EFFECTS OF IRON THERAPY ON NON-COGNITIVE BEHAVIOR OF IRON DEFICIENT ANEMIC INFANTS

by

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Abstract

Thirty-four iron-deficient anemic infants aged 6 to 24 months were recruited through the outpatient clinic of a large urban children's hospital. Subjects were randomly assigned to experimental and control groups and pretested with the Bayley Scales of Infant Development. Experimental subjects (n=17) were injected with intramuscular iron dextran, and control subjects (n=17) underwent a sham procedure. Subjects were given a posttest with the Bayley scales one week later. Ratings of the Infant Behavior Record were tested, using the McNemar test for the significance of changes, and revealed a significant ($p \leq .05$) change from suspect to non-suspect ratings for Task Orientation in the experimental group, following treatment. No significant change was observed for Test Affect. These findings support the hypothesis that intramuscular iron therapy results in improved Task Orientation. The hypothesis that intramuscular iron therapy results in improved Test Affect was not supported.

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Chapter 1

Introduction

Iron deficiency, with or without anemia, is a world-wide problem, particularly in developing countries. Prevalence rates vary, depending on the criteria used, however, iron deficiency has been well documented as the world's most common nutritional disorder (Lozoff & Brittenham, 1986; Pollitt & Leibel, 1976). A number of hematologic measures are used to determine level of iron deficiency, which ranges from depleted stores to restricted production of iron compounds. According to Scrimshaw (1984), there is a mounting body of evidence that confirms functional consequences of subclinical iron deficiency in humans.

Non-hematologic manifestations include reduced activity as well as cognitive and behavioral aberrations (Lozoff & Brittenham, 1986; Oski & Honig, 1978; Pollitt & Leibel, 1976). There is agreement among researchers that iron deficient humans tend to be irritable, apathetic, fearful, to have reduced activity levels, and to perform poorly on tests of cognitive ability (Deinard,

Gilbert, Dodds, & Egeland, 1981; Deinard, List, Lindgren, Hunt, & Chang, 1986; Lozoff, Wolf, Urritia, & Viteri, 1985; Oski & Honig, 1978; Oski, Honig, Helu, & Howanitz, 1983; Walter, Kovalskys, & Stekel, 1983). The implications for infants and children may be critical because iron deficiency is most prevalent between the ages of 6 and 24 months, a time of rapid brain growth and achievement of developmental milestones (Lozoff & Brittenham, 1986). Inadequate iron stores during this period could result in irreversible developmental disturbances. Incidence rates are highest in lower socio-economic groups (Pollitt & Leibel, 1976), however, "a host of biological and social-psychological correlates" (p. 373) may complicate study of this issue. Covarying factors could include the following: (a) level of parental education, (b) other nutritional deficiency, (c) little environmental stimulation, and (d) close spacing between births.

Longstaffe (1985) reviewed 50 cases of iron deficiency anemia treated in preschool children at Winnipeg Children's Hospital. The clinic of this primary care facility serves a mainly urban, low socio-economic population, largely of native and metis children. It was

concluded that traditional methods of therapy such as dietary counselling and oral iron were less than fifty percent effective in correcting anemia. Longstaffe attributed the unsuccessful results of oral iron therapy to a combination of mediating factors: (a) patient transience, (b) impoverished population, (c) compliance difficulties, and (d) parental caregiving problems.

Kimmons, Moffat, and Longstaffe (1987) conducted a randomized controlled trial with another sample of infants from the Winnipeg Children's Hospital, to determine the impact of intramuscular (IM) iron therapy on mental and motor development test scores one week after treatment. These researchers chose IM iron therapy because of poor response factors to oral iron therapy similar to those outlined above. Thirty-four iron-deficient anemic infants were randomly assigned to receive either IM iron dextran or a sham procedure. All subjects were assessed with the Bayley Scales of Infant Development (Bayley, 1969) on the day of randomization and one week after treatment.

The present study is a secondary analysis

of data obtained by Kimmons et al. (1987). The goal of this study is to determine if IM therapy affects change in infants' attending and responding behavior one week after treatment. The decreased responsiveness and attention span and heightened tension and fearfulness often associated with iron deficiency are considered important, because they may impinge on a subject's cognitive development.

Two major needs have been met through completion of the present study. The most immediate concern was to determine whether repletion of iron stores affected change in attending and responding behavior one week after treatment. Kimmons et al. (1987) found no significant increase in developmental test scores on the Bayley Scales of Infant Development in the primary analysis of this study, after a one week interval. However, it is possible that change in responding and attending behavior may precede measureable gains in cognition.

The present study met a second need in the use of the Infant Behavior Record (IBR), a component of the Bayley Scales of Infant Development (BSID) (Bayley, 1969). The IBR is a behavioral

assessment that does not provide a summary score but does yield important information about a child's temperament, affect, and other behaviors. Matheny (1980) factor analyzed the IBR ratings of a large sample of twins and found "that a few, and descriptively recurrent, behavioral dimensions account for the individual differences observed among infants during testing with the Bayley scales" (p. 1165). The two most salient factors were Task Orientation, and Test Affect.

Wolf and Lozoff (1985) developed an empirically based method for determining whether individual ratings on the IBR are normal (non-suspect) or indicate the need for further assessment (suspect). Lozoff et al. (1985) applied these methodologies in a study of the effects of oral iron therapy on the behavior and developmental test scores of anemic infants. Although their findings were not definitive, they warrant further exploration. This study contributes to the body of literature investigating use of the IBR in research settings.

The population served by Children's Clinic, Winnipeg Children's Hospital, has physiological

and social characteristics that contribute to a high incidence of iron deficiency in infants. These characteristics include the following: (a) low socio-economic status, (b) inadequate diet, (c) difficulties in administration of oral iron, and (d) high degree of transience, which hinders follow-up. The purpose of this study was to investigate the non-hematologic outcomes of intramuscular (IM) iron therapy one week after treatment. IM therapy was chosen because this population responds poorly to oral iron therapy (Longstaffe, 1985). An interval of one week between pretest and posttest was chosen because this was the length of time employed in similar studies (Lozoff et al., 1985; Oski & Honig, 1978).

The study addresses the following research questions:

1. Does intramuscular iron therapy result in significant change in Task Orientation?
2. Does intramuscular iron therapy result in significant change in Test Affect?

Operational Definitions

The iron deficient state is one in which

the following criteria are met: hemoglobin $\leq$ 105 gm/l; mean corpuscular volume $\leq$ 73 fl; and at least two of: serum iron concentration $\leq$ 50 ug/dl, transferrin saturation 12% or less, serum ferritin $<$ 12 ng/ml, and erythrocyte protoporphyrin values $>$ 30 and $<$ 300 ug/dl.

Task Orientation is the factor defined by Matheny (1980), which includes the Infant Behavior Record (IBR) items: (a) object orientation, (b) goal directedness, (c) attention span, and (d) reactivity (see Appendix A, Items # 8, 11, 12, 15).

Test Affect is the factor defined by Matheny (1980), which includes the IBR items: (a) responsiveness to examiner, (b) fearfulness, (c) tension, (d) emotional tone, and (e) endurance (see Appendix A, Items # 2, 5, 6, 7, 13).

Statement of the Problem

The major problem of this study was to determine the impact of intramuscular iron therapy on non-cognitive aspects of infant behavior such as Task Orientation and Test Affect.

Delimitations

1. Experimental subjects were iron deficient children recruited through Children's Clinic, private pediatricians, and other health care centres, who were 6 to 24 months on entry, and from whom parental consent was obtained.

2. Control subjects were iron deficient children recruited through Children's Clinic, private pediatricians, and other health care centres, who were 6 to 24 months old on entry, and from whom parental consent was obtained.

3. Only children whose hematologic status met the iron deficient state defined above, had no chronic illness, no documented developmental delay, no evidence of severe social chaos were eligible for the study.

4. The study is a randomized controlled trial, double blind.

Assumptions

1. Factors associated with Task Orientation and Test Affect are mediators in a subject's ability to perform on tests of mental development.

