Preschool development of coloured children in Cape Town

C. D. MOLTENO, J. HOLLINGSHEAD, A. D. MOODIE, D. BRADSHAW, M. D. BOWIE, W. WILLOUGHBY

Summary

Developmental screening was applied during infancy to a birth cohort of 1 000 coloured infants born consecutively in Cape Town. The developmental progress of a sample of 187 children randomly selected from the cohort was followed over a period of 5 years. The value of the use of developmental screening is questioned, since 4 of the children in the cohort with major handicap had been diagnosed before the first screening was carried out and a 5th child with deafness was not detected by the screening process.

Developmental milestones were similar to those studies reported in the literature. At 12 months the development correlated best with family stability. Language development at 30 months was associated with mother's education and family stability and reflected a general lag in verbal skills. By 5 years there was a good correlation between development and social indicators, particularly income and mother's education.

S Afr Med J 1991; **79:** 665-670.

Development is defined by Hurlock[1] as a progressive series of orderly, coherent changes — progressive in that the changes are directional and orderly and coherent to signify the relationship between those changes that preceded and those that will follow the ones taking place at the present time. Child development is therefore largely predictable, although the rate for each child varies. Development results from the product of maturation, an intrinsic unfolding of characteristics present in the individual, dependent upon the genetic endowment and learning that results from contact with the environment. The child's social milieu during the early formative years of life has a strong impact on the hereditary potential. The early years are most important for child development, since the changes take place rapidly and development according to Gesell[2] is automatically self-conditioning, as the past modifies the present and both project themselves into the future. In Cape Town a number of studies, both short- and long-term, have incriminated the environment for the suboptimal growth that exists among the underprivileged children, for their scholastic failure and, in extreme cases, for abnormal neurological maturation.[3-5] These studies have tended to concentrate on the environmental influences on growth and the developmental consequences of malnutrition. Little attention has been paid to the association between the social circumstances and early development. The purpose of this paper is to determine the environmental influences on the development of coloured preschool children in Cape Town.

Department of Paediatrics and Child Health, University of Cape Town and Red Cross War Memorial Children's Hospital, Cape Town
C. D. MOLTENO, M.D., PH.D., F.C.P. (S.A.), D.C.H.
J. HOLLINGSHEAD, B.SOC.SCI., B.A. HONS (SOC. WK)
A. D. MOODIE, A.R.S.H., A.M.I.A.
M. D. BOWIE, B.SC., M.D., F.R.C.P., D.C.H.
W. WILLOUGHBY, B.SOC.SCI.
Institute for Biostatistics of the South African Medical Research Council, Parowvallei, CP
D. BRADSHAW, D.PHIL. (OXON.)

Accepted 18 Oct 1990.

Subjects and methods

A cohort of 1 000 coloured infants born consecutively in the Cape Town municipal area between 1 May and 8 June 1976 was identified. From the cohort, a random sample of 187 was selected for study over a 5-year period. Details of the cohort and sample have been described.[6]

The entire cohort was screened developmentally during infancy at the maternal and child health clinics by community health nurses. A tear-off slip was completed at each visit and sent to the authors at the Institute of Child Health. Infants detected at screening were referred to the Developmental Clinic at Red Cross Children's Hospital for assessment.

Children in the random sample were visited at 3-monthly intervals by one of the two research social workers J.H. or A.M. during the first 2 years and thereafter every 6 months until they were 3 years old and yearly until they were 5. When the children were 1 year old they were assessed at their nearest maternal and child health clinic by C.D.M. At 30 months the children were tested at the Logopaedics Department of the University of Cape Town. Finally at 5 years they were again assessed by C.D.M. at their homes.

