ANTENATAL STRESS AND THE BABY'S DEVELOPMENT

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There is considerable evidence of an association between experiences during pregnancy and the health of the child. Pasamanick and Knobloch (1958), for example, report that 'in a series of studies . . . we found that certain complications of pregnancy were significantly related not only to mental deficiency (Pasamanick and Lilienfeld, 1955a), but also to cerebral palsy (Lilienfeld and Pasamanick, 1955), epilepsy (Pasamanick and Lilienfeld, 1955b), reading disability (Kawi and Pasamanick, 1958), tics (Pasamanick and Kawi, 1956), and behaviour disorders of childhood (Pasamanick, Rogers and Lilienfeld, 1956).'

There is some evidence that emotional stress during pregnancy may affect the foetus. Sontag (1941) has shown a relationship between such stress and foetal activity. Retrospective studies by Stott (1957, 1958) have suggested that 'troubles' during pregnancy may be associated with the occurrence of mental retardation, mongolism and other congenital malformations, and 'non-epidemic' ill health in the first three years of life. Although the emotional and physical components of stress could not be separated, the majority of the 'troubles' reported were primarily mental.

The present investigation was planned as an exploratory prospective study of the relationship between emotional stress during pregnancy, and the condition of the baby in the first three months of extrauterine life. As the sample was small, attention was focused on growth and neuromotor development, rather than on the occurrence of relatively rare events such as death or major defects. As will be shown, the findings suggested a relationship between antenatal stress and the infant's level of motor development.

Subjects and Method

The study took place in 1959-60, in an extremely poor Durban suburb which receives a health service from the Institute of Family and Community Health. An endeavour was made to study as many as possible of the Indian women who were resident in the area until their confinement, and gave birth within a defined six-month period. As, however, many residents used other health services, or none, this attempt was only partially successful. We knew of 136 eligible women, of whom 101 (74%) were included in the study. Seven women refused, one was too ill, and the other 27 gave birth before we were able to interview them. As official records indicate that approximately 84 other women gave birth in the area during this period, the sample is not necessarily representative of the community.

The 101 women studied ranged in age from 16 to 46 years (median: 24), and in gravidity from one to 13 (median: four). Most were Hindu (84), a few being Christian (16) or Moslem (one). Most were Tamil-speaking (71), and the remainder Telegu (17), Hindi (12) or Urdu-speaking (one). They had had from nought to eight years of schooling (median: one). All but three were married. Their monthly income (per member of household) ranged from 7s. 6d. to £12 13s. (median £2 19s. 6d.). Their husbands were, for the most part, semi-skilled or skilled workers, mainly in industry; a number were unemployed or on 'short time'. Only seven of the women had worked for gain during their pregnancy. The majority had signs of malnutrition.

Each woman was interviewed by the same investigator in her third trimester; 50 in the last month of pregnancy, 33 in the second-last, and 18 in the third-last month. Set questions were asked about the woman, her home circumstances, her diet and her troubles. Appraisals of stress were subsequently based on these interviews (see below). A physical examination was performed on all but a few of the women, including an assessment of nutritional state (see below).

Forty-eight of the women were delivered at home by a midwife, and 22 in hospital. The other 31 had no skilled intranatal care. Records of delivery were not available for this latter group. A number of the babies in this group were, however, seen at home soon after birth, so that birth weights were available for a total of 83 babies.

The home was visited as soon as possible after delivery, and the neuromotor development of the baby tested (see below). Further neuromotor examinations were carried out by the same investigator at four weeks and 13 weeks after delivery. The babies' median ages at the three examinations were, respectively, 3, 32 and 93 days. At the first examination the baby's length was measured,

and at each examination the baby was weighed. A full physical examination was carried out at 13 weeks. At each contact, the mother was asked about the baby's illnesses, feeding and progress.

Practical difficulties prevented a rigid adherence to the above schedule. As there was sometimes a delay before we knew of the confinement, and as three babies died in the neonatal period, only 84 initial examinations were carried out. Subsequently one other baby died, one was adopted, and three left the area. The four-week examination was performed on all but five, and the 13-week examination on all but one, of the babies still in the sample. Of the babies whose birth weights were known, initial neuromotor examinations were conducted on 73; the major findings will relate to this group.

