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Maternal blood pressure in pregnancy and newborn irritability

J.S. CHISHOLM[1,2], R.H. WOODSON[1,3] and E.M. DA COSTA WOODSON[1,3]

[1] *Department of Growth and Development, Institute of Child Health, University of London, 30 Guilford Street, London WC1N 1EH,*
[2] *Department of Anthropology, Rutgers University, New Brunswick, NJ 08903, U.S.A. and*
[3] *Institute for Medical Research, Kuala Lumpur, Malaysia*

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SUMMARY

The neonatal period is being recognized as an important period for the development of patterns of interaction between mother and infant, and infant state has been shown to have a significant impact on mother—infant interactions. A major dimension of infant state, with implications for this interaction and for the development of later behaviour disorders, is the infant's irritability. Research with Navajo, Malay, Chinese and Tamil mothers and infants showed that normal variation in maternal blood pressure during pregnancy was related to newborn irritability as assessed with the Brazelton Scale. This relationship is discussed in terms of possible underlying mechanisms.

maternal blood pressure; newborn irritability

The human infant is lately being recognized as having a significantly greater effect on its caregiver than had long been appreciated. Far from being a passive recipient of environmental stimuli, a number of studies have now demonstrated that the infant is an interactor in his own right, to whom others respond contingently [1,2]. The focus of child development research is thus increasingly on the process of social interaction itself and on factors which influence various parameters of that interaction.

One such factor is infant behavioural state [3,4]. The child's arousal, his alertness, reactivity, and irritability, and the frequency with which he swings from one state to another not only affect the behaviour of others, but clearly also affect the child's capacity to attend and respond to his social and physical environment [5]. Because state does have such an impact on social interaction, and because it seems to be such a fundamental reflection of the

child's neurophysiological functioning at any given developmental stage, there has been much interest recently in the very earliest manifestation of state-mediated behaviours and their possible effects on the infant's interactions with others.

In research with normal newborn infants only hours old, one is continually impressed by the great range of individual differences in behaviour, even when strict controls are made for variables known to affect neonatal behaviour (e.g. birthweight, length of labour, gestational age, maternal medication, maternal age and parity, etc.). However, in spite of this variation there seem to be a limited number of dimensions on which normal infants can be reliably shown to differ. This has been empirically demonstrated with the Brazelton Neonatal Assessment Scale [6] where it has been shown that one of the most significant and consistent dimensions of individual differences concerns aspects of the infant's state and capacity for state control. Specifically, in a large number of separate studies, the Brazelton Scale items of peak of excitement, rapidity of build-up, irritability and lability of states almost invariably load highly together on a single factor; moreover, regardless of analytic technique, this factor is also usually the first or second most powerful in terms of the total variance for which it accounts [7—9].

The infant who is poor in state control, who is irritable or 'temperamental' is one that is familiar to parents and clinicians alike. Their frequent and unpredictable shifts in mood or activity make them difficult to interact with in a satisfying, smooth and mutually responsive manner. These difficulties may be especially significant in the early neonatal period when many patterns of mother—infant interaction seem to be first established [10], when most parents are especially sensitive to even normal variations in their children's behaviour, and when the infant's behaviour, as the Brazelton data suggests, is so largely determined by state.

Our report is based on two separate cross-cultural research projects that were in fact focused primarily on the later development of infant—other social interaction, but in gathering data on the deliveries of each of the children to whom we administered the Brazelton examination, each of us also recorded whatever information was available on the mother's blood pressure during pregnancy. The decision to record maternal blood pressure was based on the work of Barnes [11], who demonstrated significant long-term sequelae in children of poor birth status, whose mothers were more likely to be at or above the accepted definition of hypertension during pregnancy.

THE NAVAJO STUDY

The first author studied newborn Navajo Indian infants. He was trained in the administration of the Brazelton Scale by Dr. T.B. Brazelton and his associates and both before leaving for the field (1974) and after returning (1976) he achieved inter-observer reliability rates of 0.90 and above. He worked in a

particularly isolated and conservative area of the Navajo reservation about 100 miles from the USPHS Indian Health Service Hospital in Tuba City, Arizona. 33 newborns were tested, 23 in hospital and another 10 in the home. Place of examination had no effect on infant scores. The infants were between 1 and 10 days old (mean age = 3.2) at the time of testing but the child's age was unrelated to items comprising the 'irritability' factor and to maternal blood pressure. Their mothers (mean age 27.4) all had normal deliveries and pregnancies, except 3 who had one blood pressure reading each above 140/90 mm Hg sometime during pregnancy; their subsequent readings were normal and none of them were treated for hypertension.

