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AUTHOR Duckman, Robert; Tulloch, Deborah
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ABSTRACT

Relationships between infant visual skills and the development of object permanence and expressive language skills were examined with 31 infants in three groups: visually typical, visually atypical, and Down Syndrome. Measures used to evaluate visual status were: forced preferential looking, optokinetic nystagmus, and behavioral. Object permanence scores were obtained from the Uzgiris-Hunt Ordinal Scales of Psychological Development and expressive language scores from the Bzoch-League Receptive-Expressive Emergent Language Scale. A relationship between intactness of binocular vision and performance on tasks measuring concepts of object permanence emerged for the visually typical and visually atypical infants. No support for a relationship between intactness of binocular vision and performance on tasks measuring expressive language skills was found for any of the groups. Down Syndrome infants demonstrated a typical, although delayed, developmental sequence for object permanence and expressive language skills and a low incidence of visual deficits. The observed cross-validation of information obtained on visual status and level of object permanence skills confirmed the value of collaborations between vision science and education. (Author/CL)

Relation of Infant Vision to Early Cognitive and Language Status[1]

Robert Duckman, O.D.[2] and Deborah Tulloch, Ed.D.[3]

Running Head: Relation of Infant Vision to Early Status

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1) Funded in part by a thesis incentive award of the American Foundation for the Blind, New York, New York

2) Associate Professor, SUNY College of Optometry, New York, New York

3) Assistant Professor, College of Saint Elizabeth, Convent Station, New Jersey; Information on cognitive and language status was part of author's doctoral disseration at Teachers College, Columbia University, New York, New York with the assistance of Profs. Frances P. Connor and Laurence R. Gardner of the Department of Special Education.

Abstract

Relationships between infant visual skills and the development of object permanence and expressive language skills were examined. Measures used to evaluate visual status were forced preferential looking, optokinetic nystagmus and behavioral measures. Information on levels of object permanence and expressive language skills were obtained from the Uzgiris-Hunt Ordinal Scales of Psychological Development with additional information on expressive language skills obtained from the Bzoch-League Receptive-Expressive Emergent Language Scale. Thirty-one infants, ages 4 to 20 months with average CA of 12.6 months, were divided into three subject groups: visually typical, visually atypical and Down syndrome. Most of the visual deficits observed were at mild to moderate levels and primarily affected binocular vision. An optometrist administered the visual status evaluation while an early childhood special educator administered the developmental status measures. A relationship between intactness of binocular vision and performance on tasks measuring concepts of object permanence emerged for the visually typical and visually atypical infants. No support for a relationship between intactness of binocular vision and performance on tasks measuring expressive language skills was observed for any of the subject groups. Down syndrome infants demonstrated a typical, although delayed, developmental sequence for object permanence and expressive language skills and a low incidence of visual deficits. A valuable implication for practice was seen in the cross-validation of information relating levels of object permanence to visual status as approaches from vision science and education were combined to arrive at comprehensive evaluations of infants demonstrating or at risk for visual deficits.

Relation of Infant Vision to Early Cognitive and Language Status

Research in psychology and education has described the critical nature of the early years of development for the achievement of highest growth potentials (Lerner, Mardell-Czudnowski & Goldenberg, 1981). Some theorists suggest the presence of early critical periods in which the infant and young child are most maleable and receptive to the effects of environmental stimulation; exposure to appropriate stimulation during these periods could enhance later levels of achievement to an extent not possible subsequently (Hunt, 1961; Bruner, 1960; Scott, 1962; Bloom, 1964; Bobath, 1967). Many professionals working in early intervention programs for young children with special needs believe that the sooner the identification of potentially handicapping conditions, the greater the possibility of enhancing typical developmental patterns (Ramey, Trohanis & Hostler, 1982).

Assessment is crucial to the complex process of early identification of handicaps. Challenges are experienced in assessing at risk or handicapped infants and young children because of reduced levels of behaviors available for evaluation (Sheehan, 1982). It appears, then, that a crucial issue in the assessment of at risk or handicapped infants is to identify measures that comprehensively describe present developmental status in order that intervention can occur when needed.

A solution to arriving at valid and functional assessments of atypical infants is to combine information derived from psychoeducational evaluations with that from other professional areas. By increasing the variety of assessment tools used, the possibility of accessing more diverse behaviors to identify developmental strengths and/or weaknesses can be enhanced. An area for multiprofessional assessment collaborations is in evaluations of visually atypical infants. Given the potentially negative effects of restricted early vision on future use of skills requiring visual mediation (Bower, 1977; Rapin, 1979) and achievement of numerous developmental milestones (Fraiberg, 1977; Warren, 1977), the identification of visual deficits and concomitant developmental deficits in infants and young children is crucial.

The present study was designed to address the problem of arriving at comprehensive evaluations of early cognitive and language developmental status of infants at risk for, or having identified visual deficits. Indices of infant visual status derived from vision science approaches were combined with that from psychoeducational tools measuring cognitive and language developmental functioning often problematic for some types of visually atypical infants. It was proposed that, compared to infants with normal visual status, some visually atypical infants would evidence deficits in these specified early skill areas influenced by vision and visual perceptual input, e.g., object permanence and expressive language skills. Visually typical infants might not demonstrate these deficits because their intact vision would afford more complete visual perceptual input than that of the visually atypical infants. A third group of Down syndrome infants was examined as being at risk for both visual and developmental deficits in order to evaluate any interplay between both areas.

