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ABSTRACT

This study examines the effects of sex, socioeconomic status, birth order and birth spacing on the cognitive performance of 12-week-old infants. A brief review of research on neonatal cognitive ability is followed by a description of the study itself. The subjects, 189 three-month-old Caucasian infants (61 first borns, 58 second borns, and 49 third borns) were given a battery of perceptual-cognitive tasks. These tasks included the Corman-Escalona Scales of Object Permanence, the Mental Development Index (MDI) of the Bayley Scales, and an attention task measuring habituation and dishabituation. An analysis of data failed to show any sex or social class differences, although the MDI was affected by birth order, with the first borns showing superior performance. In general, the three measures of perceptual-cognitive ability were unrelated. These data are used to question the notion of a developmentally constant, unchanging, unitary construct of intelligence ('g' factor) in infancy, and therefore the usefulness of a test of infant intelligence. (Author/CM)

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RESEARCH BULLETIN

COGNITIVE PERFORMANCE IN THE 12-WEEK-OLD INFANT: THE EFFECTS OF BIRTH ORDER, BIRTH SPACING, SEX, AND SOCIAL CLASS

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Errata

The following corrections should be noted on page 21:

Footnote 1 should be unnumbered;

Footnotes 2 through 4 should be numbered 1 through 3.

Abstract

Twelve-week-old infants were given a battery of perceptual-cognitive tasks. These tasks included the Corman-Escalona Scales of Object Permanence, the Mental Development Index of the Bayley Scales, and an attention task measuring habituation and dishabituation. The data failed to show any sex or social class differences, although the MDI was affected by birth order with first borns showing superior performance. In general these three measures of perceptual-cognitive ability were unrelated. These data are used to question the notion of a "g" factor in infancy and therefore the usefulness of a test of infant intelligence.

Cognitive Performance in the 12-Week-Old Infant: The Effects of Birth Order, Birth Spacing, Sex, and Social Class

Psychologists since Binet have attempted to assess early intelligence and predict subsequent intellectual ability--witness various tests of infant IQ (Brooks & Weinraub, 1976, pp. 19-58). Numerous studies spanning several decades of research have correlated various developmental test scores obtained during infancy with some standardized intelligence test administered at a later stage in life (Bayley, 1949; Bowlby, 1952; Hindley, 1965; McCall, Hogarty, & Hurlburt, 1972; Stott & Ball, 1965; Thomas, 1970). After reviewing this literature, investigators would have to agree with Bayley's (1970) overall statement that "the findings of these early studies of mental growth of infants have been repeated sufficiently often so that it is now well established that test scores earned in the first year or two have relatively little predictive validity (in contrast to tests at school age or later)" (p. 1174).[1] These results make it difficult to accept the proposition that infant intelligence is a stable and unitary construct and that a general and unchanging "g" factor exists in the infancy period.

However, while tests of IQ administered during infancy have minimal predictive validity, it has been argued that these tests reflect the status of the infant at the time of testing (Matheny, 1973). This status has been assessed from two perspectives: (1) evaluating sick and healthy infants and their performance on the MDI of the Bayley Scales of Infant

Development, and (2) assessing the relationship to other activities reported to reflect overall cognitive ability. If these tests truly reflect the current status of the child, then this performance should be related to other indices of cognitive functioning.

Studies comparing sick and healthy infants have generated mixed results. Analyses of the offspring of 116 diabetic mothers demonstrated a poorer overall performance on both Bayley mental and motor scale scores at 8 months and in Binet IQ scores at 4 years of age than nondiabetic controls (Churchill & Berendes, 1969). However, when prematurity was controlled, the differences in Bayley performance on both scales were greatly reduced and no longer significant. Interestingly, the IQ differences at 4 years of age remained significant for this group, which possibly suggests "delayed effect on mental abilities" (Hunt, 1976, p. 227).

When comparing closely spaced pregnancies with a control group on Bayley performance at 8 months and IQ scores at 4 years of age, Holley, Rosenbaum, and Churchill (1969) found lower means for closely spaced infants on mental scale scores. These authors felt that even though the spacing of the children might be affecting development by 8 months, findings of lower birth weight in the closely spaced group and a higher incidence of neurological abnormalities at 1 year of age suggest the possibility of overriding biological influences occurring at birth.