In addition to documenting developmental progress, social and environmental details were collected. These were grouped according to social background, economic status and physical environment. Social background included social class on the basis of the occupation of the breadwinner,[7] the mother's age at the child's birth, mother's and father's education — recording actual standards passed and any post school education or training — marital state, whether the mother was working or not, who was looking after the child during the day, the mother's personality assessed over a 5-year period, whether the child was living with both parents, one parent or neither parent, whether the family was living alone or with extended family or non-family members, and the family stability based on a subjective assessment including the family cohesiveness, child-centredness, the presence or absence of social pathology and the housing. The economic status of the family was classified on the basis of available income ratio (AIR) assessed against the Primary Household Subsistence Level of Potgieter.[8] The physical environment was classified on the basis of the occupational density (OD) measured on the Batson Scale.[9]

Assessment and development

Milestones

Three milestones were selected — sitting unsupported, walking unaided and saying single words. At the visit by the social worker before the expected emergence of the particular milestone, the mother or caretaker was asked to look for and record the date on which it was reached. On the subsequent visit the social worker enquired about the acquisition of the

milestones and checked the accuracy, where possible, with direct observation. The criteria for achieving the milestones were as follows: (*i*) sitting unsupported — able to sit for at least 1 minute on the floor or a table without using arms for support; (*ii*) walking unaided — able to take 10 steps alone; and (*iii*) using single words with meaning — able to use two words other than 'mama' or 'dada' correctly (the words could refer to objects or people).

Language at 30 months

All the children were assessed at the Logopaedics Department of the University of Cape Town using the Reynell Scales of Language Development.[10] In each case the home language of the child was used. The scales have been translated into Afrikaans and are currently in routine use.

Development at 1 and 5 years

All children were assessed within 1 week of their respective birthdays. Specific assessments were designed for use in the study. At 1 year a total score with subscores relating to gross motor and fine motor/adaptive behaviour were obtained. At 5 years the assessments included a global 'total score' as well as gross motor and fine motor (including visuomotor) skills and language (both comprehension and expression) subtests. The language subtests also included basic colour and number concepts. In addition a measure of general intelligence was included in the form of a Draw-A-Man. The responses were measured in terms of behaviour, pencil and paper and verbal expression. The following considerations were taken into account when compiling the assessments: (*i*) they should not take longer than 20 minutes; (*ii*) they could be carried out in the child's home; and (*iii*) the equipment used should be standard, simple and culturally appropriate.

The items selected were drawn from well-known sources and chosen so that they would be easily understood by children of differing levels of sophistication. The tests were highly structured and responses limited to correct/incorrect according to predetermined criteria.

A preliminary application was used on an unselected group similar to the population of the study. On completion of the preliminary application, the items were subjected to item analysis and the reliability index of each item was determined. Only one item was found to be unacceptable (reliability index of 0,1) and had to be altered for the final application. Internal stability was determined by calculating the split-half reliability coefficient, correcting for the full length of the subtest using the Spearman Brown formula.[11] The coefficient of internal consistency was also determined by means of the Kuder Richardson formula No. 20.[11] Finally a test-retest reliability was obtained by applying the identical assessment to a group of children 2 weeks after the initial one. The correlation coefficient was $r = 0{,}919$ ($P < 0{,}001$).

The data were coded and entered into a computer at the South African Medical Research Council. Spearman rank correlation coefficients (r_s) were used to describe the associations between the developmental scores and the social variables which were continuous or ordinal. The Mann-Whitney *U*-test was used to compare the development levels of the two categories and the Kruskal-Wallis test was used to compare the levels of three categories. Logistic regression using a backward selection procedure was used to undertake the multivariate analyses. The goodness of fit has been described by the *R* statistic which represents the proportion of the log-likelihood explained by the model. The odds ratio (OR) describes the relative effect of the variable on the chances of a child scoring below the median developmental score of the group and the approximate 95% confidence intervals (95% CI) for the ORs have been calculated.

Results

Routine screening was carried out on the cohort. At 6 months 790 infants (79%) were screened for vision, at 9 months 714 (71%) for hearing and sitting unsupported and at 15 months 734 (73%) for gross motor function. Six infants were referred because of visual problems, 10 for audiometry and 6 because of delay in gross motor function. Only 4 of the infants had major handicap (Table I). Both of those with cerebral palsy and the child with mental retardation following *Haemophilus* meningitis had been referred before the relevant screening procedure. The child who was deaf was passed on screening and only referred later because of delay in language development.