All 27 behavioural items in the Brazelton Scale were subjected to a principle components analysis. The first component to emerge (accounting for 25.8% of the variance) was the 'irritability factor'. The second component (20.3% of the variance) was an 'alertness–responsiveness' component, and the third (10.3% of the variance) was a 'motor maturity' component. The scale items loading highest (>0.70) on the first component were: peak of excitement, rapidity of buildup, irritability and lability of states.

Maternal blood pressure readings during pregnancy were obtained from both the Tuba City Hospital and various rural health clinics. All women could not attend prenatal clinics regularly, so data are not available on all 33 mothers throughout their pregnancies.

Blood pressure was converted into mean arterial pressure (MAP) using the formula

$$\text{MAP} = \frac{2 \times \text{diastolic} + \text{systolic}}{3}$$

[12] and then averaged separately for each trimester except the first, where there were too few for consideration, and for the final 24 h prior to delivery. Most of these latter readings were in fact during the first stage of labour. The mean blood pressure for the Navajo women was: (second trimester) MAP = 80.5 (systolic = 107.9; diastolic = 66.8); (third trimester) MAP = 84.0 (systolic = 111.8; diastolic = 70.1); (<24 h before delivery) MAP = 97.0 (systolic = 129.3; diastolic = 80.9). The average maternal MAP scores were correlated (Pearson's r) with individual Brazelton Scale scores for each infant. The most significant and consistent correlations were with the four scale items loading highest on the first, or 'irritability' factor. Correlations were strongest with second trimester MAP, lower with third trimester MAP, but then returned, somewhat less forcefully, with MAP in the final 24 h before delivery. The second trimester and final 24-h correlations are listed in Table I.

THE MALAYSIAN STUDY

The Brazelton Scale was administered to 113 clinically normal newborns, all within 48 h of delivery, at the Hospital Bersalin, Kuala Lumpur, Malaysia. Both pregnancies and deliveries were uneventful and none of the mothers

TABLE I

Brazelton Scale Item	2nd trimester		<24 h	
	r	P<	r	P<
Peak of excitement	0.60	0.007	0.45	0.01
Rapidity of buildup	0.64	0.004	0.29	0.10
Irritability	0.71	0.001	0.31	0.08
Lability of states	0.73	0.0006	0.33	0.07

(mean age = 24.5) exhibited hypertension in the current or previous pregnancies. All infants had 1-min Apgar scores of at least 8.

Each newborn was examined in the ward nursery by one of two individuals trained in administration of the Brazelton Scale, again by Dr. T.B. Brazelton and his associates. Inter-observer rates of >0.90 were established prior to conducting the study. In addition, each infant's gestational age was assessed using the Dubowitz method [13].

The behavioural variables relevant for this analysis were the percentage of test time during which the infant cried (% Cry) and the frequency of state changes (fSC). These two measures were substantially intercorrelated ($r = 0.50$, $P<0.001$). Only blood pressure records covering the first stage of labour were available and of these four were missing, reducing the sample size to 109. The average highest readings were MAP = 91.2, systolic = 119.2 and diastolic = 77.2. Each behavioural measure was positively related to labour MAP ($r = 0.23$, $P<0.05$ for % Cry and $r = 0.22$, $P<0.05$ for fSC).

To examine the possibility that these associations were confounded by other pre- and perinatal factors, a stepwise regression was performed. The following variables were forced into the equation prior to labour MAP: maternal age, ethnic group (Chinese, Malay, Tamil), birth order, sex, birthweight, gestational age, presence of analgesic medication during labour, length of first and second stages of labour, age at time of testing, time since last feeding and examiner. If the relationships between blood pressure and crying and lability of state depended on any one of this set, these blood-pressure—behaviour relationships would be attenuated by initially controlling for the effects of these factors. In the event, blood pressure continued to yield a significant and independent contribution to the variation in both % Cry and fSC ($F = 5.84$, df (1,94), $P<0.025$ and $F = 6.26$, df (1,94), $P<0.025$, respectively. It was therefore concluded that differences in the amount of crying and frequency of state changes were directly related to variation in maternal blood pressure during labour and that these associations persisted when several potentially confounding variables were taken into account. Higher labour blood pressure was associated with increased crying and more frequent changes of state.

