DOCUMENT RESUME

ED 465 467 PS 030 465

AUTHOR Marcon, Rebecca A.

TITLE Rate of Physical Growth and Its Affect on Head Start Children's Motor and Cognitive Development.

PUB DATE 2002-06-00

NOTE 12p.; Paper presented at the Head Start Sixth National Research Conference (6th, Washington, DC, June 26-29, 2002). Supported in part by the Human Growth Foundation Small Grants Program.

PUB TYPE Reports - Research (143) -- Speeches/Meeting Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.

DESCRIPTORS Birth Weight; *Cognitive Development; Developmental Delays; Low Income; *Motor Development; Performance Factors; *Physical Development; *Preschool Children; Preschool Education; Sex Differences

IDENTIFIERS Anthropometric Tests; Project Head Start

ABSTRACT

In the United States, growth retardation is higher among low-income children, with adverse cognitive effects of undernutrition more prevalent when combined with poverty. This study examined anthropometric indicators of physical development and their relationship to motor and cognitive development in Head Start children. Motor integration and sequential and simultaneous memory were examined in relationship to rate of physical growth. The sample of 34 rural Head Start children was 59 percent female; 82 percent of the sample was Caucasian; 18 percent was African American. Twenty-six percent of the sample was classified as low birthweight. Anthropometric data were collected monthly. Motor and cognitive measures were administered 4 times at 10-week intervals. Mean anthropometric changes across the 9-month period were graphed. After controlling for age, analyses indicated significant increases in height, body mass index (BMI), and head circumference across the year. Boys and girls were similar on all anthropometric measures but boys' head circumference was greater. Although low-birthweight children were similar to peers in height, they weighed less, and had lower BMIs and smaller arm circumference. Analyses indicated improvement across the school year in three motor and four cognitive measures: visual motor integration, hopping-right foot, finger control, "magic window," word order, matrix analogies, and spatial memory. No cognitive differences were found between boys and girls, and motor differences were limited to girls' great skill at hopping, skipping, and finger control. Relationships between rate of physical growth and memory and motor development were explored further. (Contains 17 references.) (HTH)

Rate of Physical Growth and Its Affect on Head Start Children's Motor and Cognitive Development

Rebecca A. Marcon

University of North Florida

Poster session presented at Head Start's Sixth National Research Conference, Washington, DC, June 26-29, 2002. This research was supported in part by the Human Growth Foundation Small Grants Program, Glen Head, NY. Address correspondence to Rebecca A. Marcon, Department of Psychology, University of North Florida, Jacksonville, FL 32224-2673.

Office: (904) 620-2807 Email: rmarcon@unf.edu

Abstract

In the United States, growth retardation is higher among low-income children, with adverse cognitive effects of undernutrition more prevalent when combined with poverty. The present study examined anthropometric indicators of physical development and their relationship to motor and cognitive development in Head Start children. Unlike previous studies that used global measures of development, research on brain development guided selection of cognitive and motor measures. Between ages 3-5 dominance shifts from the right to left hemisphere, and rapid myelination of the hippocampus and fiber tracts connecting the cerebellum and pre-motor cortex occurs. Therefore, motor integration and sequential and simultaneous memory were examined in relationship to rate of physical growth. The sample of 34 rural Head Start children (M = 49.03 months) was 59% female, 82% Caucasian, and 18% African American, with 26% classified as low-birth-weight (LBW, < 5.5 lb). Anthropometric data (height, weight, body mass index-BMI, mid-arm and head circumference) were collected monthly. Motor and cognitive measures were administered four times at 10 week intervals. Mean anthropometric changes across the 9-month period were graphed. After controlling for age, analyses indicated significant increases in height, BMI, and head circumference across the year. Boys and girls were similar on all anthropometric measures except boys' head circumference was greater. Although LBW children were similar to peers in height, they weighed less, had lower BMIs, and smaller arm circumference. Analyses indicated improvement across the school year in three motor and four cognitive measures: Visual Motor Integration, Hopping-right foot, Finger Control, Magic Window, Word Order, Matrix Analogies, and Spatial Memory. No cognitive differences were found between boys and girls, and motor differences were limited to girls' greater skill at hopping, skipping, and finger control. Relationships between rate of physical growth and memory and motor development were explored further.