TABLE I. COHORT — MAJOR HANDICAPS

Handicaps	Cause	Comment
Cerebral palsy, mental handicap	**Asphyxia neonatorum**	**Referred before 6 mo.**
Cerebral palsy, mental handicap	**Idiopathic**	**Referred before 6 mo. Died at 30 mo.**
Mental handicap	***Haemophilus* meningitis at 3 mo.**	**Referred after meningitis at 6 mo.**
Deaf	**Idiopathic**	**Not detected on screening. Referred when not talking**

The distributions of age of attaining milestones of sample children are given in Figs 1 - 3. The median age for sitting was 6,0 months, for walking 12,5 months and for saying four words with meaning 13,2 months. In all three distribution curves there is a skewing of the upper tail.

Correlations between development at a year and social variables are given in Table II. Family setting and AIR were associated with all the aspects of development measured. Social class, father's education and mother's personality were associated with gross motor and total development, while mother's education was associated with fine motor and total development. The gross motor score was dependent on who was mainly in charge of the child, with the children who were in the care of a grandmother achieving higher scores. The milestones for sitting and walking correlated positively with gross motor function ($P = 0{,}002$, $P = 0{,}000$ respectively). Using four words with meaning was not related to fine motor and adaptive behaviour.

Table III gives details of the correlations between language development at 30 months and social variables, although the development of a fairly large proportion (25%) of the children was not assessed at this age. Mother's education was related to comprehension of language. Family stability and occupational density were significantly correlated with language development, but social class and AIR were not. The parents being married or living together was associated with an improved expressive score and social and adaptive behaviour was almost significantly associated ($P = 0{,}057$) with expressive language. The medians for comprehension mental age equivalent (22,3 months) and expressive mental age equivalent (26 months) were below the chronological age of the children.

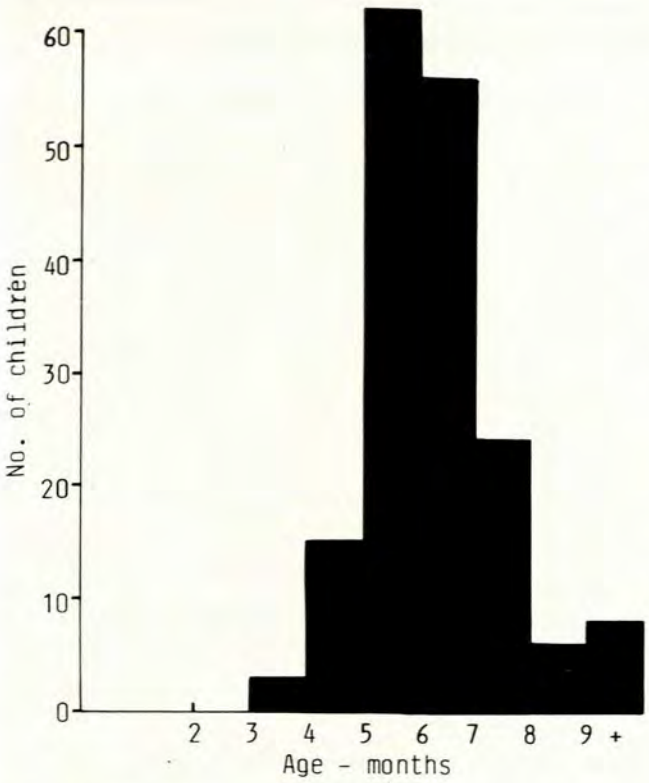

Fig. 1. Age distribution — sitting unsupported.

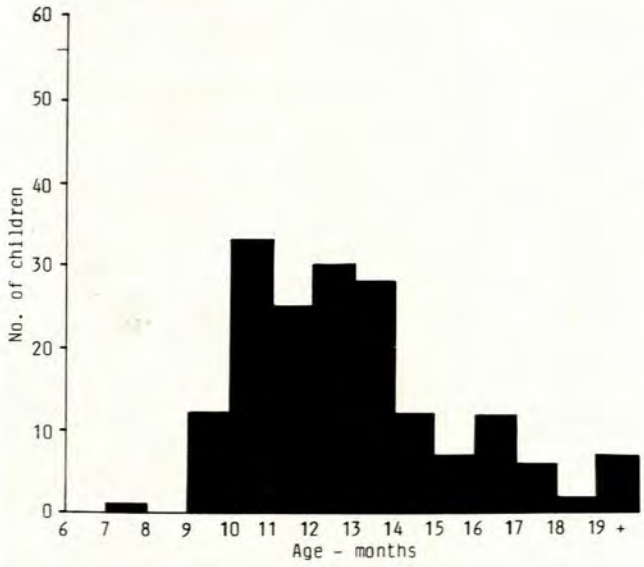

Fig. 2. Age distribution — walking unaided.

