Cognitive Development in the Failure-to-Thrive Infant: A Three-Year Longitudinal Study

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Groups of nonorganic failure-to-thrive, organic failure-to-thrive, and normal control infants were assessed in the first year of life with visual recognition memory tasks and the Bayley Mental Scale of Infant Development. Follow-up evaluations were completed at 20 months of age with the Bayley Mental Scale and at 3 years with the Stanford-Binet Intelligence Scale. Both groups of failure-to-thrive infants showed major developmental lags at outcome, with nonorganic failure-to-thrive infants functioning intellectually in the borderline range and organic failure-to-thrive infants functioning in the mildly retarded range at 3 years of age. For the entire sample, outcome was reliably associated with parental educational level which in turn was related to the number of caretaking placements an infant had experienced outside the home. Placement outside the home also was confounded with birth weight and gestational age. Both Bayley Mental Scale scores at 8 and 20 months, and visual recognition memory test scores, were reliable predictors of 3-year outcome.

KEY WORDS: failure-to-thrive; infant visual recognition memory; infant assessment.

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Although usually regarded as an indication of high risk status in the developing infant, the condition failure-to-thrive has been relatively neglected in the literature on developmental risk conditions. Failure-to-thrive infants are defined as those whose weight for height falls below the third percentile on normal growth curves (Barbero & McKay, 1975). Those who also have an identifiable physical impairment are known as organic failure-to-thrive, while those whose growth failure is not accompanied by organic disease are commonly called nonorganic failure-to-thrive.

The present study represents a longitudinal prospective investigation of the cognitive functioning of 26 infants hospitalized for organic and nonorganic failure-to-thrive within the first year of life with follow-up assessment at 20 months and 3 years of age. Groups of such infants were compared at time of initial diagnosis and hospitalization with normal infants on their ability to demonstrate recognition memory for visual stimuli, as well as on the basis of a standard infant developmental sensorimotor assessment, the Bayley Mental Scale of Infant Development.

Although the diagnostic criteria for failure-to-thrive are clearly and easily defined, there exists a lack of general agreement on the etiology, outcome, and psychosocial characteristics associated with the syndrome (Drotar, Malone, & Negray, 1979; Kotelchuck, 1980). Metabolic factors (Smith & Berenberg, 1979), dysfunctional maternal-infant interaction (Barnard & Wolf, 1973), and poor nutrition (Whitten, Pettit, & Fischoff, 1969) have all been implicated as primary causes of nonorganic failure-to-thrive. More recently the innate characteristics of the child have also been evaluated, along with environmental factors, for their interactive contribution to the risk of malnourishment. Prematurity, illness, poor suck, irritable temperament, and cognitive deficit have all been suggested as among the causative factors leading to nonorganic failure-to-thrive (Pollitt, 1973; Whitten et al., 1969; Kotelchuck, 1980).

Although clinical reports of both nonorganic and organic failure-to-thrive infants suggest poor developmental outcome, few outcome studies exist and those which do suffer from numerous methodological problems.

When studied as a group, infants who are failing to thrive with observed organic dysfunction appear to do quite poorly developmentally, even in comparison to other failure-to-thrive infants who do not have specifiable organic impairment. In one study (Riley, Landwirth, Kaplan, & Collip, 1968), 38% of a group of infants diagnosed as organic failure-to-thrive were judged to be "mildly to severely retarded." In another study of 100 failure-to-thrive infants, Ambuel and Harris (1963) found that only 35% of their group of organic failure-to-thrive infants were considered "normal" in physical and mental development as opposed to 56% considered "normal" of a group of nonorganic failure-to-thrive infants. On follow-up from 6 to 48 months later \( M = 24 \) months 69% of the nonorganic failure-to-thrive group had returned to normal height and weight in contrast to only 31% of the organic failure-to-thrive group.

