CONJUGATE LATERAL EYE MOVEMENTS: A DEVELOPMENTAL STUDY

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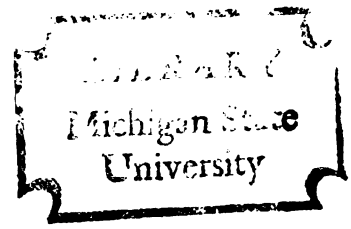
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ABSTRACT

CONJUGATE LATERAL EYE MOVEMENTS:
A DEVELOPMENTAL STUDY

By

Doris E. Weigel

Previous studies have confirmed the existence of conjugate lateral eye movements (CLEMs) related to a shift from an external to an internal focus of attention. The movement may be observed when a subject has fixed his eyes on an examiner and the examiner asks a question which requires reflection to answer. As the subject begins to reflect on the answer, he will momentarily break fixation on the examiner. A moment later he will return his gaze upon the examiner and begin to answer the question. In adults the direction of the movement is sufficiently consistent--approximately 85%--to allow classification of individuals as right- or left-movers. This study was designed to examine the development of CLEMs in children.

The subjects were 357 children (198 females and 159 males) between the ages of 3 and 18. Each subject was asked a series of 10 questions requiring reflection.

CLEMs were observed in all children tested. The percent of trials on which no movement occurred (i.e., the

subject did not break fixation before answering) generally decreased as age increased for both sexes. In addition to facilitating mental concentration, it is suggested that CLEMs may be related to learning culturally acceptable rules of "good" eye conduct.

With regard to sex, females showed a greater percentage of no-movement trials at all ages. Previous research indicates that the sex of the examiner (female) may have interacted with that of the subjects in such a way as to affect the percent of no-movement responses.

The percent of CLEMs in the same direction (consistency) did not vary with age. The mean consistency for all subjects was 80%. It was not confirmed that males are more consistent than females. In addition, the results suggest that blacks may be more consistent than whites.

There was a significantly greater proportion of left-movers in the sample; the tendency was strongest among females.

CLEMs were also observed in 20 of 21 (9 females and 12 males) severely retarded children tested. Compared with a matched sample of normal subjects, there was no difference between the groups in consistency. However, the retarded subjects showed a significantly greater percentage of no-movement responses. It is suggested that

the socializing process may take place at a slower rate in retarded children; fewer expectations may be placed on them for learning the rules of "good" eye conduct.

Approved: Paul Bakan

Date: 5/10/71

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CONJUGATE LATERAL EYE MOVEMENTS:

A DEVELOPMENTAL STUDY

By

Doris E. Weigel

A THESIS

Submitted to
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in partial fulfillment of the requirements
for the degree of

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Department of Psychology

1971

To the mansion family with whom I experience the love and joy of beginning to celebrate life and live Yes!

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I would like to thank the three faculty members who served on my thesis committee--Dr. Paul Bakan, the Chairman, and Doctors Dozier Thornton and Robert Zucker; Dr. Lawrence Messé for his consultation on statistics; and Dr. Fred Strodtbeck for his interest and enthusiasm which did much to encourage my work.

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CHAPTER I

INTRODUCTION

The action of another's eyes can be interpreted as expressive movement from which information both about the transmitter and his reaction to external events may be derived (Exline, 1963; Exline & Winters, 1965; Nielsen, 1962). Investigations into the role of visual interaction in interpersonal communication have raised questions concerning what kinds of information we may obtain from observation of another's visual behavior: "Do people who differ in personality type differ in the manner in which they visually interact with others? . . . Knowing that we use others' visual behaviors as cues to their internal states or unexpressed motives, do we also try to communicate such states and/or motives to others through our own visual behavior (Exline, 1963)?" Current research suggests that there is an observable voluntary eye movement, of which individuals are largely unaware, which has correlates at the physiological, cognitive, and personality levels.

One of the first studies involving the use of eye-movement behavior in relation to thought processes and personality was that of Moore and Gilliland in 1921.

Based on the common sense notion that the shifty eye is a sure sign of personal weakness, a test was designed to establish a quantitative relation between eye-movement behavior and the trait aggressiveness. Subjects were asked to perform a somewhat difficult series of mental additions while constantly sharing a fixed gaze with an instructor who sat facing them. The group which rated high on aggressiveness showed significantly fewer eye movements than did the group which rated low on aggressiveness.

In 1954 Teitelbaum reported observing spontaneous rhythmic eye movements. He also observed that the eye movements were associated with mental concentration. The movements occurred most commonly when subjects under observation sat in silence in mental concentration with eyes gazing into space, or when they paused for variable periods of time in the course of speech. He suggested that a movement which interferes with the precise focusing of the subject's eyes aids in the exclusion of perception through the visual sensory channel and thereby facilitates mental concentration.

While searching for some observable indication of shifting attention in patients, Day (1964) discovered a lateral eye-movement behavior similar to those reported above. The conjugate lateral eye movements (CLEMs) occur when the individual shifts his attention from an external to an internal focus. The movement may be observed when a

subject has fixed his eyes on an examiner and the examiner asks a question which requires reflection to answer (e.g., mental arithmetic). As the subject begins to reflect on the answer, he will momentarily break fixation on the examiner by moving his eyes to the left (right eye nasalward) or right (right eye temporalward). A moment later the subject will return his gaze upon the examiner and begin to answer the question.

One of Day's most significant contributions was finding that the direction of the movement to the right or to the left is characteristic for individuals (Day, 1964). It is sufficiently consistent--approximately 85%--to allow classification of individuals as right- or left-movers (Bakan, 1969; Duke, 1968). The direction of the CLEMs does not appear to be related to sex, handedness, or eye dominance of the individual (Duke, 1968; Libby, 1970). Males are more consistent than females. As Day observed, CLEMs occur more often in response to reflective questions (Duke, 1968).

Observations have been reported on differences between right- and left-movers on a wide variety of psychological, physiological and cognitive variables. Let us briefly examine some of these intriguing findings.

On the basis of clinical observations, Day (1967a) suggests that the left-mover shows "an internalized, subjective, passive, verbally expressive distribution of

attention in which he is more reactive to auditory and subjective visceral experience." In contrast, the right-mover shows "an externalized actively responsive distribution of attention emphasizing the visual-haptic modes." Bakan and Shotland (1969) have experimentally confirmed a difference between right- and left-movers on a task requiring a high degree of visual attention. Right-movers were shown to perform significantly better on the Stroop color-word test where the subject has to attend to ink colors rather than to the names of colors (e.g., the word "red" is printed in yellow ink and the correct response is "yellow"). Right-movers were also found to read faster a list of color names printed in black on white. It is suggested that reading speed is a correlate of direction of movement and that the better performance of right-movers on the reading time on the color-word card is due to their greater facility in making a covert reading response.