It proved impossible to ensure that babies were examined at identical ages. In 17% of cases the initial examination was delayed until the second week of life. The 'four-week' examination was delayed until the age of 5 weeks in 19% of cases, and until 6 weeks in 2%. The '13-week' examination was delayed until 14 weeks in 14%, 15 weeks in 9%, and still later in 5%. However, as the arrangements for examination were made without reference to the assessments of antenatal stress, this variation is unlikely to have introduced a bias; there was in fact no relationship between the degree of antenatal stress and the child's age at examination.

Full data were not available in all cases, for the reasons given above, and also because some women were unable to give definite answers (concerning, for example, household income) and occasional questions and procedures were inadvertently omitted. Such cases are omitted from the relative analyses.

In testing the statistical significance of the findings, use was made of the tables provided by Armsen (1955) or, where these were not applicable, of chi-square tests, with Yates' correction.

Antenatal Stress. Assessments of stress were based on the responses to the following questions:

How are you feeling? How have you been feeling since you became pregnant?

Since you became pregnant, have you had any illnesses, operations, accidents, shocks or frights, or worries?

Are the other members of your family well?

Is your husband in a stable job? Is his job secure?

Have you been working during your pregnancy?

Do you mind whether you have a boy or a girl?

Were you pleased when you found you were pregnant?

Have things been going smoothly in your home?

Does all go well between you and your in-laws?

Does all go well between you and your husband?

Have you any other worries?

Do you think your baby will be all right? Do you think any of these troubles may affect your baby?

Like Stott (1958), we considered it advisable to rate the woman's stress by, as far as possible, objective situational criteria. To quote Stott, 'a situation or event was rated as distress or shock-producing if this would have been its expected effect upon an emotionally stable woman'. To this end, the assessment was made some time later, on the basis of the written record, by the two investigators who had not participated in the interview. A scale of 0 to 5 was used. Typical examples were:

Assessment	Stress
1	Minimal stress: Slight abdominal pain for a week.
2	Mild stress: Husband on 'short time': unemployed for one or two days a week: no financial strain.
3	Moderate stress: Husband unemployed for three months: son is working, supplies groceries.
4	Marked stress: Husband convicted of offence: struggling to repay money borrowed to pay fine.
5	Extremely marked stress: Flooded out of house when canal burst: family had to flee for shelter.

Each circumstance which the woman had mentioned was rated in this way, and the highest rating allotted to her was taken as her stress rating. In this way the women were divided into two groups: those who had experienced moderate or major stress (ratings 3 to 5), and those who had not (0 to 2). Separate assessments were made of stress in the first four months of pregnancy, and of stress from the fifth month onward. Except where otherwise stated, the latter assessment is the one used in the analyses. There was a high correlation ($r = +0{\cdot}80$) between these ratings of stress in late pregnancy and similar ratings made by the interviewer at the time of the interview, taking into account the woman's overt expressions of stress as well as her responses.

Nutritional State. The mother's nutritional state was assessed by (*a*) rating the degree of four skin lesions (skin xerosis, phrynoderma, follicular enlargement, and dyssebacia/folliculosis) on her face, the back and front of her chest, her shoulders, upper arms and thighs; (*b*) noting the presence of selected lip, gum and tongue lesions; (*c*) measuring her arm skinfold thickness, using the Harpenden caliper (Edwards, Hammond, Healy, Tanner and Whitehouse, 1955), and height in late pregnancy, and her weight three months after delivery. The methods used have been described in detail elsewhere (Abramson, Gampel, Slome and Scotch, 1960).

The baby's nutritional state was assessed at the 13-week examination, by noting the presence of glossitis and of skin xerosis (dullness, dryness or increased reticular markings) on the face, forearms or legs.

Neuromotor Development. The test procedures fell into three groups:

(*a*) Tests of muscle tone, based on those described by Geber and Dean (1957). As the tests we selected were found to have no discriminatory value, 94-100% of the babies reacting similarly, these tests and the findings will not be detailed.

(*b*) Tests of adaptive behaviour: the 'dangling ring', 'bell-ringing', and 'rod in hand' tests (Gesell and

Amatruda, 1941). As these tests also elicited little or no variation, the findings will not be detailed.