Studies of the subsequent development of children who had been hospitalized for nonorganic failure-to-thrive as infants indicate that there may be a number of unfortunate physical, socioemotional, and cognitive sequelae to early growth problems. The majority of studies report that children diagnosed as failure-to-thrive are still under the third percentile for height and for weight when seen from 6 months to 15 years after hospital discharge (Glaser, Heagarty, Bullard, & Pivich, 1968; Elmer, Gregg, & Ellison, 1969). Later social and emotional maladjustment has also been observed, particularly in school settings (Elmer et al., 1969; Hufton & Oates, 1977). Eventual impairment in intellectual development may also be a hazard for the child who has suffered from failure-to-thrive. Elmer et al. (1969) found that 10% of their sample of 15 were "below norm" in cognitive development on follow-up evaluation with the Oppenheimer rating for mental retardation. In a 1968 study, Glaser et al. reported that a group of children who had been failing to thrive without organic involvement achieved IQ scores which were normally distributed with a mean of 95, but that a substantial number of these children were experiencing school failure. Hufton and Oates (1977) also found that most later assessment scores fell within the average IQ range of the WISC, but that two-thirds of their sample were reading 1 to 2 years below chronological age level. In a sample of 13 older children ranging from 3 to 13 years of age treated for growth retardation without organic cause, 8 achieved WISC IQ scores of 80 or less with many having exhibited early delays in walking and in speech onset (Powell, Brasel, & Blizzard, 1967). Thus, later in life, children who were initially diagnosed as having growth problems early in infancy or childhood continue, for the most part, to remain below the norm for height and weight. Their academic achievement appears to have been adversely affected, perhaps due to impairment in cognitive functioning as well as in emotional adjustment.

Although intellectual impairment seems to be a primary consequence of early growth failure, the assessment of cognitive functioning during infancy has been investigated infrequently in infants diagnosed as nonorganic failure-to-thrive. Whitten et al. (1969) gave the Cattell Infant Intelligence Scale to seven infants ranging from 3 to 24 months old who were hospitalized with a diagnosis of nonorganic failure-to-thrive. Developmental quotients obtained from most infants in the group were well below average. Eckels (1968) observed developmental lags, as measured by the Composite Developmental Inventory, of 1 to 6 months in 18 nonorganic failure-to-thrive infants whose ages ranged from 3 to 12 months. Ramey, Starr, Pallas, Whitten, and Reed (1975) found a mean Mental Development Index in
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might prevent the failure-to-thrive infant from adaptively using aspects of the environment which promote social and emotional development. Not being able to take in or process information would be expected to interfere with an infant’s responsivity and affect mother–infant interaction. One might ask whether or not the failure-to-thrive infant can perceive, discriminate, and remember visual-social stimuli as well as normal infants. The inability or ability to perform such tasks could be expected to have significant effects on an infant’s cognitive and social development. Alternatively, subsequent intellectual problems reported later in life in children who have been failure-to-thrive during infancy may be the effect of cumulative experiences, such as frequent hospitalizations, low SES and social deprivation which tend to accompany growth failure, with or without organic involvement.

In the present study, both sensorimotor tasks and visual information-processing tasks were used to assess early cognitive functioning. The Bayley (1969) Mental Scale of Infant Development served as a standard sensorimotor assessment. Visual recognition memory was assessed through use of the visual-preference paradigm developed by Fantz and Nevis (1968) and Fagan (1970). Visual recognition memory has been shown to advance in a developmental progression throughout the first year of life, to be related to neurological risk status, and to be predictive of later intelligence (Fagan & Singer, 1982). In presenting the study we begin with an explanation of the general procedure. Specific details as to subjects and result are then given for each of the three longitudinal test points: 8 months, 20 months, and 3 years.

**GENERAL PROCEDURE**

All infants were administered the Bayley Mental Scale of Infant Development and recognition memory tasks at initial assessment. On initial assessment, all nonorganic failure-to-thrive infants were tested in the hospital as soon as weight gain had stabilized, or if necessary, in the home within 1 week after hospital discharge. Organic failure-to-thrive infants were tested in the hospital after medical condition had stabilized. Control subjects were tested in the home.