The similarity between the subjective orientation of a "good" hypnotic subject and the subjective orientation of the left-mover described above, led Bakan (1969) to a study of the relationship between hypnotic susceptibility and the dominant direction of the CLEMs. Subjects were divided into a high hypnotic-susceptible group on the basis of scores on the Stanford Hypnotic Susceptibility Scale. More left movements tended to be associated with greater hypnotizability.

Noting that hypnotizability has been shown to be related to amount of EEG alpha activity during an eyes-closed resting condition, Bakan next investigated the relationship between direction of CLEMs and the amount of resting EEG alpha activity. Bakan and Svorad (1969) confirmed the hypothesis that the tendency toward left CLEMs is associated with more EEG alpha activity than is the tendency to make right CLEMs.

In a replication of this study, Floyd Strayer found that left CLEMs are found more frequently in males with more basal EEG alpha. The relationship did not hold for females (Bakan, 1971). Strayer also found that male left-movers were able to increase their production of alpha during 24 minutes of "training" in a bio-feedback system. The subject would hear a feedback tone whenever alpha waves appeared. Given instructions to keep the tone on, the left-movers were able to increase their alpha, while the right-movers were unable to do so. Left-movers were able to increase alpha even when the "feedback" was a tape-recording of the tones produced by the alpha production of another left-mover subject. Bakan suggests that since the alpha state is facilitated by relaxation, the greater production of alpha by left-movers may be due to their greater ability to relax during the experiment. This is congruent with Day's (1967b) observation that tonus in large postural muscles is greater in right-movers than it is in left-movers.

Based on clinical observation, Day (1967a; 1970) suggests that certain psychosomatic syndromes seem present more often in right- or left-movers. Right CLEMs seem to be associated with emphysema, duodenal ulcer, hypotension, bradycardia, cluttering or blocking of speech, and rate reading problems, while asthma, gastric ulcer, hypertension, tachycardia, stuttering, and reading comprehension difficulties were more associated with left CLEMs. Bakan's (1971) preliminary findings suggest eye-movement classification may have some implications for disease choice. Headaches, particularly of the migrane type, were found to be more common among right-movers and, as Day observed, asthma was found to be more common among left-movers.

Bakan (1969) has shown differences associated with the direction of CLEMs in cognitive and intellectual areas as well. Among college students, right-movers tended to score relatively higher on the quantitative part of the Scholastic Aptitude Test (SAT) and to select "hard" majors such as the natural sciences. Left-movers showed better performances on the verbal part of the SAT and tended to choose "soft" majors in the humanities and social sciences. In a test of written verbal fluency, left-movers showed greater fluency (Bakan, 1971).

In a recent paper, Bakan (1971) reports a summary of additional findings: "right-movers as compared to left-movers have more tics and twitches, spend less time asleep

(males), pay more attention to the right side of the body (males), prefer cool colors over warm colors, and make career choices earlier. Left-movers tend to have more vivid imagery, are more sociable, are more likely to be patients in a hospital ward for alcoholism (males), and report themselves as more musical and religious."

Day has made several clinical observations on the differences in type of anxiety associated with direction of CLEMs. These have not yet been confirmed experimentally. According to Day (1967a), the right-mover subjectively describes anxiety as having a "fear in search of an object" quality which he labels as diffuse anxiety. Subjective visceral experience emphasizes slowing and strengthening of heart rate and breathing rate. The left-mover subjectively describes anxiety as having definite internal locus, and he describes its quality as tensional and jittery. Visceral experience emphasizes increase in heart and breathing rate. Day has found that skid row patients differ in heart rate--left-movers 100, right-movers 83--when first seen on admission to a hospital. Given vitamins and valium, a tranquilizer, after 8 hours the heart rates are left-movers 95 and right-movers 94. The directional difference on admission is consistent with that of Day's observation noted above: in response to anxiety, a right-mover experiences a slowing and strengthening of heart and

breathing rate, while a left-mover shows an increase in heart and breathing rate.

Day's (1967a) observations also showed that approximately 71% of the 142 married couples classified had opposite eye-movement directions. A similarly high percentage of complementary right- and left-movers was reported among homosexual pairs, and a somewhat smaller one among dyads of close friends.

Most of the research on CLEMs has used college-age students. There is little information about the development of CLEMs in children. Day has made some clinical observations of younger individuals, but these have not been confirmed experimentally. The present study is designed to examine the development of the phenomenon in children, as well as to replicate Day's observations. The questions to be examined are discussed below.

Observation of CLEMs in Young Children: Age of Onset

At what age may CLEMs first be observed in children? Day (1967a) reports that no child under four (50 cases observed) has shown the phenomenon to visual observation. The present study will examine this question by observing, in a systematic way, the eye-movement behavior of 3 year-old children.

The Relationship of No-Movement Responses to Age, Sex and Race

If, as Day observed, children under four do not show CLEMs, we would expect no-movement responses on 100% of the trials. That is, the subject would share a mutual gaze with the examiner, both while the question was being asked and as he began to reflect on the answer. By the time an individual is of college age, however, CLEMs are observed on almost all trials and the percentage of no-movement responses is close to zero. The question then arises as to how the percentage of no-movement responses varies with respect to age. Is there a sudden onset of CLEMs, or a gradual decrease in the percentage of no-movement trials? And does the development of CLEMs and the decrease of no-movement responses occur in the same manner and at the same rate for both males and females, and for blacks and whites?

The Relationship of Consistency of CLEMs to Age, Sex, and Race

As reported above, by the time students are of college age, they demonstrate sufficient consistency--approximately 85%--to be classifiable as right- or left-movers (Duke, 1968). The next question, then, is whether consistency, which is the percent of movement in a dominant direction, varies with age. Another consideration is the effect of sex on consistency. Duke (1968) found that

college-age males were more consistent than college-age females. This suggests that we examine whether the trend toward higher consistency among males is constant with respect to age. Another relevant question is whether there is a difference in consistency with respect to race.

The Proportion of Right-Movers and Left-Movers in the Sample

On the basis of clinical observation, Day (1967a) reported that 58% of the 284 females observed were left-movers, whereas 56% of the 237 males observed were right-movers. In contrast, Duke (1968) found no tendency for sex to bias the direction of movement chosen. Nor did the group as a whole show any preference for direction of movement. This study will examine whether the data supports any of these findings. In addition, the tendency for race to bias the direction of movement chosen will be examined.

CLEMs in Retarded Children

Day (1967a) reports that older individuals who have retarded intelligence and lack language fail to show the CLEMs. Thus, another question posed to the data will be: Do retarded children show CLEMs? And if so, how does the consistency and percent of no-movement responses in retarded children compare with that in normals?