Rate of Physical Growth and Its Affect on Head Start Children's

Motor and Cognitive Development

Anthropometric measures have been used in research linking growth retardation with cognitive development in postnatally undernourished children. Although children's physical size is affected by many factors other than nutrition, both stunting and wasting have been associated with lower cognitive performance. As an indicator of long-term nutritional status, height for age shows the strongest anthropometric relationship with young children's cognitive development (e.g., Brockman & Ricciuti, 1971; Eisenberg, Roth, Bryniarski, & Murray, 1984, Karp, Martin, Sewell, Manni, & Heller, 1992). Weight for height has been associated with cognitive performance and attention in older children (e.g., Paine, Dorea, Pasquali, & Monterior, 1992). Head circumference and mid-arm circumference also have been related to children's neurodevelopment (e.g., Ivanovic, 1996; Johnson, 1991; Lynn, 1989; Stoch, Smythe, Moodie, & Bradshaw, 1982). In the United States, the prevalence of growth retardation is especially high among low-income children. Adverse effects of undernutrition on cognitive development are more prevalent when combined with poverty (e.g., Karp et al., 1984; Pollitt, Gorman, Engle, Matorell, & Rivera, 1993). Few studies, however, have been conducted in the United States where undernutrition among children is mild-to-moderate and rarely reaches the severe levels of deprivation examined in earlier studies of children in developing nations (Pollitt, 1987).

The present study examined anthropometric indicators of physical development and their relationship to motor and cognitive development in at-risk, low-income U.S. children enrolled in Head Start. Unlike previous studies that used more global measures of development, findings from research on brain development guided selection of cognitive and motor measures used in this study. Between the ages of 3-5 there is a shift from right to left hemisphere dominance, as well as rapid myelination of the hippocampus and fiber tracts connecting the cerebellum and pre-motor cortex (e.g., Case, 1992; Fischer & Rose, 1997; Thatcher, 1994). Therefore, motor integration and performance on measures of sequential and simultaneous memory were examined in relationship to rate of these preschoolers' physical growth.

Method

Sample

Parents of all 34 children (ages 3-5, *M* at beginning of study = 49.03 mos, *SD* = 7.28) enrolled all 9 months in a full-day, rural Head Start center gave written informed consent for children's participation in this study. The sample was 59% female, 82% Caucasian and 18% African American. All children lived in households with an annual income at or below federal poverty guidelines. Birth weights ranged from 2 lb-2oz to 10 lb-1oz (*M* = 6.50 lb, *SD* = 1.48 lb), with 26% of the sample classified as low-birth-weight (< 5.5 lb).

Measures

Data were collected mornings at the Head Start center by a team of six researchers beginning the fourth week of the school year. Anthropometric data were collected monthly and motor and cognitive measures were administered four times at approximately 10 week intervals. Weight was measured prior to breakfast and all cognitive and motor measures were made following breakfast to control for energy levels. Standard anthropometric procedures were used to collect data on children's standing height (cm), weight (kg), mid-arm (cm) and head circumference (cm). Body mass index (BMI) was calculated for each child using the Center for Disease Control (CDC) formula: (wt ÷ ht) ÷ ht. Gross and fine motor development were assessed using six items from a preschool screening tool (Developmental Indicators for the Assessment of Learning-Revised, DIAL-R; Mardell-Czudnowski & Goldenberg, 1990):

catching, hopping, skipping, block building, finger control, cutting. Both visual and auditory memory were assessed using age-appropriate subtests of the Kaufman Assessment Battery for Children (K-ABC; Kaufman & Kaufman, 1983). Development of the pre-motor cortex was assessed by the Berry-Buktenica Developmental Test of Visual Motor Integration (VMI; Berry & Buktenica, 1997) which compared children's copying of 18 geometric designs with age-based norms. Teachers rated children's daily food intake (breakfast, lunch, afternoon snack) from weeks 3 through 6 using a 4-point comparative scale: 0 = absent, 1 = ate less than other children, 2 = ate same amount as other children, 3 = ate more than other children.