Recognition memory tasks were given only at initial assessment and differed depending on the age of the infant. The tasks were similar to those which had elicited differential fixation in previous studies of normal 5- and 7-month-old infants (Fagan, 1973; 1976), and were also similar to tasks which differentiated groups of normal and Down syndrome infants (Miranda & Fantz, 1974). In addition, similar tasks had proved to be predictive of individual differences in later intelligence at 4 and 6 years for children in the normal to superior range of intelligence (Fagan & McGrath, 1981).
Infants at approximately 5 months of age (i.e., conceptional age of 60 to 64 weeks) were asked to solve four problems during a single session (Test A). The procedure was to expose the infant to one target until 40 seconds of visual fixation had been accumulated (20 seconds on the left and 20 seconds on the right side of the stage). The exposed target was then paired with a novel target for two 10-second periods with left–right positions reversed on each period. Test A was composed of tasks requiring discrimination and memory for a man's vs. a baby's face, the same man's vs. a woman's face, an upside-down and sideways versions of a woman's face, and a square vs. a curved black and white abstract pattern. The same procedure using a 20-second accumulated study period was followed for infants older than 7 months (ranging from 68 to 84 weeks of conceptional age). After the infant fixated the study target for 20 seconds, the previously exposed and novel targets were paired for two 5-second test periods, with left–right positions reversed from one period to the next. Infants 7 months or older were given five discrimination tasks during a session (Test B), two pairings of different women's faces, two pairs of babies' faces, and the same abstract designs from Test A.

Infants were given either Test A or Test B dependent on their age of entry into the study. Infants between 4-7 months of age were given Test A, while those older than 7 months were administered Test B. Of the 13 infants in the nonorganic failure-to-thrive group, 5 were tested with Test A and with Test B. The organic failure-to-thrive group included four infants given Test A and nine infants give Test B. Five control infants were given Test A and eight control infants were given Test B.

For recognition memory tasks, all subjects were tested by means of a portable apparatus, details of which have been illustrated by Fagan (1970). The apparatus consists of a testing chamber containing a pivoting stimulus presentation "stage." Removable 7 x 7 inch stimulus plaques were attached to the stage. When in place, the two plaques were 12 inches apart from center to center and approximately 12 inches from the infant's eyes. Through a ¼-inch peephole in the center of the stage, the observer could see corneal reflections of the stimulus targets. Amount of time of superimposition of the left or right reflection over the pupil of either eye was recorded. Tests of interobserver reliability in the measurement of differential fixation employing the same criteria as the present study have been made by a number of investigators and found to be uniformly high (see review in Fagan, 1973). Targets employed in the present study were chromatic and achromatic photographs of men's, women's, and babies' faces (four babies, four women, and two men) and two abstract black and white patterns. Each face photo measured approximately 5½ inches from crown to chin and was mounted on a 7 x 7 inch white stimulus plaque. Each abstract pattern measured approximately 6 x 6 inches and was mounted on a 7 x 7 inch white stimulus plaque.

At entrance into the study all infants were given visual recognition tasks and the Mental Scale of the Bayley Scales of Infant Development (Bayley, 1969). The Mental Scale was readministered at 20-month follow-up. At 36 months, the Stanford-Binet Intelligence Scale—Form L-M (Terman & Merrill, 1973) was given. A breakdown of the Bayley Mental Scale, the Kent Scoring Adaptation (Reuter, Stancin, & Craig, Note 1), was also used in an attempt to delineate specific areas of strength or deficit in cognitive functioning at initial assessment and at 20 months of age. The Kent Adaptation was used to differentiate performance along four domains drawn from items on the Bayley Mental Scale: cognition, language, fine motor skills, and social skills. This scoring adaptation of the Bayley yields a developmental age equivalent for each infant for each developmental skill domain when a total score of items passed is computed for each domain.

