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REVIEW PAPER

Intellectual stimulation at the very beginning of life

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ABSTRACT

Intellectual stimulation at the earliest stages of life should be one of the most important concerns of specialists and international organizations in the field of health and well-being as well as in education.
Numerous reports indicate a correlation between the emotional state of the newborn and the influence of the environment, especially in relation to the mother's living conditions.
On the other hand, this study aims to present the meaning of intellectual stimulation, which in fact begins even before birth.
The quality and extent of intellectual stimulation activities undertaken can.

KEY WORDS:

environment, newborn, intellectual stimulation.

INTRODUCTION

This study aims to explain the meaning of intellectual stimulation, which in fact begins before birth.

Intellectual stimulation at the earliest stages of life should be one of the most important concerns of health professionals, especially organizations such as the WHO, UNESCO, and UNICEF. An international colloquium on intellectual stimulation at the very beginning of life, organized by A.D.E. [1], under the auspices of UNESCO in Paris (1989), showed that consideration of intellectual development is important because it concerns the first weeks of life, and even the period before birth. These considerations may have long-term consequences to a greater extent than other health problems that have already been addressed. The conclusions of this colloquium, even if they are only fragmentary and appear more often as suggestions, are important.

According to Dr. Brian and Robert Morgan, *The greatest and subtlest qualities of the human mind lie in its capacity to think and reason, that is, in its intellec*t [2].

The period of prenatal development is extremely important for the future development of the child, but unfortunately it is the period about which we know the least, especially in the first and second periods of pregnancy. Only studies in later foetal life could be conducted in infants born prematurely, assuming that these babies developed before birth and would develop after birth in exactly the same way as babies who remain in the womb for the average duration of pregnancy [3].

THE BRAIN

Anatomically, the brain develops very early, during embryogenesis, in a strictly programmed way, during which we witness the establishment of connections that will gradually constitute the adult brain.

In the fifth week after conception, the first synapses begin forming in the foetus's spinal cord. By the sixth week, these early neural connections permit the first foetal movements that researchers can detect through ultrasound imaging. From the eighth month of pregnancy to adulthood, the number of neurons and synapses decreases. The maximum number of neurons remaining in the foetus depends on the neurons or group of neurons that establish the sufficient number of connections [4].

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By stimulating different sensory systems of the foetus, one can reduce the removal of neurons and increase the number of connections [5].

The stabilized phase probably occurs in the last trimester of pregnancy, but in the initial phase of the installation, a stable network already operates under the influence of external stimuli. This period is critical. It is known that the foetus has 2–3 times more neurons than an adult and loses half of them during pregnancy. The production of neurons is practically completed about half way through pregnancy, after which the production of glial cells continues until the end of pregnancy and until the second postpartum year [6].

For Claudia Clopath, *Memories are thought to be stored in the connections between neurons called synapses, whose strength can be changed by learning. Every new memory changes the synapse strengths, which in turn alters previously stored memories. This phenomenon is puzzling, because some memories appear to be stored for an entire lifetime. Synaptic plasticity is thought to be the basis of learning and memory* [7].

The right cerebral hemisphere develops faster. Higher activity can be observed in the first week of life, e.g. a smile in active sleep, manipulation of the left hand, etc. Hearing, on the other hand, develops in the left hemisphere. Also, the dominance of the left hemisphere exists for language.

From a functional point of view, development is a learning function. It is known that programming is partly genetically determined (programming defects can result from innate errors or toxic aggressions).

DREAM

Sleep and the development of the senses depend on age (during pregnancy and after birth). There are differences in the quantity and quality of stimuli before and after birth. Before birth, the transfer of neuromediators is possible in the placenta. After birth, sensory stimuli (e.g. tactile, visual, etc.) are more significant.

The research of Michel Jouvet's team showed that there is a genetic programming of REM sleep. According to Curzi-Dascalova, *Several data support the hypothesis that restless sleep is essential for the integration of information from the environment and for maintenance, recapitulation, the development of certain innate functions. Observations of foetal behaviour using ultrasound shows that both stages of sleep exist in-utero, with a clear predominance of time spent in restless sleep* [8]. According to Marie-Josephe Challamel, *The sleep of the foetus is completely independent of that of its mother; there is, however, a circadian influence* [9].

At the 15th week of pregnancy – a period of complete brain formation – we observe better coordination of movements, smiling, and sobbing. When the foetus sleeps, it is possible to see on 3D ultrasound panoply of emotional expressions towards the end of the second trimester: joy, fear, or anger is easy to decipher.