2. Iron status affects Task Orientation and Test Affect.

Chapter 2

Review of Literature

The following chapter presents a brief review of a developmental theory based on adaptation to the environment. This is followed by a review of the literature on iron deficiency and the Infant Behavior Record, which provides a rationale for the research questions posed in this study.

Piaget's Theory

The developmental theory of Jean Piaget (1970) stems from biological presuppositions and results in epistemological consequences. The concepts of accommodation and assimilation can be applied to organic as well as behavioral development. From a biological perspective, assimilation is the process of taking an additional element such as food into an existing structure where it is transformed and incorporated into the substance of the organism. In the cognitive domain, existing organizations or schemes make new events intelligible and represent the stabilizing, generalizing side of intelligence. Biologically, accommodation involves the structure itself

and the changes it makes when new elements are added. Cognitively, accommodation is the modification of existing conceptions or schemas to new information. This represents the changing, discriminating side of intelligence (Baldwin, 1980; Cowan, 1978; Piaget, 1970).

According to Piaget (1970), accommodation, assimilation, and maturation contribute to intellectual development but require a fourth factor, equilibration, to "coordinate them in a consistent, noncontradictory totality" (p. 722). Equilibration is a self-regulatory process that includes the response of the organism to the environment as well as the organism's relationship to that environment (Piaget, 1952). Therefore, reason, can be described as an "increasingly advanced acquisition of awareness of the organizing activity inherent in life itself" (p. 19).

The equilibration between assimilation and accommodation is present in all four stages of Piaget's theory: (a) sensori-motor, (b) pre-operational, (c) concrete, and (d) formal operations (Piaget, 1970). For purposes of this study, only the sensori-motor period will be considered. Piaget maintained that there is a constancy

in the order of succession but cautions that experience with the environment may hasten or delay rate of progression. Cowan's (1978) age parameters are used here as points of reference.

The first substage of the sensori-motor stage lasts from birth to approximately 1½ months of age. During this time there is no differentiation between assimilation and accommodation; reflexes are the bases for primary emotions. Emergence of accommodative processes occurs from the end of substage one until about age 4 months. At this time, the child repeats activities to nourish hunger for stimulation (primary circular reaction). This substage marks the beginnings of differentiation of emotions. Secondary circular reactions or voluntary accommodative activity are apparent during the third substage, or until the age of 6 months. Repetitions are retained and generalized to other stimuli. There is a fascination with adults as social objects when they are in view. Permanency of objects, beginning with the self, occurs during the fourth substage (from 6 to 12 months). True imitation of a novel response is observed during this stage. Overt trial

and error behavior to acquire knowledge (tertiary circular reactions) emerges during the fifth substage, between 12 and 18 months. There is an enhancement of affect and an awareness of self as a causal agent. The final substage extends to about 24 months. The child engages in mental trial and error behavior and the construction of cognitive maps. Deferred imitation is evident, as well as symbolic play for conflict resolution, compensation, and role inversion (Piaget, 1952).

Each substage consists of behavior patterns that are formed by differentiation and adaptation of preceding behaviors (Piaget, 1952). Bayley (1970) suggested that the nature of mental processes changes in infant development from simple sensori-motor adaptations to complex abstractions and reasoning, and that clusters of ability are stage rather than age related. Bayley stated that this position is congruent with the findings of Piaget. This theoretical perspective was used in the Bayley Scales of Infant Development (Bayley, 1969), which were designed to elicit and test infant adaptive responses to the environment. The scales are organized into situations that elicit

increasingly complex behaviors. Bayley (1970) cautioned that adequacy of function at a simple level is not necessarily predictive of later ability with complex processes. However, she emphasized that the primary value of the scales is to establish the child's current status so developmental problems can be recognized and appropriate corrective measures taken.

The mental and motor scales are standardized and have been used extensively in clinical and research settings. A third component of the scales, the Infant Behavior Record (IBR), was not designed to generate a summary score or profile. However, it does provide information about the child's social and objective orientations to the environment (Bayley, 1969). The IBR has recently been identified as a more useful research tool than was previously recognized (Matheny, 1980; Wolf & Lozoff, 1985).

Some of the behaviors that are often associated with iron deficiency are (a) irritability, (b) apathy, (c) decreased responsiveness, and (d) poor attention span (Lozoff & Brittenham, 1986). The IBR includes items that rate these and other behaviors and

is considered an appropriate tool for measuring the variables to be tested in the hypotheses of this study.

Iron Deficiency

According to Harris and Kellermeyer (1970): "iron is quantitatively the single most important biocatalytic element in the entire realm of animal enzymology" (p. 66). Iron is important for the use, transport, and storage of oxygen to meet metabolic demands of tissues. Scrimshaw (1984) described overlapping stages of iron deficiency as: (a) loss of storage iron, (b) decrease in circulating iron, and (c) restriction of production of essential iron compounds. The hematologic measures are, respectively: (a) serum ferritin, (b) serum iron, and (c) hemoglobin. The first two criteria indicate iron deficiency alone; the third denotes iron deficiency anemia.

The anemic state represents a threat to sufficient tissue oxygenation. Oxidative enzymes affect Central Nervous System (CNS) neurochemistry and muscle function (Scrimshaw, 1984). CNS function affects attending behavior, which is generally defined as "the process by which an organism directs his [her] sensory and elaborating

(cognitive) systems" (Lewis, 1971, p. 173). The ability to attend well gives infants an advantage over ones whose attending capacities are limited; observed differences are predictive of differences in other learning phenomena. Pollitt, Viteri, Saco-Pollitt, and Leibel (1982) investigated the effect of iron therapy on discrimination-learning tasks. These researchers suggested that effects of iron deficiency and anemia are located at the information reception level. They claimed that inadequate attention to environmental cues delays problem solving processes in children.

Oski and Honig (1978) conducted a randomized controlled study to investigate the effects of intramuscular iron treatment on the developmental test scores of iron deficient anemic infants. Subjects were pretested with the Bayley Scales of Infant Development (BSID) (Bayley, 1969) preceding randomization to experimental and placebo groups. This was done to avoid the possibility of the procedure interfering with optimum test performance. Posttesting occurred 5 to 30 days later. At each session, all three components of the BSID were completed. The

authors found a significant increase ($p < .01$) in the Mental Development Index (MDI) scores of the experimental group. The following Infant Behavior Record (IBR) items were selected for analysis: (a) reactivity, (b) attention span, (c) gross muscle movement, and (d) fine motor coordination. Positive change was observed in the experimental group for the item "reactivity" ($p < .018$). These items were selected for analysis because they are "non cognitive behavioral areas in which decrement in functioning has been clinically suspected in iron-deficient infants" (p. 23).

Oski et al. (1983) investigated the effects of intramuscular iron therapy on non-anemic subjects one week after treatment. Subjects were grouped according to hematologic status, which ranged from normal (iron replete) to biochemical and cellular iron deficiency. Irrespective of status, all subjects were injected with iron dextran. The researchers found that MDI scores increased significantly for the iron deficient groups following treatment ($p < .01$), and did not increase significantly for normal or iron depleted subjects. This finding suggests that,

even in the absence of anemia, iron deficiency can impair cognitive performance, and that intramuscular iron therapy can improve this performance after one week. Attending and responding behaviors were not analyzed in this study.

Deinard et al. (1981) investigated the relationship between hematologic status and performance on the following three scales: (a) an habituation measure (an index of attending behavior), (b) the BSID, and (c) 3 of the Uzgiris and Hunt Ordinal Scales of Psychological Development. Following non-random assignment to mildly or severely iron deficient or iron replete groups, subjects were assessed with the three above measures by testers who were blind to group assignment. Although group means indicated more fearfulness in the severely depleted subjects than those who were iron replete, the authors found no significant differences among groups on test performance. No treatment was administered in this study, and the authors did not control for other factors that may have influenced results such as environmental conditions and nutritional status. A true experimental design controls for these factors (i.e., see Kimmons et al., 1987).