**INITIAL ASSESSMENT**

**Subjects**

The initial sample included 39 infants from three local hospitals in Cleveland, Ohio. The first 26 failure-to-thrive infants (13 nonorganic and 13 organic) identified in the hospital were recruited for the study. All 26 of the failure-to-thrive infants had been hospitalized at least once between the ages of 5 and 9 months and weighed under the third percentile for their conceptional age at testing. The absence of known organic etiology and weight gain during or shortly after hospitalization constituted the criteria in the present study for a diagnosis of nonorganic failure-to-thrive for 13 of the 26 infants. Documented organic etiology was the criterion for a diagnosis of organic failure-to-thrive for the other 13 failure-to-thrive infants, e.g., primary neurological disease, methadone addiction, cerebral palsy, congenital heart disease, pulmonary stenosis, cyanotic heart disease, polycystic renal disease, necrotizing enterocolitis, and Aarskog syndrome. The remaining 13 infants tested of the total 39 were infants who were not failure-to-thrive.

The data in Table I allow comparisons among the nonorganic failure-to-thrive, the organic failure-to-thrive, and the normal control infants at initial examinations in terms of gestational age at birth (weeks), postnatal age at test (weeks), conceptional age at test (weeks), birth weight (grams), and highest educational level attained by either parent (years of schooling com-
Mean, standard deviation, and range is listed for each characteristic. Separate analyses of variance indicated that the three groups of subjects did not differ significantly on the basis of gestational, postnatal or conceptional age, birth weight, or on levels of parental education at initial assessment.

Results

Visual Recognition Memory. To compare the three groups of infants (organic failure-to-thrive, nonorganic failure-to-thrive, and normals) on the basis of visual recognition memory, each infant’s duration of fixation to the novel relative to the familiar targets during recognition testing was computed for each problem. Total ratio of fixation to all novel vs. all familiar targets was then computed for each subject and a percentage of novelty score assigned to each subject. Mean percentages of total fixation time paid to novel targets during recognition testing are listed in the left column of Table II for each of the three groups. Percentages of total fixation time paid to novel targets vs. familiar targets were then compared with t tests to the percentage (50%) expected by chance performance. In terms of performance, recognition tasks were easily done by both the nonorganic failure-to-thrive and control infants as measured by means of 68% (SD 9.1, t(12) = 7.2, p < .001) and 62.5% (SD 9.2, t(12) = 4.0, p < .001), respectively. Organic failure-to-thrive infants, however, demonstrated only chance performance with a mean of 52.6%, (SD 8.5, T(12) = 1.1, ns).

A one-way analysis of variance was used to compare the three groups of infants on the basis of novelty scores. The results indicated a reliable difference among the three groups in responsiveness to novelty, F(2, 36) = 9.87, p < .005. Two orthogonal comparisons were made. When nonorganic failure-to-thrive infants were compared with the control infants, no reliable differences emerged, F(1, 36) = 2.1. A second orthogonal comparison indicated that the organic failure-to-thrive groups was reliably different from the other infant groups, F(1, 36) = 19.88, p < .001. Thus, when assessed for visual recognition memory, infants who were failure-to-thrive with organic etiology did significantly more poorly than both the nonorganic failure-to-thrive and the normal control infants. Developmentally, then, nonorganic failure-to-thrive infants demonstrated visual perceptual-cognitive abilities equivalent to normals, while organic failure-to-thrive infants as a group demonstrated significant deficits or delays.

Sensorimotor Abilities. A Mental Development Index Quotient (MDI) derived from performance on the Bayley Mental Scale was also computed for each infant. MDI quotients computed for each group are also listed in Table II. Control infants did quite well on the Bayley Mental Scale, as reflected in the mean MDI for that group of 120. Both failure-to-thrive groups did poorly however, with mean MDI of 77.6 for the nonorganic failure-to-thrive infants and 67.7 for the organic failure-to-thrive infants.

A one-way analysis of variance was used to compare the three groups on the basis of the Bayley Mental Scale performance, with reliable differences found in sensorimotor skills, F(2, 36) = 23.98, p < .001. Further orthogonal comparison indicated no differences between the performances of nonorganic and organic failure-to-thrive groups, F(1, 36) = .15, but reliable differences between the normal and the two failure-to-thrive groups, F(1, 36) = 46.45, p < .001. Thus, when compared on the basis of sensorimotor development at initial testing, organic failure-to-thrive and nonorganic failure-to-thrive infants did equally poorly, lagging considerably behind their nonfailure-to-thrive age mates in development.
TWENTY-MONTH FOLLOW-UP

Subjects

Table III describes the 33 infants who were available for follow-up assessment at 20 months of age (corrected for prematurity).