It is possible that agitated sleep represents a memorization phase. It is a phase during which the foetus sleeps but its mental activity is at maximum. Its brain sorts and organizes the data it collected when it was awake. In older children, intensive learning prolongs the duration of active sleep, and lack of sleep reduces performance the next day. Changes in the sleep phase are faster if premature babies are stimulated by an increase in active sleep.

Howard Roffwarg's research has shown that foetal sleep is identical to that of a premature baby at the same gestational age: the first periods of restless sleep appear as early as the sixth month of pregnancy (28 weeks), and restless sleep individualizes earlier than restful sleep. Its amount increases very quickly: it accounts for about 65% of the sleep time in the eighth month of pregnancy. Several studies suggest that the amount of this restless sleep decreases close to the deadline. In the uterus, a peaceful awakening is practically absent. According to Howard Roffwarg, paradoxical sleep (REM) may play a role in brain development and maturation: a very large amount of REM sleep in immature infants at birth *would allow the establishment and development of neural circuits and the maturation of the brain during foetal life and the first months of life* [10]. REM plays a significant role in the maturation of the development of the central nervous system. A team of researchers from the MedUni University in Vienna have shown for the first time that foetal brain development can be measured using functional magnetic resonance imaging (MRI) in the womb.

SOUND STIMULI

It is clear that in the womb, babies are familiar with sound stimuli. According to Denis Querleu, *There is an intrauterine background noise consisting of physiological noises from vascular noises (aorta) but also placental noises that introduce frequencies between 500 and 1000 Hertz. Physiological intrauterine background noise was noted at 28 decibels. When we recorded the intensity of the mother's voice, it emerged 24 decibels above this background noise. For outside voices, the emergence was of the order of 8 to 12 decibels, so less important. The maternal voice is perceived more intensely because it brings the body into vibrations. Voices are de-timbred, because the absorption of external sounds is such that low sounds are not absorbed and high-pitched sounds lose about 30 decibels, causing the timbre to change. On the other hand, the intonation persists since it is below 800 Hertz (it is a frequency well transmitted in-utero* [11]. Before birth, there is a placental barrier that then disappears. What passes through the placenta are molecules of a relatively low weight. The baby hears sounds, but the mother's voice, as well as external voices, is changed. The sound recognition rate is about 30%. High-pitched sounds are less well perceived, and low pitches are

transmitted better through the hearing. The foetus is able to hear bass sounds from weeks 19–20 [12].

Some understanding of the mother's voice is probably possible at the end of pregnancy. From birth, the baby turns its head to the source of sound but does not distinguish between different sound sources. This location of the sound source will develop at around the third month, which will allow the baby to distinguish between sounds and voices. In a newborn, the response to sound stimuli depends on the specific time within the sleep cycle and on the stability and duration of sleep. The maturation of the auditory system will be effective at around the sixth month, and the baby will then be sensitive to intonations and music.

There are many indications of a kind of prenatal memorization. This memorization relates to the recognition of perceived intonations in the placenta (a 4-day-old baby already recognizes its mother's voice). In the placenta, sensations during active sleep are generated in the right cerebral hemisphere, and during slow sleep they are generated in the left cerebral hemisphere. This difference exists from the 30th week of pregnancy. Children begin to communicate through radiant smiles. From the eighth day after birth to the third week of life, they try to grab with their hands.

The first characteristics of language appear at between 2 and 3 months of age. With modification in anatomical conditions, the onset of intelligible speech can occur at the age of about 6 months. The mother tongue affects the production of vocal sounds after 10 months of age.

MOZART EFFECT

The "Mozart effect": According to a study by the University of California (1993) [13], in students exposed for 10 minutes to classical music, their IQ increased by 8 points. It is known that a child in a multilingual environment will be able to learn another language more easily. Indeed, the brain is "open" to the sounds of several languages, so it will quickly master them in practice. This is related to the stimulation of neurons that establish links between them.

Hearing is one of the sharpest senses when a baby is born. Between the fifth and eighth month of pregnancy, the foetus already receives sounds and has the opportunity to remember them. Music is therefore an essential pillar of development that allows the child to "wake up". Therefore, it is important to pay attention to the presence of music for the foetus!

In the uterus, the foetus's emotions increase tenfold when it hears music. Long before the formation of the auditory system, the baby perceives the vibrations of sounds from the outside thanks to the bones of the skull and pelvis of the mother, which act as resonators. Thus, from the seventh week of pregnancy, the vibrations of music or various perceived sounds give the baby its first real emotions. Sounds and vibrations come like waves caressing the little lips of his/her mouth and his/her hands. This small child is upset by these vivid sensations that give him/her intense feelings and emotions. Later during pregnancy, the vibrations are increased to the ability to hear sounds. The foetus is more sensitive to low sounds, and high frequencies are filtered through the mother's amniotic fluid and abdominal wall.