CHAPTER II

METHOD

Subjects

The sample of normal subjects for this experiment was 442 children, 209 males and 233 females, who attended schools in the Chicago, Illinois, area. Children in three private nurseries and in grades Kindergarten (K), 2, 4, 6, 8, 10, and 12 in two private schools were tested. Since grades 10 and 12 in one school contained only females, an additional group of tenth and twelfth grade males was tested in two public schools. The subjects ranged from 3 to 18 years of age.

The sample of mentally retarded subjects was 40 children, 24 males and 16 females, who attended two private schools for mentally retarded children, in the Chicago, Illinois, area. All of these children had I.Q.s below 35, as measured on the Stanford-Binet Intelligence Test for Children. The subjects ranged from 5 to 16 years of age.

The Questionnaire

Two criteria were used in developing the questionnaire. First, the question must be difficult enough to

require reflection. This was based on Duke's (1968) finding that CLEMs occur more often in response to reflective questions. Second, the content or difficulty of the item must not arouse anxiety in the subject, since it is not known what effect anxiety has on the speed and direction of the CLEMs (Day, 1967b).

Therefore, similarities like, "In what way are a peach and a pear alike?" were chosen, since this kind of content seemed unlikely to arouse anxiety. Because of the difficulty in creating one list of similarities which would require reflection in the 18 year-old group, but which would not be too difficult for the 5 year-old group, two lists were constructed. Each list consisted of ten similarities; the items in List A were less difficult than those in List B. The lists appear in Table 1.

The questionnaires were pretested on children in grades 1 and 5 in one of the private schools. All of the questions in List A elicited CLEMs and were answered by most of the students in grade 1. Therefore, List A was considered appropriate for testing grades K and 2. Then children in grade 5 were tested to determine which list would be more appropriate for subjects in grades 4 and 6. Each of the students in grade 5 were given five items from List A and five from List B. The fifth graders showed CLEMs on all items from List A, but experienced some difficulty in answering the items from List B. Consequently,

Table 1. Lists of Items Used in the Questionnaires.

List A	List B
cat-mouse	scissors-copper pan
shirt-coat	cup-box
beer-wine	first-last
piano-violin	number 11-number 29
hat-firehelmet	genius-fool
pipe-cigarette	liberty-justice
paper-wood	salt-water
pound-inch	mountain-lake
button-zipper	peace-war
train-car	letter "c"-letter "u"

List C

What is your favorite T.V. program?

What color do you like best?

Who is your best friend?

What do you like to eat most?

What do you like to play with best?

What do you like to do in school?

Where do you like to go?

What do you like to play with at the playground?

What do you like to buy at the store?

it was decided to administer List A to the subjects in grade 4. However, they did answer enough items on List B to indicate that the sixth grade subjects probably would not experience too much anxiety or failure if given List B.

In consultation with a teacher of the mentally retarded children, it was decided that similarities would be too difficult for them. Upon the teacher's recommendation, questions pertaining to the subject's preferences were constructed. List C, which appears in Table 1, contains ten questions such as, "Who is your best friend?"

In terms of relative difficulty, List C was also felt to be the most appropriate for the nursery school subjects.

In summary, List A was administered to subjects in grades K, 2, and 4; List B to subjects in grades 6, 8, 10, and 12; and List C to the nursery and mentally retarded subjects.

Measurements Taken

All questionnaires were administered orally by the author. Each subject sat in a chair directly facing the examiner across a small table. The content of the subject's responses was not recorded. The subject's right eye was observed. Eye-movement behavior was noted in one of four possible categories immediately after each question was phrased. If there was no eye contact between the

subject and the examiner right after the question was phrased, the "trial" was noted as invalid. All other responses were recorded as lateral left movement, lateral right movement, or no movement if the subject did not change his gaze before answering. Lateral movements with a vertical component were scored in terms of lateral direction.

In order to determine handedness, the subject was asked to write his name or, if unable, to draw a circle using the paper and pencil on the table placed between the subject and examiner. Race was recorded as Black, White or Other.

Procedure

A criterion of 5 valid trials was set in order for a subject to be included in either the normal or retarded samples. In addition, left-handed subjects and those whose race was recorded as "Other" were eliminated from the samples. The remaining subjects were classified as right- or left-movers on the basis of majority of movements. Those subjects who were not classifiable because they made an equal number of movements in each direction were excluded from the samples.

Two scores were computed for each of the remaining subjects: the percentage of no movement on valid trials,

and consistency, which is the percentage of movement in the dominant direction on valid trials.

Subjects in the normal sample were grouped by two-year intervals into 8 age levels, viz. 3-4 year-olds . . . 17-18 year-olds.

CHAPTER III

RESULTS

Based on the criterion of 5 valid trials for a subject to be considered as part of either the normal or retarded samples, 14 subjects were eliminated from the normal sample and 5 from the retarded sample. Thirty-nine left-handed subjects were excluded from the normal sample and 12 from the retarded sample. An additional 7 normal subjects whose race was recorded as "Other" were omitted. The remaining subjects were classified as right- or left-movers on the basis of majority of movements. Three hundred fifty-seven of the remaining normal subjects, 198 females and 159 males, were classifiable, and 32 were not, since they made an equal number of movements in each direction. Table 2 summarizes the age and sex distribution in the normal sample. Twenty-one of the remaining retarded subjects, 9 females and 12 males, were classifiable, and 2 were not, since they made an equal number of movements in each direction. Table 3 summarizes the distribution of subjects eliminated from the normal and retarded samples.

In the main, questions were analyzed by 2x2 analyses of variance for unequal cell frequencies (unweighted means analysis).

Table 2. The Number of Normal Subjects by Sex and Age.

Age	Male	Female
3-4	23	26
5-6	17	23
7-8	22	19
9-10	23	22
11-12	18	26
13-14	19	25
15-16	17	39
17-18	20	18
Total	159	198

Table 3. The Number of Subjects Eliminated from the Normal and Retarded Samples.

Reason for Elimination	Normal	Retarded
<5 Valid Trials	14	5
Left-handed	39	12
Race = "Other"	7	0
Equal No. CLEMs	32	2
Total	92	19

Observation of CLEMs in Young Children: Age of Onset

CLEMs were observed in all subjects in the normal sample, including the three year-olds.

The Relationship of No-Movement Responses to Age, Sex, and Race

The results of the analysis of variance comparing percent of no-movement responses with respect to age and sex are given in Table 4. The effects of both sex, $F(1,200)=7.39$; $p<.01$, and age, $F(7,200)=5.03$; $p<.01$, were significant. The interaction was not significant. Examination of the means in Table 5 and Figure 1 shows that females had a higher mean percent of no-movement responses than did males, and that the mean percent of no-movement responses generally decreased as age increased for both males and females.

