGE

However, it is on learning that I now wish to focus the remainder of this exposition. In the light of what has been said, learning appears to be the result of a drinking up, of a massive taking over of information, by the nervous system. Indeed, it would not be far wrong to say that the whole body is thus implicated.

Let me explain. A piece of verbalized information takes the auditory pathway, which remains always the royal road of any acoustic message. The latter incorporates the information instantly via all the circuits which belong to the cochlear integrator, cascading over and drenching at the same time the vestibular integrator and introducing itself into all the living parts of the body. The long sensory tracts, both *protopathic and epicritic, send back to the cortex the body's local peripheral needs. And this verbalized information may in addition, and if necessary, voluntarily direct the gaze towards the object to be comprehended which the discourse may have summoned up.

There must be then an organizing entity which, neurologically speaking, structures and co-ordinates the different stages of the nervous system, but which gives priority, as is the rule in neurology, to that which was formed the latest in time: thence it uses, as in the cascades of a waterfall, the previously established underlying strata, taking them thus in inverse order to that of their appearance during the evolutionary unfolding of the species. Information using a path not dependent on the cochlear integrator will, on the other hand, exploit in the first place the previously established strata; but immediately after, it has no hesitation in using the more recently acquired mechanisms offered by the integrator to appear last.

In other words, for an essentially bodily act to become conscious and to become thus a fact pertinent to be communicated, it must necessarily make use of the cochlea version of it and so borrow as it were the function of speech which is intimately bound to this the last and final integrator. If an object, or a sign, or even a letter of the alphabet, is seized by sight and reaches the zone of verbalization, it is not only "seen" but, exploiting sonic echoes, it is also "heard", at the same time reawakening corporal memories engrammed elsewhere.

It is thus an operational whole which mobilizes, instant by instant, the entire nervous system in all its parameters; memory, absorption or attention, vigilance or concentration. Thus every kind of learning is, in its most fundamental expression, prehensile, that is in the sense of having as its aim to capture, to take possession of and to keep.

PROBLEMS PROPER TO LEARNING

Strengthened with knowledge of these mechanisms, to which there will no doubt be occasion to return, we are led to consider the problems which can arise in the functions proper to learning. In the majority of cases, these difficulties can be traced to three main sources.

(1) an incomplete maturation in one or other of the integrators,

(2) a modification within the particular functioning of one or other of the integrators: e.g. a purely motor lesion might cause the vestibular somatic integrator to re-adjust its smooth working in order to produce a compensatory cantilever.

(3) a false assimilation of information by a fault in the sensory analyzers and especially at the level of the organ which gives entry to the cochlear integrator.

Before even giving thought to the systematization of the results obtained which form the basis of these claims regarding faults of integration, it seems appropriate both to stress their effective and pervasive strength, and further, to align them with the language of educational psychology. It is a fact that in that specialized jargon, everyone brings up the problem of *"laterality", and some, who are bolder, even go on to speak of posture, mentioning in passing, body image. Finally, it is current fashion to use words no less ambiguous such as dyslexia, dysorthographia, dysgraphia dyscalculia, as well as many others. In reality they all belong to one and the same process, which I think you will grant me, namely a faulty use of the nervous system.

Let us take a look now at the nervous system functioning harmoniously. As has been indicated, every message is intended to be embodied, (in the sense of incarnated rather than incorporated) in a body which is both self-aware and conscient of its state of being. Analogously, we can only be said to play an instrument if its volume, shape, and operational propensities are known and understood by us.

A spontaneous idea, or ideas summoned up by the reading of a piece of writing, or words suggested by an object, all these produce verbalization. This means the putting into effect of a stratagem master-minded by the cochlea who is, so to speak, found guilty on the first count. Everything which is named assumes a deep-seated bodily meaning. And this meaning can only be transmitted to a third party if the object summoned up strikes an answering chord in a similar neuronic memory bank. The genius of any particular language resides in the fact that it is not heard by an indifferent ear, but is eagerly listened to by one whose nervous system (thanks to the linguistic integrator) has already been made drunk on it.

