The Scientific Basis of Pre- and Peri-Natal Psychology-Part 1

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Full Text: Headnote ABSTRACT: This paper deals with three significant parameters of Pre- and Peri-Natal Psychology from a research perspective. First, the development and function of the CNS is examined with particular emphasis on myelination, audiology, EEG studies and neonatal behaviour. Next, advances in our knowledge of intrauterine learning are reviewed. Lastly, the effect of perinatal trauma on personality development is considered. A. NEURO-EMBRYOLOGY AND NEUROPHYSIOLOGY One of the central issues in pre- and peri-natal psychology is the degree to which the unborn child is capable of appreciating his environment and of reacting to it volitionally. Therefore, the development and functioning of the CNS is an area of great significance. There are many ways in which we may learn about the functional maturity of the cerebral cortex. I shall deal here with only three of these: neuroembryological and neurophysiological research, the study of neonatal electroencephalographic patterns, and the observations of the behavioural development of neonates. 1. Myelinaton Lack of myelination has been proposed as an index of the lack of maturity in the neonatal nervous system.1 Incomplete myelination merely implies a slower conduction velocity in the nerves or central nerve tracts of neonates, which is offset completely by the shorter interneuron and neuromuscular distances traveled by the impulse.2 See also Grafstein3 (1963) and Salam and Adams4 (1966), who found that neuronal assemblies function before myelination. 2. Development of Hearing Infra Human Research. Armitage, Baldwin, and Vince5 (1980) were able to obtain precise information about the prenatal auditory environment of sheep by suturing hydrophones to the necks of two sheep fetuses within their amniotic sacs and recording sounds originating outside and within the dam. They found that externally presented sounds were attenuated by an average of 20dB (within a maximum attenuation of 37 dB at 1000 Hz), that conversation outside the dam was occasionally discernible, and that raised voices were almost always distinct. Audible sounds produced by the mother included drinking, eating and rumination and were characteristically of low frequencies (up to 500 Hz). The dam's heartbeat was not audible in their recordings. Vince, Armitage, Walser, and Reader6 (1982) stimulated sheep twice daily for 2-4 weeks prior to birth with series of pure tones ranging from 200-400 Hz or a series of bleats recorded from pregnant ewes. As newborns, the lambs showed a marked acceleration of heart rate when presented with an unfamiliar sound (one not experienced prenatally) and marked heart rate deceleration (or lack of acceleration) when presented with the familiar non-natural sounds (i.e. the tones). Numerous studies have shown similar effects of prenatal experience on postnatal auditory perception in birds, see the research by Vince7 (1980), Impekovens (1970; 1975), lien9 (1976), Gottlieb,10 (1979; 1980). Human Studies. Cochlear function is demonstrable by the 5th fetal month, by which time both middle- and inner-ear structures have reached their adult size. Auditory nerve fibers begin to melinate during the 6th fetal month and the auditory system is functional by the third trimester of gestation.11 The environment for the fetus resembles the aquatic environment insofar as the physical nature of sound transmission to the ear. Rubel12 (1984) reports research by Saunders and his colleagues indicating conduction of sound to the external and middle ear follows principles of vestibular and cutaneous transmission of audio signals. In a pioneering study, Spelt13 (1948) reported conditioning the fetal infant to an external auditory stimulus during the final two months of gestation. The imprinting (longterm memory, autonomic SR driven) of the mother's normal heartbeat, and the implications for normal health of the fetus, were investigated extensively by Salk14 (1960), 1962, 1966). The perinatal infant responds to the adult heartbeat rhythm with less anxiety and more stable sleep habits. A.W. Liley15 (1972) reports early data on FHR (fetal heart rate) response to both pure and complex tones. Likewise, Wedenberg16 observes that the fetus is "listening all the time after the 24th week." Grimwade17 (1970) and Grimwade et al.18 (1971) report direct differentiation of FHR to a wide variety of frequency stimuli. In addition, differentiation of response to sine tones and percussive sounds is reported. Sakabe, Arayama and Suzuki19 (1969) report AER (auditory evoked response) in the fetal brain. Thus, it appears that the stimulus is transmitted to the brain, and it can be concluded that it is perceived and stored in memory. Investigations of fetal well-being by Read and Miller20 (1977), Bench21 (1968), Grimwade17 (1970) and Scibetta22 (1971) using auditory response data further support the observation