In order to examine the percent of no movement and consistency with respect to race, it was necessary to block the data in four-year intervals because of the small N in some of the cells. Table 6 summarizes the frequency distribution of subjects by sex, race, and age, in four-year intervals. The 15-18 year-old group was excluded from the analysis because the N in one of the cells was still very small (N=3). Table 7 gives the results of the analysis of variance on the percent of no-movement responses with

Table 4. Summary Table of Analysis of Variance Comparing Percent of No-Movement Responses with Respect to Sex and Age Ordered in Two-Year Intervals.

Source	SS	df	MS	F
Total	5.2923	356		
A (Sex)	.1005	1	.1005	7.39*
B (Age)	.4792	7	.0684	5.03*
AXB	.0578	7	.0083	<1
Error	4.6548	341	.0136	

*p<.01

Table 5. Mean Percent of No-Movement Responses for Males and Females by Age.

Age	Mean	
	Male	Female
3-4	.091	.154
5-6	.063	.132
7-8	.015	.070
9-10	.074	.114
11-12	.017	.041
13-14	.027	.029
15-16	.018	.013
17-18	.026	.051

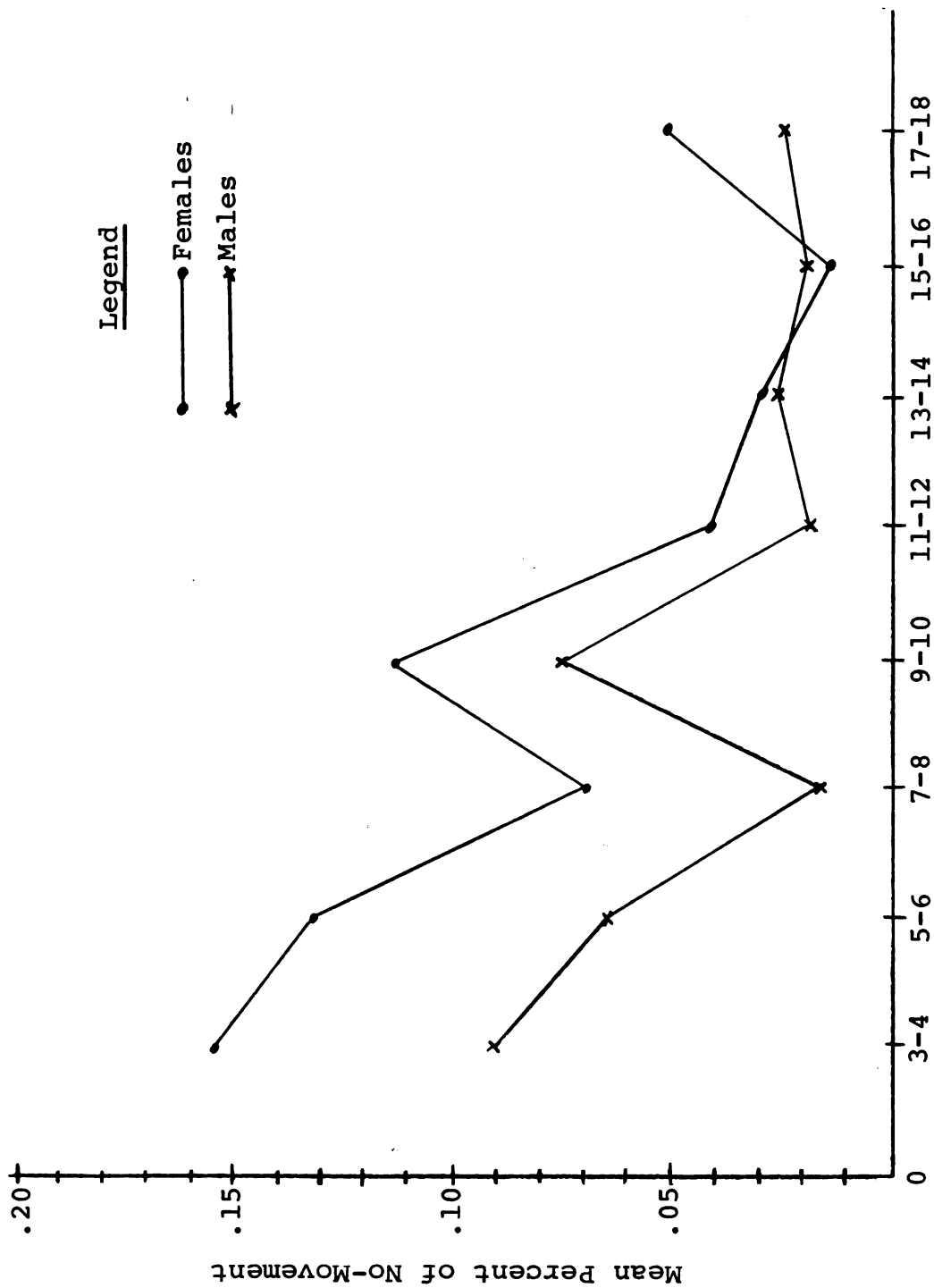

Figure 1. Mean Percent of No-Movement Responses with Respect to Sex and Age.

Table 6. The Number of Normal Subjects by Sex, Race, and Age.

Age	Male		Female	
	Black	White	Black	White
3-6	21	19	32	17
7-10	29	16	25	16
11-14	23	14	33	18
15-18	9	28	54	3
Total	82	77	144	54

Table 7. Summary Table of Analysis of Variance Comparing Percent of No-Movement with Respect to Sex, Race, and Age Ordered in Four-Year Intervals.

Source	SS	df	MS	F
Total	4.6872	262		
A (Sex)	.0935	1	.0935	5.47*
B (Race)	.0020	1	.0020	<1
C (Age)	.2540	2	.1270	7.43**
AXB	.0081	1	.0081	<1
AXC	.0183	2	.0192	<1
BXC	.0041	2	.0020	<1
AXBXC	.0244	2	.0122	<1
Error	4.2828	251	.0171	

*p<.05

**p<.01

respect to sex, race, and age, blocked in four-year intervals. Age was again found to be significant, $F(2,200)=7.43$; $p<.01$. Similarly the sex difference was still significant, $F(1,200)=5.47$; $p<.05$. Neither race nor any of the interactions was significant. Figure 2 and Table 8 again show the trend for females to show a higher mean percent of no-movement responses than males, and for the mean percent of no-movement responses to decrease for both sexes as age increases. The data for the 15-18 year-old group are included in Figure 2 and Table 8 to show the general trend.

