Maternal Stress and Fetal Motor Behavior: A Preliminary Report

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Full Text: Headnote ABSTRACT: Fetal motility was observed by ultrasound scan in 15 pregnant women awaiting amniocentesis, in order to assess the effects of maternal stress on fetal motor behavior. Amniocentesis was considered a stress situation giving rise to maternal anxiety not artificially induced. The control group consisted of 15 pregnant women undergoing routine ultrasound examination. Fetal motor activity was assessed in terms of quantity and quality. Anxiety was measured using the State-Trait Anxiety Inventory (S.T.A.I.). Fetuses showed a significantly higher motor activity ($p < 0.01$), although qualitative differences did not appear in the experimental group. Anxiety score was also found to be higher than in controls ($p < 0.002$ for the State and $p < 0.05$ for the Trait anxiety). Results are discussed in relation to possible implications for the psychosomatic development of the child. Several lines of research have shown how an emotionally disturbed pregnancy may have various adverse effects on the infant's well-being, suggesting that the mother's psychological experiences during pregnancy are important for the subsequent physical and psychological development of the child. Many authors have established a relationship between maternal anxiety or negative attitude towards the pregnancy and a higher incidence of obstetric complications, neonatal suffering and various handicaps in children (Carlson et al. 1979; Crandon, 1979a; Crandon, 1979b; Davids et al., 1962; Ferreira, 1965; Istvan, 1986; McDonald et al., 1963; Ottinger et al., 1964; Rutt et al., 1971; Stott 1956). A direct study of the effects of negative maternal emotional states on the fetus is lacking since most studies are retrospective and do not establish any direct links between the child's disorders and the psychological factors affecting the mother during pregnancy. Maternal anxiety is very likely to favour the incidence of obstetric complications especially during labour and these in turn have an adverse effect on the newborn infant. As real-time echography allows direct display of the fetus, it has proved an invaluable instrument in the assessment of fetal behavior (Birnholz et al., 1978). The time-sampling method allows intra- and inter-individual studies of fetal behavior during the various stages of gestation. This information provides patterns of normal development and allows detection of biological or experimentally induced changes. This study aimed to establish the effects of maternal stress on fetal motor activity. To this end, fetal motility was assessed in pregnant women awaiting amniocentesis. This investigation consists of the removal of a small amount of amniotic fluid in order to diagnose congenital abnormality (Milunsky, 1976). In our experience, amniocentesis tends to arouse considerable maternal tension and stress related to the technique itself and anxiety associated with the diagnostic outcome. In view of this, fetal motility in pregnant women awaiting amniocentesis may well be more marked than that detectable under normal conditions. METHOD Fetal motility was observed for 10 minutes in 30 pregnant women. Informed consent had been obtained from all women prior to the study. In 15 women (experimental group) ultrasonic scanning was performed just before amniocentesis; in the others (control group) it was a routine examination. There were no clinical or personal differences between the two groups (obstetric history, course of pregnancy, social history). However, age was statistically higher in the experimental group than in the control group since advanced maternal age is a frequent reason for amniocentesis (Table 1). The experimental group also included less primigravidae. Gestational age, determined by ultrasound measurement of fetal biparietal diameter, varied between 18 and 20 weeks. During this period fetal motor development is completed (Ianniruberto et al., 1981; Milani et al., 1981) and the whole fetal body can still be visualized. Fetal observations were performed with a Combison 100 Kretzteknik real-time scanner and recorded on video tape. The transducer was positioned to allow continuous display of a median sagittal section of the fetal body.

Table 1

Group Characteristics

	n	*Age (yrs)**		*Gestational age (weeks)*	*Primigravidae*
		Mean	*SD*		*%*
Experimental group (amniocentesis)	15	37.6	4.77	18÷20	40
Control group (routine ultrasound scanning)	15	27.73	7.10	18÷20	73