that the prenatal infant "hears" and responds to a wide variety of external sound sources. Walker, Grimwade, and Wood23 (1971) recorded intrauterine sound in 16 pregnant women, before and after the rupture of the fetal membranes (with the microphone in the cervical canal) and after their rupture (with the microphone lateral to the fetal head). Human intrauterine recordings, taken after the rupture of the amniotic sac, indicated that the most audible speech stimulus in utero was the mother's voice, presumably because her vocal tract is located closer to the uterus than are any other speech generators24 (Querleu &Renard, 1981). Bernard and Sontag25 (1949) stimulated three fetuses within the last two-and-a-half months of gestation with a wide range of pure tones, presented via a loudspeaker positioned over the head region of the fetus. Cardiac acceleration (indicative of a startle response) was seen in all fetuses shortly after the onset of tonal stimulation. Fetuses within the last seven weeks of gestation showed an increase in pulse rate in response to the presentation of a 3000-Hz pure tone at 110 dB (Johansson, Wedenberg, &Westin, 1964)26 and fetal eye-blink responses have been observed, via ultrasound imaging, to vibroacoustic stimulation from the 25th week of gestation on (Birnholz &Benacceraf27 (1983). Auditory evoked responses have been obtained from fetuses in response to a pulsed sound stimulus after rupture of the anmniotic sac during labor (Scibetta, Rosen, Hochberg, and Chik,28 (1971). By the use of ultrasound imaging, third trimester fetuses have been shown to increase their activity levels when a 2000-Hz tone at 110 dB was presented to the lower maternal abdomen (Gelman, Wood, Spellacy, &Abrams,29 1982). Fetuses between 37- and 40-weeks gestational age showed significant increases in heartrate and limb movements to an 800-Hz tone presented through the maternal abdomen at both 106 dB and 113 dB (approximately 86 dB and 93 dB in utero, respectively; Granier-Deferre, Lecaunet, Cohen, Busnel, &Sureau,30 1984). Thus, by the third trimester the human auditory system is capable of processing sound and human fetuses appear to be responsive to the presentation of certain sounds emanating from sources that are not in contact with the maternal abdomen. B EEG Studies Intermittent EEG bursts in both cerebral hemispheres are see at 20 weeks and bilaterally synchronous at 26 to 27 weeks.31 By 30 weeks, the distinction between wakefulness and sleep can be made on the basis of electroencephalographic patterns.31-32 Cortical components of visual and auditory evoked potentials have been recorded in preterm babies (born earlier than 30 weeks of gestation),32'33 whereas olfactory and tactile stimuli may also cause detectable changes in EEG of neonates.32-34 REM sleep has been found to exist as early as 23 weeks (using optic fibers).35 C Behavioural Development of Neonates. Several forms of behaviour imply cortical function during fetal life. Well-defined periods of quiet sleep, active sleep, and wakefulness occur in utero beginning at 28 weeks of gestation.36 In addition to the specific behavioural responses to pain which time does not allow me to elaborate on today, preterm and full-term babies have various cognitive, coordinative and associative capabilities in response to visual and auditory stimuli, leaving no doubt about the presence of cortical function.37 Several lines of evidence suggest that the complete nervous system is active during prenatal development and that detrimental or developmental changes in any part would affect the entire system.34-38-39-40 Other evidence: Dominick Purpura41 believes that "brain life begins somewhere between 5-6 months." Researchers42 at New York's Sinai School of Medicine report that a fetus may "contemplate" its movements before it kicks or waves its arms. Using fetal-monitoring devices Niels H. Lauersen found that in most cases among pregnant women he observed, the fetal heartbeat began to rise some six to ten seconds before the fetus moved. Lauersen and his partner, Zoe Graves point out that in adults the heart rate speeds up during the contemplation of an action. Graves says the discovery of a similar acceleration in fetuses is evidence that thought may start at the gestational age of five or sixth months. Audiologist Michele Clements43 in her attempt to diagnose hearing impairment as early in life as possible has experimented with playing music to the unborn child during the last trimester. She found that fetal behaviour changed according to the music that was played. While the large orchestral pieces of Brahms and Beethoven and all forms of hard rock occasioned an increase in heart rate and movement occasionally leading to painful "protest" kicking, the compositions of Mozart and Vivaldi lead to a steady, resting heart rhythm and peaceful "swimming" movements of the baby. Henry Truby44 studied the precursors of breathing and vocalization patterns in fetuses. He found that