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AN ANALYSIS OF CIRCLING DIRECTIONALITY AS A FACTOR RELATING TO ACADEMIC ACHIEVEMENT, LATERALITY, AGE, SEX, AND POINT OF CIRCLE COMMENCEMENT IN STUDENTS, GRADES K, 1, 2, 3

by

MAITLAND MACISAAC

B.A., St. Thomas University, 1966
B.Ed., University of Moncton, 1969

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Department of Reading Education

The University of British Columbia
1956 Main Mall
Vancouver, Canada
V6T 1Y3

Date March 12, 1985.

ABSTRACT

This study sought to discover the relationship of torque to the academic performance and other variables of children from five to eight years old. Torque was defined as the production of clockwise circles during a writing task. The phenomenon was first reported by Theodore Blau (1977) who proposed that children who torqued past a certain age were predisposed to problems both academic and behavioural. To measure the torquing propensities of children, Blau developed a Torque Test which had children produce six circles around X's (⊗), three with the preferred hand and three with the non-preferred hand. The present study used the preferred writing hand only and two torque tests, the Circling Directionality Test developed by the researcher using an embedded task to detect torquing and a modified form of Blau's Torque Test. Variables of academic achievement, age, sex, point of circle commencement, laterality, neuromuscular motor control, test comparisons, and circling directionality were analysed. The population for the study consisted of 300 regular classroom children ages five to eight. Seventy-five children per grade were randomly selected by age from grade levels K-3.

Significant relationships between torquing and low academic achievement were only found for the eight year old group who also had a higher incidence of left-handedness and crossed hand/foot laterality. Significantly more boys torqued than girls. As well, those who torqued in most instances commenced their circles at the bottom. Predictably

significant relationships were found for hand and foot, but only left-handedness was significantly related to torque. No significant relationships could be found for measures of eyedness. Both tests used to measure torque were equally effective. The rapidity of circle construction did not alter the pattern of torquing in the children. There was a significant relationship between age and torquing with over 50% of the five year olds torquing with the preferred hand; by age eight this incidence had been reduced to 8% of the population. Torquing was then seen as a developmental trait found in a large percentage of five and six year olds but by age eight it was indicative of academic school difficulties. Recommendations for further study of the torquing phenomenon were made.

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CHAPTER ONE

THE PROBLEM

The purpose of this study was to explore factors relating to the circling directionality of children five to eight years old, where circling directionality was defined in terms of the use of the dominant hand to produce circles in the Torque Test (Blau, 1974) and the Circling Directionality Test (MacIsaac, 1981).

Specifically answers were sought to the following questions:

1. Does a significant relationship exist between academic achievement and circling directionality as measured by a norm referenced test used in grades one, two, and three?
2. Is there a significant relationship between readiness for grade one in kindergarten populations as measured by teacher assessment, and circling directionality?
3. Is the point of commencement in circle construction and circling directionality significantly related?
4. Is there an equivalent increase, according to age, in the production of counterclockwise circles as has been found in related studies?
5. Is there a significant relationship between gender and circling directionality?
6. What is the relationship of laterality, as measured by foot, hand, and eye dominance, to circling directionality?

7. Does rapidity in the construction of circles affect directionality?
8. Is there a significant difference in circling directionality when circles are constructed as O's embedded within words or as discrete entities?
9. Is there a significant relationship between the Torque Test and the Circling Directionality Test?

Background of the Problem

In his presidential address of 1974, the incoming president of the American Psychological Association, Theodore Blau, suggested that the production of written circles in a clockwise manner, past a certain age, was genetically related to a) mixed cerebral dominance, b) sinistrality, and c) a "variety of behaviours." In a later paper he made further suggestions that the continued production of clockwise circles past the age of five might be an external manifestation of neural deficits in the writer's corpus callosum (Blau, 1977c). These deficits, Blau stated, could place a child at a developmental disadvantage causing abnormal stress and even a predisposition to schizophrenia. Such a statement had an immediate and profound effect upon the psychological, medical, and educational community at large.