Oral iron was the treatment used in four studies of anemia and behavior (Deinard et al., 1986; Lozoff et al., 1985; Lozoff, B., Brittenham, G., Wolf, A., McClish, D., Kuhnert, P., Jimenez, R., Mora, L., Gomez, I., & Krauskoph, D., 1987; Walter et al., 1983). The latter researchers found no significant pre- and posttest differences on the MDI for control subjects (iron replete) and iron-deficient, non-anemic infants. The third group, which was anemic, had significantly improved MDI scores ($p < .01$) after 11 days of treatment. These results were not confirmed by Lozoff et al. (1985), who found that MDI scores did not improve significantly after a similar interval; or Lozoff et al. (1987) who observed no significant differences between iron treated and placebo groups on MDI scores one week and 3 months after the onset of treatment. Deinard et al. (1986) found that mean MDI scores were not significantly improved in their experimental group, despite hematologic correction after 6 months.

Data on improved cognitive performance in anemic infants after iron treatment is inconclusive,

and methodologies for measurement of attending and responding behaviors have been inconsistent. Despite the absence of a standardized measure of non-cognitive behavior, certain tendencies have been observed that warrant further investigation. Although no evaluation of hematologic status was done post-treatment, Walter et al. (1983) found significantly improved attention span and cooperativeness in anemic subjects following oral iron therapy. Improved reactivity following treatment was observed in experimental subjects, though not at significant levels, by Oski and Honig (1978). Deinard et al. (1986) detected differences between anemic and control subjects in responsiveness to the examiner and responsiveness to the environment. The differences were significant 3 and 6 months following the onset of treatment with oral iron.

In summary, it is clear that two conditions must be met in order to determine the effectiveness of iron therapy on the behavior of iron-deficient anemic infants. First, a true experimental design is necessary to control for possible influencing factors such as home environment

and nutritional status, because these variables could have an impact on developmental test performance. The second criteria is a standardized measure for attending and responding behaviors, which have been shown to improve in some subjects following iron therapy.

Infant Behavior Record (IBR)

Recent work by Matheny (1980) and Wolf and Lozoff (1985) indicated that the IBR is a valuable instrument for determining deviant or suspect behavior in infants. Retrospective studies were conducted on the original IBR data and the Louisville Twin Study. Wolf and Lozoff (1985) found that suspect behaviors are "clinically identifiable as poorly adaptive, belong to a group of ratings clearly separated from those reflecting more adaptive behavior, and ... infrequent in the normative samples".

Matheny (1980) factor analyzed all of the IBR items for age cohorts ranging from 2 to 24 months. Five major and 2 minor factors were obtained, which were consistent across age, sex, and culture. The five major factors were: (a) Task Orientation, (b) Test Affect, (c) activity,

(d) auditory-visual awareness, and (e) motor coordination. The two minor factors were mouthing and nonnutritive sucking. The cluster of items, Task Orientation, had the highest factor loadings, which confirms the results of other researchers (Oski & Honig, 1978; Walter et al., 1983). This is consistent with the theoretical perspective of Piaget (1970). A central tenet of his developmental theory is that constructions are a natural consequence of interactions with the environment. These operations are generated by active adaptation of inborn mental processes to environmental experience, rather than mere sensory recordings or associations. This theory implies intentionality on the part of the subject; the subject attends because stimulation activates the drive to equilibration between assimilation and accommodation. Lewis (1971) viewed attention as an operation of information processing and "as a measure of cognitive functioning" (p. 177).

Test Affect is the second major factor identified by Matheny (1980). Also labelled "extraversion", this factor had the second highest loadings and was evident from the age of 3 months.

It pertained to "the degree that infants were positive, outgoing, and involved in the social give-and-take of the test situation" (p. 1159). The concept of extraversion fits well with Piaget's theory because he views cognition and emotion as aspects of a single system (1951). A child does not imitate a model for the sake of imitation but as a continuation of his/her understanding of a model or familiar figure. Even though sometimes the intensity is low, the child must have some level of interest in the model. There is incentive to imitate a familiar figure or model, one for which some assimilative scheme already exists: "the esteem in which the model is held becomes an important element" (Piaget, 1951, p. 73). A child's emotional state is observeable by the measured degree of happiness, level of arousal, level of energy, and expressive style (Cowan, 1978).

Wolf and Lozoff (1985) considered infants abnormal if they were suspect for two or more items in a given cluster such as Test Affect or Task Orientation. These researchers and others analyzed the IBR ratings for subjects

in a cohort study of iron deficiency and behavior (Lozoff et al., 1985). They concluded that performance on developmental tests is an indirect result of disturbances in affective behavior. They also recommended further validation of the IBR as a research tool. In a later study, however, Lozoff, Klein, and Prabucki (1986) suggested that variations in affective behavior can be accounted for by attachment theory. These researchers conducted an exploratory study of play behaviors of iron-deficient anemic infants and non-anemic controls. They found no significant differences between groups on measures of irritability, distractibility, and apathy. However, Lozoff et al. did find that mother-anemic infant dyads sought close contact significantly more often ($p < .02$) than control dyads. They interpret these findings to reflect poor affect, but also "a relatively effective compensatory mechanism that enabled the iron-deficient anemic babies to play without ... obvious behavioral disturbances" (Lozoff et al., 1986, p. 156). In other words, although their data was collected from free play situations, it is possible the same phenomenon

occurs in a testing situation where the child is accompanied by a parent.

Hypotheses

Inadequate stores of body iron affect oxidative enzymes and Central Nervous System (CNS) functioning (Scrimshaw, 1984). CNS dysfunction has a negative effect on a subject's ability to attend to environmental stimulation (Lewis, 1971). Attention or orientation to objects is considered a fundamental aspect of cognition and is linked to intellectual functioning (Lewis, 1971; Matheny, 1980; Piaget, 1970). Piaget claimed that knowledge arises from interactions between subject and environment. This interaction implies the existence of two interdependent activities: (a) coordination of actions, and (b) introduction of interrelations between objects. Object permanence is achieved during the fourth substage of the sensori-motor stage of infant development, when objects become entities independent of the subject. The ability to attend to environmental stimuli is a prerequisite to actions on them.

Based on this Piagetian theory, one can develop the following propositions: (a) the development of cognition is a process that requires

the subject to attend to persons and objects so he/she can act upon them; (b) anemic children, whose ability to attend is impaired because of Central Nervous System dysfunction, are not able to attend adequately to the environment; and (c) the attending and responding behaviors included in the factors, Test Affect and Task Orientation, can be improved with iron therapy.

The hypotheses for the study were based on the propositions outlined above, which were based on Piaget's theories, and the review of the relevant literature. The two hypotheses addressed in this study are as follows:

H_I. A significant number of experimental subjects will change from suspect to non-suspect ratings in Test Affect following intramuscular iron treatment. The number of control subjects rated as suspect will not change significantly.

H_{II}. A significant number of experimental subjects will change from suspect to non-suspect ratings in Task Orientation following intramuscular iron treatment. The number of control subjects rated as suspect will not change significantly.

Chapter 3

Methods of Procedure

The present study was a secondary analysis of data obtained from a study conducted at the Winnipeg Children's Hospital on the effects of intramuscular (IM) iron therapy on infant behavior (Kimmons et al., 1987). The findings of the primary analysis indicated no significant change in developmental test scores in the experimental group one week after treatment.

Description of Sample

The targeted population for the original study was all children, 6 to 24 months, screened as anemic through Children's Clinic or other Winnipeg physicians. The study was explained to interested parents and their informed consent was obtained. Eligibility criteria included: hemoglobin $\leq$ 105 gm/l;[1] mean corpuscular volume $\leq$ 73 fl; confirmation of hematologic status by at least two other measures. Children with intercurrent illness, chronic disease, previous indication of developmental delay, or severe chaotic home situations were considered ineligible.

Parents who participated in the study received transportation to and from appointments.