Music, to awaken the mental and physical functions of the foetus, develops its intellectual abilities. When the foetus listens to music, it broadcasts and creates in it the effect of relaxation and harmony, an effect that lasts even after birth. Music also promotes children's concentration.

Listening to a melody develops the infant's listening skills, which is essential in learning a language. Music stimulates children's creativity, and awakens and promotes good intellectual development. An infant who lives with music learns to live with other children and develops a broader ability to communicate with those around him/her. Music helps in socialization.

An Italian study called "inCanto" [14] that lasted 6 years (from the sixth month of pregnancy to 6 years) was conducted on children whose mothers had taken music or singing classes. This study found that children have a memory for the melodies perceived in the womb. These same children chirped earlier and demonstrated an earlier ability to articulate the first words. They were able to sing just before they were 3 years old, whereas in other children, this ability was only observed around the age of 6 years.

Other techniques used to stimulate the foetus's auditory system include the mother speaking to the foetus and using music with simple rhythm and melody [15].

To test the hypothesis that foetal memory persists into the neonatal period, 41 newborns were repeatedly stimulated by using foetal vibro-acoustic stimulation and were compared with 31 controls. The newborns who were stimulated in utero habituated earlier than those who had not previously experienced the stimulation [16]. These results suggest that the foetuses were able to learn.

It is also a significant help for his/her personal autonomy. Music promotes logical development and memorization. Music radically develops emotional sensitivity. For children, music with more catchy rhythms and lyrics promotes memory and language learning. Music is a language in itself.

TASTE AND SMELL

Taste and smell are archaic cognitive ways. The sensory modalities of taste and olfaction are functional very early, practically from the fourth month of intrauterine life. This has been proven, for example, by injecting intravenous glucose solutions. When glucose arrives in the amniotic fluid, the foetus begins to suckle and swallow amniotic fluid. But when it urinates, it does not suckle because the amniotic fluid becomes bitter.

Breastfeeding promotes the discovery of these different flavours and develops taste (through the development

of taste buds), as well as the subsequent diversification of the diet. The child perceives 4 basic flavours: salty, sweet, sour, and bitter.

Smell is a much richer feeling and does not develop as a hedonic model. It is always an emotional pattern: cultural and from personal experience. According to Maty Soule, a person perceives many different smells: 500 or 600 and up to 5000–10,000 when someone is more talented with a little training [17].

SIGHT

Vision is the last sense to develop in the foetus. The eyelids remain fused until the 24th week of pregnancy. Only the retina and optic nerve develop more significantly. Around the seventh month of pregnancy, the child can distinguish shadows and shade in the light. It reacts if a strong light is directed at its mother's belly. Its heart beats faster when a light source is inserted during an amnioscopy. This reaction means that its visual system is sensitive to light. *Purpura found that the cells of the primary visual area of the cortex had their chief burst of maturation in the relatively brief period between 28 and 32 postmenstrual weeks. At this time the dendrites grew and 'spines' appeared on them, which is believed to signify full maturation* [18].

Vision begins to develop from birth when the sharpness is only 1/10. Net perception is about 30–50 cm distance. About 8–10 days after birth, the baby fixates its eyes on nearby objects. At around one month, the baby follows large, close objects at an angle of 90° and on a horizontal plane. In the second month, objects are tracked at an angle of 180°, always on a horizontal plane. The child sees colours. Human faces attract his/her attention and he/she smiles at them. At 3–4 months, the vision is bright to a distance of 80 cm; the gaze is both vertical and horizontal. Binocular vision begins at around 4–6 months. After 6 months, the development of the eye is complete. From 9 to 24 months there is precise coordination of vision, ending with depth perception. Peripheral vision develops between 12 and 18 months and visual acuity is 10/10 at 24 months [19].

The emotional state of a newborn depends largely on the environment and especially on the living conditions of the mother. The development of happiness is impossible without positive influences. Mental depression is a later phenomenon that occurs at the beginning of the second semester after birth. Depression in mothers before, during, and after pregnancy (immediately or delayed) can have a significant impact on the emotional state of the baby.