(*c*) Tests of gross motor behaviour (Gesell and Amatruda, 1941). The following five procedures were applied and the responses rated as shown. The sum of these ratings was used as the baby's 'motor score'; the higher this score, the higher the developmental level. In occasional cases, the baby's response to a specific procedure was inadvertently left unrecorded; this applied to 1% of the individual procedures; in calculating the 'motor scores' of such babies, the missing rating was taken as 1.

(i) *Pull to sitting.* The baby was pulled by the arms from a supine to a sitting position, and the presence of head lag recorded. 0 = complete or marked lag; 1 = moderate lag; 2 = slight or no lag.

(ii) *Sitting supported.* The child was then held in the sitting position, supported by the sides of the chest, and the upper back observed. 0 = back rounded; 2 = back straight.

(iii) *Standing supported.* The baby was then held in the standing position. This test was omitted in the initial examination. 0 = slight or no resistance to table top; 1 = appreciable weight support; 2 = rises to toes.

(iv) *Prone (held).* The child was then suspended in the prone position, and the head observed. 0 = head droops; 2 = head up.

(v) *Prone on table.* The baby was then placed prone on the table, with the head turned to the mid-position, and the head watched. 0 = head not raised; 1 = raised momentarily; 2 = raised for several seconds or recurrently.

Results

Relationship with Baby's Weight and Length. Babies born to women who had experienced moderate or major antenatal stress did not differ significantly in weight (at birth, 4 weeks, or 13 weeks) or in length from those born to other women. Prematurity rates (birth-weights of 5½ lb. or less) were 14% and 18% respectively.

Relationship with Baby's Motor Development. Babies born to mothers who had experienced moderate or major stress tended to have lower 'motor scores' at their first examination. This tendency was, however, not statistically significant ($p < 0{\cdot}20$). A similar tendency was found in respect of three of the four separate test procedures, reaching statistical significance ($p < 0{\cdot}02$) in respect of one (the 'prone on table' test).

It was thought possible that the inclusion of babies of all birth weights might be obscuring an actual relationship, as the heavier babies might be more mature. Among babies weighing 8 lb. 0 oz. or less, there was no evidence whatever that their 'motor scores' varied with their weight. However, it was noted that of the babies who were heavier than this, none had low 'motor scores'. Although they were few in number, so that this difference was not a significant one, it was considered advisable to exclude them from the analysis. Accordingly, a separate analysis was made of the babies weighing 8 lb. 0 oz. or less at birth, i.e. excluding heavier babies and those with unknown birth weights. It was not considered necessary to exclude the very light babies, both because they did not differ in their 'motor scores', and because it is doubtful whether in this community a very low birth weight is usually indicative of immaturity; it has been noted, for example, that although the prematurity rate is very high, the first-week mortality rate ascribed to prematurity is not high (Kark, 1957). Although studies elsewhere have shown a relationship between prematurity and disturbed neuromotor development (Drillien, 1959; Knobloch and Pasamanick, 1959a and b), this relationship is marked only among extremely small premature babies. Only two of our babies weighed under 4½ lb. at birth, and none under 3½ lb. Neuromotor examinations were carried out soon after birth on 66 babies weighing 8 lb. 0 oz. or less at birth, of whom 40 were born to mothers who had experienced moderate or major antenatal stress, and 26 to mothers with little or no stress. These groups will be referred to as the 'high-stress' and 'low-stress' groups respectively.

There were clear indications that the babies in the high-stress group were relatively backward when first examined. Seventeen of the 40 had 'motor scores' below 3, compared with four of the 26 in the other group ($p < 0{\cdot}05$). Two of the individual test procedures showed similar differences. The percentage with rounded backs when sitting supported was 33 for the high-stress group, and 7 for the low-stress group ($p < 0{\cdot}05$). The percentage who did not raise their heads when laid prone on the table was 63 for the high-stress group, and 29 for the low-stress group ($p < 0{\cdot}05$). The 'pull to sitting' test showed a similar tendency which however, fell short of significance.

A similar relationship was found at the 4-week examination of babies weighing 8 lb. 0 oz. or less at birth. Of the 38 'high-stress' babies examined, 25 were relatively backward ('motor scores' of under 8), compared with five of the 23 'low-stress' babies ($p < 0{\cdot}01$). The individual test procedures showed similar relationships, but these were not significant.