A total of 68 children were identified as potential subjects for the original study. Nine parents did not wish to have their children participate in the study and two children were considered ineligible because of major family upheaval at the time. Twelve children from whom previous parental consent had been obtained were excluded from the study. The reasons for their exclusion were that eight had increased hemoglobins ($>$105 gm/l), and 4, despite repeated attempts by the research team, were not brought in for scheduled appointments. Eleven children were withdrawn from the study following group randomization for the following reasons: (a) 4 had increased hemoglobins ($>$105 gm/l), (b) 2 parents did not wish their children to continue in the study, and (c) 4 were excluded because they failed to keep the second appointment. All children who were withdrawn from the study were referred to the clinic for routine follow-up. In one case, the child was not assessed because of her extreme anxiety in the testing situation.

Caregiving problems were also noted so the child was referred to Child Development Clinic for further assessment and follow-up. A total of 34 subjects participated in the study.

The 34 subjects who made up the final sample had a median age of 13 months, 19 of whom were male and 15 of whom were female. The heads of 9 households were employed, and 25 received social assistance. Twenty-seven families were of Native or Metis extraction, and 7 were non-native.

Procedure for Data Collection

Within one week of providing informed consent subjects returned to Children's Clinic for the first study appointment. At this time, in the presence of the infants' parents, a trained research assistant administered the pretest with the Bayley Scales of Infant Development (BSID). Developmental testing preceded randomization into groups and venipuncture necessary for blood work, because these procedures can be stressful and could interfere with optimum performance during the assessment.

An independent statistician provided a table of random numbers for control and experimental group assignments. Subjects received either

an injection of iron dextran (experimental group) or a sham procedure (control group), which consisted of a dot of India ink on the thigh. In each case, a bandage was placed over the site, and parents were advised that a small dark spot would appear. One nurse performed all randomization into groups and disposition of blood samples. She had minimal contact with other study personnel and parents, who remained blind to group assignments.

Subjects returned after one week for posttesting with the BSID and a second venipuncture to test hematologic status. All subjects were placed on a course of oral iron, and given dietary counselling. Follow-up treatment continued for two months for the primary study; one parent withdrew his child during that time. Upon completion of the study, all children were referred to Clinic for routine care.

To ensure that environmental variables were similar for the experimental and control groups, one member of the research team visited the homes and administered Caldwell's Home Inventory. This inventory measures the following conditions that could affect development: (a) responsivity

of mother, (b) avoidance of restriction/punishment, (c) organization of environment, (d) play materials, (e) maternal involvement, and (f) daily stimulation. No significant differences were found between the experimental and control groups on this measure.

Instrumentation

The dependent variables, Test Affect and Task Orientation, were measured by the Infant Behavior Record (IBR) of the Bayley Scales of Infant Development (Bayley, 1969) (see Appendix A). The scales were designed for use with children from one to 30 months and have been widely used in clinical and research settings. The IBR standardization sample had a total of 885 infants representative of the general population of the United States at the time of the 1960 census (Bayley, 1969). The assessment consists of the Mental Development Form, the Psychomotor Development Form, and the Infant Behavior Record (IBR).

The IBR is completed by the examiner immediately following administration of the test. The purpose of the IBR is to aid in the assessment of "the

nature of the child's social and objective orientations toward his environment" (Bayley, 1969, p. 4). The IBR does not generate a summary score, but it does provide an opportunity for the examiner to record qualitative observations and impressions that add to clinical understanding of a child's status. There are 30 items that focus on affect, motivation, and sensory areas of interest. The majority of the items are rated on 5 to 9 point scales. The examiner chooses the statement that best describes the child's observed behavior. Each item stands alone as an evaluation of the child's behavior indicated by the specific item. Only three items are rated according to expected behavior for age: (a) level of energy, (b) coordination of gross muscle movements, and (c) coordination of fine muscles (see Appendix A, items 25-27). Distributions of ratings, by age, for the standardization sample are provided in the manual. Matheny (1980) obtained interobserver reliabilities for 96 subjects (median 87%); Seegmiller and King (1975) obtained agreement to within one scale point (median 89%) for 40 subjects.

Wolf and Lozoff (1985) investigated behavior

patterns of infants during testing by examining IBR data from the original standardization group (Bayley, 1969) and the Louisville Twin Study (Matheny, 1980). These researchers found that from 6 to 30 months, the two samples were similar for 15 general behavior rating scales in the following respects: (a) the point on each rating scale that indicated maladaptive behavior, and (b) the proportion of subjects who were rated below this point. Maladaptive, or suspect behavior was observed infrequently in these normative samples.

Variations in behavior during the first 6 months of life can be attributed to the fact that a child is focused on his/her own body. Behavioral organization remains unstable until means and ends become separate entities, at the end of the third substage of the sensori-motor stage, at about 6 months of age (Piaget, 1952; Wolf & Lozoff, 1985). All subjects in the present study were over 6 months old, therefore the IBR is appropriate for use with the sample.

Data Analysis

The present study investigated data obtained from a double blind randomized controlled trial.

This experimental design meets the criteria described by Campbell and Stanley (1963) for the pretest-posttest control group design. This design controls for other variables that could confound results, such as maturation, test effect, and regression. Non-parametric statistics were selected to test the hypotheses, because the data were nominal (Siegel, 1956). The dependent variables were the post-treatment Infant Behavior Record status for Test Affect and Task Orientation. The data were tested with the chi-square, goodness of fit, to determine whether differences existed between groups following treatment. Given that each subject served as his/her own control, the McNemar test for the significance of changes was also used to analyze individual change.

The parametric *t*-test was used to test the null hypothesis that the experimental and control groups were not significantly different at the pretest, with respect to hemoglobin counts. Probability levels of $<.05$ were considered significant in these analyses.

Chapter 4

Results

The first part of this chapter presents the raw data for the study, and statistics concerning hemoglobin counts at the pre- and posttests. The following sections present the results of the tests of the hypotheses for Test Affect and Task Orientation.

Descriptive Statistics

The raw data for the experimental and control groups are shown in Table 1 and Table 2, respectively. Hemoglobin counts for the experimental group ranged from 71 to 105 gm/l at the pretest (M=91.76 gm/l; SD=8.8), and from 88 to 112 gm/l (M=99.47 gm/l; SD=7.2) at the posttest.

Control group hemoglobin counts ranged from 81 to 106 gm/l (M=96.13 gm/l; SD=8.3) at the pretest, and from 83 to 105 gm/l (M=94.65 gm/l; SD=8.4) at the posttest. The pretest hemoglobin count for one control subject was not available, therefore, hemoglobin counts for that subject were not analyzed.

Table 1 indicates which experimental subjects

Table 1

Experimental Group Raw Data

Subject	Hemoglobin		Test Affect		Test Orientation	
	pre	post	pre	post	pre	post
1	96	102	x	x	x	x
2	105	110			x	x
3	89	98	x	x		
4	96	105		x		
5	101	99			x	x
6	71	89			x	x
7	91	100			x	
8	96	105	x	x	x	x
9	91	89				
10	77	91			x	
11	89	98	x			
12	88	88			x	
13	103	112			x	
14	83	107				
15	90	102				
16	97	99		x		
17	97	97		x	x	

x rated as suspect

Table 2

Control Group Raw Data

Subject	Hemoglobin		Test Affect		Task Orientation	
	pre	post	pre	post	pre	post
1	90	93				
2	95	91	x	x		x
3	106	101				
4	99	96				
5	104	105				
6	103	99			x	x
7	81	83			x	x
8	100	95			x	x
9	*	62				
10	103	101			x	
11	101	101			x	
12	102	103			x	x
13	104	98	x		x	
14	84	85		x		
15	85	105			x	x
16	95	103			x	x
17	86	88				

* data not available

x rated as suspect

were rated as suspect for the dependent variables, Test Affect and Task Orientation, at the pre- and posttests. Data on control subjects is shown in Table 2.