Blau coined the term TORQUE for the production of clockwise circles and developed a Torque Test as a measure of this phenomenon. The test consisted of the production of six circles. Each circle was drawn around an X, three with the dominant hand and three with the non-dominant hand.

Developmental psychologists have had for many years an interest in the reproduction of geometric shapes. One has only to think of the Bender Visual Motor Gestalt Test, the Preschool and Primary Scale of

Intelligence, and The Culture Fair Intelligence Test as examples.

Goodnow and Levine (1973) in their work with children using a geometric pattern test designed by Graham et al. (1960) refer to the developmental progression children make in drawing geometric shapes as "a limited set of principles or rules that specify where to begin and how to proceed" (p. 82). Lashley (1951) proposed that acts requiring the use of skilled motor behavior demonstrate a "syntax . . . or general pattern imposed upon specific acts as they occur" (p. 119). Restle (1970) suggested that we categorize behaviors from "simple walking to the complexities of driving an automobile, speaking, playing the piano, or even playing chess" (p. 481). Sensorimotor and cognitive behaviors are not seen by these researchers as separate entities but rather interactive behaviors, each dependent upon the other.

The study of circling directionality did not start with Blau. With the introduction of manuscript writing to the United States in 1922 by Marjorie Wise, letter reversals became an issue in the teaching of handwriting (Hildreth, 1934). Researchers began to question why, after considerable instruction and time, some children still reversed certain letters. Opinions varied as to the root cause. Some felt it was poor teaching (Wilson & Flemming); others, a natural developmental stage (Hildreth, 1932). Today one can find as many as 13 different explanations to why children do this past a certain age.

As the developmentalist movement grew, more studies were undertaken concerning a child's posture, letter formation, word production, and even the correlation between reading achievement and all the above behaviors. In their research on the developmental stages of handwriting, Gesell and Ames (1946) and Ames and Ilg (1951) reported that children do produce

circles in different ways according to age. No comments as to the reason behind the various circle constructions were given other than viewing it as another stage the child goes through towards the mastery of a mature handwriting style.

Research by Thomassen and Teulings (1979) in the development of directional preference in handwriting movements investigated the extent that directional preference was caused by neuromuscular properties of the motor system and to what extent it was determined by higher cognitive processes such as those found in handwriting. Their findings enhanced the initial work of Gesell and Ames (1946) and Ames and Ilg (1951) by investigating circling directionality not only as a developmental factor, but also exploring possible relationships which might account for the variations that occur according to age, cognition, and sensorimotor maturity.

The implications of torque as proposed by Blau did not go unnoticed by the scientific community. People began to question whether such a simple test could be a reliable measure of such diverse areas as handedness, mixed dominance, cerebral deficits, learning disabilities, and schizophrenia. The support for this position to date has been mixed.

Zendal and Pihl (1980), in their work with eight to ten year olds could find no apparent link between torque, deviant behavior, abnormal psychomotor scores, or mixed dominance. Alberts and Tocco (1980) in their research with over 700 grade three students stated that there was a significantly higher incidence of torque among children who exhibited various forms of learning disorders. Luchins et al. (1980) studied 55 schizophrenic patients and found that there was a significant relationship between torquing and patients with milder (acute) forms of schizo-

phrenia, but not in more advanced (chronic) cases of schizophrenia. They suggested, however, that left-handedness might be, in some individuals, a predisposition to schizophrenia. Blair (1980), on the other hand, found no support for Blau's claim that torquing was related to lefthand dominance.

Blau's hypotheses and the subsequent research of others are, then, fraught with uncertainties. No one, at present, is prepared to state that torque is an actual measure of anything. There is a feeling among researchers that those who torque have some kind of abnormality but are not prepared to go beyond the level of speculation. Much more research is clearly needed before we can say with certainty that torquing is a measure of a particular abnormal cognitive or sensorimotor process. It is in this spirit of exploration that this present research was undertaken.