Table 8. Mean Percent of No-Movement Responses by Sex, Race, and Age.

Age	Male		Female	
	Black	White	Black	White
3-6	.078	.081	.152	.128
7-10	.031	.071	.106	.076
11-14	.022	.023	.026	.052
15-18*	.022	.022	.026	.000

*not included in analysis

The Relationship of Consistency of CLEMs to Age, Sex, and Race

The summary of the analysis of variance comparing consistency with respect to sex and age, blocked in two-year intervals, appears in Table 9. None of the effects

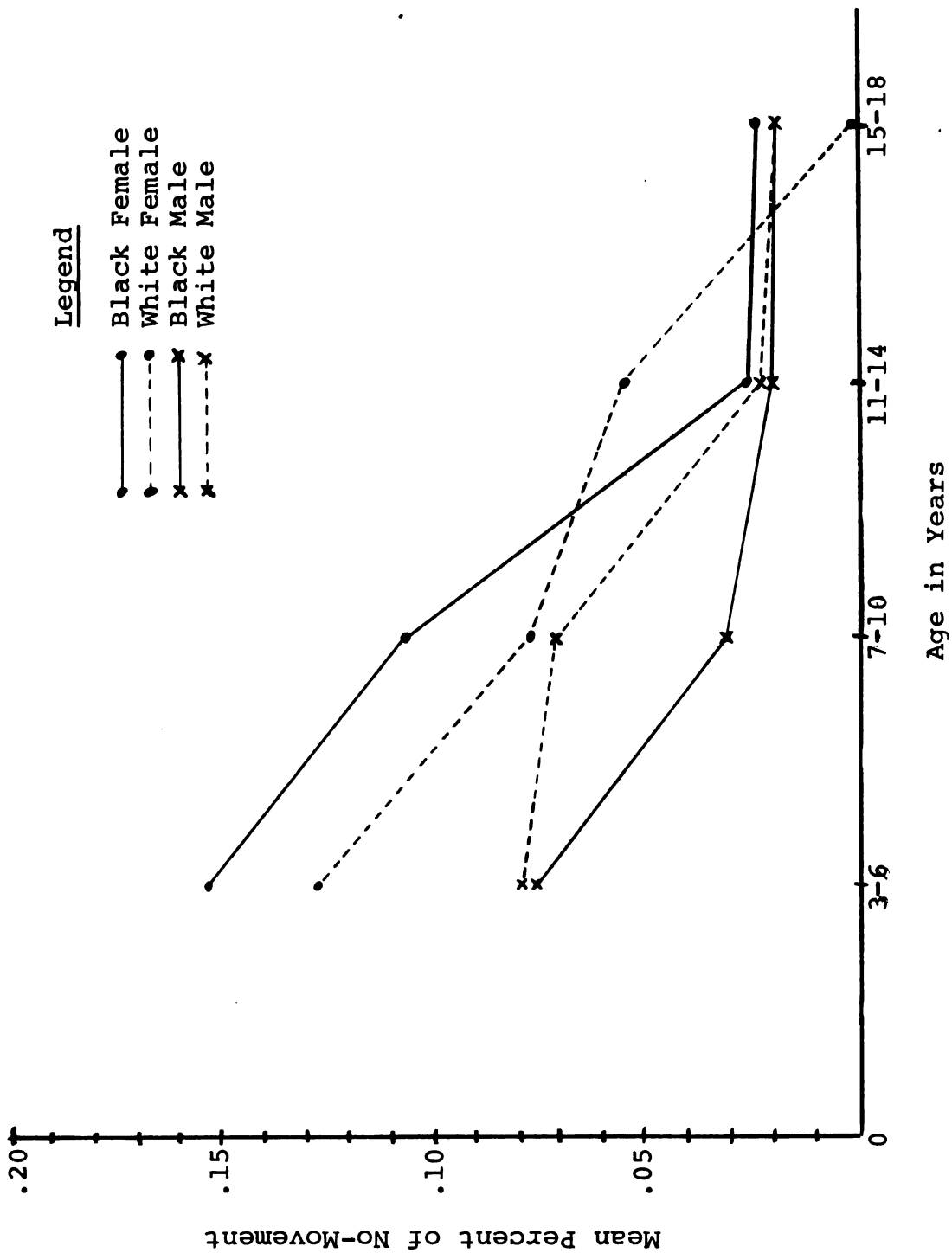

Figure 2. Mean Percent of No-Movement Responses with Respect to Sex, Race, and Age.

or interactions was significant. As can be seen from Figure 3, there are no differences in consistency between males and females in any of the age groups. On the average, subjects made about 80% of the CLEMs in the same direction. The mean consistency for males was 80% and for females 79%.

Table 9. Summary Table of Analysis of Variance Comparing Consistency with Respect to Sex and Age Ordered in Two-Year Intervals.

Source	SS	df	MS	F
Total	7.6510	356		
A (Sex)	.0300	1	.0300	1.40
B (Age)	.1348	7	.0192	<1
AXB	.1690	7	.0241	1.13
Error	7.3172	341	.0214	

The results of the analysis of variance on consistency with respect to sex, race, and age, blocked in four-year intervals, are given in Table 10. Because of the small N in one of the cells, the 15-18 year-old group were again eliminated. The data show that while sex and age were still not significant, race was significant, $F(1,200)=4.60$; $p<.05$. Figure 4 and Table 11 show that the difference was that black subjects were generally more consistent than white subjects. In addition, the