To go into further detail, we see that the ear of a person who speaks becomes the captor, the first listener in a sense, of every sound emitted by him, both purely sonic and a fortiori phonological. Every speaker thus proves to be his own first listener. And without this first listener, speech has no real semantic value. In order that meaning may be integrated, (that is, grasped, whittled down exactly and fixed with permanence), the accurate focussing of sounds becomes obligatory. It is this focussing which establishes additionally the leading ear, to which I referred briefly at the beginning of this lecture in connection with my earliest researches. And it is from this directional and leading activity, (which as a rule, though not necessarily, is established in the right ear), that a lateralizing function arises. Lateralization means in effect giving to the nervous system a higher and more specialized operational capacity. The expression leading ear is much to be preferred to the word "laterality", which suggests, in its ambiguity, the division of a creature into two distinct parts. On the contrary the reverse is true. A lateralized operational organization acts both by establishing a dialogue between the two hemispheres, and by extending that dialogue to each pair of homologous integrators, i.e. those operating at the same level. Thus both a right and left state of play is made possible to each one in a pair of integrators, whether at the vestibular, visual or cochlear levels: that is, each one of the six can act bilaterally, thanks to the homo- and heterolateral nerve tracts. In this way each integrator, taken by itself, acquires an operational autonomy in conjunction with that of both hemispheres. Thus any centralization in the left hemisphere will concern itself with perception and motricity, whereas that in the right hemisphere concerns control.

This organization can be traced to two factors:

- the projection outward of an internal *visceral asymmetry

- the need that the external surface of the body, which is the most sensitive, should maximize its information-gathering capacity.

It is from this latter need notably that vertical posture is acquired.

Thus the ear collects and decodes everything, from thought down to the smallest details gathered by its associated senses and in particular by the eye. Eye and ear, those two organs of integration, create between them a veritable *duet; a duet of cooperation and coordination taking place instant by instant. One can give no better examples of that cooperation than obtains in reading and writing.

Indeed, any piece of language, fixed into immobility by writing, only recovers its living aspect thanks to a new lift-off of the acoustical element in the two superimposed sight/sound images. A letter of the alphabet can be said to exist linguistically only on condition that it be possible for it to be fitted out with an acoustic value, which allows it to be transmitted and translated into oral, and therefore useable, language. Without a sonic value a letter is bereft of life; it is a dead letter.

Thus the whole of language has in the last resort to be collected by the ears, and may I recall here that the very meaning of the word 'legere' (to read) was originally 'to harvest'. In order therefore to be read, to be collected by the ears, to be harvested, language must have the benefit of a good quality cochlear integrator. But it also needs the associative ply of the other integrators, in order both to 'see' what is signified and to meet up with its associated memories engrammed in the nervous tissue depths.

For the cochlear integrator to have the required qualities, it must have the wish to listen. That wish is, in my opinion, the most archaic within the human dynamic; an ancient ontological mooring. It remains, according to my own view I admit, the thread of Ariadne which directs and subtends the ulterior development of the human person in its entirety.

Thus the listening faculty projects itself as a goal to be reached. Indeed beyond the basic *auditory function, which continues to remain an apparently passive mechanism, the fact of hearing appears as a more advanced stage and yet it remains subject to availability and, in a sense, to the whim of the moment. But the act of listening which implies a committed assent, which is both constant and willed, to everything which is of interest, is wholly other.

The process which leads man towards that function which seems to be peculiarly his own is nonetheless difficult to acquire. Indeed, that sensory and sensitive antenna, the ear, if, on the one hand, it is able to integrate every kind of information to an extraordinary degree, is also able to pull back in a manner no less unexpected when faced with something it judges inopportune. It is thus that its development becomes fixed in one or other stage of its ontogenetic thrust.

*ONTOGENESIS OF THE LISTENING EAR: PARENTAL ROLES

Already functional in its intra-uterine life, the fetus engrams at this time the empathy of its mother's voice. Hence the great importance of warm communication from that source. The possible tribulations which beset the uterine journey, meant to go without a hitch, are well-known. Today little consideration is given to the child in this context, and still less to the woman as a mother; her rights as a mother having been traded for her having been conceded certain rights as a person. There is no doubt that this is to commit one of the most fundamental errors in our ontogenetic ethics, which is unable to sustain such innovations, so inherent is ontogenesis in the process of life itself. This personal parenthesis, taken in its defence, will I imagine be granted me in this year consecrated to the child.