the unborn child was "practicing" in the amniotic fluid those groups of muscles which after birth would be necessary for crying and voice production. Truby45 also did research on the cry patterns of premature infants using acoustic spectrograms. In many instances he found that the voice prints of newborns corresponded to a large degree with that of their mothers but not their fathers. In other words, the voice was not genetically inherited but acquired from listening to one's mother. This thesis is further supported by the finding that newborns of mute mothers do not cry or cry in a peculiar fashion. II Learning in Utero Animal Studies Marion Diamond, neuroanatomist, U. of Cal., Berkeley, placed pregnant rats on an enriched environment. Their offspring showed a distinct thickening of the brain's cortex.46 Enriched animals had a 10% increase in cholinesterase and a 10% increase in glial cells. (Several years ago Diamond reported on a higher ratio of glial cells to neurons in the brain of Albert Einstein47). And the enriched get richer. Each succeeding generation had increasingly thicker cortices. Diamond estimates that 50-75% of neurons are lost during prenatal development and neurons continue to be lost at a reduced rate throughout life. Diamond's finding is supported by Japanese researchers48 who report that the offspring of rats reared in a toy-filled environment are better at learning mazes than the offspring of a control group. This is true even when the pups are reared by foster mothers. Human Research. Anthony DeCasper, professor of psychology at the University of North Carolina, has been researching fetal perception and memory for the past ten years. He has conducted a remarkable series of experiments. First, he demonstrated that newborns can pick out their mothers' voices from among other female voices.49 DeCasper wondered, however, if babies might not just prefer a familiar voice to an unfamiliar one heard after birth. These infants were then tested with a non-nutritive nipple hooked up to a tape recorder to see if they preferred their father's voices to that of other men's. (By changing the rhythm of their sucking, the babies could switch the taped voices.) They did not. However, after a few weeks they were retested-and they did opt for their fathers' voices. Next, DeCasper rigged up his "suck-o-meter" in such a way that infants could choose between listening to a taped maternal heartbeat and a taped male voice. The majority of babies favored a tape recording of the heartbeat.50 Finally, a group of pregnant mothers was asked to tape record their reading of two different children's stories. "The Cat in The Hat" and "The King, the Mice And the Cheese." During the last six and a half weeks of their pregnancy half the group was asked to read story A twice a day and the other half read story B. When the babies were born, the researchers offered them a choice between the two stories. Within a few hours after birth, eleven of the twelve newborns adjusted their sucking rhythm to hear the familiar story as opposed to the new story.51 These data provided the first direct evidence that the unborn not only hears and recognizes his mother's voice, but also that he seems to remember the words! Robin Panneton52 a student of DeCasper's asked pregnant women who were close to term to sing a melody everyday for the rest of their pregnancies. Their infants were tested postnatally with a choice procedure in which they could listen to the familiar melody or an unfamiliar melody. Sixty-three infants were tested. The melodies differed only in their prosodic characteristics (e.g., frequency contours). A previous experiment had demonstrated that non-experienced newborns could discriminate between these two melodies. Analyses of preferential responding showed that the prenatally experienced newborns preferred the familiar melody over the unfamiliar melody whereas a control group of non-experienced newborns showed no systematic preference. These results are consonant with our understanding of the fetal auditory system and the intrauterine sound environment. Donald Shetler, a professor of music education at the University of Rochester, has been studying the effect of music during pregnancy on infant development. To date he has studied 30 infants, the oldest of which is now five years old. Shetler evaluates the musical response of newborns by looking at attention span and body movements. Later he measures the child's ability to imitate rhythms and vocal sounds and to manipulate such sound-making objects as small bells. The sessions in Shetler's classroom-a music lab of tiny xylophones, drums, and musical toys-are videotaped for later analysis. Some of the children, he says, can imitate a two or three-note melody within eight months of birth. By the age of two, 80% of the children will play the lab's piano or synthesizer with one finger at a time, as opposed to banging several random keys at once. The children, he says, pick out