MALNUTRITION

Malnutrition during pregnancy has little effect on the development of the brain and intellectual performance of the baby (iodine deficiency is an exception). In utero, malnutrition surely plays a role, but there is protection, because it is the mother who, even malnourished, makes a fee. She prevents the foetus from suffering intrauterine malnutrition. On the other hand, all intoxications and any vitamin deficiency during pregnancy have a cerebral impact. In the long run, some effect on intellectual development is possible: disruption of the stimulating environment or poor stimulation. The variety of stimulation depends on the stimulating environment: this variety allows for different reactions. Stimulation is less in malnourished children, especially during weaning. If the child is malnourished for a long period of time, it will be difficult to stimulate him/her. Winick and Dobbing showed that malnutrition reduces the number and size of brain cells, as well as the content of lipids, nucleic acids, enzymes, and proteins [20]. According to Fox, the total amount of myelin is reduced in malnourished infants, but the chemical composition of myelin does not change [21].

THE INFLUENCE OF THE SOCIO-CULTURAL ENVIRONMENT

Nowadays, it is obvious that children are stimulated and remember from the very beginning of life and even before birth. Stimulation seems only to affect at certain times: the baby needs to be ready.

At the moment, it is difficult to assess the role of the environment and genetics with precision.

The influence of the socio-cultural environment is of great importance. The environment has a significant impact on children's emotional responses and intelligence. Intelligence is not acquired from birth; it is necessary to work on it and cultivate it. By developing the child's cognitive abilities, it significantly increases his/her IQ.

In view of the current accelerated technological development in our societies, we should better prepare future generations so that they can fully experience this evolution, and therefore we can begin to stimulate intellect at the very beginning of life.

This action should also be a fundamental problem of states and international organizations in the field of human health and well-being, in the so-called "well-being of MAN", as well as in education.

CHINA AND AFRICA

Observations in China and Africa showed the differences in the conception of the term of birth and the means of early stimulation of the child.

For the Chinese, the baby is born at the time of conception (for us on the day of birth), so the age of the child is also counted from conception. Because the baby already exists during pregnancy, there are also all its functions, of course, it depends on their development.

Due to the one-child policy, in addition to 2 parents, 4 grandparents are interested in the unborn child and therefore also participate during pregnancy. This means that they can influence the baby's intellectual stimula-

tion through discussions around the pregnant mother and even through the touch of her belly. Grandparents' words can act directly on the baby if they are low piched, but they can especially affect the pregnant woman, triggering emotions that can act on the baby. We do not yet have significant and tangible evidence of this. However, it is possible to measure or record a child's brain activity during external stimulation. It is also possible to observe the movement and expression of the baby's face (smiles and grimaces) using tomography (intersubjectivity in infants), also thanks to the latest medical imaging and micro cinematography technologies (environmental electron microscopy, cellular micro cinematography, computed tomography, MRI, positron emission tomography (PET), 4D ultrasound, foetal scoundrel).

Observed for only 20–30 years, the Chinese "boom" is associated not only with the political and economic opening of the country. The Chinese, who for a long time were hibernating and remained as if asleep, when they "woke up", they developed extremely quickly, using their innate intellectual abilities thanks to the influence of several thousand years of civilization and their intellectual abilities that were more developed than ours. An example is their spoken (4 intonations) and written (over 50,000 characters) language, which affects the brain's abilities. Remembering these thousands of signs is decisive in the development of their brain.

In Africa, the environment can affect the development of the brain, especially after birth when stimulation is the most important[1]. The baby is carried constantly on the mother's back, so it is stimulated by movements, sounds, words and a varied field of vision. Unfortunately, from the age of 3 years, the intellectual "development curve" decreases in relation to our children who are more stimulated by schools and the richness of the environment.

INTELLECTUAL STIMULATION

Already in the first months of pregnancy, intellectual stimulation should be included in the "care programs" for the pregnant mother. We do not yet have scientific evidence for the effects of intellectual stimulation of the child in the period before birth, but we have enough observations that stimulation before birth causes faster intellectual development of the child.

A child can be stimulated from the first weeks of pregnancy both directly and indirectly. We know that the baby reacts to sounds and vibrations very early and that it senses taste at the third month of foetal life. We also know that it reacts emotionally to the touch of the abdomen or other area of the mother's body, but also through the emotional state of the mother herself[2]. Touching and tapping the womb together with the kicking game of the foetus are among these techniques. Therefore, mothers are advised to perform these techniques from week 27 of gestation, as the best time for performing these techniques, in order to observe the beneficial effects of them on neonate behaviour and mother-neonate bonding [22].

There are several methods of stimulation, observed both in the environment of the average European population and in the environment of the population still living in a very traditional way, in primitive conditions and without education. Personal observations of populations still living in a traditional way have allowed us to develop several stimulation schemes (in African in southern Sudan, on the island of Zamboanga in the Philippines, as well as in a poor agricultural area far from Shanghai).