Significance of the Study

Kay (1979) stated that "Blau's hypotheses admittedly far exceed the data" (p. 357). It is necessary, therefore, to examine the different hypotheses using diverse populations, and even replicate Blau's conditions. To date, the major research has focused on exceptional populations, or populations eight years of age or older. This current research studied the circling directionality in children five to eight years old from normal school environments.

Some research (Torrington, 1976; Thomassen & Teulings, 1979; Jarman & Nelson, 1981) did use younger subjects than eight years of age but the rather radical change in circling directionality among children of this

age group makes the development study of populations over several age levels a more useful population with which to deal. Blau's (1977) comment demonstrates the need to study the age groups of this present research.

> Children who fail to develop complete counterclockwise, or left turning behavior by the time they are five may have some degree of difficulty in developing and responding to the culture's requirements for cognitive, language, motor motility, peer group acceptance, and success/accomplishment. Groups of children who exhibit torque do not seem to adapt as well as groups of children who do not exhibit torque after the age of five. (pp. 1001-1002)

Circling directionality has been studied in conjunction with handwriting. It is common practice for kindergarten and grade one teachers to teach manuscript handwriting using what is generally described as the "ball and stick" method. Students are taught, for those letters requiring a circle, to form the circle at the top and proceed in a counterclockwise manner. If, as the data suggest, over 50% of five and six year olds have a predisposition to make clockwise circles what does this do for a child's "mind set" for handwriting?

Blau's Torque Test uses both the dominant and non-dominant hand as measures for eliciting possible clockwise circling directionality. Jarman and Nelson (1981) reported weak relationships between the left and right hand and circling directionality. They suggested that use of the dominant hand only is a more reliable measure of torque.

The Circling Directionality Test used by this researcher involved the production of 24 circles under various conditions. Thus using the dominant hand only provided a contrast to the Torque Test, enabling an examination of the relationship that might exist between drawing circles within words and in isolation, as opposed to their construction around a series of Xs.

Thomassen and Teulings (1979) suggested that there may be two sensorimotor systems operating as we construct some forms of print, one for rapid and nonfigurative language and one for accurate and symbolic purposes. As part of the testing procedure in this study, children were asked to produce circles in a controlled slow manner and, again, in a rapid fashion. This was done to assess if there would be a difference in directionality under these two conditions. In this way confirmation of Thomassen and Teulings might be obtained.

One of the principal reasons for conducting this study was to determine the academic achievement of students who torqued. In light of Blau's hypothesis, it would be of interest to know whether there is a significant relationship between torquing and academic performance at school for the age group 5-8 years old. Specifically, torquing was viewed against measures of reading, math, and language (Metropolitan Achievement Test, 1978).

The speculative nature of Blau's proposal and the inconsistency of the data to date, calls for further research of the torque phenomenon. A study that involves students 5-8 years old (the age of this sample), would be particularly relevant as it may provide insights as to the developmental nature of torquing, its possible diagnostic strengths, as well as perhaps suggesting considerations for the instruction of handwriting.

Definitions

For the purposes of this study some terms are necessarily defined.

1. Torque is the production of written circles in a clockwise manner.
2. Torque Test is a test developed by Blau (1974) as a measure of circling directionality. (See Appendix A.)
3. Circling Directionality refers to the direction a person draws a circle, clockwise or counterclockwise.
4. Circling Directionality Test (C.D.T.) was developed by the researcher as a measure of circling directionality. (See Appendix B.)
5. Start of Circle refers to the place (top - bottom - side) that an individual begins to make a circle.
6. Dominance refers to the preferential use of the hand, foot, or eye when performing a specific task.
7. Age is defined in terms of students who are: a) five years old in kindergarten, b) six years old in grade one, c) seven years old in grade two, d) eight years old in grade three. No distinction is made based on a child's age in months.
8. Academic Achievement was measured by the administration of the Metropolitan Achievement Tests, form JS, Primary I, Primary II, and Elementary (1978) in reading, mathematics, and language.