A series of analyses of variance indicated that, except for the birth weight, groups were not reliably different at follow-up on the demographic and birth status variables noted at initial assessment. Based on an orthogonal comparison, the organic failure-to-thrive group available for follow-up was characterized by lower birth weight than the other two comparison groups. At follow-up, it was also discovered that at least half the subjects in both failure-to-thrive groups had experienced from one to three relatively long-term placements outside their original home. Thus the number of such placements in a different caretaking setting, e.g., foster home, group home, rehabilitation facility, was computed for each subject.

Results

Developmental Outcome. At follow-up (mean age = 20.6 months), data from the Bayley Mental Scale on the 11 remaining subjects in each group were entered into a $3 \times 2 \times 4$ analysis of variance with repeated measures on the last two factors, using groups, age at testing, and Bayley Scale domain scores from the Kent Adaptation as factors. A significant main effect due to groups emerged, $F(2, 30) = 21.3, p < .001$, as the only

Table III. Comparison Among Nonorganic Failure-To-Thrive, Organic Failure-To-Thrive, and Normal Control Infants on Different Measures at Follow-Up at 20 Months

<table>
<thead>
<tr>
<th>Group</th>
<th>GA</th>
<th>CA</th>
<th>BW</th>
<th>P. Ed.</th>
<th>Placements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonorganic failure-to-thrive</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$M$</td>
<td>38.9</td>
<td>21.4</td>
<td>2,838</td>
<td>12.5</td>
<td>1.0</td>
</tr>
<tr>
<td>$SD$</td>
<td>1.9</td>
<td>3.5</td>
<td>680</td>
<td>1.4</td>
<td>1.0</td>
</tr>
<tr>
<td>Range</td>
<td>36-40</td>
<td>18-27</td>
<td>1,808-3,828</td>
<td>11-16</td>
<td>0-3</td>
</tr>
<tr>
<td>Organic failure-to-thrive</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$M$</td>
<td>37.</td>
<td>19.8</td>
<td>2,259</td>
<td>11.4</td>
<td>1.4</td>
</tr>
<tr>
<td>$SD$</td>
<td>3.6</td>
<td>3.22</td>
<td>897</td>
<td>1.4</td>
<td>1.0</td>
</tr>
<tr>
<td>Range</td>
<td>28-40</td>
<td>17-27</td>
<td>1,035-4,195</td>
<td>10-15</td>
<td>0-3</td>
</tr>
<tr>
<td>Normal controls</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$M$</td>
<td>38.9</td>
<td>19.6</td>
<td>3,091</td>
<td>12.5</td>
<td>0</td>
</tr>
<tr>
<td>$SD$</td>
<td>1.9</td>
<td>2.11</td>
<td>685</td>
<td>1.8</td>
<td>0</td>
</tr>
<tr>
<td>Range</td>
<td>36-40</td>
<td>18-25</td>
<td>2,041-4,368</td>
<td>11-16</td>
<td>0</td>
</tr>
</tbody>
</table>

*GA = gestational age (in weeks); CA = chronological age (in months corrected for prematurity); BW = birth weight (in grams); P. Ed. = parental education; Placements = number of placements.

* $n = 11$ per group.
reliable finding. For the cases remaining at follow-up, results of the initial Bayley Scale assessment were replicated, indicating that normal control infants had more advanced sensorimotor skills than both groups of failure-to-thrive infants, who in turn were not reliably different from each other. Since there were no main effects due to time of testing, the sensorimotor lags in the failure-to-thrive groups seen at original assessment apparently were still evident at follow-up approximately 1 year later. At both initial and 20-month assessments, no evidence for differential abilities in specific cognitive or developmental skills within any group were found based on the Kent Scoring Adaptation of the Bayley Mental Scale.

**Prediction of Outcome.** In order to address the questions of the predictive ability of the infant assessments and of the relationship of demographic and social variables to outcome, Pearson product-moment correlations were computed. Table IV illustrates the interrelationships among several demographic, cognitive, and environmental factors for all groups combined (n = 33).