Another area of neonatal risk research receiving much attention today concerns itself with the effects of fetal exposure to drugs administered during pregnancy (Bowes, Brackbill, Conway, & Steinschneider, 1970; Kelsey, 1973). Conway and Brackbill (1970, pp. 24-34) compared the behavior of clinically normal, full-term infants delivered to mothers who had received no anesthesia during delivery, local anesthesia, or general (inhalation) anesthesia. Nonsignificant correlations were found between the potency of medication and Bayley MDI scores administered at 4 weeks of age. Potency was significantly correlated with the motor test scores and a measure of habituation to an auditory orienting response. Moreover, there were no significant correlations between the medication level and birth weight, length of labor, parent's education and income and maternal age. Upon readministration of the Bayley scales and the habituation measure at 20 weeks of age, the MDI scores again showed no differences, yet there were apparent effects in habituation rate.

According to Sameroff and Chandler (1975), "It would appear that, in general, pregnancy variables taken alone do little to predict deviant outcomes during the first year of life, and in a strict sense, do not, by themselves, constitute risk factors" (p. 202). The prediction of pathological and developmental outcome based on combined scores of prenatal and neonatal variables has been used successfully in several studies. For example, Niswander et al. (1966) found a highly significant correlation between combined factors of pregnancy complications, low Apgar, and an abnormal newborn neurological examination to subsequent low scores on the Bayley MDI and the 12-month neurological examination. Similarly, using multiple criterial factors, Drage and Berendes (1966) found a significant relationship between low birth weights, low Apgar scores, and later deviance on the Bayley and neurological examination.

Using clusters of several discrete, perinatal insults, Honzik, Hutchings, and Burnip (1965) had the birth records of 197 infants grouped into four categories by several independent pediatricians: not suspect, possibly suspect, suspect, or definitely suspect of neurological handicaps. Subsequently, these cases were categorized by the kinds and degrees of insult leading to these specific classifications. These infants were then tested at 8 months of age on the Bayley scales of mental and motor development. Upon examining specific items of the mental scale, several characteristics emerged which separated the most suspect infants from the remainder of the population (i.e., less success on tasks requiring eye-hand coordination and problem solving). However, these authors quickly pointed out that the correlation between mental score and the definitely suspect status was questionable since some of these "suspect children" scored well within the normal limits for this age group.

Although the studies previously discussed utilized the Bayley Scales of Infant Development, other tests of infant IQ (Gesell, Griffiths, and Cattell) have attempted to compare sick and well babies. In general, the results have been mixed. While several studies have shown significant IQ differences (Braine, Heimer, Wortis, & Freedman, 1966; Knobloch & Pasamanick, 1960; Stechler, 1964; Knobloch & Pasamanick, Note 1), other investigations have not demonstrated such discrepancies in IQ (Apgar, Girdany, McIntosh, & Taylor, 1955; Ucko, 1965).

IQ data from the comparison of healthy and sick infants is still unclear. There is some indication that sick infants score lower on the Bayley than do well children. Thus, in some sense the test does reflect the status of the infants at the time of testing. Unfortunately, the fact that the test reflects a status difference does not logically mean the test is measuring intellectual differences. For example, it may be the case that a simple motor task or sucking rate would also show differences between healthy and sick infants.

Another way to approach the issue of IQ tests in infancy is to compare children's performance on an IQ task to performance on other tasks also thought to be related to intellectual ability. By showing a relationship one could argue that infant IQ tests do measure, at the time of testing, some skills which are similar to those measured by other tasks thought to be intellectual in nature. King and Seegmiller (1973) administered the Uzgiris and Hunt Infant Psychological Developmental Scale (IPDS) of perceptual-cognitive development and Bayley MDI to 14-, 18-, and 24-month-old infants. They found that the MDI correlated significantly with 4 out of the 7 subscales at 14 months, 2 of the subscales at 18 months, and 3 subscales at 22 months of age. At none of the ages was the Bayley MDI significantly related to the object permanence subscale. However, the schemata and causality subscales were related to the Bayley at all three ages.[2]

In another longitudinal study, Lewis and McGurk (1972) compared scores on the Bayley MDI with performance on the Corman-Escalona Sensorimotor Scales at 3, 6, 9, 12, 18, and 24 months. Only at 6 months of age did a significant relationship exist between the performance on the two tasks. The authors subsequently related the Bayley MDI at 24 months of age to the Peabody Picture Vocabulary Test (PPVT), also given at that time. Performance on these two tasks was found to be significantly related.