Population

Subjects for the study were drawn from the Greater Vancouver Catholic School Board. Intact classes, kindergarten to grade three, were chosen. Seventy-five pupils from each of four levels, who met the age

criterion were randomly selected from a total population of 432 students.

The students came from low middle to middle income families and were tested at the following schools.

St. Jude Elementary School	Vancouver
St. Francis of Assisi Elementary School	Vancouver
St. Marys Elementary School	Vancouver
St. Francis de Sales Elementary School	Burnaby
Holy Cross Elementary School	Burnaby

Limitations of the Study

There were certain limitations to the study. These were:

1. The students were drawn from the Catholic Schools of the Greater Vancouver School Board.
2. Only students who completed the Metropolitan Achievement Tests, the Circling Directionality Test, and the Torque Test were considered.

Organization of the Report

The first chapter has given a general description of the problem, the specific questions to be answered by the study, the background of the problem, a statement about the significance of the study, definitions of terms used, a description of the population, some statements about the limitations of the study, and an outline of the organization of the report.

Chapter two consists of a review of the related literature. Chapter three contains a description of the design of the research. Chapter four presents the results of the study and an analysis of the data. The fifth and final chapter is a summary of the finding and includes some conclusions and implications for further research.

CHAPTER TWO

REVIEW OF THE LITERATURE

The review of the literature is presented under the following headings: a) Research of Theodore Blau, b) Torque and Cerebral Dominance, c) Torque, Learning Disability, and Psychosis, d) Torque and Cognitive Ability, e) Torque and Sensorimotor Development, f) Findings of Torque to Date.

Research of Theodore Blau

The first investigation on circling directionality from a psychological perspective was conducted by Theodore Blau (1977a, 1977b). The purpose of his original study was to "explore certain behavioral manifestations of left handed children and to develop a test for handedness or cerebral dominance" (p. 6). His specific areas of consideration were: a) the significance of the relationships between the chosen writing hand and the Torque Test, b) the Torque Test and a variety of behaviors, c) the chosen writing hand and a variety of behaviors. These behaviors included stubbornness, variable emotional behavior, excess energy, inability to follow directions, variable intellectual performance, bedwetting, kindness to animals, irritable without cause, being overly sensitive, being socially embarrassing, performance below potential, impulsiveness, creating "war" in family, doesn't learn from experience, cannot complete

projects, and prefers swimming underwater.

Blau's subjects were 463 children between the ages of 4 and 17 years who were seen by him in his private clinic between 1966 and 1974. Of the sample, 84% were considered to be right-handed, 13% left-handed, and 3% of mixed dominant hand. The results of the study indicated that torque was "probably a reasonable measure of handedness defined as 'chosen writing hand' and facility in using chosen hand" (p. 20). The behaviors investigated were grouped into two categories, neurological and neurotical and were both shown to have a significant relationship with torque. The results regarding the effects of left or mixed dominance in children led Blau to the conclusion that the Torque Test was a reliable measure of lateral dominance.

He recognized that his results were highly speculative and posed a series of questions which have formed the basis for the majority of subsequent research. These were:

1. How does the measure of torque relate to dichotic listening, evoked potentials and other more sophisticated measures of cerebral dominance?
2. What are the base rates of torque in various populations?
3. Does torque measure circling tendencies which are learned or developmental?
4. What neural mechanisms explain torque?
5. What neural mechanisms explain the tendency for left dominant children to continue to be neurotic longer than right dominant children?
6. Does handedness relate to a broader spectrum of functional disorders than heretofore believed?
7. What implications would these results have for motor training?
8. Should childrearing practices and early education methods be influenced

by the presence of sinistrality?

9. What are the cross cultural base rates for torque?

10. Are there geophysical concomitants to torque (northern vs southern hemisphere)?

11. How does torque relate to adult behavior variables?

In his second torque study, Blau (1977c) speculated as to the possibility that torque may be a manifestation of some neural integrative defect which might be the root cause of a "variety of cognitive, language, behavior, and learning problems found among children" (p. 999). He postulated that this defect might be the result of improper development of the corpus callosum. While he presented no data to support his suggestion, researchers were eager to place what can be best termed speculation into statements of fact attributed to Blau.