The mean hemoglobin counts for the pre- and posttests are shown in a bar graph (see Figure 1). A *t*-test was performed to assess the difference between the pretest means, and yielded a *t* value of 1.46. Therefore, the null hypothesis cannot be rejected at the .05 level of significance. At the pretest, the experimental and control groups were not significantly different with respect to hemoglobin counts.

Test Affect

The Test Affect ratings for the experimental and control groups are shown in Table 3. The χ^2, goodness of fit, was performed to test whether a significant difference existed between the number of control and experimental subjects rated as suspect and non-suspect, at the pretest and posttest. The results ($\chi^2=1.31$; $p < .3$) indicated that the groups were not significantly different.

Each subject was considered as his/her

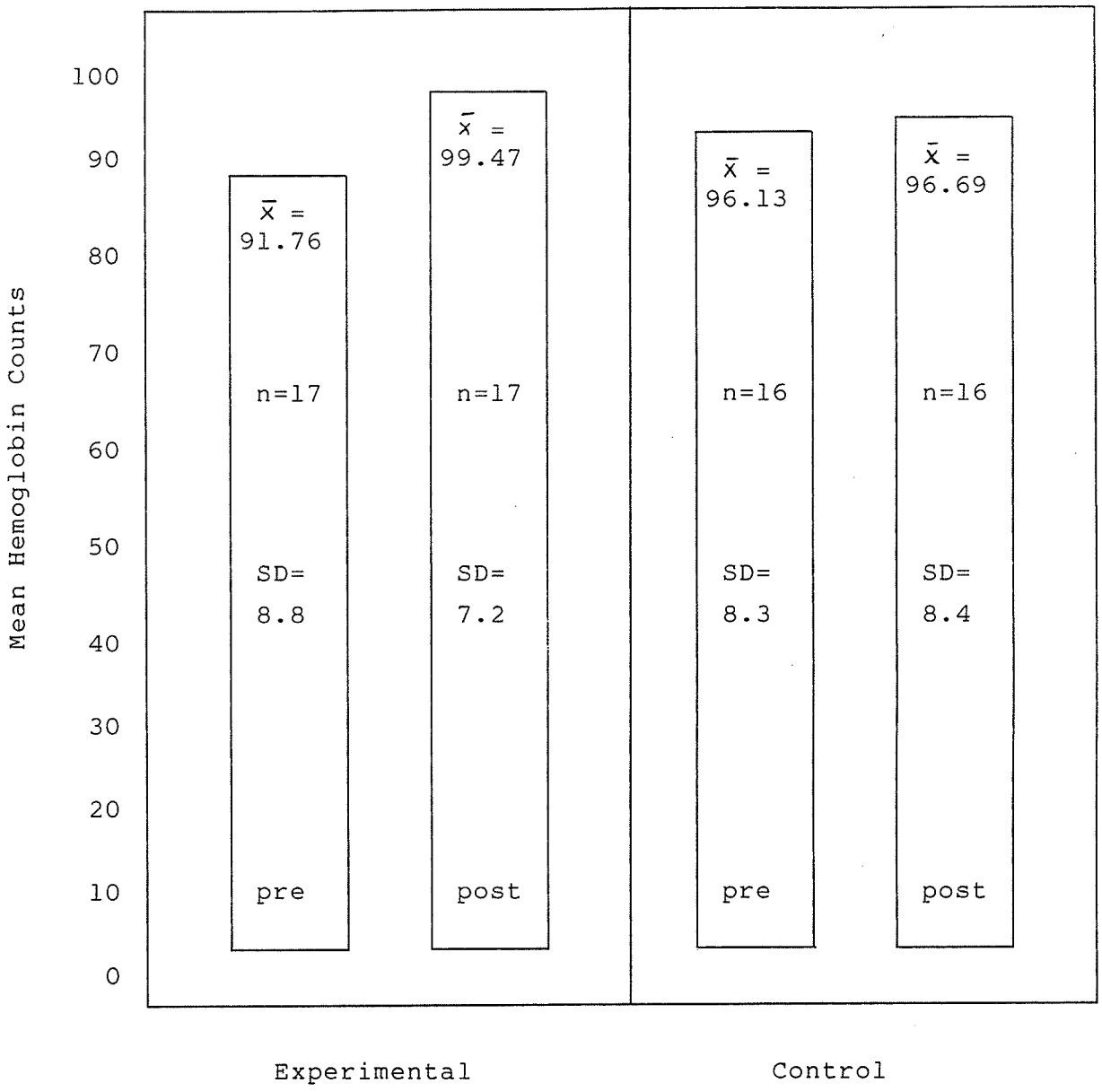

Figure 1. Mean hemoglobin counts by group at the pretest and posttest

Table 3

Test Affect Ratings by Group

Group	Rating	
	Suspect	Non-suspect
Experimental		
Pretest	4	13
Posttest	6	11
Control		
Pretest	2	15
Posttest	2	15

own control, and any change of category was noted. Four-fold tables are presented in Table 4 to indicate the number of subjects who were rated as changed, or who were rated, following treatment, as having remained in the same category for Test Affect. Cell A represents the number of subjects who were rated as suspect at the pretest and rated as non-suspect at the posttest. Cell D represents the number of subjects who were rated as non-suspect at the pretest and rated as suspect at the posttest. Cells B and C represent the number of subjects who were rated the same at both tests. The McNemar test for the significance of changes was performed to analyze change in the individual subjects in cells A and D only. The χ^2 for changes in Test Affect yielded probabilities of $p < .25$ and $p < .5$ for the experimental and control groups, respectively. Change in Test Affect was not significant for either group (see Table 4), and, therefore, Hypothesis I was not supported.

Task Orientation

Table 5 shows the Task Orientation ratings for the experimental and control groups. The

Table 4

Individual Change in Test Affect Ratings

Group			n	statistic: McNemar's χ^2	p
Experimental		post: Non-suspect			
	pre: Suspect	A: 1	17	1	.25
		B: 3			
	pre: Non-suspect	C: 10			
		D: 3			
Control		post: Non-suspect			
	pre: Suspect	A: 1	17	0	.5
		B: 1			
	pre: Non-suspect	C: 14			
		D: 1			

Table 5

Task Orientation Ratings by Group

Group	Rating	
	Suspect	Non-suspect
Experimental		
Pretest	10	7
Posttest	5	12
Control		
Pretest	9	8
Posttest	6	11

numbers of subjects rated as suspect and non-suspect were tested to determine whether a significant difference existed between the pretest and posttest. The χ^2, goodness of fit, for Task Orientation was 8.2 ($p < .01$).

Individual change of category was noted, and tested with the McNemar test for the significance of changes (see Table 6). Five subjects in the experimental group were rated as having changed from a suspect to a non-suspect rating; no subjects rated as non-suspect at the pretest were rated as suspect at the posttest. The test yielded a score of 5 ($p < .025$). In the control group, 2 subjects were rated as having changed from a suspect to a non-suspect rating, and 2 subjects were rated as having changed from a non-suspect to a suspect rating. The probability for this change was $p < .5$, which was not significant. Consequently, Hypothesis II was supported.

Summary

One hypothesis of the study, that a significant number of subjects who received intramuscular

Table 6

Individual Change in Task Orientation Ratings

Group			n	statistic: McNemar's χ^2	p
Experimental		post: Non-suspect / Suspect			
	Suspect	A: 5 / B: 5			
pre			17	5	.025*
	Non-suspect	C: 7 / D: 0			
Control		post: Non-suspect / Suspect			
	Suspect	A: 2 / B: 6			
pre			17	0	.5
	Non-suspect	C: 7 / D: 2			

* significant at $p < .05$

iron would change from suspect to non-suspect ratings in Test Affect as compared to those subjects who received the sham procedure, was tested using the McNemar test for the significance of changes. The results are shown in Table 4. No significant changes were noted in the ratings for Test Affect for either the experimental or control groups. Therefore, this hypothesis is not supported by the data presented in the study.