But there is also another side to the story. For when birth supervenes the intra-uterine journey, there is, at the present time, a plethora of effort taking place to prevent that major event becoming just another branch of industry, both on behalf of the mother and of the newborn. For the ear too it is a major event: its great passage from liquid, to aerial, audition. Then for each child comes its own busy period; the infant has to decode the sonic bath (in its widest sense) into which he is plunged and will bathe. From the very start he will seize, with a peculiar facility, every emission which reaches him. His mother's voice continues to be his basic, as it was his primal, nourishment and its presence will continue to ensure the succour of that former relationship he had with her during his fetal life. But, together with this voice, the small child will condition himself little by little to perceive the surrounding world of sound in order to prepare for his linguistic introduction into it. As he grows, though still clinging to his mother's apron strings, he attempts little by little to gain his independence.

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Soon, armed with a richer and better structured vocabulary, he will strengthen his relationship with his mother, whilst at the same time preparing for his individuation and his committal to the community of the grown-ups. The father is now deputed to become the linguistic intermediary which ensures this participation. The father becomes, as it were, the link between the mother and the social world outside, continuing thus the primordial role held by him since the beginning of his wife's pregnancy. Besides the initial exiguous spark which he contributes in order to induce the ovule to commence its creative journey, the father extends to the mother-child couple the same constancy and love which is manifested by the mother in her motherhood, thus ensuring an ambience which is peaceful and secure, and in which there is a rich burgeoning of empathy. Sooner or later the father, originally a giver of seed, becomes the sun in his child's life, giving it meaning: the once-off giver of semen becoming an ongoing symbol of semantics.

And through the mediation of this symbolic fatherhood, representing the world of meaning, the child is able to try his wings and to become more outgoing. Becoming independent of his mother, at no time means that he should leave her in the literal sense of the word, as the current tendency sometimes thinks opportune, and as is suggested by the term :the "breaking of chains" or by "the cutting of the umbilical cord". However, our thirst for liberty is so unquenchable that these false psychoanalytic notions have made fortunes. But the realization of this widening orbit means simply making tensions relative in order that affection may ultimately be expressed in an objective and tempered manner in an adult relationship.

Alas, there is no need to linger long on this subject in order to recall that everything does not develop thus, even in the best of worlds. In all honesty, one must recognize gladly that quite a few come through unscathed. Nevertheless, our ever-growing excess of zeal could result in nothing to boot, but only in creating a society in which the will to live is transmuted into a capricious satisfaction in destruction. If a population of schoolchildren be scrutinized, usually the following distribution is to be found with regard to academic performance:

- a third make their way in life, without suffering too much from it, and their school marks reflect that advance;
- a further third manages with difficulty to maintain a reasonable average, but this taxes the pupil heavily and exhaustingly;
- as for the final third, they make their daily way in life, sadly, and without finding any joy in the educational programme on offer at school. For them this institution, the principle of which is nonetheless based on leisure obtained through knowledge, is totally devoid of interest. School will be endured by these children as a restrictive duty imposed on them by their elders, and which has nothing commensurate with their hopes, which, moreover, often become either attenuated or else are exacerbated and turned instead into revolt.

It has to be admitted, to be sure, that this institution has lost much of its constitutional force in many parts of the world. School has become an immersion in a bath of learning, which is no longer centred upon the indispensable requisites to becoming adult, but which focusses, on the contrary, at picturing the child as already a sixth-former, and that at a time when he has not attained an adequate neuropsychological maturation. Because of this the child looks upon himself as already an adult; which is as good a formula as any for never reaching maturity.

FAULTY MATURATION

In the case of faulty maturation, what happens at the level of the cochlear integrator? Several possibilities have to be taken into account.

(1) The cochlea no longer acts as a satisfactory sense organ, and hearing will be badly controlled. Thus

- air-conduction may be dulled,
- or the two air-conduction curves may be asymmetric,
- or the bone conduction curves do not accord with the shape of the air-conduction curves,
- or distortions are to be found in either one or in both pairs of air-conduction and bone-conduction curves, or in any one of the curves, singly or combined.