One theoretical basis of the present study comes from vision science. Contrary to traditional views, the human infant's visual system is, at least on a sensory level, extremely precocious. Research clearly indicates that the infant's visual system approaches adult-like function by 5-6 months of age. Marg, Freeman, Peltzman and Goldstein (1976), and Sokol and Dobson (1976), utilizing the visually evoked potential (VEP), demonstrated near adult responses to a 20/20 stimulus display, i.e., phase-alternated checkerboard patterns, by six months of age. Haynes, White and Held (1965), Banks (1980), and Brookman (1983) found that between the third to fifth month of life the infant's accommodation, i.e., the eye's ability to focus for near vision, is reaching adult capability and appropriateness. In addition, between 3-6 months of age, the infant can make accurate ocular motor responses to pursuit (Roucoux, Culee & Roucoux, 1983) and saccadic stimulus presentations (Dayton, Jones, Steele & Rose, 1964) as well as demonstrate accurate fusional responses (Wickelgren, 1967; Aslin, 1977; Braddick & Atkinson, 1982) and normal stereoscopic acuity (Fox, Aslin, Shea & Dumais, 1980; Held, Birch & Gwiazda, 1980; Birch, Shimojo & Held, 1985).

Given the presence of functional infant visual abilities, visual evaluation methods using indirect measures, e.g., electrically recorded cortical response in the visually evoked potential (VEP) (Sokol, 1976), and gaze preference in forced preferential looking (FPL) (Teller 1979), can be used with notoriously non-compliant infants (Fagan & Shepherd, 1982). Once the intactness of visual abilities has been ascertained, correlations with developmental status can occur based upon the assumption that the more biologically efficient an organism is, the more efficiently sensory information is processed and acted on (Chalke & Ertl, 1965). Previous studies relating visual abilities to indices of early developmental status have attained varied results. Studies relating visual abilities derived from the visually evoked potential (VEP) to measures of infant intelligence, motor skills and language abilities have been contradictory (Butler & Engel, 1969;

Jensen & Engel, 1971; Engel & Fay, 1972; Engel & Henderson, 1973). In contrast, more direct relationships have been established between visual abilities and indices of developmental status, i.e., intelligence, in studies employing the visual preference method of Miranda and Fantz (1974) that is the basis of the forced-choice preferential looking (FPL) assessment method described by Teller (1979), Gwiazda, Wolfe, Brill, Mohindra and Held (1980) and Dobson (1983).

A second theoretical base is derived from psychoeducational research relating specific developmental deficits to inadequate visual skills in blind infants and young children. Substantial delays in the acquisition of concepts of object permanence, i.e., up to 2 years, have been widely observed (Fraiberg, 1968; 1977). Some theorists suggest that visual perceptual skills can facilitate development of object concepts during early development (Bower, 1966; Gratch, 1975), a source of object knowledge missing for blind infants and children (Fraiberg, 1977). In the development of early expressive language, agreement is less uniform on the existence of quantitative delays for these children; some theorists like Fraiberg (1977) affirm the existence of such delays while others like Mills (1983) maintain that they are equalized eventually in later development. Researchers like Warren (1977) believe that the existence/non-existence of language delays has not been established unequivocally for blind infants and young children with the need for studies examining the relation of partial vision to early developmental status (Warren, 1981).

In the present study, in addition to identifying infants functionally penalized in the attainment of cognitive and language competencies strongly mediated by visual input, it was anticipated that cross-validation of the information obtained from vision science and psychoeducational sources would occur. As a result, a multiprofessional linkage of early intervention services for atypical infants and their families could be facilitated.

METHOD

Subjects

Thirty-one infants from the New York City metropolitan area were included in the study. They were selected from the patient caseload of children, ages birth to three years, seen for vision screening at the Infants Vision Clinic of the SUNY College of Optometry in Manhattan. Additional infants from the previous year's patient list were contacted through correspondence with their parents. A private early intervention program in New York City for young developmentally delayed children having an affiliation with the primary optometrist in the study was also sent information for distribution to interested parents.

Infants attending the clinic included those with demonstrated visual deficits, those at risk for the development of visual deficits due to genetic, biological or environmental factors, and those with typical visual status. Criteria for subject selection included: CA between 1 and 23 months to match the developmental ages on the psychoeducational measures of cognitive and language status; compliance with test of visual status; compliance with test of object permanence with expressive language information derived from parent interview. For the purposes of statistical analyses, three subject groups were identified: visually typical, visually atypical and Down syndrome infants.

Subjects with typical visual status, Group I (average CA 12.3 months), were determined to have binocular visual acuity within the normal range relative to CA ($n_1 = 13$). None of these infants had previously identified developmental delays or other sensory deficits noted in their files at the clinic.

Subjects with atypical visual status, Group II (average CA 15.7 months), showed visual anomalies in infancy during the first 18 months of development. For some of these infants corrective procedures, e.g., lenses or surgery, had been undertaken prior to the study. The visually atypical infants as a group demonstrated varying degrees of intactness of binocular visual acuity relative to CA (n_2 = 9). When observed, the degree of visual deficit was mild to moderate in severity and affecting binocular vision, e.g., strabismus (esotropia) or nystagmus. Only one visually atypical infant had a visual deficit of the severity of a visual impairment. None of the visually atypical infants had previously identified developmental delays or other sensory deficits noted in their files at the clinic.

Group III (average CA 9.8 months) was comprised of infants with Down syndrome at risk for both atypical visual and developmental status (n_3 = 9). All infants in this group demonstrated typical visual functioning relative to CA, a finding that was not anticipated given the likelihood of visual deficits associated with Down syndrome (Blackman, 1984). None of the Group III infants had other identified sensory deficits, e.g., hearing impairments, also associated with Down syndrome (Blackman, 1984) described in their files at the clinic. In order to achieve a homogeneity of characteristics for the purposes of statistical analyses, two other developmentally delayed infants were excluded from the final results: a Down syndrome infant with a a severe visual impairment; a brain-damaged, not Down syndrome, infant also having a visual impairment at the severe level.