Results

Based on June 2000, statistics from the Center for Disease Control, 2 of 34 children in this sample were classified as stunted (ht < 5^{th} percentile for age and sex) at the beginning of the school year. Although both of these children increased in height across the school year, they remained stunted in height at the end of the year. One of these children was classified as wasted (wt < 5^{th} percentile for age and sex) at the beginning of the school year. Weight gains placed this child just outside the wasted classification at the end of the school year (increased from 1.7^{th} percentile to 5.9^{th} percentile).

Mean changes in anthropometric measures across the 9- month period of children's enrollment in Head Start were graphed (see Figures 1- 4). After controlling for age, repeated

---

Insert Figures 1, 2, 3 and 4 about here

---

measures MANCOVA (with Huynh-Feldt correction as needed) indicated significant increases in height, $F(3.3, 89.4) = 9.29$, $p = .000$, BMI, $F(5.1, 138) = 2.64$, $p = .02$, and head circumference, $F(3.6, 79.5) = 3.32$, $p = .02$, across the school year. Further analyses indicated boys and girls were similar on all anthropometric measures except boys' head circumference was approximately 1.6 cm greater than girls', $F(1, 27) = 9.29$, $p = .005$. Although low-birth-weight (LBW) children were similar to peers in height (LBW = 103.3 cm, non-LBW = 104.9 cm; $p = .28$), they weighed an average of 2.2 kg less, $F(1, 27) = 3.78$, $p = .06$, with lower BMI scores (LBW = 15.21, non-LBW = 16.60), $F(1, 26) = 3.16$, $p = .08$. Mean mid-arm circumference of LBW children was 1.4 cm smaller than that of non-LBW classmates, $F(1, 27) = 4.24$, $p = .05$.

After controlling for age, repeated measures MANCOVA (with Huynh-Feldt correction as needed) indicated significant improvement across the school year in three motor and four cognitive measures. Motor gains were seen in (a) VMI scores, $F(3, 24) = 5.14$, $p = .007$, (b) Hopping-right foot, $F(3, 23) = 3.34$, $p = .04$, and (c) Finger Control, $F(2.8, 71.2) = 2.44$, $p = .07$. Cognitive gains were seen in (a) Magic Window (simultaneous, visual-vocal), $F(1.4, 35.6) = 3.12$, $p = .07$; (b) Word Order (sequential, auditory-motor), $F(1.3, 25.3) = 17.70$, $p = .000$; (c) Matrix Analogies (simultaneous, visual-motor), $F(2, 4) = 20.00$, $p = .008$; and (d) Spatial Memory (simultaneous, visual-motor), $F(2, 5) = 4.54$, $p = .075$. [Note. Degrees of freedom varied because different K-ABC tests were administered at different ages.] No significant cognitive differences were found between boys and girls, and motor differences were limited to girls' greater skill at hopping (right foot, $F(1, 25) = 7.03$, $p = .01$; left foot, $F(1, 25) = 7.50$, $p = .01$), skipping, $F(1, 23) = 5.04$, $p = .04$, and finger control, $F(1, 25) = 4.42$, $p = .05$. Although LBW children scored lower on 5 of 7 cognitive measures compared to non-LBW classmates, these differences were not statistically significant. Gross motor skills of LBW children were comparable to or slightly better than those of non-LBW peers, but their fine motor skills were somewhat lower than non-LBW peers and they scored significantly lower on scissors cutting, $F(1, 25) = 8.42$, $p = .008$.