different melodies and try them at different places on the piano, much the way a composer does. "It's not unusual for them to sing them" he says. "And the more exceptional children will replicate them on another instrument." One of the most striking observations Shetler has made has more to do with speech than with music. "We've seen the development of highly organized and remarkably articulate speech in the experimental group" he says. Shetler reports that infants exposed to music while in the womb show "remarkable attention behaviours, imitate accurately sounds made by adults and structure vocalization earlier than controls." He believes that pre-natal music may in fact give babies a "head start".53 There is much speculation, however, and little hard data to prove a connection between music and language. Neurologists recognize that spoken language has a musical component. But what the neurological mechanisms are that connect them is unknown.54 Obstetrician Rene Van De Carr55 who has applied the new knowledge about the incredible mind power of babies to a program of prenatal stimulation which he calls tongue-in-cheek, the Pre-natal University. Here in teaches pregnant mothers not only to talk, play music and read stories to their unborns, but also to associate words with actions. For example, he advises a mother to say "pat, pat, pat," while patting the baby's back or "rub, rub, rub" while rubbing her abdomen. The pre-natally stimulated babies are generally described as mentally quick, very adaptive, socially aware, demonstrating advanced locomotion and speech. III Birth Trauma and Mental Health Evidence in the scientific literature overwhelmingly favors the view that physiological complications at birth predispose the individual to a wide range of injuries; from psychological damage56 to organic brain damage. For example, in a study of 33 schizophrenic youngsters, investigators57 found a 40% rate of birth complications of all types. The rate for their mentally healthy brothers and sisters was, in contrast, only 10 percent. In the early 1960's Sarnoff A. Mednick58 Director of the Psykologisk Institute in Copenhagen began following a group of more than 170 youngsters who had been marked as possible candidates for schizophrenia because their mothers had the disease. 20 of them developed schizophrenia, of these 70% had one or more birth complications. 150 developed normally, only 15% of these had one or more birth complications. In 1971 Mednick59 examined the records of all violent criminals in the Danish penal system. Fifteen of the 16 most violent criminals had extraordinarily difficult births. The 16th had an epileptic mother. Perinatal origin of eventual suicides The notion that a traumatic birth is of importance for suicide proneness is not new. The psychoanalyst Otto Rank60 proposed this in his book The Trauma of Birth published in 1929. Several others, including myself have expressed similar thoughts in the past. However these concepts were based on clinical rather than statistical data. The first statistical study to support the effect of birth trauma on suicide proneness was published in 1985 by Salk, Lipsitt, Sturner, Reilly and Levatt.61 They found an increased rate of several perinatal risks factors among 46 tested variables for adolescent suicide victims. Particularly, two maternal factors and respiratory distress for more than one hour at birth were found to differentiate suicides from controls. Bertil Jacobsen, of the Karolinska Institute in Sweden has recently published62 the most extensive study on the relationship between birth trauma and suicide. His paper contains the results of three investigations: an ecological study dealing with the epidemiology of self-destructive behaviour in the United States, a case-control study of forensic victims in Stockholm63 and the preliminary results from an ongoing study of amphetamine addicts in Stockholm.64 I would like to briefly summarize his findings. 1. In the ecological study, mortality rates were studied for an age cohort born in the late 1910's at two periods 20 years apart. Twelve possible risk factors were considered during the life span of the victims. Birth injury was found to be more closely associated with suicides than the other 11 risk factors including socioeconomic variables. 