In short, there are as many possibilities as there are peripheral signs of the faulty coordination of the various elements which go to the make-up of the external and the middle ear. These elements are the tautness of the drum and the adaptive play of the whole chain of ossicles, both of which are controlled by two small muscles; and the regulation of air pressure by means of the Eustachian tube.

(2) The integration at the level of the central nervous system may be poorly assembled due to jamming at various levels and especially at the level of the *thalamus. As a result, the projection onto the temporal area cannot take place effectively. Also the further distribution to the rest of the body of information received cannot take place either. Hearing then becomes incapable of frequential analysis, and frequential "selectivity" or discrimination for pitch is said to be closed. In other words this means that every *frequency (on that part of the scale which is "closed") will in no way be heard distinctively as occupying a specific place on that scale. The subject is said to be tone-deaf within that range.

(3) The failure to establish an operational dynamic differentiation between any two integrators which are at the same level. This will result in a faulty localization of sounds in space.

(4) Finally, the two cerebral hemispheres may fail to arrive at a separation of their distinctive functioning hegemonies, since they are impeded in this by the functional immaturation of the various integrators. This gives rise to an absence of dialogue, the effect of which is manifested at the level of the *corpus callosum, and which is characterized by a faulty functional organization of the two hemispheres. This disorganization will result, via somatic projection, to phenomena which can be grouped together under the rubric of psychomotor inco-ordination and defects of lateralization.

DIAGNOSIS OF FUNCTIONAL IMMATURITY

Faced with such a neurological picture of things both in theory and also (as we have seen) in practice, it is possible to determine by a single test, where and at what level in the nervous system as a whole the disorganization, destined to affect language, is located. Let us go take up the various points once again.

(1) Peripheral disorders will result in every sort of difficulty of integration of a qualitative nature. Such distortions come under the heading of spelling mistakes. The faulty adaptation of air and bone conduction (seen registered on their curves) renders difficult the deciphering of written signs and their dovetailing with their relevant acoustic images. Also fluency of speech is often disrupted.

(2) Centro-encephalic difficulties, even non-organic in origin, are enough to explain the impossibility of linguistic analysis whether of writing or reading.

(3) (a) Instability of a functional equilibrium between (collateral) integrators horizontally (caused on either side), and the lack of functional vertical fusion between the three levels, manifest themselves by innumerable inco-ordinations. These inco-ordinations accompany all forms of expression, which are also sometimes parasitized (in the technical sense) by *synkineses of faulty quality.

(3) (b) Furthermore, when the coordination which should preside over the linguistic function (even to its associated gestures) is late in appearing, the acoustic message is taken in slowly. Or, to put it in familiar language, the penny does not drop. This is due to the amount of sustained effort needed to deal with insufficient acoustic spatialization. The controls are quickly weakened and language becomes laborious. Words are inadequate or poorly chosen and thought exploited with difficulty. Reading becomes a prey to every possible sort of phantasy inherent in a badly oiled dovetailing of written word and sound. Deficient co-ordination between the visual and cochlear integrators produce inversions, overlappings and elisions. Also to be noted under the same rubric of difficulties of spatial differentiation, are difficulties encountered in the organization of the act of writing, difficulties in representing solid geometrical shapes, as well as in the ordering of mathematical progressions; i.e. dysgraphia and dyscalculia. Besides this, fluency of speech may be disturbed to the point of stammering.

(4) As for the absence of *cochlear lateralization, i.e. the functional linguistic organization of the two cerbral hemispheres (I repeat: the left operant, the right monitoring), here the importance of the troubles encountered (in hearing and in audio-visual control) can be measured. Besides which, even if the infrastructure consisting of the first two integrators, happens to be lateralized, the cerebral hemispheres (in the absence of their own lateralization) cannot use or benefit from them. Thus the potential of the nervous system, which is always great, is insufficiently utilized.

My exposition ends where it began, as though the thought elaborated between the beginning and end of this report were one vast personal parenthesis destined to call forth questions, to stimulate research and to commit each one of us to a long-term voyage of discovery.

RE-EDUCATING THE EAR

I began by saying that the conditioning of the ear, taken in the widest sense of the word, changes a host of things. This is how we go about it. Our mode of operation rests on two factors.