Unfortunately, very few studies have related early IQ scores to other cognitive activities. Further, most of the studies reported to date have used a small number of subjects with too broad an age range. More importantly, the effects of such variables as the child's sex, socioeconomic status, birth order, and birth spacing have not been taken into consideration when we have information indicating that they may be important determinants. The present study, using a large number of subjects varying along these dimensions, seeks to explore the relationship of IQ as measured by the Bayley MDI to such other measures as a perceptual-cognitive task (attention distribution) and a sensorimotor task in the very young child.

Method

Subjects

One hundred and eighty-nine three-month-old Caucasian infants comprised the sample for this study. Using a modified version of the Hollingshead Two-Factor Index of Social Position (Note 2), this sample (94 females and 95 males) was divided into 90 high SES subjects and 99 low SES subjects.[3] Subsequently, the sample was grouped into four birth orders as follows: 61 first borns, 58 second borns, 49 third borns, and 21 fourth borns. Finally, the population was distributed into six spacing groups contingent upon the number of months between a subject's birth date and that of the next older sibling. The spacing groups were as follows:

(1) 9-18 months (N = 7); (2) 19-30 months (N = 35); (3) 31-42 months (N = 38); (4) 43-45 months (N = 18); (5) 55-66 months (N = 17); (6) 67+ months (N = 16).

Procedure

Infants were recruited through local advertisements, birth records, local pediatricians, and church groups and were seen within one week of their three-month birthdays. These subjects were administered two standardized tests of intelligence: the Mental Developmental Index of the Bayley Scales of Infant Development and the Corman-Escalona Scales of Object Permanence. The Bayley was given in the infant's home following two hours observation of mother-infant interactions. The Corman-Escalona Scales were administered in the Infant Laboratory of Educational Testing Service at the same time as the administration of an attentional task. In both instances, the mother was always present. Testers consisted of a pool of Caucasian females who had been trained on all aspects of each scale and had met an agreement score of .85.

The attention task measured responsivity to visual stimuli. Specifically, fixation time was obtained as the infants watched seven trials of a visual array, each 30 seconds in duration with a 30-second intertrial interval. The first six trials were redundant--a slide of 20 curved colored linec--while the seventh trial consisted of 20 straight colored lines. The stimuli were presented by rear screen projection while the infant and its mother sat in an enclosure. (The infant sat in an infant seat while its mother sat to the side and rear of her child.) Fixation time was determined by a trained observer who depressed a push button each time the stimulus was superimposed on the infant's pupil. Inter-observer reliability taken on 15% of the subjects was consistently high. For each subject, the amount of time spent looking during each trial for each observer was obtained and individual subject reliability determined. The range was .87 to .99 with a mean reliability score of .93.

First and total fixation time (in seconds) were obtained as measures of habituation and recovery. First fixation was the amount of time the infant first looked before turning away during a stimulus presentation. Total fixation was the total amount of looking time accrued over all 30 seconds of presentation. In this study, habituation was defined as the score based on the difference in attending behavior between trial #1 and trial #6, while recovery was defined as the score based on the difference in attending behavior between trial #6 and trial #7. Individual subject scores for habituation $(\frac{1-6}{1})$ and recovery $(\frac{6-7}{6})$ were used in these analyses. Similar results were obtained using all trials in the ANOVAS to be reported.

Results

One hundred and eighty-nine subjects completed the Bayley MDI: 146 subjects completed the Corman-Escalona Scales of Object Permanence; and 170 subjects completed the attention task. While every attempt was made to administer all tests to each subject, some infants lacked scores because they were either too fussy or too tired at the time of testing.

An analysis of these subjects indicated that they were fairly evenly distributed across the variables under investigation--birth order, sex, and social class.

Bayley MDI and Corman-Escalona Scale of Object Permanence

Insert Table 1 about here

Table 1 presents a distribution of the mean MDI scores by birth order, sex, and SES. For the total sample, the mean MDI score of 121.9 was nearly two standard deviations above the mean as reported by Bayley ($\bar{X}$ = 100). This can be attributed to several factors: (1) on the average, more time was spent by the experimenter than usually reported in obtaining a score of the infant's performance and (2) the Bayley was administered in the home in conjunction with a two-hour observation period which allowed the experimenter more of an opportunity to notice those items which might depend upon incidental observations (the Bayley test allows an examiner to use observation to mark an item correct). It has been reported by Honzik (1976, pp. 59-95) that this procedure affects the scores in a similar fashion, i.e., by elevating them.

Insert Figure 1 about here

With respect to birth order, the MDI scores varied inversely with ordinal position (see Figure 1). Thus, first borns achieved the highest scores ($F(3,135) = 2.76$, $p < .04$). No significant differences were found between males and females or between social classes (see Table 1), nor was there a birth spacing effect. Moreover, there were no significant interactive effects for these main variables.