2. Case-control study of forensic victims. It seemed obvious that these results based on ecological data had to be checked by a case-control study. Since it is possible in Sweden to trace the birth of an individual in an hospital from a person's social security number, it was decided to conduct the study in Stockholm. The material comprises all unambiguous cases of suicide victims (n = 281), alcoholics (n = 66), and drug addicts (n = 106) born at an identifiable hospital in Stockholm or vicinity after 1940, and upon which autopsies were performed at the State Institute of Forensic Medicine from 1978 to 1984. A control material compromising 2,901 birth records was gathered from six major hospitals in Stockholm for the period 1940-1960. Factors that were considered consisted of breach presentation, twin births, forceps delivery (Caesarean section were rare among cases and controls), asphyxia, umbilical cord entanglement, and administration to mothers within ten hours before delivery of opiates, barbiturates, nitrous oxide and chloroform. These factors were listed for seven victim categories including five different means of suicide. To obtain sufficient numbers of observed or expected cases, risk factors and categories were sometimes combined into groups as required to test the hypothesis. Three different types of birth trauma were investigated (i) whether fetal asphyxia constitutes a risk factor for committing suicide by means involving asphyxiation, (ii) whether mechanical birth trauma constitutes a risk for committing suicide by mechanical means and (iii) whether drugs administered to the mothers during labor constitute a risk for the infant to choose, as an adult, the lifestyle of an alcoholic or drug addict. The detailed analysis of birth records involved a comparison with controls as well as a mutual comparison of certain victim categories. (i) The rate of suicides by hanging, strangulation, drowning, and poisoning by gas was more than four times as high in the birth asphyxia group than in the control group. (ii) Mechanical injuries are involved in suicides from hanging, strangulation, jumping from heights, firearms etc. This combined category (N = 126) has an increased rate of mechanical birth trauma involving the head and traction of the neck (breech presentation, forceps delivery and nuchal entanglements with multiple loops) as compared to controls (P = 0.0001). The suicide group involving mechanical trauma, contrary to other suicides, had a high rate of twin births, 5.56 percent (controls 1.07 percent, P = 0.0005). Perinatal Origin of Drug Addiction A preferred emotional state of a drug addict is an altered mood. Hence, it is relevant to study the amount of opiates and barbiturates administered during labor. The doses ranged from 0.01 to 0.02g morphine, 0.05 to 0.1g meperidine hydrochloride, or 0.05 to 0.2g phenobarbital (two other barbiturates were given in sedative or hypnotic doses in a few cases). Considered were only cases when the drugs were administered within ten hours of delivery. Of the mothers of the addicts more than twice as many had been administered opiates as compared to controls (P = 0.0002). Barbiturates were administered about three times as often (P = 0.0002). Opiates and/or barbiturates were given to about one fourth of the mothers of the addicts (P = 0.0002). The study on forensic victims was criticized on the grounds that it did not take socioeconomic factors into account. Hence, a new study is presently being undertaken.64 So far birth records have been gathered for 99 amphetamine addicts, who were arrested in Stockholm in late 1986 and early 1987. The criteria for addiction were scars from injection needles, as well as documented criminal behaviour related to a drug offense. By comparing the birth records of the 99 addicts with 133 siblings it is possible to control for social class in studying associations with obstetric pain medication. The most obvious difference so far observed for addicts and siblings is the high incidence of pain medication with multiple types of drugs among the addicts, 18.2%, siblings 7.6 percent (P <0.05). Consequently, the amphetamine addict study proves that socioeconomic conditions are not related to addiction. According to Jacobsen these results demonstrate the powerful convergence of a fundamental ethnological mechanism-imprinting with an equally quintessential psychodynamic mechanism-repetition compulsion. A traumatic birth experience is imprinted on the mind and the individual will attempt to deal with the anxiety thus produced by various unconscious mechanisms including repetition compulsion thus leading to an increased rate of suicide and drug addiction amongst traumatized individuals. SUMMARY Evidence from every branch of medical investigation whether it be neuro-embryology, neuro-physiology, audiology, epidemiology, etc. is overwhelmingly favoring a scientific re-evaluation of the mental and emotional capabilities of neonates. The research available to us today would indicate that certainly from the sixth month of intrauterine life on, the unborn child is a sensing, feeling, aware and remembering human being. We are just starting to explore the implications of this new knowledge on the practices of obstetrics, psychology, psychiatry, nursing, midwifery, etc. References REFERENCE NOTES 1. Tilney F, Rosett J. The value of brain lipoids as an index of brain development. Bull Neurol Inst. NY 1931; 1:28-71. 2. Schulte, F.J. Gestation, wachstum und hirnentwicklung. In: Linneweh F. ed. Fortschritte der Paedologie. Vol 2. Berlin: Springer-Verlag, 1968:46-64. 3. Grafstein, B. 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