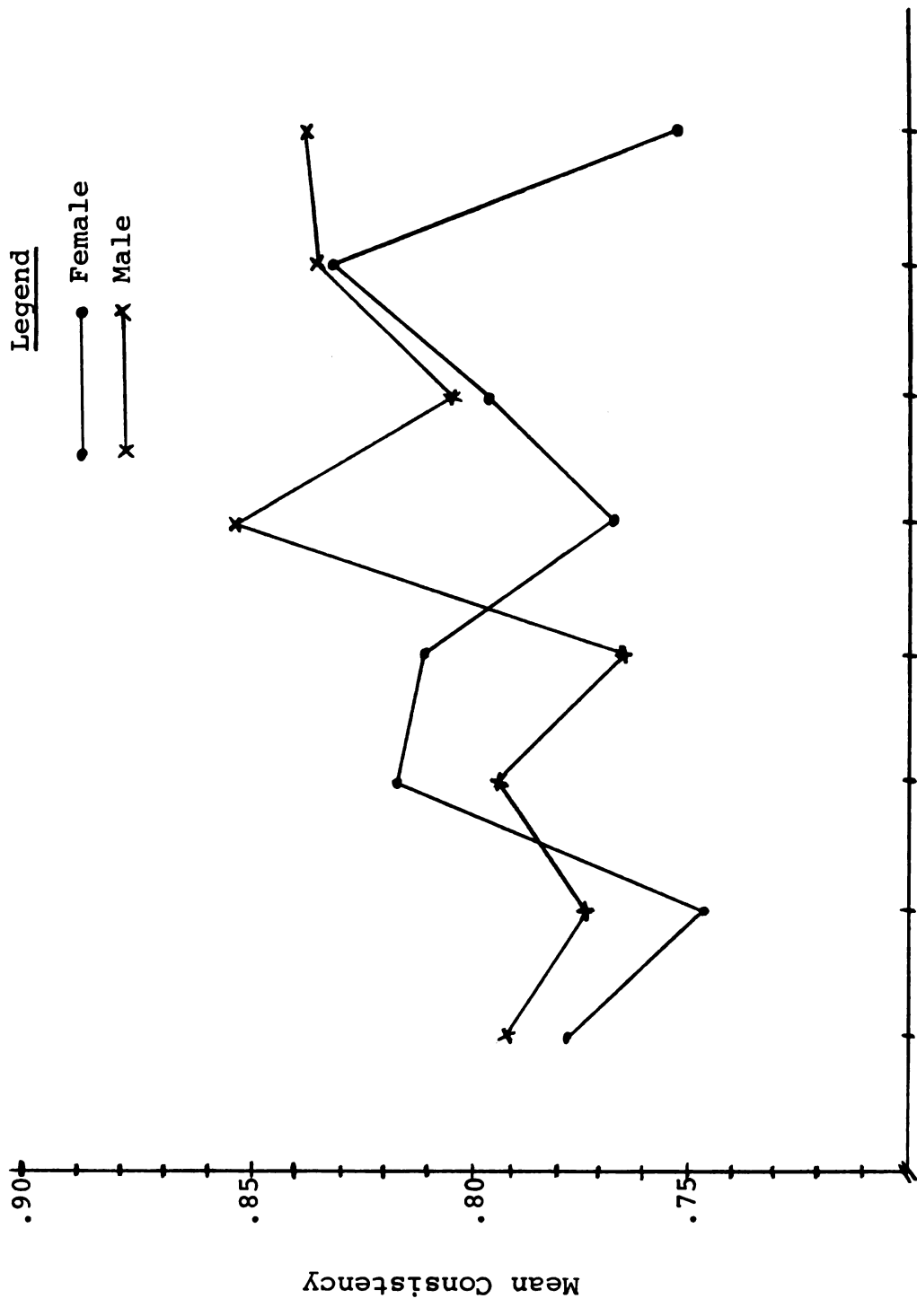

Figure 3. Mean Consistency with Respect to Sex and Age.

Table 10. Summary Table of Analysis of Variance Comparing Consistency with Respect to Sex, Race, and Age Ordered in Four-Year Intervals.

Source	SS	df	MS	F
Total	5.3701	262		
A (Sex)	.0102	1	.0102	<1
B (Race)	.0914	1	.0914	4.60*
C (Age)	.0203	2	.0102	<1
AXB	.0000	1	.0000	<1
AXC	.0894	2	.0447	2.25
BXC	.0061	2	.0030	<1
AXBXC	.1565	2	.0782	3.93*
Error	4.9962	251	.0199	

*p<.05

Table 11. Mean Consistency for Sex, Race, and Age.

Age	Male		Female	
	Black	White	Black	White
3-6	.829	.732	.748	.794
7-10	.788	.762	.835	.780
11-14	.829	.828	.817	.718
15-18*	.851	.831	.810	.733

*not included in analysis

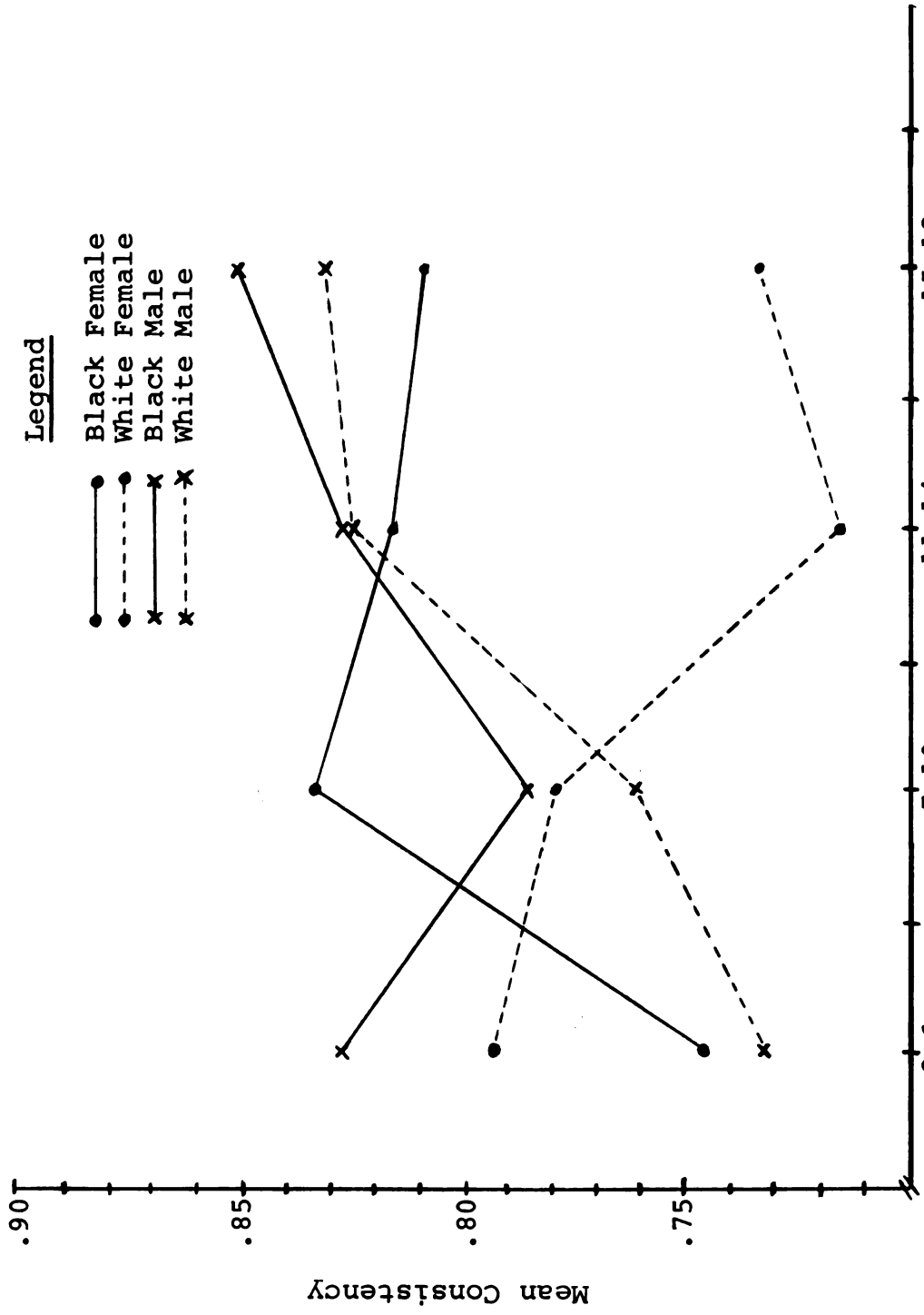

Figure 4. Mean Consistency with Respect to Sex, Race, and Age.