Rate of physical growth was examined for the two anthropometric measures that showed the most change across the school year, height and weight. The proportion of overall increase in height and weight that occurred between each period of motor and cognitive assessment was calculated. Children were then categorized according to the period in which they had experienced the most change: early in the year, middle of the year, late in the school year. There were no significant differences between the height or weight groups at baseline measurement of motor and cognitive development. By mid-year, gross motor skills were notably better among children who had experienced their greatest period of growth early in the school year. By the end-of-the-year, these same children were performing better on cognitive measures (number recall and matrix analogies) than children whose height increases came later in the year. Children whose greatest weight gains were in the middle of the year did poorer than peers on several mid-year cognitive measures (magic window and hand movements). Although period of greatest height or weight increases were not associated with age or birth status, girls were more likely to experience their greatest height increase early in the year while boys were more likely to increase most in height at the end of the year, χ^2 (2, $N = 32$) = 5.62, $p = .06$.

Implications

These findings add to our understanding of the relationship between physical growth and motor and cognitive development and expand the small data base in this area of study by demonstrating outcomes for children from industrialized nations. Even within an at-risk, low-income population of preschoolers, anthropometric variability exists, and these differences are related to development of memory processing capacities (both auditory and visual), motor skills, and sensory-motor integration.

References

Berry, K. E., & Buktenica, N. A. (1997). *The Berry-Buktenica Developmental Test of Visual-Motor Integration*. Parsippany, NJ: Modern Curriculum Press.

Brockman, L. M., & Ricciuti, H. R. (1971). Severe protein-calorie malnutrition and cognitive development in infancy and early childhood. *Developmental Psychology, 4,* 312-319.

Case, R. (1992). The role of the frontal lobes in the regulation of cognitive development. *Brain and Cognition, 20,* 51-73.

Eisenberg, N., Roth, K., Bryniarski, K. A., & Murray, E. (1984). Sex differences in relationship of height to children's actual and attributed social and cognitive competencies. *Sex Roles, 11,* 719-734.

Fischer, K. W., & Rose, S. P. (1997). Dynamic growth cycles of brain and cognitive development. In R. W. Thatcher, G. R. Lyon, J. Fumsey, & N. Krasnegor (Eds.), *Developmental neuroimaging: Mapping the development of brain and behavior* (pp. 263-279). San Diego: Academic Press.

Ivanovic, D. M. (1996). Prospective overview on 'Does undernutrition during infancy inhibit brain growth and subsequent intellectual development?' *Nutrition, 12,* 568-571.

Johnson, F. W. (1991). Biological factors and psychometric intelligence: A review. *Genetic, Social and General Psychology Monographs, 117,* 313-357.

Karp, R., Martin, R., Sewell, T., Manni, J., & Heller, A. (1992). Growth and academic achievement in inner-city kindergarten children. *Clinical Pediatrics, 31,* 336-340.

Karp, R., Snyder, E., Fairorth, J., Nelson, M., Solimano, G., Acker, W., Greene, G., & Krehl, W. A. (1984). Parental behavior and the availability of foods among undernourished inner-city children. *Journal of Family Practice, 18,* 731-735.

Kaufman, A. S., & Kaufman, N. L. (1983). *Kaufman Assessment Battery For Children.* Circle Pines, MN: American Guidance Service.

Lynn, R. (1989). A nutrition theory of the secular increases in intelligence: Positive correlations between height, head size and IQ. *British Journal Educational Psychology, 59,* 372-377.

Mardell-Czudnowski, C., & Goldenberg, D. S. (1990). *Developmental Indicators For the Assessment of Learning-Revised.* Circle Pines, MN: American Guidance Service.

Paine, P., Dorea, J. G., Pasquali, J., & Monterior, A. M. (1992). Growth and cognition in Brazilian school children: A spontaneously occurring intervention study. *International Journal of Behavioral Development, 15,* 169-183.