At 13 weeks, no relationships with antenatal stress were manifested, either by the 'motor score'

TABLE 1

COMPARISON OF MOTHERS UNDERGOING MODERATE OR MAJOR STRESS WITH THOSE UNDERGOING LITTLE OR NO STRESS*

	High-stress Group	Low-stress Group	p†
Age (yrs): Median	27·5	23	
Aged 30 or over (%)	38	15	<0·05
Schooling: Median (years of schooling)	0 (38)	3 (26)	
No schooling (%)	53 (38)	27 (26)	
Religion: Hindu (%)	90	85	
Home circumstances:			
No. in home: Median	6	6	
10 or more (%)	28	8	
Crowding index:‡ Median	4	3	
5 or over (%)	45	8	<0·01
Monthly income per member of household (shillings): Median	44 (34)	68 (21)	
Under 40 (%)	33 (36)	14 (22)	
Monthly food expenditure per member of household (shillings): Median	29 (31)	36 (21)	
Under 30 (%)	55 (31)	24 (21)	
Diet (no. of days per week on which item is taken):			
Meat or fish: Median	2	3	
Under 2 (%)	35	8	<0·02
Milk (as a beverage): Median	0	1	
Not taken (%)	71	40	<0·05
Fruit: Median	1	6	
Under 2 (%)	58	23	<0·02
Nutritional state:			
Skin lesions (median scores): Skin xerosis (range 1 to 27)	12 (37)	11 (25)	
Phrynoderma (range 0 to 7)	1 (37)	1 (25)	
Follicular enlargement (range 0 to 6)	0 (37)	1 (25)	
Dyssebacia/folliculosis (range 0 to 6)	1 (37)	2 (25)	
Moderate or marked mucosal lesions (%): Lips	0 (37)	4 (25)	
Gums	16 (37)	12 (25)	
Tongue	16 (37)	16 (25)	
Arm skinfold thickness (mm.): Median	10·1 (37)	9·8 (25)	
Height (in.): Median	60·5 (37)	59·5 (25)	
Weight (lb.): Median	110 (27)	101·5 (22)	
120 or over (%)	33 (27)	9 (22)	
Pregnancy:			
Work during pregnancy (%)	7	12	
Calculated gestation period (wks): Median	39 (24)	40 (19)	
Complaints of ill health (%): In first 4 months	45	46	
Later in pregnancy	75	46	<0·05
Delivery:			
Duration of second stage (min.): Median	15 (17)	15 (17)	
'Easy labour' reported by mother (%)	72 (39)	73	

* These findings relate to women whose babies weighed 8 lb. 0 oz. at birth and had a neuromotor examination in their first two weeks of life. There were 40 such women in the high-stress group, and 26 in the low-stress group. In some respects data were not available for all women; in such cases the figures are based on the number of women shown in parentheses.

† The probability that the difference may be due to chance. Stated only if under 0·05.

‡ Number in household — number of rooms used for sleeping.

or by the results of separate tests. Of the 35 'high-stress' babies examined, six had 'motor scores' of under 8; of the 26 'low-stress' babies, four.

It was considered likely that the association of antenatal stress with a low level of motor development in these subjects was a real one, and not a mere chance finding resulting from vagaries in the appraisals of stress or motor capacity. A relationship manifesting itself by the use of more than one separate test procedure, and found at two different stages in the infant's life, was considered unlikely to be an accidental artefact.

However, it was possible that the differences in motor development between the two groups were expressions, not of differences in antenatal stress, but of coincidental differences between the two groups. Accordingly, the 'high-stress' and 'low-stress' groups were compared in respect of a number of other variables. The salient findings are summarized in Tables 1 and 2. Wherever a difference was found, the role of the factor was explored by (*a*) seeking evidence of a relationship between it and the babies' initial 'motor scores', in the 'high-stress' group, in the 'low-stress' group, and in both combined; and (*b*) seeing whether the 'high-stress' babies were more backward than the 'low-stress' babies when the factor was held as constant as the small numbers of babies permitted.