Subjects received the first five items from the Corman-Escalona Scales of Object Permanence. Analyses were performed on the total number of items passed as well as on each item. Examination of the data revealed no significant differences in the number of items passed as a function of birth order, spacing, sex or SES. However, when we examined the interactive effects of these variables, a significant three-way interaction occurred. An analysis revealed a birth order x social class x gender effect ($F(3,130) = 2.98$, $p < .03$). Low SES, later born females, tended to perform better than high SES, later born females.

Attention

Insert Table 2 about here

Table 2 presents the mean amount of habituation and recovery by the various groups. An ANOVA indicated significant response decrement (total fixation, $F(1,169) = 17.20$, $p < .001$ and first fixation, $F(1,169) = 11.67$, $p < .001$) and recovery (total fixation, $F(1,167) = 4.02$, $p < .05$ and first fixation, $F(1,167) = 10.51$, $p < .01$) for the sample as a whole. Three-month-old infants showed a 20% decrement in looking over the six redundant trials. Using individual scores in an ANOVA $(\frac{1-6}{1})$ (that is, the percentage of change from the first to last trial as a ratio of the amount of visual regard on the first trial), as a measure of habituation, no significant differences as a function of sex, birth order, or SES were found. Moreover, there were no significant interaction effects.

Response recovery (defined as the percentage of change from the sixth to seventh trial as a ratio of the sixth ($\frac{6-7}{6}$)) did not differ as a function of sex, birth order or SES. Although all subjects showed response decrement and recovery, group differences could not be demonstrated.

Interrelationship of Perceptual-Cognitive Ability

Insert Table 3 about here

MDI-Object Permanence. In order to determine if any relationship exists between these two cognitive tasks, Pearson product moment correlations were obtained. For the total sample, the overall correlation was .13, accounting for less than 3% of the variance between tasks (see Table 3a). Because birth order appeared to affect MDI performance, it was necessary to partial it out of the correlations. Observation of the partialed correlations revealed little difference. In general, infants' MDI scores and object permanence performance were unrelated.

MDI-Attention. Across the sample as a whole, there was minimal relationship between the infant's performance on the MDI and its attentional distribution (see Table 3b). Interestingly, males showed a significant correlation between first fixation-habituation and MDI performance (.22, $p < .05$), while other groups showed minimal significance. Partialing birth order from these correlations did little to affect results.

Object Permanence Attention. There were very few significant relationships between object permanence performance and attentional distribution parameters. Further, there were no significant birth order or SES differences in the correlation of these two tasks. Moreover, partialing out birth order did not affect these results (see Table 3c).

Discussion

Mean group differences as a function of sex, social class, birth order and birth spacing were found to be minimal except for birth order. Birth order was found to affect only performance on the MDI with first borns scoring the highest and fourth borns the lowest. Lee-Painter and Lewis (Note 3) also found the MDI to vary as a function of birth order. In a study of 96 three-month-old infants, the following significant birth order differences were obtained: $\bar{X}$ MDI scores of 128.9, 125.6, 118.1 and 120.4 for first, second, third, and fourth borns, respectively. Reasons for this birth order effect are unclear. Furthermore, the fact that birth spacing effects were nonsignificant leads us to discount this as a major variable (Zajonc, 1976). Another possibility rests on the differential maternal-infant relationship as a function of birth order. Judd and Lewis (Note 4) reported that for the same 189 subjects, there were significant birth order effects in the mother-infant interaction, with mothers showing more interaction with their first borns and least with their fourth borns. In fact, there was a significant monotonic relationship between birth order and level of interaction. It may be the case that the MDI is sensitive to the mother-infant interaction and is reflected in these differential scores. Interestingly, neither the attention nor the object permanence scores were affected by SES, sex or birth order.

The relationship between these three different measures of the young infant's perceptual-cognitive performance raises several important issues. The general failure to find any relationship between the MDI and the attention tasks and the MDI and the object permanence task suggests that it is impossible to assess the validity of a "test of IQ" by comparing it to performances on other tests measuring cognitive ability. To date, the MDI has shown only limited predictability both within the infancy period and across longer age spans and has been only partially successful in differentiating sick from well infants. As stated earlier, this type of demonstration would not provide a sufficient justification for considering the MDI as a test of intelligence even though it might be used as a diagnostic indicator of some general dysfunction. These results must force one to conclude that while the MDI may measure infant "IQ," the empirical data at this time would not support such a belief.