The McNemar test was also used to test the second hypothesis of the study, that intramuscular iron would effect a significant change in the number of subjects rated as suspect for Task Orientation. The results of this test (see Table 6) indicate that this hypothesis is supported, because the number of experimental subjects who changed from suspect to non-suspect ratings was significant at $p < .025$. A non-significant change ($p < .5$) was found for the control subjects, who received the sham procedure.

Chapter 5

Discussion

The following chapter presents a discussion of the results of this study. The first part of the chapter is a discussion of the relevance to Piaget's Theory, and subsequent sections deal with iron deficiency, Test Affect, and Task Orientation.

Piaget's Theory

The results of the present study lend support to the general hypothesis that depleted iron stores have a negative impact on a subject's ability to attend and respond to environmental stimulation. According to Piaget (1970), a child adapts mental processes to experiences with the environment. If attending behavior is impaired, a natural consequence would be a maladaptive response to the environment. The child's response to the environment is part of the equilibration process, an integral factor in Piaget's theory of development. The use of attention as a measure of cognitive functioning was described by Lewis (1971). Several researchers

have postulated that a maladaptive response to the environment is manifested in poor affect, inadequate orientation to tasks, or a combination of both effects, and can be changed with iron therapy after one week (Deinard et al., 1986; Oski & Honig, 1978; Walter et al., 1983). The lack of consistent evidence to support the primacy of either affect or orientation to tasks may be due to the interdependence of cognitive and emotional development, as perceived by Piaget (1951).

In the present study, a significant number of experimental subjects received improved ratings for Task Orientation following intramuscular iron treatment, while change in Test Affect ratings was not significant. These findings are congruent with Piaget's perspectives on adaptation to the environment. Attachment-seeking behaviors may be regarded as adaptations to the environment. The child who is tired or irritable may need to establish contact with the caregiver through assimilative activity (scheme) in order to engage in accomodative activity (schema). It is possible that subjects

in the present study, who sat on their mothers' laps for most of the assessment period, were able to compensate for fatigue or irritability because of this proximity. This interpretation is similar to the conclusions of researchers (Lozoff et al., 1986) who found that mother-anemic infant dyads sought close contact significantly more often than control dyads.

Iron Deficiency

The results of the present study lend support to the theory that impaired central nervous system functioning has irreversible consequences (Lozoff & Brittenham, 1986; Pollitt & Leibel, 1978). Before treatment, over 50% of these anemic subjects had a suspect rating for Task Orientation. Although a significant number of experimental subjects had improved ratings following treatment, it should be noted that 35% of all subjects were still rated as suspect. This is well above the average of 15% of subjects in a normative sample who were rated as suspect in Task Orientation.

One reason for this elevated percentage of suspect cases may be related to permanently

damaged central nervous system functioning. Previous evidence indicates that as soon as the child receives intramuscular iron, neurotransmissions in the central nervous system improve. This improvement occurs before a rise in hemoglobin, therfore, it should have occured in all treated subjects, even if hematologic correction was not achieved one week after treatment. This finding concurs with that of Deinard et al. (1986), who found that iron-deficient anemic subjects were significantly less responsive to the environment than non-anemic controls at study entry and at 3 and 6 month intervals when hematologic correction was achieved.

One of the issues that continues to be debated is whether to use intramuscular or oral iron therapy as the treatment for anemia. The results of the present study demonstrated that a statistically significant number of subjects had improved Task Orientation ratings one week after intramuscular iron therapy. Even though some subjects remained in the suspect category for Task Orientation due to what may be irreversible damage, an improvement in a significant number

of subjects is sufficient evidence that the expediency offered by intramuscular therapy warrants its use whenever possible instead of oral therapy.

Test Affect

The methodology employed in this study was developed in previous studies that were based on the Infant Behavior Record data (see Matheny, 1980; Wolf & Lozoff, 1985). These previous studies were based on large, normative samples, therefore, the incidence of suspect and non-suspect behaviors in those samples can be assumed to represent a normal distribution. In contrast to Lozoff et al. (1985), who found that 36% of anemic infants were rated as suspect in Test Affect before treatment and showed no change after treatment, all subjects in the present study were anemic, but only 17% (n=6) were rated as suspect for Test Affect at the pretest. This proportion is slightly higher than the incidence of suspect Test Affect ratings found in the Bayley standardization sample (14%) and the Louisville Twin Study (16%) mentioned above. It is possible that compensatory mechanisms,

such as initiation and maintenance of body contact (see Lozoff et al., 1987) with the mother in the testing environment, were operative in subjects in the present study.

To summarize, the findings of the present study indicate that ratings for the factor, Test Affect, did not change significantly one week after intramuscular iron therapy. The lack of effect of iron treatment on Test Affect ratings was consistent with the results found by Lozoff et al. (1985). The fact that the findings on Test Affect of the present study conflict with those of other researchers may be due to differing study designs and criteria for establishing abnormal behavior. For example, Deinard et al. (1981) administered no treatment in a non-random sample and found that iron depleted subjects showed more fearfulness but were not more listless than iron-replete infants. In a later study, Deinard et al. (1986) reported that after 6 months of treatment, experimental subjects were still significantly less responsive to the examiner than non-anemic controls. Walter et al. (1983) observed that anemic infants had statistically significant lower ratings for

emotional tone pre-treatment, but no significance was stated post-treatment (their study did not include a placebo group).

Task Orientation

In this study, 56% of all subjects were rated as suspect for Task Orientation at the pretest, and a significant number of these subjects were changed to a non-suspect rating following iron treatment. This finding is consistent with the results of several investigators (Deinard et al. 1986; Oski & Honig, 1978; Walter et al., 1983) who studied items included in the factor, Task Orientation. Deinard et al. (1986) found that iron-deficient anemic subjects were significantly less responsive to the environment than non-anemic controls at study entry and at 3 and 6 month intervals. Oski and Honig (1978) observed significant improvements in reactivity approximately one week after intramuscular iron therapy. The results of the study by Walter et al. (1983) indicated that iron-deficient anemic subjects treated with oral iron had significantly improved ratings for attention span ten days after the start of treatment.

The finding of improved ratings for Task Orientation in this study is generally in line with Piaget's theory that children's attention to environmental stimulation results in a drive toward equilibration (1970). The four items that make up the factor, Task Orientation: (a) goal directedness, (b) reactivity, (c) object orientation, and (d) attention span are all related to Piaget's concept of equilibration. In this study intramuscular iron therapy resulted in improved ratings for the cluster of the four items in a significant number of subjects. This improvement in equilibration demonstrated here will likely result in improved cognition over time. Although Kimmons et al. (1987) did not find improved mental development scores one week after treatment in the original study from which the present secondary data analysis was done, it is possible that the interval of one week following treatment was too short to allow for observeable gains in cognition.

The results of the present study conflict with those of Lozoff et al. (1985) who found that suspect Task Orientation was normally distributed

in anemic subjects. The percentage of subjects rated as suspect in the present study was considerably higher (56%) than the proportions in the Bayley standardization sample (14%) and the Louisville Twin Study (16%). Speculations about why the present percentages of suspect ratings are so different from that of Lozoff et al. are not possible, because the Infant Behavior Record has been shown to be consistent across age, sex, and culture (Matheny, 1980). Because these two studies have been the first ones to use this methodology, evidence from future studies will be required before a definitive answer on the relationship between iron deficiency and Task Orientation can be reached.

Chapter 6

Summary and Conclusion

The purpose of this study was to investigate the impact of intramuscular iron therapy on non-cognitive behaviors one week after treatment. The following research questions were addressed: 1) Will intramuscular iron therapy result in significant change in Test Affect one week after treatment?, and 2) Will intramuscular iron therapy result in significant change in Task Orientation one week after treatment?

The present study yielded some results consistent with previous research findings. Iron treatment has been shown to improve attention span, reactivity, and goal directed behavior (Deinard et al., 1981; Oski & Honig, 1978; Walter et al., 1983). These items are included in the factor Task Orientation, which was shown to have significantly improved ratings following treatment, in the present study. The fact that Lozoff et al. (1985) observed suspect ratings for Task Orientation to be within the range for the general population, while the present

study found suspect ratings to be elevated, emphasizes the need for further research.