*Student's t test: $p < 0.01$

Fetal movements were assessed according to the criteria proposed by Birnholz et al. (1978) which classify various types of fetal movements in relation to the body segments involved. The following movements were assessed in this study: 1. Isolated head- simple movements of extension, rotation and anterior and lateral flexion of the head without trunk or limb movements; 2. Hand-face: adduction movement of the hand towards the face (hand-mouth, hand-forehead, hand-nose); 3. Independent limb: isolated movement of one of the limbs; 4. Limb joint: regular flexion and extension movements of a limb or its extremities ("locomotive"); 5. Startle: sudden movement of the whole fetal body (jerk, startle); 6. Combined-repetitive: massive movements involving the head, trunk and limbs at the same time. Fetal position in relation to the major uterine axis (longitudinal, transverse or oblique), fetal decubitus in relation to the posterior uterine wall (prone, supine or right or left side) and fetal pose (mutual relationship between various fetal body segments) were also observed. Fetal motor activity was assessed in terms of quantity and quality. Quantity of movements was calculated by the overall period of fetal motor activity. Quality of movements was determined counting the overall number of movements and the movements of each motor pattern during the ten minute observation period. This period is an average of the times generally selected in the literature (Remold, 1976; Birnholz et al., 1978; Ianniruberto et al., 1981). Longer observations were avoided for ethical reasons. Anxiety was measured by the State-Trait Anxiety Inventory (S.T.A.I.), a brief self-report developed by Spielberger et al. (1970). Each subject completed the A-State scale of the questionnaire before and after ultrasound examination and the Trait form only before. State anxiety measures the individual reaction to specific stress situations, whereas Trait anxiety refers to a relatively stable proneness to anxiety, a personal characteristic responsible for the strength of the anxiety reaction. The two-tailed Students t-tests were used to compare the two groups of women as regards the fetal movements. For the psychological evaluation the Mann-Whitney U-test and the Wilcoxon test were used. RESULT AND DISCUSSION The statistical analysis showed that fetal motor activity lasted significantly longer in the experimental group than in the control group ($p < 0.01$). Although a higher overall number of fetal movements were noted in the women awaiting amniocentesis, this difference did not reach statistical significance (Table 2). No changes were noted in fetal position, whilst fetal decubitus changed in 4 women in the experimental group (twice in 2 cases) and in 3 of the control group. However, in the 4 cases of the experimental group, more rotation around the longitudinal fetal axis occurred (180°, 180°, 180° and 270° respectively) than in the control group (90° in all 3 cases). No changes were detected in fetal position. Psychological evaluation revealed a statistically higher score in the A-State ($p < 0.002$) and A-Trait ($p < 0.05$) scales before ultrasound in the experimental group. Only in this group did State-anxiety significantly decrease sifter echography ($p < 0.01$). (Table 3) Our results show that fetal motor activity is higher in pregnant women awaiting amniocentesis than in those undergoing routine ultrasound scans. Although the overall number of fetal movements is higher in the experimental group, this figure does not reach statistical significance nor do any quality differences (specific

motor patterns) emerge between the two groups of women. This finding is accounted for by the number of combined-repetitive movements which are complex, sometimes prolonged motor sequences involving head, trunk and limbs at the same time. Hence, the duration of motor activity may increase without a corresponding change in the actual number of fetal movements. In fact, one combined-repetitive movement was taken as one movement whatever its complexity or duration. The greater frequency of these movements which involve the whole fetal body and can be quite forceful, probably account for the more marked changes in fetal decubitus noted in the experimental group of women.

Table 2

Fetal Motor Activity in Pregnant Women before Amniocentesis and Control Group. Duration and Number of Movements during the Ten Minute Observation Period

	Experimental group (n 15)		*Control group (n 15)*		*p**
	Mean	*SD*	*Mean*	*SD*	
Duration of movements (seconds)	243.86	57.07	164.33	74.01	<0.01
Total no. movements	67.86	23.96	58.80	16.61	<0.1
Isolated head	9.46	6.65	12.20	10.10	N.S.
Independent limb	18.40	13.14	15.66	12.11	N.S.
Hand-face	4.86	6.19	4.20	3.70	N.S.
Limb joint	1.26	2.08	1.73	4.00	N.S.
Combined-repetitive (Duration of movements (secs)	96.40	75.83	79.00	55.52	N.S.
Combined-repetitive (No. movements)	4.80	2.78	3.46	2.29	N.S.
Startle	24.00	26.72	11.00	13.71	N.S.