No differences among the three subject groups were determined for the following infant status characteristics that could have accounted for differences other than visual status in attainment of object permanence and expressive language skills: gender (male or female); SES (low if visual status evaluation was paid by Medicaid, above-low if paid by private medical insurance); birth status (pre- or full term birth); birth problems (e.g., placement in isolette following birth); current health problems (absence or presence of problems like cardiac conditions or seizure disorders); language origin (monolingual or multilingual family background). Information on these characteristics was obtained by parent interview as well as examination of vision clinic files.

Instrumentation

The forced-choice preferential looking measure (FPL) as specified by Duckman and Selenow (1983) was the predominant measure of visual status employed. The FPL has been described as an effective clinical tool for testing the visual acuity of infants from birth until about ten months of age in a normal population. The test's premise is that infants will resolve and attend to a striped stimulus more often than to a homogeneous blank stimulus (Fantz, Ordy & Udelf, 1962). By taking advantage of this naturally occurring visual preference, an index of visual acuity can be determined (Teller, 1979). Compared to the visually evoked potential, the tasks required in the FPL more closely resemble adaptive patterns of visual behaviors that have been related to later perceptual cognitive functioning (Fantz & Nevis, 1967) and thus offer valuable information to the infant researcher. Duckman and Selenow (1983), and Lennerstrand, Axelsson and Andersson (1983a, 1983b, 1983c) have shown that the FPL technique is also effective with developmentally disabled individuals well beyond this ten month limit . Other visual evaluation measures employed included optokinetic nystagmus (OKN), which obtains visual acuity estimates similar to the FPL (Salapatek & Banks, 1978), and behavioral tests comprised of visual fixation, hand-eye coordination, and discrimination of Lighthouse picture cards.

The Uzgiris-Hunt Ordinal Scales of Psychological Development (Scale I--The Development of Visual Pursuit and the Permanence of Objects and Scale IIa--The Development of Vocal Imitation) (Uzgiris & Hunt, 1975) were employed as the measures of cognitive and language status. Scale IIa was supplemented by the expressive language section of the Receptive-Expressive Emergent Language Scale or REEL (Bzoch & League, 1971). The Uzgiris-Hunt scales are considered by educators to be the most in depth cognitive developmental evaluation of those presently available for young children. Their descriptions of very small steps in the demonstration of specified areas of early development are so well delineated that they are particularly useful with young atypical children (Horowitz, 1982).

Procedure

The measures of visual status were administered by an optometrist skilled in the testing of infants and young children. The evaluation of object permanence and expressive language skills was conducted by an early childhood special educator. Each part of the combined visual and developmental status assessment required approximately 15-25 minutes for a total testing time of less than one hour. The developmental status assessment usually followed that of visual status on the same day; in some instances this was not possible and so this part of the assessment occurred in the infant's home or the office of the early childhood special educator within no more than two months of the visual status evaluation.
Prior to each developmental assessment, attempts were made to insure that the early childhood special educator was unaware of the visual status of each infant so as not to bias results derived.

An inferential measure of visual acuity is made during the FPL procedure. The paradigm is based upon research indicating that infants prefer to fixate patterned over unpatterned fields (Fantz et al., 1962). The infant, seated in an adapted chair or the parent's lap, is simultaneously presented with a square wave grating, i.e., black and white stripes, and a homogeneous gray field matched for average luminance. The presentations are rear-projected and a "blind" observer at an observation hole midway between the two fields judges whether the stripes are on the left or right side based upon the infant's fixations. As long as the infant can resolve the stripes, he/she should demonstrate a preference for that field. When the stripes fall below visual acuity threshold, both fields should appear gray and thus no preference is shown.

In the present study, the slides were rear-projected via two Kodak carousel slide projectors onto two pieces of 3M Polacoat material (resolution = 85 lines/mm or better) measuring 10 cm X 10 cm each. Presentation fields were mounted into a wooden frame painted black and totally filling the infant's visual field. The two presentation fields were separated by 36 cm with an observation hole centered between them. The infant's viewing distance was 50 cm. Stripes were presented randomly on the right or left side with the corresponding gray slide on the opposite side. A television camera was placed behind the wooden frame at the observation hole. The observer viewed the infant's eye movements and fixations on a television monitor. At each presentation, the observer made a judgment as to which side the stripes were on. If the observer was correct, the scorer advanced the slides and if incorrect, moved the slides backward. There were three pairs of slides at each spatial frequency value. A staircase presentation was used, i.e., from lowest spatial frequency or widest stripes to highest spatial frequency or narrowest stripes. The criterion for perception at a given spatial frequency was 70% or greater "correct" responses. Two distractor slides of colored circles were presented between test trials to prevent habituation and fixation bias which could have invalidated the procedure. As a further control, all testing was done in a totally "black" room. Figure 1 illustrates the arrangement of the FPL apparatus.