Expectedly, birth weight and gestational age were highly intercorrelated (r = .81, p < .001). For the sample as a whole, black infants tended to have lower birth weights than white infants (r = -.38, p < .02). The number of placements outside the home an infant had experienced was highly and negatively related to 20-month Bayley MDI scores (r = -.66, p < .005). Although the number of placements was the only single variable which significantly related to outcome, birth weight and parental education were reliably associated with the number of placements an infant had experienced (r = -.48, -.38, p < .02). Thus, lower birth weight failure-to-thrive infants, who tended to be black and of less-educated parents, were placed more often in foster homes or institutions and had poorer developmental outcome at 20 months.

Examination of the data indicated that, by time of follow-up, a large proportion of infants in both failure-to-thrive groups had experienced some placement outside the home. This variable, considered to be a gross measure of changes in caretakers, had been unanticipated when the normal comparison group was recruited. Since individual Pearson-product-moment correlations, had indicated that number of placements were related to 20-month outcome, the normal control infants were not comparable to the other two groups of infants on this measure. Thus, within the two failure-to-thrive groups, the mean MDIs of those infants who had been reared at home were compared to the mean MDIs of those infants who had been moved out of the home as well as to the scores of the control infants. Table V presents the results of that breakdown, indicating that failure-to-thrive infants who were home-reared, whether organic or nonorganic failure-to-thrive, attained Bayley MDIs in the low average range at 20 months (mean MDI = 87.5), whereas infants placed outside the home achieved scores which would place them at risk for continued developmental delay (mean MDI = 68.8).

<table>
<thead>
<tr>
<th>Organic failure-to-thrive</th>
<th>Nonorganic failure-to-thrive</th>
<th>MDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home-reared</td>
<td>83.3</td>
<td>90</td>
</tr>
<tr>
<td>Placed</td>
<td>67.4</td>
<td>70.2</td>
</tr>
<tr>
<td>MDI</td>
<td>75.4</td>
<td>80.5</td>
</tr>
</tbody>
</table>

Correlations were also examined to assess the predictive power of perceptual-cognitive and sensorimotor measures to 20-month outcome. Performance on the Bayley Mental Scale during the first year of life was highly related to performance on the same measure at 20 months (r = .82, p < .001) for the entire sample. The correlations for the nonorganic failure-to-thrive, organic failure-to-thrive, and control groups between the two Bayley scores were similar (r = .51, .61, .75, p < .01).

Except for the organic failure-to-thrive group (r = .54, p < .01) visual recognition task performance was unrelated to Bayley MDIs achieved at 8 months. Correlations for the nonorganic failure-to-thrive, normal control, and combined groups were -.21, .06, and .11, respectively. By 20 months, correlations between measures of infant recognition memory and standard infant intellectual assessments for the same groups had risen to .54 (p < .01), .25 (ns), .52 (p < .01), and .29 (ns) for organic failure-to-thrive, nonorganic failure-to-thrive, control, and combined samples, respectively. Thus, visual recognition memory performance was unrelated to skill on sensorimotor measures during the first year of life except for the most severely compromised group of infants. By the end of the second year of life, however, visual recognition tasks bore a substantially increasing relationship to later performance on the standard infant assessment for all groups of infants.

**OUTCOME AT 3 YEARS**

**Subjects**

At 3 years of age, 25 children were available for follow-up assessment. As noted in Table VI, all nonorganic failure-to-thrive infants seen at 20 months remained for follow-up while 9 of 11 organic failure-to-thrive infants seen at 20 months remained for study. However, there was unusually high attrition of subjects in the normal control group, with less than half the original group attainable at 3-year follow-up. Losses appeared to be due to transience rather than lack of cooperation. Control subjects moved as often as subjects in other groups but were not as easily traceable through
community agencies such as County Welfare or medical providers which served the failure-to-thrive infants.