CONCLUSIONS

We can stimulate the baby before birth directly through sounds, songs, and music. It is known that the foetus has different reactions depending on the type of music. For example, it calms down with Mozart, and becomes agitated while listening to rock music. We can ask the family members to act, especially the husband because the voices of men have a greater impact through their low pitch. Also, we can act through caressing the belly of the future mother ("haptonomy" leads the father and mother to establish with the foetus a tender and complicit relationship).

We can also stimulate the baby before birth indirectly by assigning certain physical or intellectual activities to the mother, depending on her abilities; for example, through embroidery which is an art of fabric decoration. It consists of adding to a fabric an embossed pattern made of simple threads, incorporating materials such as pearls or precious stones. Also through reading books, but more complicated than usual, leading to strengthening of her attention. And through observation of special events that occur around her.

DISCLOSURE

The authors declare no conflict of interest.

REFERENCES

1. Ostrowski ZL. Stimulation intellectuelle au tout début de la vie, 2ème Edition, Harmattan, Paris 2018.
2. Morgan B, Morgan R. Brain food. Michel Joseph Ltd, London 1986, 136.
3. Tanner JM. Foetus into man. Physical growth from conception to maturity. Fletcher & Son, Norwich, 1978.
4. Blackburn ST. Maternal, fetal, and neonatal physiology. E-book: A Clinical Perspective. 5th ed., Elsevier Health Sciences 2017, 564-583.
5. Anderson AL, Thomason ME. Functional plasticity before the cradle: a review of neural functional imaging in the human fetus. Neurosci Biobehav Rev 2013; 37: 2220-2232.
6. Jacobson M. Developmental neurobiology. Plenum Press, New York 1978, 221.

[1] Our personal observations in Sudan and Uganda.

[2] Biographies of great composers such as Beethoven, Schubert, Liszt, Chopin, Mozart... reported that in fact there have always been exceptional events during their mother's pregnancy.

7. Clopath C, Vasilaki E, Buesing L, et al. Connectivity reflects coding: a model of voltage-based spike-timing-dependent-plasticity with homeostasis. Nat Neurosci 2010; 13: 344-352.
8. Curzi-Dascalova L. INSERM, Hôpital Antoine Beclère Clamard. In : Ostrowski ZL. Stimulation intellectuelle au tout début de la vie, 2ème Edition, Harmattan, Paris 2018, 24.
9. Challamel MJ. Centre Hospitalier Lyon-Sud. In: Ostrowski ZL. Stimulation intellectuelle au tout début de la vie, 2ème Edition, Harmattan, Paris 2018, 65.
10. Roffwarg H, Muzio JN, Dement WC. Ontogenetic development of human sleep-dream, cycle. Science 1966; 152: 604-619.
11. Querleu D. Clinique d'obstétrique Roubaix. In : Ostrowski ZL. Stimulation intellectuelle au tout début de la vie, 2ème Edition, Harmattan, Paris 2018, 59-60.
12. Partanen E, Kujala T, Tervaniemi M, et al. Prenatal music exposure induces long-term neural effects. PLoS Digital Health 2013; 8: 6.
13. Rauscher FH, Shaw GL, Ky CN. Music and spatial task performance. Nature 1993; 365: 611.
14. Tafuri J. Infant musicality. Edited by Graham Welch. Routledge, London 2016, 91.
15. Walt van der MM, Lubbe W, Coetzee H, et al. Effect of prenatal stimulation programs for enhancing postnatal bonding in primigravida mothers from the western cape. Afr J Nurs Midwifery 2016; 18: 27-46.
16. Gonzales-Gonzles NL, Suarez MN, Perez-Pinero B, et al. Persistence of fetal memory into neonatal life. Acta Obstet Gynecol 2006; 85: 1160-1164.
17. Soule M. Institut de puériculture et de périnatologie de Paris. In: Ostrowski ZL. Stimulation intellectuelle au tout début de la vie, 2ème Edition, Harmattan, Paris 2018, 67-68.
18. Tanner JM. Foetus into man. Physical growth from conception to maturity. Fletcher & Son, Norwich 1978; 110.
19. Loume L. Question de la semaine: comment les bébés voient-ils le monde. Science avenir, Ophtalmo 2016.
20. Illingworth RS. Abrégé du développement psychomoteur de l'enfant, Masson, Paris 1978; 65
21. Jacobson M. Developmental neurobiology. Plenum Press, New York 1978, 221.
22. Mahboubeh Valiani M, Hadi Aljjani S. The effect of fetus stimulation techniques on newborn behaviour. Iran J Nurs Midwifery Res 2021; 26: 550-554.