interaction was barely significant, $F(2,200)=3.93$; $p<.05$. Table 11 indicates that the interaction is due to a tendency for consistency to increase as age increases among white males, and decrease as age increases among white females. There was no trend among the black subjects for consistency to increase or decrease systematically with age. The data of the 15-18 year-old group are included in Figure 4 and Table 11 to show the general trend.

The Proportion of Right-Movers and Left-Movers in the Sample

A chi-square test was performed on the hypothesis that the observed frequency of right- and left-movers in the sample was equal to 50%. This hypothesis was rejected, $X^2(1)=13.34$; $p<.001$. Table 12 indicates that there is a greater proportion of left-movers (60%).

Table 12. Frequency of Right- and Left-Movers by Sex.

Sex	Right-Movers	Left-Movers	Total
Females	71	127	198
Males	73	86	159
Total	144	213	357

The next step was to determine whether there was a significant difference in direction of movement related to

sex, or race. Table 12 shows the frequency of right- and left-movers by sex. Fifty-four percent of the males and 64% of the females observed were left-movers. A chi-square test performed on the data showed that sex was a contributing factor, though not a highly significant one, $X^2(1)= 3.70$; $p<.10$. A further breakdown of right- and left-movers by sex and race, shown in Tables 13 and 14, indicates that black females contributed the most to the high frequency of left-movers in the sample. Neither of these chi-square tests was significant. Thus, while sex and race were not significantly related to direction of movement, there was a trend toward more left-movers, especially among females, with black females contributing the largest number.

CLEMs in Retarded Children

Since the number of subjects in the retarded group was small, a sample of normal subjects matched for age, sex, and race was randomly selected for comparison. The mean age of the matched groups was 10.14.

All but one mentally retarded subject showed CLEMs. One 16 year-old female showed 100% no-movement responses. The consistency and percentage of no-movement means for the retarded and matched normal sample are presented in Table 15. A t-test performed on the difference between the mean consistency for the retarded and normal samples was not significant. There was a larger mean percent of

Table 13. Frequency of Right- and Left-Mover Females by Race.

Race	Right-Movers	Left-Movers	Total
Black	50	94	144
White	21	33	54
Total	71	127	198

$X^2(1)=.296$

Table 14. Frequency of Right- and Left-Mover Males by Race.

Race	Right-Movers	Left-Movers	Total
Black	35	47	82
White	38	39	77
Total	73	86	159

$X^2(1)=.711$

Table 15. Mean Percent of No-Movement Responses and Consistency for Mentally Retarded and Matched Normal Samples.

Sample	No-Movement	Consistency
Normal	4.24	75.90
Retarded	20.52	78.43

no-movement responses among the retarded subjects. A t-test on the difference between the mean percent of no-movement responses for the retarded and normal samples was significant, $t(40)=2.36$; $p<.05$.

CHAPTER IV

DISCUSSION

Observation of CLEMs in Young Children: Age of Onset

The results of the present study contradict Day's (1967a) finding that no child under four showed the phenomenon to visual observation. CLEMs were observed in all subjects, including 20 three year-olds. Day does not report the method by which his observations were made. Because the percent of no-movement responses is much greater in young children, casual observation may not have picked up the phenomenon.

Because of the limited verbal facility in children younger than three, it will be necessary to develop a nonverbal method to further assess CLEM behavior in children. Bruner and his colleagues have been exploring experimental ways to enable infants to maximize the limited means of expression and action they possess. Their work suggests the presence of an eye-movement behavior in infants similar to the CLEMs observed in older children and adults. As in adults, the CLEMs seem to occur when the individual shifts his attention from an external to an internal focus of attention. The device described below offers the

possibility of measuring the consistency of the direction of the movements in infants. This device consists of a pacifier that has been fitted with tiny sensors. Measures of the lip pressure and the vacuum caused by sucking are then fed into a computer programmed to respond in various ways. By sucking, the infant can call up a picture on a screen, focus it, and hold it there for observation. They have found that the infant is eager and able to effect the changes he prefers. But he cannot concentrate on his sucking and on the picture at the same time. If he stops sucking, the picture goes out of focus. Before too long the average baby arrives at a solution: he averts his gaze while he sucks the picture into focus, then stops sucking long enough to glance at the picture before it slides out of focus again (Alexander, 1970).

The Relationship of No-Movement Responses to Age, Sex, and Race

The percent of no-movement responses varied significantly with respect to both sex and age, but not race. Younger children showed the greatest percentage of no-movement responses; the percentage generally decreased as age increased for both sexes. One explanation of this finding is that in addition to facilitating mental concentration, CLEMs may be related to social learning. "Just as children learn to stay at arm's length and keep the proper distance, so the rules of good eye conduct are learned in

a subtle, social process. No one can stare at an object as a child does, can look at it, and devour it with his eyes; nobody is allowed to stare as much as a child . . . And yet there is a limit even for the blue eyes of childhood. Children are not 'told' how to behave visually; they do not learn it like the multiplication table. They come to know it without realizing how. They develop culturally adequate habits of making eye-contact, they know that they must look at another person who addresses them, although not consistently . . . (Nielsen, 1962)"

There was one exception to the trend for the percent of no-movement responses to decrease as age increased: the percent of no-movement responses increased noticeably for both males and females in the 9-10 year-old group. This rise may have been an artifact of the questionnaire. The 9-10 year-old group corresponds roughly to the fourth grade, which received List A. If the questions were too easy and did not require enough reflection, more no-movement responses may have resulted.