Insert Figure 1 about here

Spatial frequencies and their corresponding approximate Snellen acuity equivalents were determined as illustrated in Table 1. Measures of Snellen acuity on the FPL procedure are significantly lower than acuity measured by the VEP, e.g., at 6 months of age VEP = 20/20 while FPL = 20/100. The VEP acuity values reflect the intactness of the

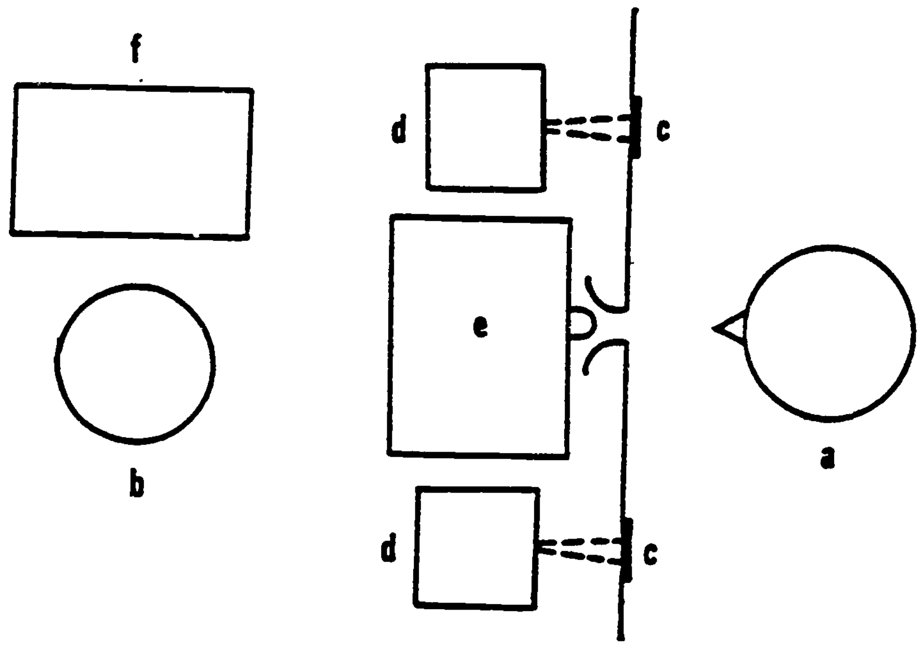

Figure 1. Placement of FPL apparatus:

A) Infant's Head B) Optometrist

C) Projected Slides (one spatial frequency and one homogenous slide)

D) Slide Projectors E) Television Camera

F) Television Monitor

Note: Adapted from "Use of Forced Preferential Looking for Measurement of Visual Acuity in a Population of Neurologically Impaired Children," by R. Duckman and A. Selenow, 1983, American Journal of Optometry and Physiological Optics, 60, 817-821. Reprinted by permission from the authors.

visual system from retina to visual cortex, but indicate nothing about the infant's perceptual levels. Since the FPL is a behavioral response, it introduces a perceptual-cognitive component to the assessment of visual acuity. In the FPL, the infant must compare the two fields and then, based upon the perception of a pattern on one, show a preference to fixate that field. The observer's response of the infant's preference is based on the infant's first fixation, total time spent fixating each of the fields and the "crispness" of the response. At the lower spatial frequencies, i.e., wider stripes, the infant's responses and the observer's responses are fast and accurate. As the square wave gratings approach the infant's visual acuity threshold, judgments become much more difficult to make and the observer's responses are slow and approach chance level.

Insert Table 1 about here

In the administration of the Uzgiris-Hunt scales, the infant sat on the floor in front of the parent on a rug opposite the examiner also on the floor. Toys and objects typically found in preschool settings or at home were used in test administration. A box containing the test materials was placed in back of the examiner out of the infant's direct

Table 1

Spatial Frequencies and Corresponding Snellen Acuity Levels in the FPL

Spatial Frequency	Approximate Snellen Acuity
0.39 cycles/degree	20/1400
0.80 cycles/degree	20/700
1.60 cycles/degree	20/400
2.10 cycles/degree	20/300
3.20 cycles/degree	20/200
4.20 cycles/degree	20/150
6.10 cycles/degree	20/100
8.80 cycles/degree	20/70
12.40 cycles/degree	20/50
16.90 cycles/degree	20/40
24.80 cycles/degree	20/25
30.00 cycles/degree	20/20

line of vision. For active infants and to gain the attention of those who were initially non-compliant, it was often necessary to move around on the floor--infant, parent, evaluator and materials. For some older infants over the age of 12 months, it proved less distracting to be seated on their parent's lap at a cleared table, a procedure corroborated by Kramer, Hill and Cohen (1975).

Items from Scale I were typically administered before those from Scale IIIa. It was believed that engaging infants in new situations with familiar-looking toys would be less stressful for them than would be producing vocalizations immediately. Vocalizations were likely to be available for evaluation when demonstrated spontaneously in the course of object play in the administration of Scale I. Objects were presented to the infant one at a time for the purposes of visual fixation, tracking and retrieval in full view, partially hidden and competely hidden presentations to assess the level of attainment of concpets of object permanence for Scale I. To help infants get the "gist" of what was required on this scale, the item involving retrieval of a completely hidden object was administered to all of them in as natural a play situation as possible, except when it was thought to be above the ceiling level of some of the infants, e.g., those with Down syndrome; in these instances, item administration began with tasks involving visual fixation and tracking. Noises made by the evaluator and the singing of typical childhood songs accompanied the item administration to sustain the infants' attention and to elicit vocalizations that could be evaluated according the expressive language measures, i.e., Scale IIIa and the REEL.

For quick reference by the evaluator, items from the scales were written on 3 X 5 inch index cards and covered with clear contact paper for durability. They were adapted from the procedures described by Uzgiris and Hunt (1975) and Dunst (1980) by simplification for efficient administration. Prior to test administration, the index cards were sorted so that the starting point was about three to four items below the infant's CA to prevent fatigue effects from administering too many items, especially to older infants. For the Down syndrome infants, items substantially below CA were initially selected in order to estimate a realistic starting point. A tape recorder was placed nearby to record the infants' spontaneous and elicited vocalizations as well as the examiner's brief observations and noting of items presented to and achieved/failed by the infant.