*Two-tailed Student's t test
N.S. = Not significant

To sum up, intense fetal motor activity occurs in pregnant women awaiting amniocentesis, mainly involving an increase in prolonged massive (combined-repetitive) movements of the whole fetal body whilst no significant changes were noted in simple movements confined to separate body segments.

Table 3

Anxiety Score Obtained by the Pregnant Women Waiting Amniocentesis and the Control Group on the State-Trait Anxiety Inventory (S.T.A.I.)

	State Anxiety						*Trait Anxiety*	
	Before ultrasound		*After ultrasound*				*Before ultrasound*	
	Mean	*SD*	*Mean*	*SD*			*Mean*	*SD*
Experimental group (amniocentesis)	52.00 (median 53)	12.12	39.81 (median 38)	9.23	$p^* < 0.01$		46.66 (median 47)	6.96
Control group (routine ultrasound scanning	35.06 (median 35)	8.58	33.86 (median 32)	8.78	N.S.		39.60 (median 39)	8.33
	$p^\circ < 0.002$		$p^\circ < 0.05$				$p^\circ < 0.05$	

p^*: Wilcoxon test
p°: Mann-Whitney U test

In our opinion, increased fetal motility can be accounted for by the emotional state of mothers awaiting amniocentesis.* In fact, these women obtain a higher score than controls on the S.T.A.I. before ultrasound scan. In particular they show a high anxiety reaction as measured by the A-State scale, which significantly decreases after ultrasound examination. By assessing a stress situation experimentally controllable, but nonetheless not artificially induced, our study gives a reliable indication that maternal anxiety is associated with more pronounced fetal motor activity. By adopting artificial stimulation (sounds, lights and mechanical devices), previous research has shown fetal responses as a direct result of sudden traumatic environmental changes and/or the emotional state aroused in the mother by the stimuli (Benson et al., 1987; Ianniruberto et al., 1981; Read et al., 1977; Reinold, 1976; Sontag et al., 1969). Our study confirms that it is the latter which affects fetal motor behavior. This finding albeit preliminary, could have widespread implications ranging from the field of prenatal prevention and clinical pediatrics to psychological research into early psychosomatic development and the emotional consequences of fetal experiences. A number of previous studies have shown significant links between various childhood disorders and negative emotional states on the part of the mother during pregnancy. A correlation between maternal anxiety and delayed infant development was observed by Stott (1956), whilst Grimm (1961), Rutt et al. (1971), Davis et al. (1962), McDonald et al. (1963) and more recently Crandon (1979a,b) have noted a higher incidence of disorders (malformations, less vitality, weight loss, tendency to cry) and birth complications in babies born to mothers who were very anxious during pregnancy or had a negative attitude to motherhood. Similar data were reported by Sontag who emphasized the relation between maternal stress and fetal activity, noting a lower birth weight in very active fetuses (Sontag, 1940, 1966; Sontag et al., 1969). On the other hand, it is well-known that like the infant's general well-being and the onset of various psychosomatic disorders, his psychological development and the mother-child relationship established soon after birth are largely dependent on the psychophysical characteristics present at birth (Kreisler et al., 1976; Spitz, 1965). These characteristics are generally considered constitutional and include hyperexcitability, hypermotility, special needs and the type of response to frustration. In particular, relations between neonatal activity level and personality features have been repeatedly shown (Korner et al., 1985; Schaffer, 1966).

SUMMARY In conclusion, it can be suggested that marked maternal anxiety may be associated with persistent changes in physiological fetal functions which, combined with constitutional biological factors, may be responsible for some psychophysical predisposition on the part of the newborn. In turn, these may condition the