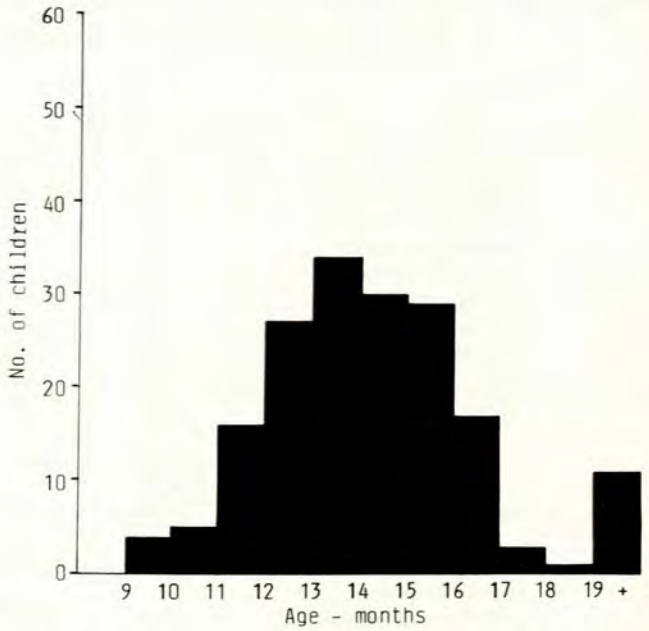

Fig. 3. Age distribution — saying four words with meaning.

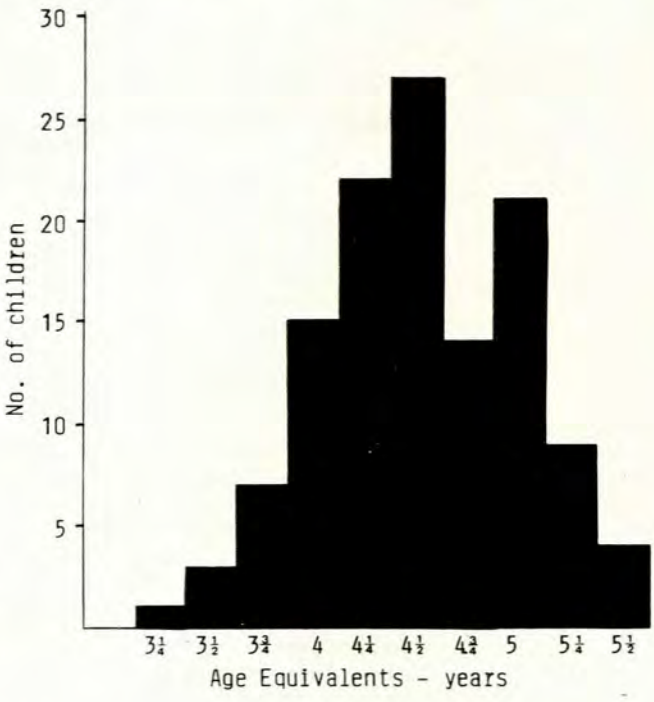

Fig. 4. Distribution of Draw-a-Man scores at 5 years of age.

Girls had higher total and social and adaptive behaviour scores at 12 months and expressive age equivalents at 30 months, but at no stage did the difference reach statistical significance.

At 5 years (Table IV) there was a good correlation between the social variables, and all aspects of development except fine motor. Fine motor development was only related to mother's education and AIR. The distribution of Draw-A-Man scores is given in Fig. 4.

Logistic regression was used to model the odds of a child's developmental score being below the median score for the group at 12 months and 60 months. This was not done at 30 months owing to missing information. Table V shows the results of these analyses and the factors included in each model.