> (1) In the first place, we make sure, by means of a complex electronic circuitry, that the message we transmit is actually perceived; indeed even listened to.
>
> (2) Secondly, we offer an education of the ear which recapitulates its ontogenetic development. In this way the various stages of development are gone through again and made firm, though sometimes one or other of them may be met for the first time, since the organ may, in spite of everything, never have experienced them previously. In such cases, the stage is made from scratch. For, looked at closely, the difficulties which are encountered are always linked to the disharmony which appears when the various stages of organic and functional maturation do not take place concomitantly.

It is this co-ordination that we try to construct or reconstruct by following its developmental course, starting with the sort of hearing which exists in the womb. For this we make use of a recording of the mother's voice - her voice, i.e. its phonetic and acoustic elements, rather than her manner of speaking, since she may elect to read aloud, rather than speak spontaneously. Then, depending on the results obtained, the functional progress can be monitored, since we know what to expect at the various landing-stages or developmental phases. Thus after `hearing which mimics that heard in utero` (in French `le retour sonic`), we pass to a `sonic birth` (in French `l`accouchement sonic`),

linguistic, but preverbal, preparation, consisting simply in the establishment of rhythm. The whole programme is carried out and based on listening to music which has been specially pre-selected in terms of its particular output (i.e. of particularly useful frequencies) and whose efficacy has been proven for many years now. This music, whose various parameters are all the while under electronic control, installs the rhythms pertinent to the preparatory phase of language. Later, to this music are added local nursery rhymes, which serve as an introduction to folk song, and then on to the speech of the language in question itself. During a subsequent phase this language is absorbed in an active manner. Chosen pieces of dictation are addressed to the child (through headphones, the monitored circuit of which gives precedence to the right ear). These phrases are then repeated by the child, and, again through the same privileged position being given to the right ear, he listens to his own voice. The machine thus used makes sure that the child listens as he should listen, were that function to have been already permanently gained by him. This work allows him, both in his relation to the environment, and in his communication with others, to experience and benefit from the appreciation of the global proprioceptive sensations, whose effect he has come both to know and to enjoy through the use of the equipment. These sensations are, as it were, spread out and extended and redistributed to the whole of the body. They give particular structuralization to a postural body image which is vertical, and at a particular level, to the kineses associated with speech, but without the interference of the synkineses by which it is so often parasitized. Equally these sensations extend to the recognition and then to the mastery of the voice, which becomes assured, firm, modulated, harmonious, fluent and perfectly controlled. All these signs witness the maturation brought about by the vestibular and cochlear integrators through the polarising interplay of the integrators situated on the right-side of the body.

CONCLUSION

There are still a hundred and one things to be said, but in so short a time it is impossible to sum up thirty years of research. It would be interesting to enumerate the succeeding recuperative stages developmentally in terms of the observed patterns of overall emotional affectivity. These are manifested in outgoing behaviour and social communication on the one hand, with, on the other, a linguistic approach, with its new acquisition of vocabulary and *grammar. Though vocabulary be enriched it is only able to affirm itself by grammar, and grammar is organized in a similar way to the neurological substrate which supports it. That is, noun-words are activated by verb-words. Through language, a postural body image becomes a vertical self image. Finally one could discuss at length the phenomenon of the crystallization of laterality. However, these allusions may call forth a number of suggestions capable of making the debate more lively.

In conclusion, may I thank you all for letting me pour out into your attentive ears not only a highly specialized proposition, to be sure, but one which is also no doubt strange in its novelty. But new ideas can in no wise not be so.

May I also thank publicly all children everywhere. For more than thirty years I have dedicated a large portion of my work to them, and they have brought me a great deal of joy, and have been more than generous in the knowledge they have offered me.

For it is indeed true that they should rather teach us; it is, alas , also true that we have a marked propensity to forget it. We often tend to construct educational worlds which please our adult minds without even taking the child into account. I do not like, for example, the way we obtrude the ears of our young children, who are only potentially adults, with all the strange and inadequate information with which they are showered, just at a time when their nervous systems, virgin to every impression, soak it all up like a sponge. But this is a red herring, which although presenting a certain interest, deflects us from our aim.

So let us conclude by making a wish in this year dedicated to the child. In order that the ears of the children who will be the adults of tomorrow may be opened henceforth to the communication of their elders, may we for our part finally apply ourselves to listening to <u>them</u>; and thus enter into resonance with the person within each child who hymns the joy of love and of life.