It was initially intended that Scale IIIa would be supplemented by the administration of the expressive language items of the REEL. It became evident that more time than was available in any one session would be needed to arrive at comprehensive estimations of the subjects' expressive language competencies using Scale IIIa as the primary information source. Thus when time was restricted or when infants were non-responsive to the evaluator's attempts to elicit language samples, most of the information on expressive language status came from the REEL.

Performance on each Uzgiris-Hunt scale was reported initially in terms of an estimated developmental age or EDA according to the work of Dunst (1980). Derivation of these developmental ages then allowed the derivation of deviation scores. Deviation scores could be positive, if the EDA was at or above the subject's CA, or negative, if below (Dunst, 1980). In going beyond Dunst's guidelines (1980), deviation scores could also be calculated in terms of number of steps away, i.e., above, at or below, from step on scale corresponding to CA. Another modification of Dunst's guidelines (1980) was in simplifying the computation of CA: the infant's birthdate was subtracted from that of the developmental testing and adjusted to the nearest month, with 2 weeks or more rounded off to the next highest month and less than 2 weeks to the next lowest month. For pre-term infants, CA was corrected to conceptional age.

For the three subject groups of visually typical, visually atypical and Down syndrome infants, relationships between visual status and 1) levels of concepts of object permanence and 2) expressive language skills were examined. In addition, levels of concepts of object permanence attained compared to those of expressive language were investigated for the three subject groups.

RESULTS

Non-parametric measures were used to analyze data derived on developmental age scores of levels of concepts of object permanence and expressive language skills relative to chronological age for the three subject groups. Table 2 summarizes these results. Data were then converted to categorical frequencies described in Table 3. Due to the smallness of the sample size that prevented use of the chi-square test of association, the Fisher exact probability test (p) was used to compare categories two at a time.

Insert Table 2 about here

Insert Table 3 about here

Differences between the subject groups were identified in attainment of concepts of object permanence. In particular, the visually atypical infants scored below

Table 2

Object Permanence and Expressive Language Relative to CA

Subject	O.P. Score (A)	O.P. Deviation Score (B)	E.L. Score (C)	E.L. Deviation Score (D)
GROUP I (Visually Typical)				
1	8	0	9	>
2	9	0	9	=
3	8	+1	8	>
4	18	0	N/O*	
5	22	+1	20	=
6	18	0	18	=
7	15	+1	12	<
8	8	+2	N/O	
9	22	+1	18	=
10	7	+2	6	=
11	7	-2	8	<
12	15	+1	N/O	
13	18	+4	14	>
GROUP II (Visually Atypical)				
14	10	-2	14	=
15	13	-3	15	<
16	13	0	N/O	
17	10	-1	N/O	
18	23	+2	14	<
19	10	-1	14	=
20	15	0	14	<
21	10	-5	14	<
22	18	0	18	=

Subject	O.P. Score (A)	O.P. Deviation Score (B)	E.L. Score (C)	E.L. Deviation Score (D)
GROUP III (Down Syndrome)				
23	4	-1	4	<
24	9	-8	9	<
25	3	-3	3	<
26	4	0	3	<
27	7	-1	4	<
28	3	-2	3	<
29	13	-1	12	<
30	13	-1	12	<
31	9	-6	12	<

(A): Developmental age score on test of object permanence in months.

(B): Discrepancy between chronological age and developmental age for test of object permanence expressed as number of steps higher (+), lower (-), or equal to (=) CA.

(C): Developmental age score for expressive language from Scale IIIa or the upper limit of the REEL, whichever was higher, in months.

(D): Discrepancy between chronological age and developmental age obtained for expressive language expressed as higher (>), lower (<), or equal to (=) CA.

*N/O: Information not obtained.

Table 3

Frequency Distributions of Categorical Information on Object Permanence and Expressive Language Scores

A.

Object Permanence Score	Group*		
	I	II	III
< CA	1	5	8
= or > CA	12	4	1

N = 31

B.

Expressive Language Score	Group*		
	I	II	III
< CA	2	4	9
= or > CA	8	3	0

N = 26

* Group I = Visually Typical

Group II = Visually Atypical

Group III = Down Syndrome

CA compared to visually typical infants who scored at or above CA ($p = .02$). All infants with Down syndrome scored below CA, a significant difference compared to the performance of visually typical infants ($p < .001$). No other significant differences were observed among the subject groups for concepts of object permanence.

One difference between the subject groups was identified in attainment of expressive language scores. Down syndrome infants scored below CA criterion compared to visually typical infants who scored at or above CA ($p < .001$). No significant differences in attainment of expressive language skills for the visually typical and visually atypical infants were observed.

Differences between the subject groups in attainment of levels of object permanence compared to that for expressive language skills were observed. Both the visually typical and Down syndrome infants scored higher in levels of object permanence (39% and 44%, respectively) compared to that for expressive language skills (20% and 11%, respectively); 30% of the visually typical infants scored at the same level in both areas as did 44% of the Down syndrome infants. In contrast, 22% of the visually atypical scored highest on object permanence, 57% highest on expressive language and 14% the same level for both areas. Figure 2 depicts these results.

Insert Figure 2 about here

Results of use of the Uzgiris-Hunt scales can also be described. Problems were noted in use of the EDA's derived by Dunst (1980) for the object permanence items from Scale I. Between some items the intervals are more than a one month difference. Thus true ceiling levels for infants having CA's falling inbetween the EDA of two items could not be determined until the CA matched an EDA on the scale. For this reason, no EDA for Scale I was used unless an item existed equal to the subject's CA. Thus six subjects, almost 20% of the total, had to be tested or retested when their CA's matched an EDA on the scale. The requirement of an EDA-CA correspondence was waived for some of the Down syndrome infants who attained an EDA more than one step below their CA and thus for whom it could be determined that the ceiling level observed in the testing session was below CA.