A series of t tests compared nonorganic failure-to-thrive and organic failure-to-thrive infants on the basis of gestational age, birth weight, parental education, initial novelty score, initial Bayley MDI, and 20-month Bayley MDI. Results suggested no reliable differences between the groups except on the basis of novelty score at initial assessment (t = 4.18, df = 18, p < .001). However, by 3-year assessment, the normal control group tended to be of higher birth weight, gestational age, and parental educational level than the failure-to-thrive groups.

Results

Developmental Outcome. Significant persistent cognitive deficits were apparent in both failure-to-thrive groups at 3-year follow-up as illustrated by the intellectual test results listed in Table VI. Organic failure-to-thrive infants performed most poorly, achieving a group mean standard score within the range of mild mental retardation (Stanford-Binet mean IQ = 67.7). Nonorganic failure-to-thrive infants obtained a mean IQ score in the borderline range of cognitive functioning (mean IQ = 78.6) which did not, however, reliably differentiate them from the organic failure-to-thrive group (t = 1.49, df = 18, ns). Control subjects attained a mean standard score well within the average range of functioning (mean IQ = 97.4). Due to the high dropout rate among control infants, the mean Bayley MDIs at 20 months of the control subjects remaining to 3-year follow-up were compared to scores of those control infants lost to follow-up. The results were essentially equivalent, with the former group obtaining a mean MDI of 109, and the latter obtaining a mean MDI of 111. Since the relationship between 20-month Bayley MDI and 3-year-old Binet IQ for the entire sample was highly reliable, as illustrated in the next section, the control group's average cognitive functioning was judged an appropriate comparison for the deficits shown by both failure-to-thrive groups.

Prediction of Outcome. Of the demographic and medical variables listed in Table VII, only parental educational level was directly related to intellectual outcome at 3 years of age (r = .49, p < .02). As at 20 months, parental educational level was highly related to the number of placements outside the home an infant had experienced (r = −.48, p < .02). Both gestational age (r = −.56, p < .01) and birth weight (r = −.65, p < .01) were related to the number of placements an infant had experienced. Twenty-month Bayley MDI was, as expected, a highly reliable predictor of Binet performance at 3 years (r = .83, p < .001). Most interestingly, both infant visual-recognition tests and the Bayley Mental Scale given at initial
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assessment were reliable predictors of 3-year Binet IQ score ($r = .47, p < .02$ and $r = .52, p < .01$, respectively).

**DISCUSSION**

The goals of the present study were threefold: (a) to assess the cognitive development of failure-to-thrive infants; (b) to investigate the relationship of demographic and medical factors to developmental outcome in this sample; (c) to compare the predictive validity of two methods of infant developmental assessment for a sample of high-risk infants.

The present results corroborate the impression of previous investigators that, early in life, nonorganic failure-to-thrive infants show delayed sensorimotor development relative to their peers, even when variations in age, race, prematurity, and SES are controlled (Elmer et al., 1969; Ramey et al., 1975; Fitch, Cadol, Goldson, Wendell, Swartz, & Jacobson, 1976). Based on the present study, such lags are still present well into the third year of life. However, the relationship between failure to thrive and development outcome is confounded by variables of prematurity, lower birth weight, and SES. Also, at least half the nonorganic failure-to-thrive infants had been placed into a caretaking situation outside the home, indicating another variable which needs to be investigated in the future study of failure-to-thrive infants.

Nonorganic failure-to-thrive infants demonstrated visual recognition memory equivalent to normal control infants, illustrating at least one information-processing skill which differentiates them from organic failure-to-thrive infants. This finding suggests that developmental delay in nonorganic failure-to-thrive infants may be related to a confluence of environmental factors rather than impaired CNS functioning. Using a conceptually similar perceptual–cognitive task on older nonorganic failure-to-thrive children, Kearsley (1979) and his associates reported case studies of children from 18-30 months of age who demonstrated a normal level of cognitive development based on a perceptual–cognitive task, but showed delayed development on the basis of the Bayley Scales. Since, with intervention, those nonorganic failure-to-thrive children studied by Kearsley had achieved a normal level of intellectual competence, their sensorimotor delays were attributed to environmental rather than intrinsic factors. In addition, in this sample, nonorganic failure-to-thrive infants who were home-reared achieved MDIs within the average range at 20 months, underscoring the importance of considering such caretaking variables in the study of nonorganic failure-to-thrive infants.