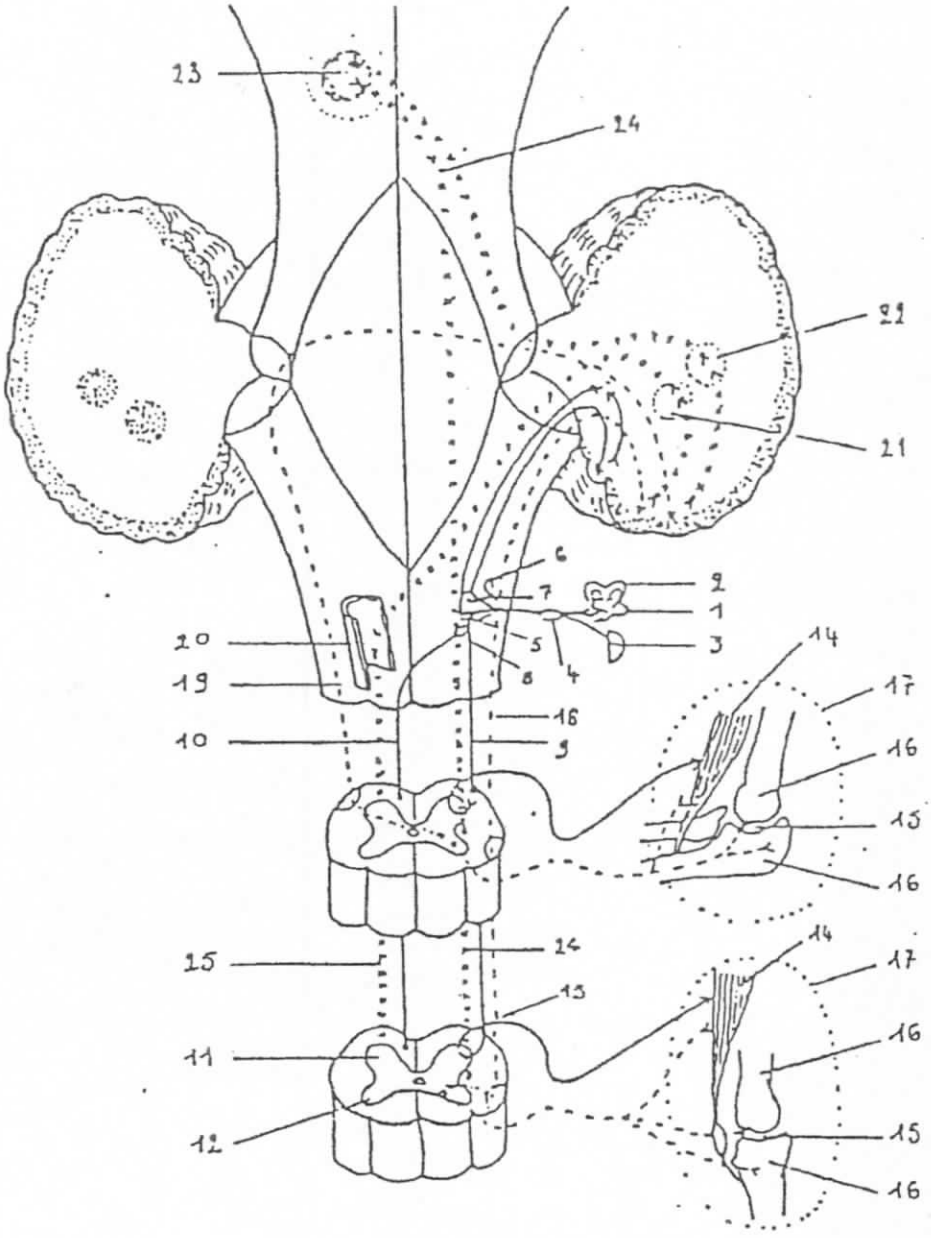

FIG. 1 THE VESTIBULAR OR SOMATIC INTEGRATOR

FIG. 1 THE VESTIBULAR OR SOMATIC INTEGRATOR

1 utricle
2 semicircular ducts
3 saccule
4 vestibular (or Scarpa's) ganglion

Vestibular nuclei:-

5 Deiters' (or lateral)
6 Bechterew's (superior)
7 Schwalbe's (medial)
8 Roller's (the inferior or spinal)

Vestibulospinal tracts:-

9 lateral
10 medial

Gray columns:- (11,12)