In attaining ceiling levels for Scale I, no major differences were noted among the subject groups. Typical reactions to the first item failed were: looking or moving away from the visual spectacle; showing signs of distress, e.g., facial frowns, whimpering or crying;

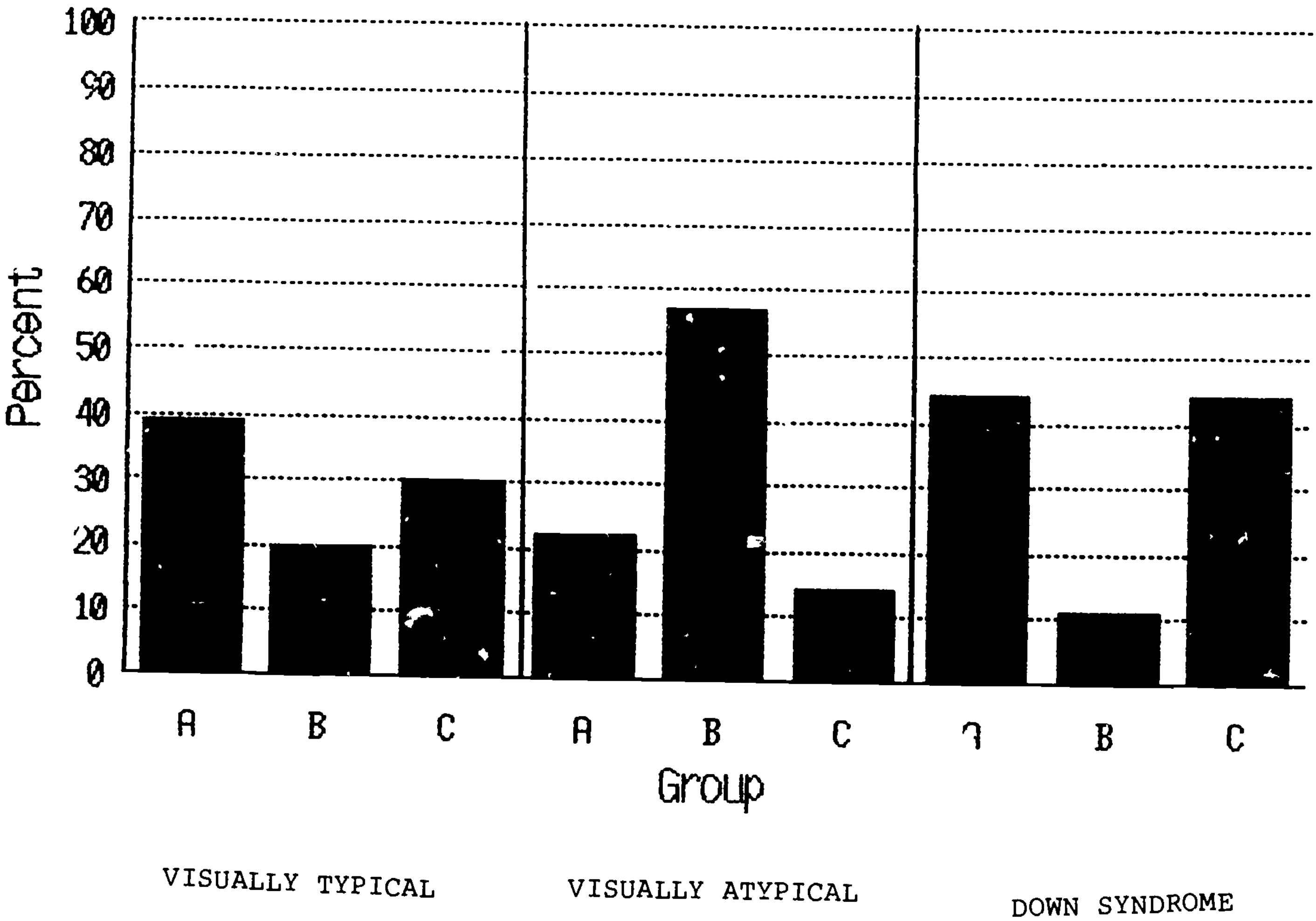

Figure 2. For all three subject groups, percent of group scoring higheron test of object permanence (A) or expressive language (B), or the same on both measures (C).

refusal to comply by retreating closer to the parent; diversionary tactics in picking up the materials and playing with them or attempting to engage the evaluator in other types of activities, e.g., banging hands on the table.

While the reactions of the Down syndrome infants were more muted and less varied than those of the other groups, it was still possible to discern when a ceiling level had been reached for Scale I. Cautions, however, in testing them were necessary since they frequently reacted to the visual spectacle of objects hidden by screens by non-purposefully "casting" off the screens. This behavior usually occurred when more than one screen was used as part of the procedure. Pausing to play with the test objects and then returning to the item procedure was effective in preventing this test-contaminating behavior from occurring again.

Some differences between the three groups were noted in obtaining expressive language information. More spontaneous sounds or words were evidenced by the visually typical and visually atypical groups compared to the Down syndrome infants who were less verbal in the testing session and also displayed lower affect levels compared to the other two groups. Thus most of the information obtained on the language status of the Down syndrome infants was the result of parent interview. This parent group was a very knowledgeable source on the types of sound and words made by their children as well as specific contexts in which they were demonstrated.