The fit of the logistic regressions was not very good (R ranged from 0 to 0,380), indicating that the variables measured could only account for a part of the variation observed in development at 12 and 60 months. Family stability was an important predictor of development at 12 months with a child from an unstable home being 3,6 times more likely than a child from a stable home to have a low gross motor score. At 60 months, income was the most important predictor of development with a low income being associated with poor

TABLE II. ASSOCIATION BETWEEN DEVELOPMENT AT 12 MONTHS AND SOCIAL MILIEU

	Total		Gross motor		Fine motor/ adaptive	
Social variables	No.	r_s	No.	r_s	No.	r_s
Social class	176	−0,148*	176	−0,175*	176	−0,093
Mother's age	177	0,014	177	0,069	177	−0,023
Mother's education	167	0,212**	167	0,140	107	0,215**
Father's education	145	0,179*	145	0,202*	145	0,129
Mother working	177	−0,029	177	0,111	177	−0,088
Family unit	177	−0,001	177	−0,032	177	0,004
Family stability	177	−0,315***	177	0,388***	177	−0,220 **
Mother's personality	177	−0,222 **	177	−0,296***	175	−0,127
AIR	175	0,226**	175	0,306***	175	0,158
OD	175	−0,130	175	−0,100	175	−0,134
	No.	*P*-value		*P*-value		*P*-value
Marital status (Mann-Whitney *U*-test)	172	0,6457		0,3555		0,8411
Family setting (Mann-Whitney *U*-test)	167	0,2311		0,3012		0,3166
Mainly in charge (Kruskal-Wallis test)	177	0,2287		0,0134*		0,4237

* $0,01 < P < 0,05$.
** $0,001 < P < 0,01$.
*** $P < 0,001$.
r_s = Spearman rank correlation.

TABLE III. ASSOCIATION BETWEEN LANGUAGE DEVELOPMENT AT 30 MONTHS AND SOCIAL MILIEU

	Comprehension		Expression	
Social variables	No.	r_s	No.	r_s
Social class	141	−0,127*	137	−0,087
Mother's age	142	−0,012	137	0,109
Mother's education	135	0,291***	130	0,164
Father's education	118	−0,068	115	0,063
Mother working	141	0,001	137	−0,075
Mother's personality	141	−0,059	137	−0,157
Family stability	140	−0,269**	137	−0,281***
AIR	140	0,082	136	0,115
OD	141	−0,189*	137	−0,173*
	No.	*P*-value		*P*-value
Marital status (Mann-Whitney *U*-test)	142	0,5186		0,0007***
Family setting (Mann-Whitney *U*-test)	141	0,2892		0,2809
Siblings born (Mann-Whitney *U*-test)	141	0,6157		0,7907

* $0,01 < P < 0,05$.
** $0,001 < P < 0,01$.
*** $P < 0,001$.

fine motor, language, Draw-A-Man and total development scores. Mother's education level was also associated with these aspects of development, except for fine motor development. Social class was associated with language development independently of income and mother's education, with children from class 2 having better scores than children from class 1 or 3.

Discussion

According to Holt,[12] screening procedures are sensitive to and specific for a particular condition capable of being performed quickly and cheaply and of providing a fail/pass result. Ideally all children in a community should be screened periodically. In addition, false positives and false negatives should be kept to a minimum. Screening during infancy should detect all children with major handicaps. In this study 75 - 80% of the cohort were presented for developmental screening. No child with major handicap (Table I) was referred as a result of screening. Three were already diagnosed and the deaf child was screened but thought to be normal. Unfortunately the screening of infants with sensorineural deafness is often unsuccessful because the children respond to visual or other cues. The value of developmental screening in Cape Town at present

TABLE IV. ASSOCIATION BETWEEN DEVELOPMENT AT 60 MONTHS AND SOCIAL MILIEU

Social variables	Total		Gross motor		Fine motor		Language		DAM	
	No.	r_s	No.	r_s	No.	r_s	No.	r_s	No.	r_s
Social class	159	−0,320***	162	−0,301***	159	−0,127***	160	−0,302***	164	−0,270***
Mother's education	153	0,409***	156	0,293***	153	0,174*	154	0,419***	157	0,277***
Father's education	130	0,268**	132	0,243**	130	0,065	130	0,256**	133	0,398***
Family stability	160	−0,254**	163	−0,255**	160	−0,099	161	−0,244**	165	−0,183*
Mother's personality	160	−0,395***	163	−0,416***	160	−0,075	161	−0,380***	165	−0,274***
AIR	159	0,481***	162	0,493***	159	0,186*	160	0,388***	164	0,396***
OD	159	−0,343***	162	−0,318***	159	−0,082	160	−0,322***	164	−0,291***

* $0,01 < P < 0,05$.
** $0,001 < P < 0,01$.
*** $P < 0,001$.