11 anterior (ventral)
12 posterior (dorsal)
13 anterior (motor) root
14 muscles
15 joints
16 bone
17 skin

Spinocerebellar tracts:- (18,19)

18 Flechsig's (dorsal)
19 Gower's (ventral)
20 olive
21 globulus
22 embolus
23 red nucleus
24 rubrospinal tract
25 olivospinal tract

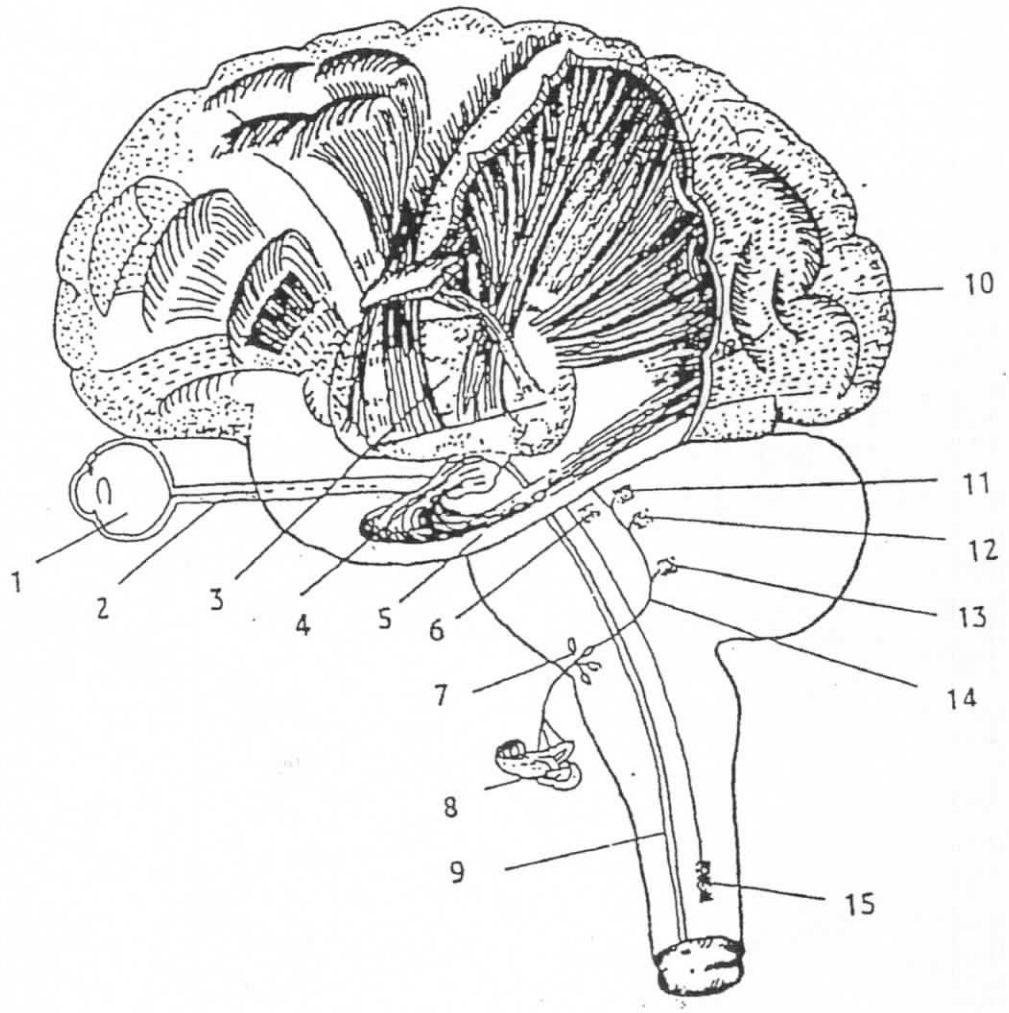

FIG. 2 THE VISUAL INTEGRATOR

1 eye
2 optic nerve
3 thalamus
4 lateral geniculate body (or nucleus)
5 optic radiation
6 Edinger-Westphal nucleus of cranial nerve III
7 vestibular nuclei
8 vestibular apparatus
9 tectospinal tract
10 visual cortex
11 oculomotor nucleus of cranial nerve III
12 trochlear nucleus (or nucleus of cranial nerve IV)
13 abducens nucleus (or nucleus of cranial nerve VI)
14 medial longitudinal fasciculus
15 Budge's ciliospinal center