Directly eliciting the expressive language items on Scale IIIa was virtually impossible for all subject groups. Infants were consistently resistive to direct requests for language samples in a test situation with either the evaluator or the parent. Information derived from this scale was usually the result of object interactions in the administration of Scale I. The evaluator attempted to incorporate as naturally as possible the vocal imitation items in the object hidings for Scale I. The inherent flexibility of the Uzgiris-Hunt scales enabled such data collection. When the parent interview was used as a source of information from the REEL scale, attempts were made to insure the reliability of each parent by asking about behaviors substantially below and above the infant's CA. When expressive language information was obtained from both Scale IIIa and the REEL, it was in agreement 100% of the time as a cross-validation of both measures.

DISCUSSION

The primary findings of the study suggest a relationship between visual status and levels of concepts of object permanence attained in the first two years of development. No similar relationship was observed for visual status and levels of expressive language skills. The main limitation of the study is seen in the relatively small number of subjects available for investigation. Findings, however, can be related to several theoretical constructs.

Differences observed between the visually typical and visually atypical infants were likely related to deficits in object concept development. In this respect, the findings share commonalities with Bower's work (1964; 1965; 1966) who believed in the influence of visually mediated perception in early concept development to a greater extent than did Piaget (1950) who emphasized that knowledge derived in the sensorimotor period was more physical, rather than perceptual, in origin. Since none of the visually typical and visually atypical infants had diagnosed motor deficits, it can be assumed that they had experienced the benefit of physical interactions with the object world from birth that Piaget claims is central to object concept development. Since the only identified differences between these groups of infants appear to have been in the intactness of visual skills, particularly for binocular vision, it is hypothesized that a source of object information derived from visually mediated perception was missing for the visually atypical infants as a group that resulted in the observed deficits in concept development. These results imply that object knowledge in infancy is related to the integrity of vison.

Differences observed between the visually typical and visually atypical infants in levels of object permanence might be the result of deficits in concept development. For example, when a visually atypical infant scored below CA, it was usually at a level one step below the estimated developmental age (EDA) on the scale equal to his/her CA. Although it is not possible to draw conclusions on the numerical significance of this observed discrepancy between CA and EDA, the item involving the visible displacement of an object, with an EDA of 13 months, was problematic for 80% of the visually atypical infants failing to reach CA age criterion. This item is unique in the sequence of items on the scale because it is the first one involving visible displacement of the hidden object: the infant is required to infer the place of hiding in a reverse two part sequence. In contrast, no visually typical infant failed to master this item who should have, i.e., for whom the item was below CA.

Corroboration of research, especially the work of Fraiberg (1968; 1977), relating the presence of visual deficits in infancy to delayed levels of object permanence occurred in the present study; the presence of a visual anomaly for infants without diagnosed developmental delays increased the likelihood of attaining levels below

CA. The difference between the present study and Fraiberg's work (1968; 1977) is that she examined the object permanence skills of blind infants, while in the present study the level of visual deficit was at mild to moderate levels. However, in the present study, the visually atypical infant whose EDA for object permanence was most below CA also had the most severe visual deficit at the level of a visual impairment. Thus a linear relationship between degree of visual deficit and delay in object permanence skills is suggested in the present study: the more severe the visual deficit, the more likely an associated severe delay in object permanence skills.

Several reasons are possible for the lack of an observed significant relationship between vision and expressive language skills. First, it is possible that the global nature of language skills combined with the general nature of the screening tools used, e.g., the REEL, prevented the identification of differences that may be inherently more discrete than discerned by the test measures. Second, there is the likelihood that the role played by vision in the early development of expressive language skills is indirect; thus the presence of visual deficits would tend not to be as negative as in the development of concepts of object permanence where the role of vision may be assumed to be more direct and delays more easily attributable to visual deficits . Also, it is possible that deficits in expressive language were not noted because, compared to other studies involving blind children (Fraiberg, 1977; Wills, 1979; McGinnis, 1981; Mills, 1983), the visually atypical infants in the present study had moderate visual deficits.

The theoretical base of previous studies that successfully related the VEP to measures of cognition (Butler & Engel, 1969) was believed corroborated in the present study for object permanence skills. The overwhelming majority (92%) of the visually typical infants scored at or above CA compared to less than half (44%) of the visually atypical infants. Where the present study differs from previous ones involving the VEP, e.g., Galbraith, Gliddon and Busk (1970), is that none of the subjects was mentally impaired and so differences in attainment of cognitive milestones like object permanence were more subtle.

A cross-validation of the indices of infant vision and the developmental measure of concepts of object permanence occurred in the present study. In contrast, corroboration of the theoretical base of studies relating visual indices with early language development (Engel & Fay, 1972) was not found in the present study. As proposed earlier, this lack of an observed relationship is likely to have resulted from the general nature of the language measures used in the present study; the Engel and Fay research (1972) used a more quantifiable one; they measured speech articulation of initial and final consonants which permitted analysis of more discrete measures than in the expressive language evaluation of the present study.

With the exception of one subject, all of the Down syndrome infants demonstrated below chronological age levels for both object permanence and expressive language skills. This pattern of performance can be expected for a group at risk for developmental delays (Blackman, 1984). What was not anticipated for the Down syndrome infants was their high incidence of typical visual skills; none was diagnosed as having visual functioning significantly outside normal limits relative to CA. This pattern of typical visual skills contrasts with the predicted high incidence of visual deficits concomitant with Down syndrome (Bleck & Nagel, 1983). No reasons can be offered for the levels of visual skills of these infants except that prior identified rates of visual deficits may have been based upon groups of infants older than the sample in the present study whose average CA was 9.8 months. It is possible that the visual deficits concomitant with Down syndrome are not evidenced until later development.