Although a number of differences were in fact found between the two groups, they did not appear to be relevant to the developmental differences found. The 'high-stress' women tended, for example, to be older. However, neither among these women nor in the other group, nor in both combined, was there any suggestion of a relationship between mothers' ages and their babies' 'motor scores'. Among

TABLE 2

COMPARISON OF BABIES BORN TO MOTHERS WITH MODERATE OR MARKED STRESS, WITH THOSE BORN TO MOTHERS WITH LITTLE OR NO STRESS*

	High-stress Group	Low-stress Group	p†
Birth rank:			
Median	4·5	3	
1 or 2 (%)	15	46	0·02
Weight (lb.):			
At birth: Median	6·75	6·25	
Under 7 (%)	50	65	
At 4 weeks: Median	8·1 (38)	7·9 (22)	
Under 8·5 (%)	61 (38)	75 (22)	
At 13 weeks: Median	11·4 (35)	11·4 (25)	
Weight growth (mean increment per week (oz.)):			
Birth to 4 weeks: Median (range 0 to 10·8)	4·2 (37)	4·7 (21)	
Birth to 13 weeks: Median (range −0·3 to +10·1)	5·2 (34)	5·4 (25)	
Length at first examination (in.): Median	19	18·9	
Nutritional state at 13 weeks:			
Skin xerosis present (%)	43 (35)	44 (25)	
Glossitis present (%)	14 (35)	19 (25)	

* These findings relate to babies weighing 8 lb. 0 oz. or less at birth, who had a neuromotor examination in their first two weeks of life. There were 40 such babies in the high-stress group, and 26 in the low-stress group. In some respects data were not available for all babies; in such cases the figures are based on the number of babies shown in parentheses.

† The probability that the difference may be due to chance; stated only if it is less than 0·05.

women aged under 25, low 'motor scores' were significantly commoner ($p < 0.05$) in the 'high-stress' group; among women aged 25 or more there was a similar difference, not significant.

Similar findings applied to other variables in respect of which the two groups differed. The 'high-stress' women tended to be of a lower educational standard, to come from more crowded and poorer homes, and to have an inferior diet. When each factor was considered in turn, findings emerged similar to those relating to maternal age.

In spite of the dietary differences, the nutritional indices used revealed no differences in the state of nutrition of the two groups, except that women in the 'high-stress' group tended to be heavier. This was probably related in part to their greater age. Using the procedures described above, no relationship could be shown between mothers' weights and their babies' 'motor scores'. The association between stress and motor retardation thus appeared to be independent of nutritional factors, with the reservation that the crude clinical measures used may not have been adequate to demonstrate actual nutritional differences.

Complaints of ill health in the latter part of pregnancy, but not in early pregnancy, were commoner in the 'high-stress' group. However, both among women with complaints and among those without, 'high-stress' babies had lower 'motor scores', significantly so in the latter group ($p < 0.01$). It was found, however, that in the 'low-stress' group, the babies of mothers with complaints tended to have lower 'motor scores' ($p < 0.05$); this finding did not apply to the 'high-stress' group. These findings suggested that while the developmental difference between the two groups was not accounted for solely by differences in the prevalence of maternal disorders, the presence of such disorders might have had some bearing on the baby's development. We were not able to obtain full medical records for all the women, many of whom made scanty use of health services. The few definite major complications of pregnancy which were recorded occurred in both groups.

Delivery was for the most part short, easy and uneventful in both groups. Four obstetric complications were recorded in the 'high-stress' group, and two in the 'low-stress' group.

The two groups of babies are compared in Table 2. In each group the sexes were almost equally represented. The 'high-stress' babies tended to be of a higher birth-rank; this was related to the greater age of their mothers. No evidence could be found, however, that rank was independently related to motor development. They tended also to be slightly, though not significantly, heavier at birth; this was probably a reflection of their higher birth ranks, as there was a significant relationship between rank and birth weight. As has already been stated, no relationship could be shown between birth weight and motor development, within this weight range. The two groups did not differ notably in their subsequent weight growth, in length, or in the prevalence of signs of malnutrition at the 13-week examination.

Other Relationships.