DISCUSSION

The congruity of these results is striking. The fact that the same finding

emerged while using different measures in such diverse samples argues that this may be a pervasive relationship.

In the entire sample, only three women had single blood pressure readings >140/90, and for all practical purposes, the combined samples were normotensive. However, the distinction between normotension and hypertension is arbitrary as blood pressures in pregnancy follow a normal distribution[14]. Therefore, the causal mechanisms known to operate in hypertension of pregnancy could well be operating among normotensive mothers. Aherne and Dunnill [15] review evidence showing significant morphological changes in the placentae of pregnant hypertensive women correlated with decreased blood flow. Brown and Veall [16] found that normal placental blood flow in the last two weeks of pregnancy was 600 ml/min, but that in pre-eclamptic and chronic hypertensive mothers the rate was only about one-third of this. Hypertension has also been shown to reduce the total mass of the placenta in humans [17], rats [18] and in rhesus monkeys [19].

These morphological changes, coupled with reduced utero-placental blood flow, comprise a less-than-optimal environment for fetal development. Pre- and perinatal hypoxia have specifically implicated in ".....reduced attention span, poor concentration and persistence, hyperactivity, impatience, irritability and sometimes explosive temper tantrums" [20,21]. However, deficiencies in glucose or some other nutrient might just as easily be acting singly or in concert with hypoxia. It is not yet known how these deficiencies might affect the fetus, although Dobbing's [22] research suggests that the developing fetal brain may be especially vulnerable to growth restriction, largely independent of the specific agent involved.

To the extent that blood pressure rises with subjective stress, circulating levels of maternal catecholamines during pregnancy might also play a role. The possibility of their direct affect arises from the fact that some maternal hormones readily cross the placenta and thus might sensitize the fetal neuroendocrine system as it develops [23,24]. Circulating catecholamines could also operate indirectly to decrease utero-placental blood flow through their vasoconstrictive properties, either chronically throughout pregnancy [25] or acutely during labour [26]. Although we have no information on stress levels during pregnancy in our samples, prenatal stress or anxiety has been related to aspects of newborn behaviour [27] and to greatly increased fetal body movements during the stress period itself [28]. High degrees of maternal prenatal emotional stress have also been related to neonatal crying [29] and to fretful and hyperactive behaviour in children of a variety of ages [30]. Barnes work [11] has already been mentioned; although not measuring maternal stress, she found that mothers of 'poor birth status' infants were more likely to be at or above the accepted definition of hypertension. Three years later these 'poor birth status' children were more accident prone, had more trouble sleeping, showed more fear of strangers, and were more likely to be left handed or ambidextrous than were normal children.

Finally, it may not be a chance finding that newborn irritability among

the Navajo infants correlated very highly with the second trimester MAP, less so with MAP during the 24 h prior to delivery, but not at all with third trimester MAP. Whatever mechanisms may be involved, it is interesting to note that Page and Christianson [31] have also recently implicated second trimester MAP specifically. In a sample of over 12,000 women, they found that MAP during the 5th and 6th months of pregnancy and just prior to delivery were better predictors of increased neonatal morbidity than the rise in blood pressure between the second and third trimesters. Moreover, many of their significant correlations were with blood pressures well below the 140/90 normally considered as hypertensive.

Given the powerful influence of infant state on the child's interactions with his mother and other caretakers, the potential ramifications of this association should be examined in greater detail. The work of Bernal [32] and Richards [33] has stressed the importance of pre- and perinatal events for infant state and subsequent mother–infant interaction. Since children can develop a variety of behavioural disorders in the absence of any obvious abnormal antecedents, it might be enlightening to consider the information potentially available in the wide and normal range of maternal blood pressure during pregnancy. The parallels between newborn irritability and the clinical symptoms of hyperactivity, for example, are quite suggestive [34].

Determining just how maternal blood pressure in pregnancy may be implicated in the etiology of various childhood behavioural disturbances is something that will require more extensive and detailed research. This report might help to stimulate such research by drawing attention to the fact that even very ordinary variations in maternal blood pressure in pregnancy are associated with marked differences in manifestation of neonatal state and state control.

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Reprint requests to: R.H. Woodson, Department of Growth and Development, Institute of Child Health, 30 Guilford Street, London WC1N 1EH, England.