TABLE V. SUMMARY OF MULTIVARIATE ANALYSIS USING LOGISTIC REGRESSION TO MODEL THE ODDS OF A CHILD SCORING BELOW THE MEDIAN DEVELOPMENT SCORE

Outcome	Variable	Categories	OR	95% CI	R
12 months					
Total development ($R = 0,016$)	**Family stability**	**Unstable v. stable**	**2,0***	**1,0 - 3,9**	**0,104**
Gross motor development ($R = 0,247$)	**Family stability**	**Unstable v. stable**	**3,6*****	**1,7 - 7,2**	**0,215**
	Mainly in charge	**Grandmothers v. mothers or other**	**0,3***	**0,1 - 0,8**	**0,107**
Fine motor adaptive		**No variables selected**			
60 months					
Total development ($R = 0,324$)	**AIR**	**Below median v. above**	**3,7*****	**1,8 - 7,5**	**0,231**
	Mother's education	**Std 5 or below v. Std 6 or above**	**2,6***	**1,2 - 5,2**	**0,148**
Gross motor development		**No variables selected**			

is therefore debatable. The prevalence of major handicap (4 children — 1 with deafness, 3 mentally retarded and 2 with cerebral palsy per 1 000 live births) agrees with published figures.

As developmental milestones are often used in the detection of abnormalities of development, it is important to determine whether the children in Cape Town passed their milestones at similar ages when compared with children elsewhere. In the design of the study we used the same criteria for sitting unsupported and walking unsupported as described by Neligan and Prudham.[13] For single words with meaning, we stipulated four words relating to different people or objects, whereas they required only three or four words. Our median ages and distributions for sitting and walking were almost identical to those of Neligan and Prudham.[13] Our median age for single words was 13,2, approximately a month later than the Newcastle children.[13] This could be accounted for by the slightly different criterion. Neligan and Prudham drew attention to the general agreement between their median values and those of Frankenburg and Dodds[14] and Hindley *et al.*[15] In addition the skewing of the upper tail appears to be a consistent finding in all the studies.

Neligan and Prudham[13] in 1969 reported a social class difference in age of independent walking in Newcastle-upon-Tyne, the differences favouring the lower class children. They postulated a 'deprivation of the opportunity to learning resulting from over protection' for more advantaged children as the reason for this. Hindley *et al.*,[15] on the other hand, found no social class differences in the age of walking among 5 European longitudinal samples. Social class did affect gross motor development in our study favouring the higher classes, and there was also a correlation with income, parental education, mother's personality and family stability.

There was no association between social class by occupation of the breadwinner and early language milestones, but there was a relationship with family stability, occupational density and mother's education. No significant social class differences in early language development were found by Miller *et al.*,[16] Frankenburg and Dodds[14] and Neligan and Prudham.[13] Hindley[15] demonstrated a progressive deceleration in the language development of lower class children in contrast to higher classes in the UK. Although there was no direct relationship to social class at 30 months in our study, there was a strong association with parental education and family stability. At 5 years language correlated with social class, maternal education, mother's personality, income, occupational density and family stability.

Ireton *et al.*[17] found no correlation between socio-economic status and infant development assessed by the Bayley Scales. At 4 years, however, there was a significant correlation between socio-economic status and intelligence. In our study there was some correlation between social class and development during infancy, but at 5 years there was a strong association between development and social class by occupation grading of the breadwinner, income, occupational density and family stability.