MOTHER'S ATTITUDE TO CHILD. It is recognized that experiences during pregnancy have important implications for the mother-child relationship (Caplan, 1959). Two of our findings had a bearing on this topic. First, mothers were asked, soon after delivery, 'Were you pleased you had a son (or daughter)?' Among women giving birth to daughters, their responses were significantly related to their experience of stress during pregnancy. Of 22 women exposed to antenatal stress, nine stated that they were dissatisfied with their child's sex; of 20 women with little or no stress, two ($p < 0{\cdot}05$). There was no such relationship among the mothers of sons, who tend to be preferred in this community.

Secondly, the mothers were asked, four weeks and 13 weeks after their confinement, 'Do you sometimes wish you hadn't had this baby?' Of 54 women exposed to stress in pregnancy, 13 answered 'Yes'; of 43 women exposed to little or no stress, only one answered 'Yes' ($p < 0{\cdot}01$).

INFANT FEEDING, DISORDERS AND DEATHS. Antenatal stress bore no apparent relationship to infant feeding practices; 95% of the women were still breast feeding at 13 weeks.

There was no relationship to the occurrence of illnesses in the first 13 weeks. Two babies had major congenital defects, one of whom died. The mothers of both had been exposed to stress. Three other babies died of pneumonia; the mother of one had been exposed to stress.

Causes and Timing of Stress. Almost half the women in the 'high-stress' group were exposed to more than one category of stressful situation (Table 3). The commonest circumstances causing stress were the unemployment or partial unemployment of the husband, and distress at being pregnant, usually in conjunction with straitened economic circumstances. In no case was maternal illness the sole stress to which the woman was exposed. Nine women in the group definitely experienced sudden shocks.

Although the women were classified according to their experience of stress in the latter part of their pregnancy, it could not be concluded that the relationships found were specific to late-pregnancy stress; 92% of the women in the 'low-stress' group were also exposed to little or no stress in the first four months of pregnancy, and 87% of the women in the 'high-stress' group were also subjected to moderate or marked stress in early pregnancy. In fact, when the women were classified according to their stress in early pregnancy, the same significant relationships were found with their babies' 'motor scores' as when they were grouped according to their stress in later pregnancy.

TABLE 3
CIRCUMSTANCES CAUSING STRESS

	No. of Categories in Which There is Moderate or Major Stress				
	1	2	3	4	Combined
No. of women	22	12	4	2	40
Percentage of women	55	30	10	5	100
Category:					
Husband's unemployment or job insecurity	8	7	3	2	20
Distress at being pregnant	5	9	3	1	18
Serious illness in family	3	—	2	1	6
Low income	2	3	1	—	6
Own illness	—	2	1	1	4
Marital difficulties	1	—	—	1	2
Anxiety concerning child's sex	—	1	1	—	2
Miscellaneous	3	2	1	2	9

These findings apply to the women in the 'high-stress' group.

Relation of Motor Development to Baby's Nutritional State. Although at their first examination the 'motor scores' of babies weighing 8 lb. 0 oz. or less at birth bore no relationship to their birth weights, at the subsequent examinations of these babies there was a significant association of low 'motor scores' with low weights or a low rate of weight growth (Table 4). These associations applied

TABLE 4
RELATIONSHIP BETWEEN MOTOR DEVELOPMENT AND BABY'S NUTRITIONAL STATE

	No.	Motor Development Score <8 (%)	p*
4-week examination:			
Weight (lb.): Under 8·5	38	66	0·01
8·5 or more	21	24	
Mean weight gain per week since birth (oz.): Under 3	16	75	0·05
3 or more	42	40	
13-week examination:			
Weight (lb.): Under 11	24	38	0·005†
11 or more	36	3	
Mean weight gain per week since birth (oz.):			
Under 6	37	27	0·025†
6 or more	22	0	
Skin xerosis: Present	26	27	
Absent	34	9	
Glossitis: Present	10	30	
Absent	50	14	

These findings relate to babies weighing 8 lb. 0 oz. or less at birth.
* The probability that the difference may be due to chance; stated only if it is less than 0·05.
† According to Table 8 in Fisher and Yates (1953).

both to 'high-stress' and to 'low-stress' babies, though significance was not reached in each instance. There appeared to be a similar association, not significant, between low 'motor scores' and the presence of skin xerosis or glossitis at the 13-week examination.