Pollitt, E. (1987). A critical review of three decades of research on the effects of chronic energy malnutrition on behavioral development. In B. Schurch & N. S. Scrimshaw (Eds.), *Chronic energy deficiency: Consequences and related issues* (pp. 77-93). Lausanne, Switzerland: International Dietary Energy Consultative Group.

Pollitt, E., Gorman, K. S., Engle, P., Matorell, R., & Rivera, J. (1993). Early supplementary feeding and cognition: Effects over two decades. *Monographs of the Society for Research in Child Development, 58* (7, Serial No. 238).

Stoch, M. B., Smythe, P. M., Moodie, A. D., & Bradshaw, D. (1982). Psychosocial outcome and CT findings after gross undernourishment during infancy: A 20-year developmental study. *Developmental Medicine and Child Neurology, 24,* 419-436.

Thatcher, R. W. (1994). Cyclic cortical reorganization: Origins of human cognitive development. In G. Dawson & K. W. Fischer (Eds.), *Human behavior and the developing brain* (pp. 232-266). New York: Guilford.

Figure 1

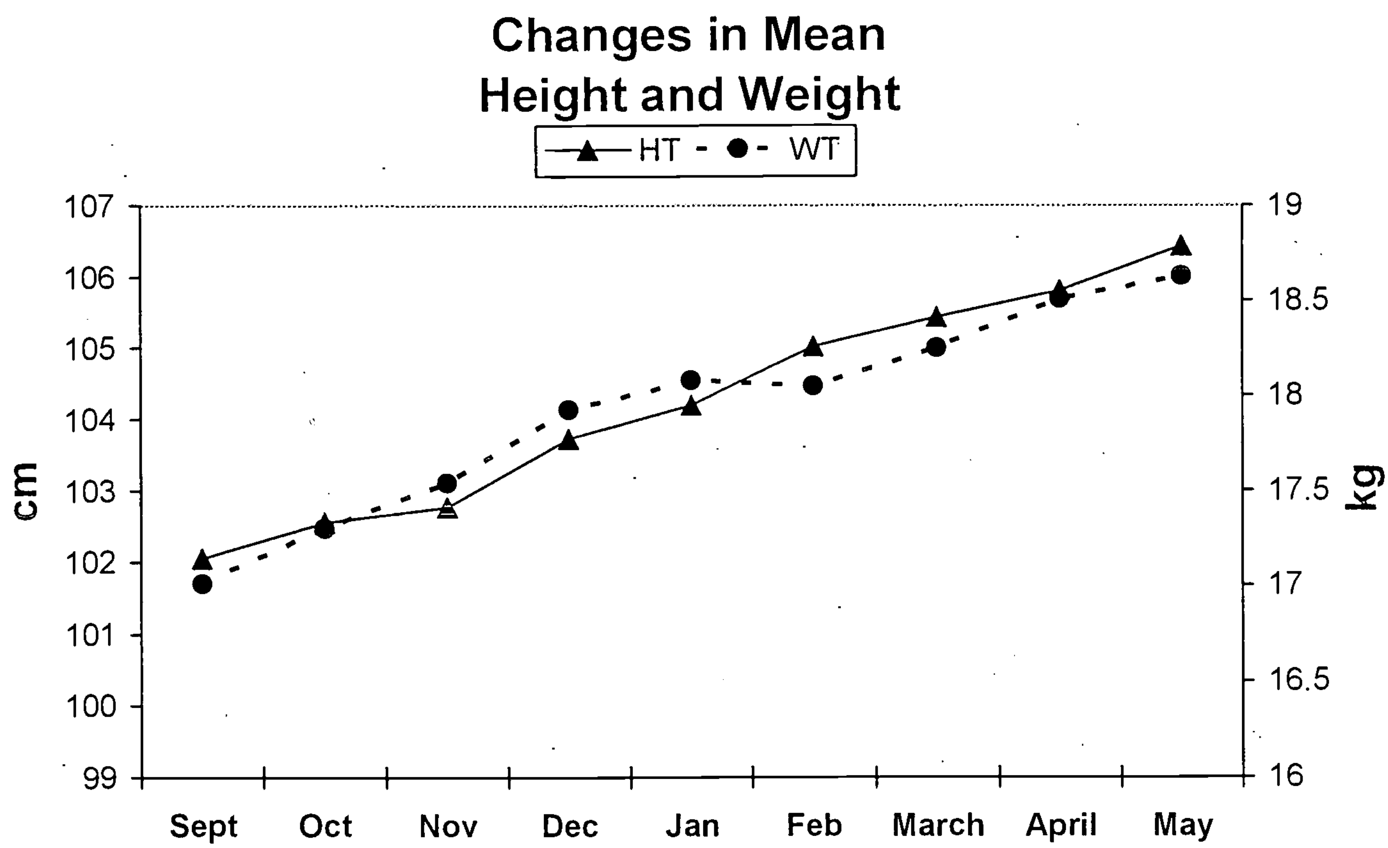


Figure 2

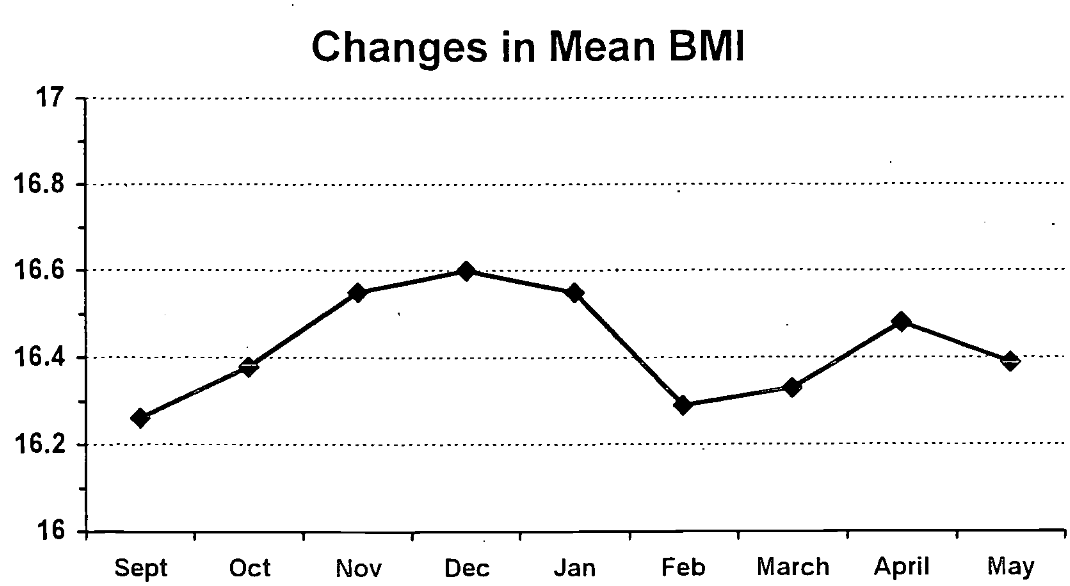


Figure 3

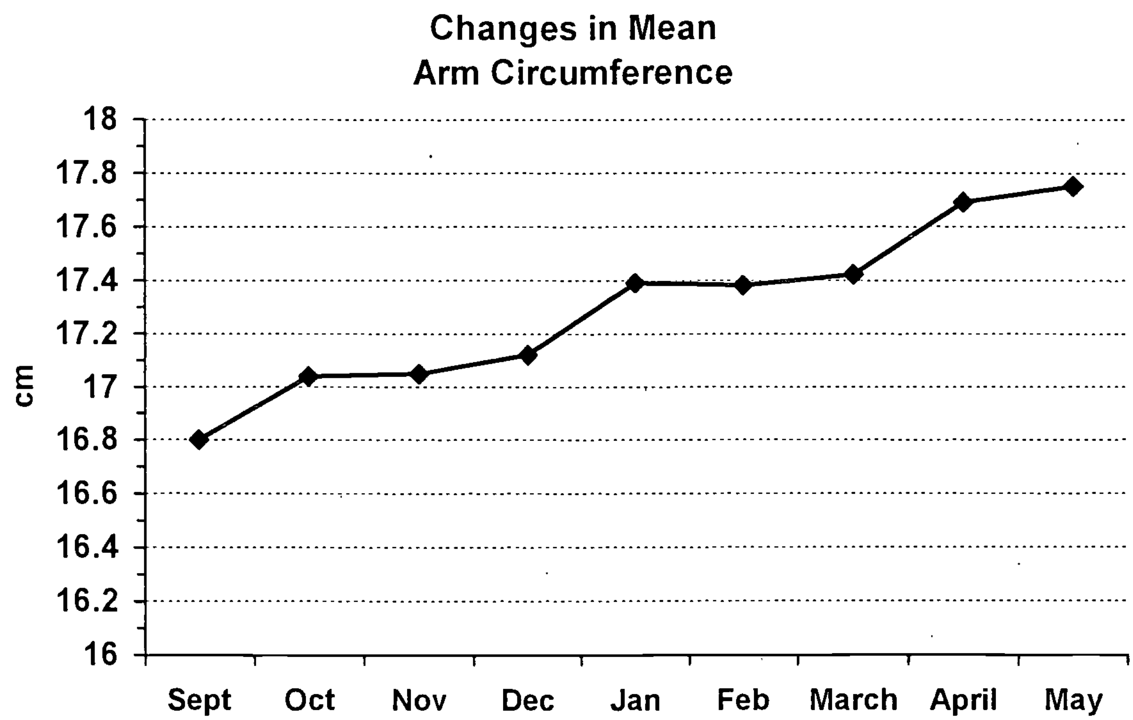
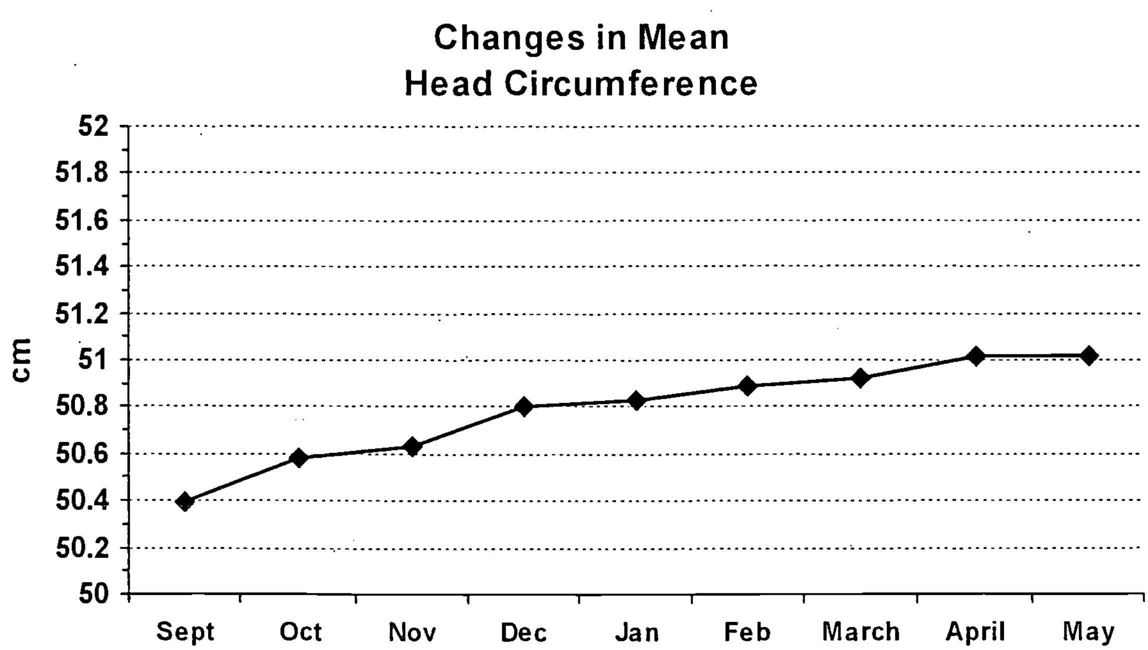