McCall[18] has proposed a conceptual scheme of childhood development in which early development in the first 18 - 24 months is highly canalised and follows species-typical paths. After this period, canalisation slowly begins to weaken and individual differences in experience and genetic inheritance

have a greater effect. According to this scheme, genetic and environmental factors have minor correlations with development before 18 - 24 months and then both have increasing correlations thereafter. Such trends are evident in our study in that at 12 months correlations between social factors and development are considerably weaker than at 60 months. However, genetic and environmental factors should not be discounted in infant development, as factors such as family stability and maternal education did correlate with development performance. Family stability is a composite assessment based on family cohesiveness, child-centredness, the presence or absence of social pathology, and housing. Between 1 and 5 years of age there appeared to be a deceleration in development. Early milestones, both motor and language, were similar to those published in the literature, whereas language skills at 30 months were on average delayed (approximately 8 months for comprehension and 4 months for expressive language) and the Draw-A-Man test showed that the ability of the study children was less mature than expected. At 5 years, although all social variables correlated with most developmental aspects, income and maternal education showed the strongest associations.

The children in our study, therefore, emerged from infancy with developmental skills similar to those of children studied in other countries. In the ensuing years, there appeared to be a deceleration in development as assessed by the Reynell Language Scales and the Draw-A-Man test and an increasing association between developmental abilities and social milieu. Although one must caution against confusing correlation with causation, it is likely that children from more socially disadvantaged homes experience less stimulating environments. An improvement in the socio-economic circumstances of the less affluent, lower social class families would better prepare their children for formal education. Our study supports the elimination of social disadvantage in general, requiring employment opportunities with a living wage and appropriate social security benefits. As an interim measure developmental intervention programmes to compensate for poor maternal education should be implemented.

REFERENCES

1. Hurlock EB. *Child Development*. 5th ed. Tokyo: McGraw-Hill, Kogakusha (International Student Edition), 1972.
2. Gesell A. *The First Five Years of Life*. London: Methuen, 1973.
3. Wittmann W, Moodie AD, Fellingham SA, Hansen JDL. An evaluation of the relationship between nutritional status and infection by means of a field study. *S Afr Med J* 1967; **41:** 664.
4. Evans D, Bowie MD, Hansen JDL, Moodie AD, Van der Spuy HIJ. Intellectual development and nutrition. *J Pediatr* 1980; **97:** 358.
5. Stoch MB, Smythe PM. 15 year developmental study on effects of severe undernutrition during infancy on subsequent growth and intellectual functioning. *Arch Dis Child* 1976; **51:** 327.
6. Molteno CD, Hollingshead J, Moodie AD *et al*. A study on child development in Cape Town: the cohort and sample. *S Afr Med J* 1980; **58:** 729-732.
7. Registrar General. *Classification of Occupations*. London: HMSO, 1960.
8. Potgieter JF. *The Household Subsistence Level in the Major Urban Centres of the RSA* (Fact paper No. 16.) Port Elizabeth: University of Port Elizabeth, 1976.
9. Batson E. *Notes on the Concept of Measurement of Overcrowding* (Report SS27). Cape Town: University of Cape Town, 1944.
10. Reynell J. *Developmental Language Scales*, Slough: National Foundation for Educational Research, 1969.
11. Downie NM, Heath RW. *Basic Statistical Methods*. New York: Harper & Row, 1965.
12. Holt KS. Functional assessment of handicapped children: an assessment. *Proc R Soc Med* 1973; **66:** 611.
13. Neligan D, Prudham D. Norms for four standard developmental milestones by sex, social class and place in family. *Dev Med Child Neurol* 1969; **11:** 413.
14. Frankenburg WK, Dodds JB. The Denver developmental screening test. *J Pediatr* 1967; **71:** 181-191.
15. Hindley CB, Filliozat AM, Klackenberg G, Nicolet-Meister D, Sand EA. Differences in age of walking in five European longitudinal samples. *Hum Biol* 1966; **38:** 363.
16. Miller FJW, Court SDM, Walton WS, Knox EG. *Growing Up in Newcastle-Upon-Tyne*. London: Oxford University Press, 1960.
17. Ireton H, Thwing E, Graven E. Infant mental development and neurological status, family SES and intelligence at four years. *Child Dev* 1970; **41:** 937.
18. McCall RB. Nature-nurture and the two realms of development: a proposed integration with respect to mental development. *Child Dev* 1981; **52:** 1-12.