The research component of his second study involved 106 children who had been seen by him between 1963 and 1969. In the spring and summer of 1977, personal interviews were conducted with the parents or guardians of the children in which questions of a social, academic, vocational, and personal nature were asked. Students were rated on a nine point scale which ranged from having outstanding emotional adjustment to having been diagnosed as schizophrenic. In those children who exhibited good to fair adjustment, torque was found in 36% of cases. In those who demonstrated poor to bad adjustment, torque was found in 77% of cases.

Of the 106 children in the study, 54 demonstrated no torquing and of this group only one was diagnosed as schizophrenic while in the torque group of 52, 11 children had, ten or more years later, been diagnosed as schizophrenic. The results, as Blau stated:

> indicate quite clearly that children who exhibit torque during their developmental years are more likely to reach maturity with a higher incidence of the clinical symptoms of schizophrenia than a similar group of children with psychological problems who did not exhibit torque behavior during their early years. (p. 1002)

Of particular significance to this present study is Blau's comment concerning the failure of children to develop complete counterclockwise or left turning drawing behavior by the time they are five. He suggested that such children may experience some difficulty in developing and responding to the cultural requirements for "cognition, language, motor motility, peer group acceptance, and success/accomplishment" (p. 1002).

Prior to the examination of other research in the area of torque several comments are warranted.

1. Blau, by his own admission, wanted people to be aware of the highly speculative nature of his studies on torque. His comment "there are serious methodological and base rate problems in the present study . . . if this research is to serve as a contribution to preventive activity with children at risk" (p. 1002), serves as an indicator of his awareness of the need for extensive research on the topic.
2. In both studies the subjects were exceptional children in that they had been referred to Blau because of learning, developmental, or behavior problems ranging from mild to severe.
3. Blau's measure of mixed dominance was the apparent ability of children to have equal facility with the right and left hand when writing. This accounted for only 3% of his population.
4. Laterality was assessed by observing the use of the dominant hand during writing tasks.
5. Mixed circling directionality using the dominant and non-dominant hand

in the Torque Test was the criterion used by Blau as an indication of possible defects in the corpus callosum.

6. In both studies approximately 50% of the subjects torqued. In his first study 16% of the subjects were categorized as left or mixed dominant. In his second study 21% of the subjects were diagnosed as schizophrenic. This meant that while there may be a significant relationship between torquing, handedness, and schizophrenia, many people who torqued did not fall into either category.

Torque and Cerebral Dominance

The terms hemispheric dominance and laterality have been used simultaneously in much of the current literature regarding cerebral dominance. Dominance is better equated with specialization rather than one part of the brain exercising a control over the other (Leong, 1980). A deviation in the normal pattern of consistent preference for hand, eye, ear, and foot, referred to as crossed dominance, is said by some researchers to put a child "at risk." In crossed laterality as opposed to mixed laterality, consistent hemispheric patterns have been established but rather than being totally left or right dominant, different body parts (e.g., hand/eye) may be left and right lateralized. Blau's research focused on mixed dominance, the tendency to have equal facility with either body part when performing a similar task. He left it to others to explore in detail the implications inherent in his cerebral dominance hypothesis.

The validity of crossed laterality as an accurate measure of cerebral dominance has been questioned. A base rate for left-handedness in the population has been established at approximtely 8-10% (Bakwin, 1950; Zangwill, 1962; Satz, 1973). Kinsbourne and Hiscock (1978)

estimate that up to 30% of the population has left eye dominance. This means that there are a substantial number of people who are right-handed and left-eyed dominant. Ullman (1977) reported on a study in which the population of elementary school children were given tests of eye, foot, and hand dominance to determine consistent lateralization (stable and ipsilateral), crossed lateralization (stable but not contralateral), and inconsistent lateralization (absence of stability). He found that 60% of the younger children and 35% of the older children demonstrated crossed lateralization while no differences were found in reading, mathematics, spelling, and I.Q. scores among the three groups for either sex or any age. Balow (1963, 1964) could find no significant relationship between hand/eye dominance and reading achievement. His conclusion at the time was "lateral dominance does not seem to be a fruitful area for seeking out determiners of individual achievement" (p. 143).