That three tasks of perceptual-cognitive performance failed to demonstrate a significant relationship supports the conclusion that a developmentally constant, unchanging, unitary construct of intelligence does not exist in infancy (see McCall et al., 1972). Further, if one is interested in assessing infant intellectual performance, it may be more advantageous to evaluate infants directly on those skills one wishes to measure, or affect, rather than on some general performance criterion. While the findings reported in this study refer to 12-week-old infants, quite different results might be obtained when different age groups are subjected to similar perceptual-cognitive tasks (although the minimal amount of data collected to date would not support this notion--King and Seeg-miller, 1973; Lewis and McGurk, 1972). Whatever the outcome for older children, the data make it quite clear that for the very young infant, the notion of a general "g" factor as measured by the Bayley scales is inappropriate and that other measures of cognitive performance should be explored in much greater depth.

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2. Hollingshead, A. B. Two-factor index of social position. Unpublished manuscript, 1957. (Available from 1965 Yale Station, New Haven, Connecticut 06515).

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Footnotes

[1]A shorter version of this paper was presented at the Eastern Psychological Association meetings, New York City, April 1976. This research was supported by NICHD contract number N01 HD 42803. We would like to thank Beverley Barker for her help with data collection. Reprint requests should be sent to Michael Lewis, Institute for Research in Human Development, Educational Testing Service, Princeton, New Jersey 08540.

[2]It should be noted that prediction to older IQ performance using the Bayley Mental Development Index Score (MDI) has, to some extent, been facilitated by taking extreme groups. Studies looking at sick and well children, as measured by several prenatal or perinatal dysfunctions, show stronger correlations than studies on normal subjects (Drage & Berendes, 1966; Niswander, Friedman, Hoover, Pietrowski, & Westphal, 1966).

[3]Measuring subjects' performance on the seven subscales of the IPDS, Uzgiris (1973) found marginal agreement existing between the performance on one scale and performance on the other six scales.

[4]Hollingshead's (Note 2) Two Factor Index of Social Position was used to divide this sample into high and low socioeconomic groups with two modifications: (1) not only was the father's occupational and educational level taken into account, but the mother's level was assessed and included in these calculations as well; (2) instead of using Hollingshead's five established social classes, the scale was divided into two equal sections such

that a score of 11-27.4 would reflect high SES and a score of 27.5 and greater would reflect low SES. Typically, the high SES group exhibited some college education with managerial and professional experience, while the low SES group displayed a high school education or lower and was categorized as a semi-skilled or skilled worker.

Table 1

Bayley MDI Scores

	Mean	S.D.
Males	123.2	14.96
Females	120.7	16.15
High SES	121.7	15.41
Low SES	122.3	15.79
First Born	125.4	15.52
Second Born	120.6	15.80
Third Born	122.5	15.62
Fourth Born	114.6	11.89
Total	121.9	15.61

Table 2

Means for Measures of Habituation and Recovery

	Habituation		Recovery	
	Total Fixation	First Fixation	Total Fixation	First Fixation
Males	-0.40	-0.61	-0.50	-1.28
Females	0.14	-0.53	-0.49	-1.23
High SES	-0.36	-0.45	-0.63	-1.10
Low SES	0.10	-0.69	-0.37	-1.40
First Born	-0.19	-0.04	-0.18	-1.21
Second Born	-0.08	-0.18	-0.47	-1.37
Third Born	-0.21	-0.93	-0.67	-0.84
Fourth Born	0.15	-2.27	-1.05	-2.02
Total	-0.12	-0.57	-0.50	-1.25

Table 3

Correlation Between MDI Scores and Object Permanence Performance (a)

Total	.13 (.15)$^{\Delta}$
Males	.11
Females	.13
High SES	.13
Low SES	.12

Correlation Between Measures of Attention and MDI Scores (b)

	Habituation		Recovery	
	Total Fixation	First Fixation	Total Fixation	First Fixation
Total	-.01 (-.00)$^{\Delta}$	.12 (.10)$^{\Delta}$	-.04 (-.07)$^{\Delta}$	.02 (-.00)$^{\Delta}$
Males	-.00	.22**	-.03	-.08
Females	-.03	.05	-.05	.10
High SES	-.00	.22**	-.05	-.08
Low SES	-.07	.06	-.04	.09

Correlation Between Measures of Attention and Object Permanence Performance (c)