These findings were interpreted as indicating that if a baby's growth and nutrition were impaired, his rate of motor development was likely to be slow, whether as a direct result, or because of the action of common or related causes. As the rate of postnatal growth is largely affected by extra-uterine factors, it appeared that the tempo of motor development after birth also was largely dependent on such factors, the effect of which had by 13 weeks obscured the original association with antenatal stress. Knobloch and Pasamanick (1953) have shown a similar relationship between behavioural development and physical growth.

Discussion

The results indicate an association between antenatal stress and motor retardation, among babies weighing 8 lb. 0 oz. or less at birth. This association, which was apparent both soon after birth and at four weeks after birth, appeared to be independent of other factors associated with emotional stress in this sample.

In view of the small size of the sample, however, it would be incautious to generalize from the findings in this one group, pending their confirmation elsewhere.

It may be noteworthy that Knobloch and Pasamanick (1959b) found, in a study of the neuromotor development of babies aged 40 weeks, that their degree of neuromotor disturbance bore a positive relationship to the amount of tension shown by their mothers at that time. Although there are alternative explanations, it may be that this finding is due in part to a tendency for a pregnant woman's stress to persist after the baby has been born.

Pasamanick and his colleagues have postulated that similar antenatal processes may produce a wide variety of effects on the foetus, so that there is a 'continuum of reproductive casualty', extending from lethal to various non-lethal effects (Pasamanick and Knobloch, 1958). If confirmation of our findings is forthcoming, it may well be that slight motor retardation comprises part of such a continuum of reproductive casualty, falling into place at the extreme non-lethal end of the scale. Stott's studies, cited above, have indicated that emotional stress in pregnancy may, in some cases, have more damaging effects. It is noteworthy that figures derived from a prospective study carried out by McDonald (1958) show that of women undergoing marked anxiety or emotional shocks in the first 12 weeks of pregnancy, 7·2% subsequently had abortions, stillbirths, neonatal deaths or infants with major defects. The corresponding figure for women with no such anxiety or shocks was 5·7%. The difference between these figures was, however, not significant.

Our findings suggest that the tempo of motor development after birth is closely affected by extra-uterine conditions; by 13 weeks, the relationship with antenatal stress is no longer apparent. It may be that in less unfortunate communities, where the conditions of extra-uterine life are generally more favourable, any retardation resulting from adverse intra-uterine conditions may remain obvious until a later stage of life.

It is of little value at this stage to speculate on the possible mechanisms by which stress in the expectant mother may affect her baby's development. Not only endocrine and nervous influences, but associated nutritional factors also may play a part. Further, the limited evidence found of an association between complaints of ill health during late pregnancy and motor retardation, suggests the possibility that maternal illness may also play a part. Such complaints were significantly commoner in the 'high-stress' group, although no women were allocated to this group on the grounds of illness alone. This last finding is consistent with that of Gordon and Gordon (1957), who found a relationship between emotional disturbance and physical complications of pregnancy in a group of United States maternity patients.

It is of interest that, in so far as our evidence goes, a woman's exposure to conditions which, objectively considered, appear likely to produce emotional stress, bears relatively little relationship to her baby's development. There was no simple relationship with, for example, poverty, crowding or a poor diet. On the other hand, when the presence of stress was assessed on the basis of the woman's own report of her difficulties, a significant association with her baby's development was found. This finding parallels that of Hinkle and Wolff (1957) and their colleagues, whose intensive studies of several groups of subjects indicate that the occurrence of illness bears a closer relationship to the subjects' own perception of their life situations as being unpleasant or demanding, than to their exposure to 'objectively' adverse circumstances.

Summary

A prospective study of Indian expectant mothers in Durban revealed a relationship between emo-

tional stress during pregnancy and a low level of motor development in the infant. This association, which applied to babies weighing 8 lb. 0 oz. or less at birth, appeared to be independent of other factors associated with emotional stress. By 3 months of age this relationship was no longer apparent, as the tempo of motor development after birth appeared to be largely dependent on extra-uterine conditions.

The possible significance of these findings is discussed. It is suggested that motor retardation may form part of a continuum of reproductive casualty, and that in some cases emotional stress during pregnancy may have more far-reaching effects on the baby.

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