Similarities in attainment of ceiling levels on the object permanence evaluation were evidenced by the Down syndrome infants and the visually typical, nondevelopmentally delayed infants. As for overall pattern of performance in the psychoeducational evaluation, both the visually typical and Down syndrome infants scored higher more frequently on the object permanence evaluation than on the expressive language one. In contrast, the visually atypical infants showed the opposite pattern with the object permanence evaluation seeming to be more problematic than the expressive language one. Some conclusions are proposed from these findings. First, similarities between the visually typical and Down syndrome infants are consistent with Weisz and Zigler's (1979) similar sequence hypothesis which posits that mentally retarded individuals attain the stages of cognitive development in the same sequence, although delayed, as do non-retarded individuals. Second, a possible reason why the Down syndrome infants demonstrated performance patterns similar to those of the visually typical infants is that as a group they demonstrated typical visual status.

Predictions of positive developmental outcomes for Down syndrome infants as the result of early intervention services (Hanson, 1984) seem confirmed by the performance of the Down syndrome infants in the object permanence evaluation in the present study. Over 77% of them scored within three scale steps of the level equal to CA; of this group, over 71% (or about 56% of the total group) scored within one step of of CA. All of the Down syndrome infants had been enrolled in early intervention programs prior to their participation in the study that could have been related to their strong performance. However, since they had an average CA of 9.8. months, it is not possible to determine if the predicted plateau in cognitive development believed to be characteristic of Down syndrome infants in later infancy (Gibson, 1978) will be true for the group in the present study. It should be noted that two of the older infants (CA 13 months) were among those scoring within one scale step of their CA. This pattern of performance could be viewed as an indicator that for some of the Down syndrome infants, developmental strengths are being maintained into the second year of life, possibly with the help of early intervention.

A limitation of the present study is seen in the nature of infant research whose results are dependent on the investigator's skill in developing rapport with a group of subjects demonstrating much response variability. As a result, it is usually impossible with this subject group to anticipate what situations will elicit meaningful responses for any infant in particular. Both the optometrist and early childhood special educator involved in the present study had considerable experience with typical and atypical infants. It is possible that less clear results would have been obtained by other investigators less experienced with these populations.

The need to identify mild to moderate visual deficits in infancy can be drawn from the results derived. For many of the visually atypical infants under the age of 18 months, the path to attainment of concepts of object permanence was detoured compared to that followed by infants with normal vision. Given the assumption that early critical periods for learning occur within the first three years of life, the importance of identifying visual deficits having observable negative impacts on early development is supported. The developmental fragility of atypically developing infants, who may be unable to compensate spontaneously for deficits, underscores the need for identification followed by intervention during these presumed critical periods. The consequences of untreated visual deficits affecting binocular vision may affect adversely later school-related achievements in what have been described as eye-teaming abilities seen in spelling skills and the alignment of letters and numbers in written work (Heinke & Greenburg, 1981). Thus the identification and treatment of mild to moderate visual deficits in infancy may prevent the occurrence of some subsequent learning problems during the school years.

In addition to describing the need to identify visual deficits in infancy, the value of a multi-professional partnership can be implied from the present study. The observed cross-validation of information obtained on visual status and level of object permanence skills is confirmation of the value of collaborations between vision science and education. Given the inherent adaptability of the Uzgiris-Hunt scales, it is suggested that inclusion of items from the object permanence scale occur in evaluations of infant vision. The effect would be to determine if visual deficits were impacting negatively on developmental status. Similarly, deficits observed by all early educators in attainment of concepts of object permanence could indicate the need for evaluation of vision in some infants, if only to rule out the possibility of problems.

The enhancement of professional development is possible as the result of multi-professional collaborations like that of the present study. Effective transdisciplinary teams, the hallmark of early intervention (Connor, Williamson & Siepp, 1978), might best occur if this proposed partnership begins at the pre-service level. Field experiences and coursework uniting common sources of information and approaches are a starting point. If early childhood educators from both regular and special education desire credibility in transdisciplinary settings, it is necessary to develop competency in and knowledge of areas previously thought outside the realm of their discipline. Similarly, other professions involved in the delivery of early intervention services can be enriched by the perspectives of early childhood educators.

Since examination of the impact of mild to moderate visual deficits in infancy in the present study was unique in its focus and contained a relatively small number of subjects, additional investigation is needed to confirm and expand the findings. First, it is suggested that additional analysis of the performance of visually atypical infants in object permanence skills relative to chronological age be made. Other types of visual deficits common in infancy could be examined, e.g., myopia and hyperopia, in order to discern with added precision the effects of lack of intact vision during this period of development. It is possible that some types and degrees of visual deficit will prove to be more detrimental than others in this respect.

Suggested also is the need to evaluate the effects of visual deficits on the performance of Down syndrome and other developmentally delayed infants in attainment of concepts of object permanence. This examination did not occur in the present study because the Down syndrome infants evaluated seemed to be visually typical. Additionally, distinctions might be made on types of handicapping conditions in combination with visual deficits which seem to affect most negatively the development of object permanence skills in infancy.

Evaluations of the effects of visual deficits could be expanded to areas of early development other than object permanence. Many are well delineated in the other scales of the Uzgiris-Hunt measure, all of which are crucial to infant concept development, e.g., means-ends, operational causality, object spatial relations, and object schemes. Thus it might be possible to determine more exactly the nature of visually mediated perception as a facilitator of object knowledge.

Identification of developmental problems in infancy is but a first step in meeting the needs of at risk or atypical infants and their families. Therefore, the creation and validation of intervention techniques derived from assessments like that described in the present study is supported. As emphasized by Dunst (1980), these infants should not be taught specific, splintered behaviors (e.g., learning how to recover objects hidden under one of two screens versus one screen). Rather, an interrelati n of achievements within a developmental context should be facilitated. Thus the completeness that is the right of all infants to attain, and the responsibility of early intervention professionals to insure, might be enhanced.

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