infant's early object relations and thus influence the structuring of specific personality traits. Footnote * No fetal malformations were revealed by ultrasound examination in either group of pregnant women and no chromosome alterations were subsequently detected by amniocentesis in the experimental group. References REFERENCES Birnholz, J.C, Stephens, J.C, &Faria, M. (1978). Fetal movement patterns: A possible means of defining neurologic developmental milestones in utero. American Journal of Roentgenology, 130, 537-540. Carlson, D.B. &Labarba, R.C (1979). Maternal emotionality during pregnancy and reproductive outcome: A review of the literature. International Journal of Behavioral Development, 2, 343-376. Benson, P., Little, B.C., Talbert, D.G., Dewhurst, J., &Priest, R.G. (1987). Fetal heart rate and maternal emotional state. British Journal of Medical Psychology, 60, 151-154. Crandon, A.J. (1979a). Maternal anxiety and neonatal well-being. Journal of Psychosomatic Research, 23, 113-115. Crandon, A.J. (1979b). Maternal anxiety and obstetric complications. Journal of Psychosomatic Research, 23, 109-111. Davids, A., &De Vault, S. (1962). Maternal anxiety during pregnancy and childbirth abnormalities. Psychosomatic Medicine, 24, 464-470. Ferreira, A.J. (1965). Emotional factors in prenatal environment: A review. Journal of Nervous and Mental Diseases, 141, 108-118. Grimm, E.R. (1961). Psychological tension in pregnancy. Psychosomatic Medicine, 23, 1161-1173. Ianniruberto, A. &Tajani, F. (1981, April). Fetal movements. In: Seminars in Perinatology. Grune &Stratton Inc.: New York. Istvan, G. (1986). Stress, anxiety, and birth outcomes: A critical review of the evidence. Psychological Bulletin, 100, 331-348. Korner, A.F., Zeanah, C.H., Linden, J., Berkowitz, R.I., Kraemer, H.C &Agras, W.S. (1985). The relation between neonatal and later activity and temperament. Child Development, 56, 38-42. Kreisler, L., Fain, M., &Soule, M. (1974). L'enfant et son corps. Etudes sur la clinique psychosomatique du jeune age. Paris: Presses Universitaires de France. McDonald, R.C., Gynther, M.D., &Christakos, A.C (1963). Relations between maternal anxiety and obstetric complications. Psychosomatic Medicine, 25, 357-363. Milani Comparetti, A. (1981, April). The neurophysiological and clinical implications of studies on fetal motor behavior. In: Seminars in Perinatology. Grune &Stratton Inc.: New York. Milunsky, A. (1976). Prenatal diagnosis of genetic disorders. New England Journal of Medicine, 95, 377-372. Ottinger, D.R., &Simmons, J.E. (1964). Behavior of human neonates and prenatal maternal anxiety. Psychological Reports 14, 391-394. Read, J.A. &Miller, F.C (1977). Foetal heart rate acceleration in response to acoustic stimulation as a measure of foetal well-being. American Journal of Obstetrics and Gynaecology, 129, 512-519. Reinold, E. (1976). Diagnostic scanning and fetal motor activity. In: Ultrasonics in early pregnancy. Basel: S. Karger. Rutt, C.N., &Offord, D.R. (1971). Prenatal and perinatal complications in childhood schizophrenics and their siblings. Journal of Nervous and Mental Diseases, 152, 324-331. Schaffer, H.R. (1966). Activity level as a constitutional determinant of infantile reaction to deprivation. Child Development, 37, 595-602. Sontag, L.W. (1940). Effect of fetal activity on the nutritional stage of the infant at birth. American Journal of Diseases of Children, 60, 621-630. Sontag, L.W. (1966). Implications of fetal behavior and environment for adult personalities. Annals of the New York Academy of Science, 34, 782-786. Sontag, L.W., Steele, W.G., &Lewis, M. (1969). The foetal cardiac response to environmental stress. Human Development, 12, 1-8. Spielberger, CD., Gorsuch, R.L., &Lushene, E.R. (1970). Manual for the State Trait Anxiety Inventory. Palo Alto, Calif.: Consulting Psychologist Press. Spitz, R. (1965). The first year of life. A psychoanalytic study of normal and deviant development of object relations. New York: International Universities Press, Inc. Stott, D.H. (1956). Physical and mental handicaps following a disturbed pregnancy. Lancet, 1, 1006-1012. AuthorAffiliation Nicolino Rossi,* Paola Avveduti,* Nicola Rizzo,** Raffaele Lorusso** AuthorAffiliation The authors' affiliations are as follows: *Nicolino Rossi, Paola Aweduti, Department of Psychology, **Nicola Rizzo, Raffaele Lorusso, Prenatal Physiopathology Unit, II Institute of Obstetrics, University of Bologna, Viale Berti, Pichat n5, 40127 Bologna, Italy. Address correspondence and reprint requests to Dr. Rossi.

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