	Habituation		Recovery	
	Total Fixation	First Fixation	Total Fixation	First Fixation
Total	.03 (.03)$^{\Delta}$	-.03 (-.04)$^{\Delta}$	.16* (.14)$^{\Delta}$	.08 (.08)$^{\Delta}$
Males	.17*	.04	.16*	.05
Females	-.17*	-.07	.15	.09
High SES	.05	-.01	.17	.07
Low SES	-.10	-.04	.13	.11

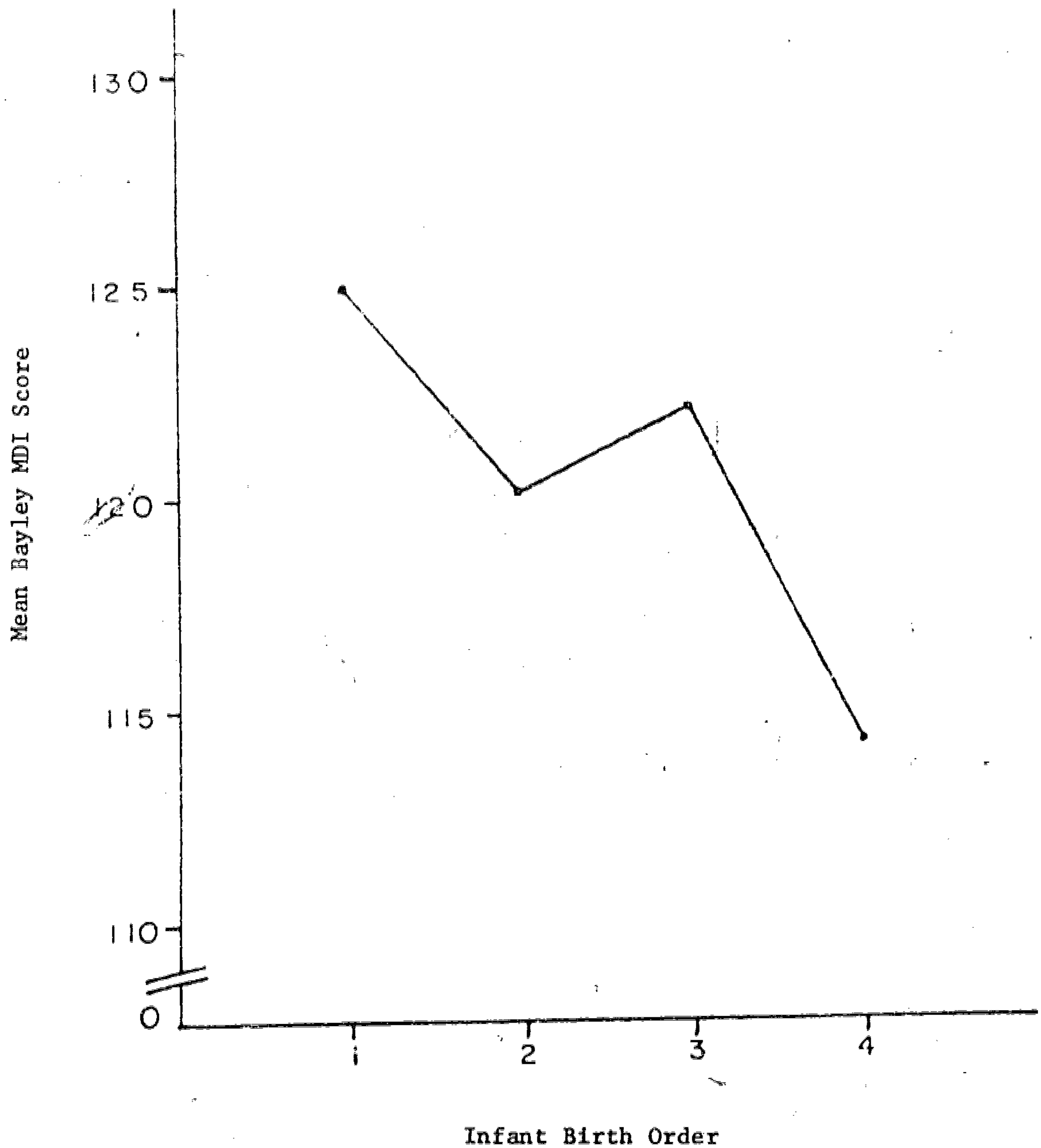
*$p < .05$

**$p < .01$

$^{\Delta}$ Birth Order partialed out of correlation.

Figure Caption

Figure 1. Mean Bayley MDI scores by infant birth order.


130
125
120
115
110
0
1
2
3
4
Mean Bayley MDI Score
Infant Birth Order