Figure 4



U.S. Department of Education
Office of Educational Research and Improvement (OERI)
National Library of Education (NLE)
Educational Resources Information Center (ERIC)

ERIC®

REPRODUCTION RELEASE

(Specific Document)

I. DOCUMENT IDENTIFICATION:

Title: Rate of Physical Growth and Its Affect on Head Start Children's Motor and Cognitive Development

Author(s): Rebecca A. Marcon

Corporate Source:

Publication Date: June 2002

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, *Resources in Education* (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic media, and sold through the ERIC Document Reproduction Service (EDRS). Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce and disseminate the identified document, please CHECK ONE of the following three options and sign at the bottom of the page.

The sample sticker shown below will be affixed to all Level 1 documents	The sample sticker shown below will be affixed to all Level 2A documents	The sample sticker shown below will be affixed to all Level 2B documents
PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY Sample TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) 1	PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE, AND IN ELECTRONIC MEDIA FOR ERIC COLLECTION SUBSCRIBERS ONLY, HAS BEEN GRANTED BY Sample TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) 2A	PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY Sample TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) 2B
Level 1	Level 2A	Level 2B
[X]	[ ]	[ ]
Check here for Level 1 release, permitting reproduction and dissemination in microfiche or other ERIC archival media (e.g., electronic) *and* paper copy.	Check here for Level 2A release, permitting reproduction and dissemination in microfiche and in electronic media for ERIC archival collection subscribers only	Check here for Level 2B release, permitting reproduction and dissemination in microfiche only

Documents will be processed as indicated provided reproduction quality permits.
If permission to reproduce is granted, but no box is checked, documents will be processed at Level 1.

Sign here, → please

Signature: Rebecca A. Marcon

Printed Name/Position/Title: Rebecca A. Marcon / Professor
Organization/Address: Department of Psychology, University of North Florida, Jacksonville, FL 32224-2673
Telephone: (904) 620-2807
FAX: (904) 620-3814
E-Mail Address: rmarcon@unf.edu
Date: 6/24/02

~~MICRO~~
6th Head Start National Research Conference

(over)

III. DOCUMENT AVAILABILITY INFORMATION (FROM NON-ERIC SOURCE):

If permission to reproduce is not granted to ERIC, *or*, if you wish ERIC to cite the availability of the document from another source, please provide the following information regarding the availability of the document. (ERIC will not announce a document unless it is publicly available, and a dependable source can be specified. Contributors should also be aware that ERIC selection criteria are significantly more stringent for documents that cannot be made available through EDRS.)

Publisher/Distributor:
Address:
Price:

IV. REFERRAL OF ERIC TO COPYRIGHT/REPRODUCTION RIGHTS HOLDER:

If the right to grant this reproduction release is held by someone other than the addressee, please provide the appropriate name and address:

Name:
Address:

V. WHERE TO SEND THIS FORM:

Send this form to the following ERIC Clearinghouse:	Karen E. Smith, Acquisitions Coordinator ERIC/EECE Children's Research Center University of Illinois 51 Gerty Dr. Champaign, Illinois, U.S.A. 61820-7469

However, if solicited by the ERIC Facility, or if making an unsolicited contribution to ERIC, return this form (and the document being contributed) to:

ERIC Processing and Reference Facility
1100 West Street, 2nd Floor
Laurel, Maryland 20707-3598

Telephone: 301-497-4080
Toll Free: 800-799-3742
FAX: 301-953-0263
e-mail: ericfac@inet.ed.gov
WWW: http://ericfac.piccard.csc.com