On the basis of their performance early in life on early visual recognition task and outcome at 3 years, organic failure-to-thrive infants would be

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<th>BW</th>
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<th>P.Ed.</th>
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\[ *p < .02, p < .01, p < .001\]
considered to be at higher risk for neurological problems and intellectual delay than nonorganic failure-to-thrive or normal infants, supporting the data of previous investigators (Riley et al., 1968; Ambuel & Harris, 1963). Additionally, in the present sample, a number of the organic failure-to-thrive infants had primary or secondary neurologic problems which would be expected to impair intellectual ability. Both outcome measures and the results of early visual recognition tests concur that infants who are failing to thrive secondary to organic disease show major continuing lags in development. Future studies need to focus on those factors associated with a diagnosis of organic failure-to-thrive which may be responsible for the severe cognitive deficits observed in such infants. It is unclear, for example, whether the delay in perceptual–cognitive development is due to the specific disease associated with the growth failure, the malnourishment, the interaction of physical illness with malnourishment, or lower SES and deprivation frequently associated with certain physical problems or prematurity and lower birth weight. The present study attempted to control for degree of malnourishment in the failure-to-thrive groups since all infants were under the third percentile in weight for age. However, the degree of malnourishment in organic failure-to-thrive infants may still be greater than that of the nonorganic infants (i.e., infants may be under the first percentile rather than the third), may be more pervasive (i.e., affecting length and head circumference as well as weight), or may be more chronic.

The fact that any group of organic failure-to-thrive infants is constituted of a heterogeneous population with diverse etiologies and outcomes also makes generalization from the present data difficult. Some organic diagnoses not necessarily accompanied by a diagnosis of failure-to-thrive, such as primary CNS dysfunction, fetal alcohol syndrome and drug addiction, are generally thought to be prognostic of later delayed or impaired intellectual status (Streissguth, 1977; Streissguth, Herman, & Smith, 1978). Other diagnoses, such as cyanotic heart disease and cystic fibrosis have not been found to be associated with poorer later intellectual development (Rasof, Linde, & Dunn, 1967; Lloyd-Still, Hurwitz, & Wolfr, & Schwallmann, 1974).

However, not all infants with organic disease fail to thrive, and whether or not malnourishment in conjunction with organic disease poses additional risk for later intellectual delay, as suggested by the present data, is unknown. Virtually no studies have compared organic failure-to-thrive infants with a specific disease to their nonfailure-to-thrive counterparts.

For the entire sample, parental educational level emerged as the only demographic variable reliably associated with 3-year outcome. In turn, whether or not a failure-to-thrive infant was placed in an alternate caretaking environment or was reared at home was related to parental educational level and prematurity. The possible interaction of perinatal factors and SES in determination of developmental outcome has been raised in other studies (Illsley, 1966; Drillien, 1959; Wiener, 1968), and highlights the importance of accounting for the influence of such variables on eventual cognitive competence in failure-to-thrive populations.

In contrast to other reports (Kopp & McCall, 1980), the first-year Bayley Mental Scale performance was a surprisingly high predictor of later intellectual achievement in this sample. Testing failure-to-thrive infants towards the end of or after their hospital stay may have decreased the interference of state variables and thus increased the concurrent validity of the assessment (Drotar et al., 1980).

Most interestingly, visual recognition memory proved to be an easily administered, valid predictor of cognitive deficit in this sample. Since Bayley Mental Scale scores were uncorrelated with visual recognition memory performance at initial test, visual recognition memory testing appears to have tapped perceptual–cognitive information-processing skills in a way not sampled by the Bayley. Because they appear less dependent on state and motivational variables, and because they do not rely as greatly on motor skills as do standard infant assessment procedures, visual recognition memory tasks appear to be a promising adjunct to the developmental assessment of high-risk or physically disabled infants.

REFERENCE NOTE


REFERENCES


Cognitive Development in Failure-to-Thrive Infants


Singer and Fagan