Ratings for Test Affect were within the normal range as defined by Matheny (1980) and Wolf and Lozoff (1985) and did not change significantly following iron treatment. These findings do not concur with those of Lozoff et al. (1985), who found that suspect Test Affect was elevated in anemic subjects. However, their finding that iron treatment did not result in improved ratings was confirmed in the present study. Lozoff et al. (1986) speculated the following:

> The anemic infant's behavior may differ from the behavior of a non-anemic infant as a result of altered central nervous system neurochemistry or muscle function, and increased seeking of body contact may be a manifestation of concomitant changes in mood, alertness or activity. (p. 157)

The ability of some iron deficient infants to play without obvious behavioral disturbance may be due to maintenance of close proximity to caretakers, an effective compensatory mechanism when a child is sick, tired, or irritable.

Affect may be subject to subtle changes which are not identifiable by the procedure employed in the present study.

The subjects in the present study were randomly assigned to experimental and control groups, and there was no significant difference in hemoglobin between groups at the pretest. Based on these findings, it is concluded that intramuscular iron therapy made a significant difference in the subjects' orientation to tasks during assessment with the Bayley Scales of Infant Development. This finding adds to the existing body of knowledge about non-cognitive aspects of behavior in anemic infants. Although anemia, per se, was not corrected for all subjects, an increase in body iron resulted in improved ratings in Task Orientation.

Implications

The present investigation has shown that intramuscular iron therapy results in improved attention span, reactivity, goal directedness, and object orientation in infants after one week. A major implication of this finding has to do with the nature of the treatment. The

population of this study was shown to have a poor response to oral iron therapy (Longstaffe, 1985). Compliance problems were cited as inhibitors of administration. The use of intramuscular iron would alleviate this difficulty, and children would be ensured of receiving treatment, which could ultimately lead to improvements in cognition and attending behavior in infants.

The methodology used in this study is relatively new, and has been employed in only one published study (Lozoff et al., 1985) prior to the present one. Because of this and the cross-sectional nature of the study, generalization of results should be made with caution.

The findings of the present study contribute to the existing body of literature, and generate possibilities for further research. A definitive answer to the effect of iron treatment on Test Affect and Test Orientation has not been reached. Additional cross-sectional data would validate the use of the Infant Behavior Record as a research tool. Longitudinal studies could provide information on the long-term effects of iron treatment on behavior. In addition, the relationship between

attention and cognitive performance could be further explored, using the Bayley scales in conjunction with an attention processing measure.

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Footnote

[1]At study entry, one subject had a hemoglobin of 106 gm/l, which exceeded the criteria established for the primary study. The principal investigators decided to maintain the subject for study, because all other laboratory values were indicative of iron deficiency anemia.

Appendix A

Infant Behavior Record

BAYLEY SCALES OF INFANT DEVELOPMENT

INFANT BEHAVIOR RECORD

NAME _____ AGE _____ SEX _____

	Year	Month	Day
Date Tested			
Date of Birth			
Age			

67 Development Index*
Mental Scale _____ (MDI)
Motor Scale _____ (PDI)

* The standard score for the Mental Scale is called the MDI (for Mental Development Index); for the Motor Scale it is the PDI (for Psychomotor Development Index). See Manual for discussion.

INSTRUCTIONS: Fill out this form immediately after the Mental and Motor Scales have been administered. For each rating scale, circle the number next to the one statement that best describes the child's behavior. Additional comments or specific behaviors may be noted in the space to the right of each rating scale; also in this space are partial lists of specific behaviors which may be checked off if observed by the examiner. Space is provided at the end of the form for recording any deviant behavior and an overall evaluation of the child. (For complete instructions, see the Manual.)

	CHECK RELEVANT BEHAVIORS WRITE CLARIFYING DESCRIPTIVE NOTES
SOCIAL ORIENTATION 1. Responsiveness to persons (Circle one) Rating 1 Behavior towards persons is not different from behavior towards objects 2 Between 1 and 3 3 Responds briefly to social approach but when not approached directly by persons does not attend to them 4 Between 3 and 5 5 Responds to social approach and persons present, but less than half the time 6 Between 5 and 7 7 Responds to social approach and continues interest in persons present 8 Between 7 and 9 9 Behavior seems to be continuously affected by awareness of persons present	
SOCIAL ORIENTATION 2. Responsiveness to examiner (Circle one) Rating 1 Avoiding or withdrawn 2 Hesitant 3 Accepting 4 Friendly 5 Inviting (initiating, demanding)	_____Freezes _____Frowns _____Watches warily _____Brightens _____Smiles _____Laughs _____Vocalizes _____Fusses _____Hides and peeks
SOCIAL ORIENTATION 3. Responsiveness to mother (Circle one) Rating 1 Avoiding or withdrawn 2 Hesitant 3 Accepting 4 Friendly 5 Inviting (initiating, demanding)	Examiner / Mother Calls to _____ _____ Turns from _____ _____ Turns to _____ _____ Approaches _____ _____ Other (Specify):

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	CHECK RELEVANT BEHAVIORS WRITE CLARIFYING DESCRIPTIVE NOTES
COOPERATIVENESS 4. Cooperation with examiner, based on interpersonal reactions (Circle one) Rating 1 Resists all suggestions or requests 2 Does not cooperate 3 Refuses or resists one or two specific tests, or refuses to cooperate during part of the session (e.g., initially, or towards the end), or refuses to attempt the more difficult items he is likely to fail 4 Between 3 and 5 5 Responds to or accepts the test materials or situation; neither cooperative nor resistant in relation to examiner 6 Between 5 and 7 7 Seems to enjoy the give-and-take with the examiner in the testing situation 8 Between 7 and 9 9 Very readily and enthusiastically enters into suggested games or tasks	_____Refuses test materials _____Turns away _____Says "No" _____Pushes toys away _____Uses toys his own way _____Says "No" but does task _____With a magic word like "Okay" will conform _____Continues "games" (e.g., ball throw) once started _____Initiates game involving examiner _____Other (Specify):
FEARFULNESS 5. Reaction to the new or strange; e.g., strangers, strange surroundings, test materials (Circle one) Rating 1 Accepts the entire situation with no evidence of fear, caution, or inhibition of actions 2 Between 1 and 3 3 Some slight vigilance, and restrained behavior in the first few minutes 4 Between 3 and 5 5 Behavior is affected by the new and strange, but just moderately and for approximately the first third of the testing period 6 Between 5 and 7 7 Shows evidence of being bothered by the strange situation or persons much of the period 8 Between 7 and 9 9 Strong indication of fear of the strange, to the extent that he cannot be brought to play or respond to the tests	_____Uninhibited _____Reckless _____Outgoing _____Calm _____Wary _____Quietly alert _____Apprehensive expression _____Reduced activity _____No vocalizations _____Turns to mother _____Clings to mother _____Withdraws from examiner _____Cries _____Vocal protests _____Other (Specify): After initial test period, does the child engage in easy play? ☐ Yes ☐ No If "No," describe signs of persistence of fearfulness: _____Continued inhibition _____Cautious play _____Overexcited activity _____Other (Specify):
TENSION 6. Tenseness of body (Circle one) Rating 1 Inert; may be flaccid most of the time 2 Between 1 and 3 3 Body has tone and is generally relaxed 4 Has bounce 5 Becomes tense at times although body has relaxed quality; subsequent quick return to supple, relaxed condition 6 Between 5 and 7 7 Body is tense more than half the time; may be stiff or tight in one or more areas; startles, quivers or trembles easily 8 Between 7 and 9 9 Body is predominantly taut or tense	