With regard to sex, females showed a greater percentage of no-movement responses at all ages. If a decrease in no-movement responses is associated with learning not to look at another individual for a long period of time, why should females learn at a slower rate than males? The fact that men and women differ markedly in their visual behavior during free discussion suggests

an explanation. Exline (1963) found that women tend to look at one another more than do men and, once contact has been made, also hold the other's gaze longer than do men. In a recent study of eye-movement behavior in response to both embarrassing and non-embarrassing questions, Libby (1970) also found that women tended to maintain eye-contact more than men, while the question was being asked. In another study of the effect of distance on eye-contact, Argyle and Dean (1965) found that there was less eye-contact and glances were shorter, the closer two subjects were placed together (where one member of each pair was a confederate who gazed continuously at the other). Eye-contact was reduced most for the male subject-female confederate pair and least for the female subject-female confederate pair. The effect was most marked at two feet.

The above studies suggest that the sex of the examiner (female) may have interacted with that of the subjects in such a way as to affect the percent of no-movement responses. Female subjects may have shared more gazes with the examiner for longer periods of time, and thus shown more no-movement responses. The distance between the examiner and subjects was about three feet. The work of Argyle and Dean suggests that this distance should have maximized the difference in amount of eye-contact between the male subject-female examiner pair and the female subject-female examiner pair.

The Relationship of Consistency of CLEMs to Age, Sex, and Race

Consistency did not vary with respect to age or sex. Subjects averaged about 80% of the CLEMs in the same direction. Duke (1968) and Bakan (1969) reported a consistency of about 85% in college subjects. While the overall consistency is somewhat lower in the children tested, the difference is not significant. This study contradicts Duke's (1968) finding that males were significantly more consistent than females; consistency for males was only about 1% greater than that for females.

Blacks were significantly more consistent than whites. It is difficult to determine what effect the large blocking factor and omission of the 15-18 year-old group may have had on this difference.

The Proportion of Right-Movers and Left-Movers in the Sample

Contrary to Duke's (1968) finding of no group preference for direction of movement, there was a significantly greater proportion of left-movers in this sample. Sixty percent of the children observed were left-movers. Similar to Day's (1967a) report that 58% of the females observed were left-movers, 64% of the females observed in the present study were left-movers. However, while Day found that 56% of the males observed were right-movers, in

this study 54% of the males observed were left-movers. The greatest percentage of left-movers was found among the black females. The proportion of right- and left-movers in the different samples seems to vary significantly.

Bakan (1969, 1971) offers one explanation for the difference in the direction of the CLEMs. He suggests that laterality of eye movement can be considered in terms of functional asymmetry of the brain. For a given individual, the right or the left hemisphere may be relatively dominant in his psychological functioning. He suggests that the right- or left-movement associated with the reflective process may be symptomatic of easier triggering of activities in the hemisphere contralateral to the direction of eye movement. Left-movers, then, would have more dominant right hemispheres, and right-movers would have more dominant left hemispheres. It is assumed that different functions are mediated by each of the hemispheres. Each hemisphere may mediate a particular cognitive, perceptual, and emotional "style." Thus, the direction of CLEMs may be related to which side of the brain is dominant.

CLEMs in Retarded Children

CLEMs were found in all but one of the retarded subjects. It is possible that the movement occurred even in this subject, but at a rate imperceptible to visual observation. In the present study only subjects with some

verbal responses were included to be sure that the question was understood. Day (1967a) reports that older individuals who have retarded intelligence and lack language fail to show the movement. It is difficult to determine, in such a case, whether the individual comprehended the question. Several subjects not included in the present data showed distinct CLEMs but responded with unintelligible sounds. This suggests that, as in the case of infants, if one could find a non-verbal test, CLEMs might also be observed in retarded children who lack language.

The consistency of the retarded subjects was about the same as that of the matched sample of normal subjects. However, as with very young normal children, the retarded children showed a high percentage of no-movement responses: the mean percent of no-movement responses in the retarded children was significantly higher than in the matched normal sample. One explanation of this finding is that socialization may take place at a slower rate in retarded children; fewer expectations may be placed on them for learning the rules of "good" eye-contact. The retarded child may therefore be allowed to stare more, as would a young normal child.

Implications for Future Research

The results of the present study suggest several areas for further investigation.

Current methods of assessing CLEM behavior rely heavily on the use of language (i.e., the subject is asked to respond verbally to a series of questions). With regard to age, this study has tested the lower limits using this verbal method. A new non-verbal technique is needed to study CLEM behavior in children under three years of age and in retarded children who lack language. The work of Bruner and his colleagues (Alexander, 1970), mentioned above, suggests one such device that might be employed with infants. The evidence suggests that there may be an observable eye-movement behavior in infants that accompanies a shift from an external to an internal focus of attention. It would be interesting to measure whether the movement is consistent in direction. In the present study, the percentage of no-movement responses decreased as age increased from 3 to 18 years. Another question we might examine, therefore, is how the percent of no-movement responses varies from zero to 36 months of age.

It was suggested above that the decrease in percent of no-movement responses may be due to social learning: children may learn the rules of "good" eye-conduct such as not to stare. Another hypothesis is that as children grow

older, the facial expressions and body movements of the person with whom they are interacting begin to serve as stimuli. It would be easier for an individual to focus his attention internally, to reflect on the answer to a question, when he is not distracted by the stimuli of another person. The response of looking away may facilitate concentration by eliminating these stimuli which would cause him to refocus his attention externally. One approach in examining this question would be to have subjects fixate a point while listening to questions administered via a tape recorder. Observations could be made through a one-way mirror. If the presence of the examiner is serving as a distracting stimulus for the older children, we would expect a greater percentage of no-movement responses when the directions are to fixate a point rather than the eyes of an examiner. On the other hand, we might expect little difference in the percentage of no-movement responses among the younger children, whether they are fixating the eyes of an examiner or a point.

Another interesting question raised by this study concerns the effect of the sex of the examiner on the percent of no-movement responses of the subject. Argyle and Dean (1965) found that there was less contact and glances were shorter, the closer two subjects were placed together (where one member of each pair was a confederate who gazed continuously at the other). In the present study, the

percent of no-movement responses of the female examiner-female subject pairs was significantly greater than that of the female examiner-male subject pairs. This difference is consistent with the findings of Argyle and Dean (1965). Based on their work, we might also predict that the percent of no-movement responses of subjects in male examiner-male subject and male examiner-female subject pairs would fall between these two, the male examiner-male subject pairs showing a higher percentage of no-movement responses than the male examiner-female subject pairs.

This study also found that blacks tended to be more consistent in direction of movement than whites. Additional research is needed to confirm this finding.

Another area for exploration is the effect of heredity on the direction of CLEMs in children. One important comparison would be the direction of CLEMs in identical twins. If all identical twins show the same direction of CLEMs, we might suspect that there is a genetic factor influencing the direction of the CLEMs. We might also examine whether there is a correlation between the dominant direction of CLEMs in parents and children (e.g., do right-mover couples tend to have more right-mover children).

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