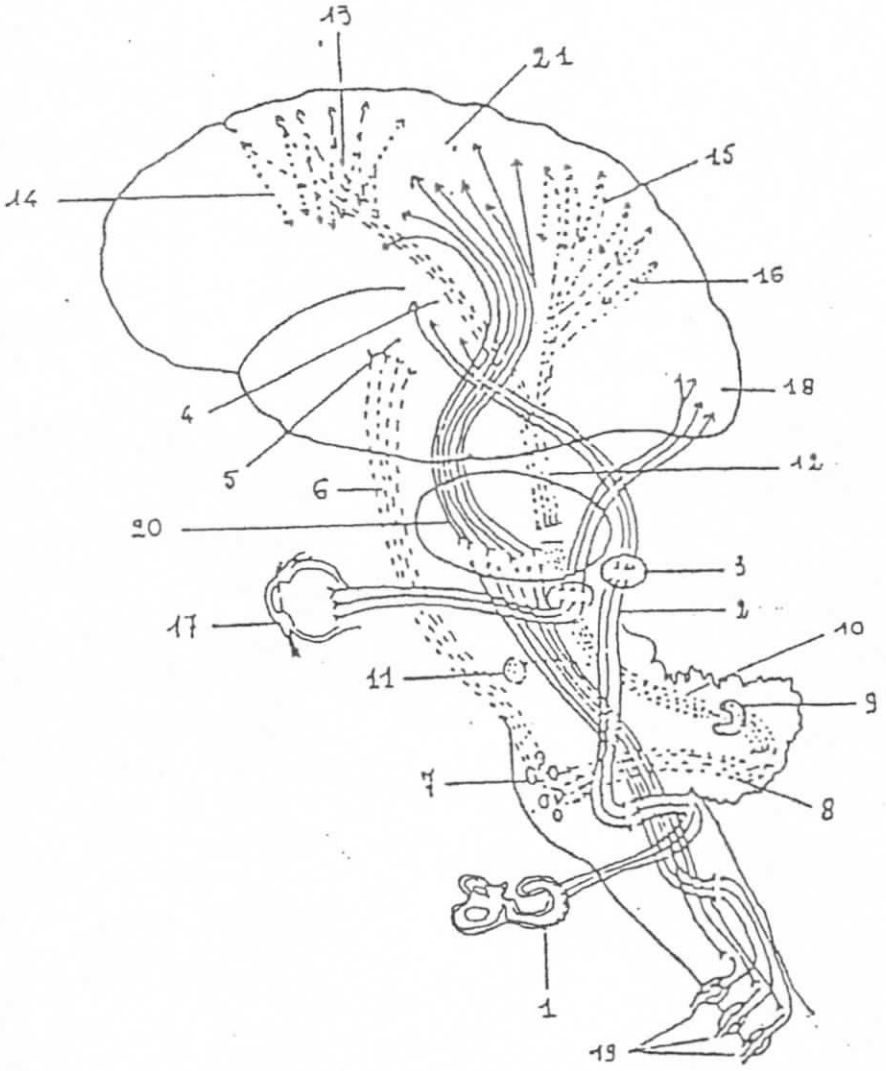

FIG. 3 THE COCHLEAR INTEGRATOR

1 cochlea
2 lateral lemniscus
3 medial geniculate body (or nucleus)
4 auditory area
5 auditory association area
6 temporopontine tract of Turck-Meynert
7 pontine nuclei
8 pontocerebellar fibers
9 dentate nucleus (or nucleus dentatus)
10 dentothalamic tract
11 red nucleus
12 thalamocortical projections
13 anterior thalamic radiation
14 frontopontine tract
15 middle thalamic radiation
16 parietopontine fibers
17 eye
18 visual cortex
19 sensory nerve fibers
20 thalamoparietal sensory fibers (or sensory radiation)
21 parietal area