	CHECK RELEVANT BEHAVIORS WRITE CLARIFYING DESCRIPTIVE NOTES
GENERAL EMOTIONAL TONE 7. Degree of happiness (Circle one) Rating 1 Child seems unhappy throughout the testing period 2 Between 1 and 3 3 At times rather unhappy, but may respond happily to interesting procedures 4 Between 3 and 5 5 Moderately happy or contented; may become upset, but recovers fairly easily 6 Between 5 and 7 7 Generally appears to be in a happy state of well-being 8 Between 7 and 9 9 Radiates happiness; nothing is upsetting; animated	_____Cries _____Fusses _____Whines _____Listless droop _____Protests _____Frowns _____Unhappy expression _____Non-expressive _____Smiles _____Coos or babbles with happy intonations _____Laughs _____Squeals _____Crows _____Animated expressions _____Other (Specify): Describe any disturbing incidents or conditions:
OBJECT ORIENTATION 8. Responsiveness to objects; toys or test materials (Circle one) Rating 1 Does not look at or in any way indicate interest in objects 2 Between 1 and 3 3 When given materials, glances at them and holds them briefly but does not exploit them 4 Between 3 and 5 5 Plays with materials when presented; discards or loses interest in each after a brief reaction 6 Between 5 and 7 7 Sustained interest in the test materials, in each new one in turn as presented 8 Between 7 and 9 9 Reluctantly relinquishes test materials	_____Touches _____Manipulates _____Examines _____Mouths _____Throws _____Bangs _____Relates 2 objects _____Reaches for _____Asks for _____Cries for _____Clings to _____Offers to person _____Other (Specify):
OBJECT ORIENTATION 9. Plays imaginatively with materials; e.g., arranging them in new relationships, or introducing them into play sequence (Circle one) 1 Yes 2 No	
OBJECT ORIENTATION 10. Is there persistent attachment to any specific toy or to some object of his own? (Circle one) 1 Yes 2 No	If "Yes," does he relinquish it during testing? ☐ Yes ☐ No

	CHECK RELEVANT BEHAVIORS WRITE CLARIFYING DESCRIPTIVE NOTES
GOAL DIRECTEDNESS 11. Persistence in goal-directed effort (Circle one) Rating 1 No evidence of directed effort 2 Between 1 and 3 3 Makes a few attempts at a goal, but is easily distracted or does not show interest in carrying to completion (e.g., attaining an object, solving a problem) 4 Between 3 and 5 5 Makes fairly persistent efforts towards a goal, or repeated attempts to achieve a goal (e.g., to attain an object of interest) 6 Between 5 and 7 7 Persistent efforts to reach goal or solve a problem 8 Between 7 and 9 9 Compulsive absorption with a task until it is solved	____Tries to retain test materials ____Becomes angry at failure ____Expresses satisfaction with success ____Elated with achievement ____Repeats successful acts ____Talks about task ____Asks for help ____Whines at difficulty ____Cries ____Other (Specify): Describe any typical goal-directed behaviors, giving quality of actions:
ATTENTION SPAN 12. Tendency to persist in attending to any one object, person or activity, aside from attaining a goal (Circle one) Rating 1 Fleeting attention span 2 Between 1 and 3 3 Attends to a toy, task or person, but is easily distracted 4 Between 3 and 5 5 Moderate attention to each new toy, person, or situation; soon ready for another 6 Between 5 and 7 7 Continues interest in persons, tasks or things for rather long periods 8 Between 7 and 9 9 Long-continued absorption in a toy, activity or person	
ENDURANCE 13. Behavior constancy in adequacy of response to demands of the tests (Circle one) Rating 1 Tires easily; quickly regresses to lower levels of functioning 2 Between 1 and 3 3 Grows restless fairly soon and terminates the test situation 4 Between 3 and 5 5 Adequate tolerance for most of the test; only restless towards the end 6 Between 5 and 7 7 Holds up well throughout testing period 8 Between 7 and 9 9 Continues to respond well and with interest, even during prolonged tests at difficult levels	

	CHECK RELEVANT BEHAVIORS WRITE CLARIFYING DESCRIPTIVE NOTES
ACTIVITY 14. Amount of gross bodily movement (Circle one) Rating 1 Stays quietly in one place, with practically no self-initiated movement 2 Between 1 and 3 3 Usually quiet and inactive but responds appropriately in situations calling for some activity 4 Between 3 and 5 5 Moderate activity; enters into games with freedom of action 6 Between 5 and 7 7 In action during much of the period of observation 8 Between 7 and 9 9 Hyperactive; cannot be quieted for sedentary tests	_____Face and head movements _____Hand movements _____Waves arms _____Squirms _____Rolls _____Kicks _____Twists _____Creeps _____Runs _____Climbs _____Jumps _____Bounces _____Other (Specify): Note any peculiarities in motor activities:
REACTIVITY 15. The ease with which a child is stimulated to react in general; his SENSITIVITY or EXCITABILITY; reactivity may be positive or negative in tone (Circle one) Rating 1 Unreactive; seems to pay little heed to what goes on around him; responds only to strong or repeated stimulation 2 Between 1 and 3 3 Some tendency to be unreactive to the usual testing stimuli, etc. 4 Between 3 and 5 5 Moderately alert and responsive in reaction to test stimuli, etc. 6 Between 5 and 7 7 Quickly shows awareness of changes in test materials and situations 8 Between 7 and 9 9 Very reactive; every little thing seems to stir him up; he startles, reacts quickly, seems keenly sensitive to things going on around him	_____Quiets _____Startles _____Quivers _____Fusses _____Cries _____Looks alert _____Vocalizes _____Squeals _____Other (Specify): Responds to: _____Sights _____Sounds _____Temperatures _____Touches _____Pressures _____Smells _____Being jarred _____Being carried _____Other (Specify):

SENSORY AREAS OF INTEREST DISPLAYED (Circle one for each item)

Note.—Ratings range from 1 (None) to 9 (Excessive).

	None							Excessive	
16. Sights—looking	1	2	3	4	5	6	7	8	9
17. Listening to sounds	1	2	3	4	5	6	7	8	9
18. Producing sounds—vocal	1	2	3	4	5	6	7	8	9
19. banging toys or hands on table, throwing toys, etc.	1	2	3	4	5	6	7	8	9
20. Manipulating (exploring with hands)	1	2	3	4	5	6	7	8	9
21. Body motion	1	2	3	4	5	6	7	8	9
22. Mouthing or sucking—thumb or fingers	1	2	3	4	5	6	7	8	9
23. pacifier	1	2	3	4	5	6	7	8	9
24. toys	1	2	3	4	5	6	7	8	9

	CHECK RELEVANT BEHAVIORS WRITE CLARIFYING DESCRIPTIVE NOTES
ENERGY AND COORDINATION FOR AGE (Circle one for each item) Note.—Ratings for these items should be estimated in relation to other children of the child's own age. 25. Level of energy (range: low to high) Low 1 2 3 4 5 High 26. Coordination of gross muscle movements for age (range: smooth functioning to poor coordination) Smooth functioning 1 2 3 4 5 Poor coordination 27. Coordination of fine muscles (hands) for age (range: smooth functioning to poor coordination) Smooth functioning 1 2 3 4 5 Poor coordination	
JUDGMENT OF TEST 28. Judgment of optimal vs. minimal adequacy of the test as an indicator of this child's characteristics (Circle one) Rating 1 Minimal 2 Fairly adequate 3 Average 4 Very good 5 Excellent	If you circled 1 or 2, give reasons why you think the test was not a fair indication of the child's capacities (e.g., child's sleepiness, hunger, health, emotions; mother's behavior; outside interruptions):
UNUSUAL OR DEVIANT BEHAVIOR 29. Was any unusual or deviant behavior observed, or incidentally reported (e.g., by the mother), that has not been recorded above? (Circle one) 1 Yes 2 No	If "Yes," describe: (Note such things as staring spells, temper tantrums, holding breath and turning blue, banging head, head rolling, sudden and fearful awakening at night, tics, autisms.)
GENERAL EVALUATION OF CHILD 30. (Circle one) 1 Normal 2 Exceptional	If "Exceptional," specify:

Write a brief general evaluative statement about the child, giving (a) the quality of the child's performance at this time; (b) if relevant, any prognosis of subsequent development, with reasons:

21 22 23 24 A B C D