Alberts and Tocco (1980) conducted a study in which 733 grade three students from regular and exceptional educational environments were administered Blau's Torque Test. Two hundred and ninety-six nonspecial students from this population were designated a control group. The results indicated that 60% of the special children torqued as opposed to 37% of the nonspecial group. In the exceptional group 79% of the left-handed children torqued while only 47% of the right-handers torqued. In the normal population 57% of the sinistrals torqued and 34% of the right-handers showed the presence of torque. Alberts and Tocco suggested that the higher incidence of torque found in the learning disabled, speech, and hearing group might be indicative of "interhemispheric anomalies underlying some developmental problems" (p. 159). Results also indicated that 18% of the mentally retarded subjects as opposed to 13% of the normal

population were left-handed. Students diagnosed as "emotionally disturbed" also showed a higher incidence of torque than did the normal population. Alberts and Tocco suggested that their results fit the hypothesis set forth by Blau concerning the corpus callosum but recommended that a more definitive explication of the results must await clearer base rate data before torque became a useful measurement device.

Torrington (1976) based her hypothesis on the fact that torque appears to be a measure of lobe dominance as well as certain observable behavior problems. Her subjects, selected from first through sixth grade, were divided into three groups and matched for lateral dominance, sex, grade level, and intelligence. In two groups children were given bilateral exercises in either motor-motility (non-turning and non-twisting) or torque (turning and twisting). The third group had no such exercises and became the control group. Pre-and-post Torque Tests were administered to the children. Behavior questionnaires were completed by the students' teachers before and after the experiment. Results indicated that there was no significant difference with regard to changes in cerebral dominance or behavior. The author concluded that as a result of a ten week program of bilateral practice exercises, demonstrated cerebral dominance or reported behavior previously correlated with left or mixed dominance did not significantly change. As torque appears to be both developmental and/or permanent in nature past a certain age, it is not surprising that after a mere ten weeks few children's circling patterns would be altered. It could be that any amount of practice will not alter directionality and that a child will not change until changes occur in cerebral functioning--witness the time a grade one child spends with the "ball and stick" handwriting.

As a test of Blau's hypothesis regarding handedness, right dominance and mixed laterality, Blair (1980) conducted a study using 198 students between the ages of 8 and 13 years from special and regular classrooms. Each child was administered measures of manual preference, manual dexterity, eye dominance, and circle and triangle drawing behavior. The parents were asked to complete a questionnaire which contained items concerning a family history of handedness and the child's developmental background. The results of Blair's data did indicate that torque had a low test-retest reliability. As well, weak relationships were found between torque and the measures of manual preference of the boys. He suggested, therefore, that there is little evidence to support the proposition that torque was a reasonable measure of hand dominance or facility. Statistically significant but weak relationships were found between mixed circling behavior (torquing and non-torquing) and the measures of manual dexterity and crossed hand/eye dominance. The results of his research also led Blair to the conclusion that little if any support could be given to the hypothesis that mixed circling directionality was a valid measure of mixed laterality. It should be emphasized that Blau never did include mixed hand/eye dominance in his investigation.

Demarest and Demarest (1980) in a study conducted using 74 volunteers from a college population, used the dichotic listening test as a measure of hemispheric dominance of language abilities to determine if torque, sinistrality, and mixed cerebral dominance were related. Forty-one subjects were classified as right-handed and 33 as left-handed. Subjects were first given handedness tasks and the Torque Test. They then were administered the dichotic listening test in which they heard a series of words in groups of six and asked to write them down in whatever order

they found easiest. Halfway through the test the headphones were reversed and the subjects heard the words again. The word list in each ear on the second trial was opposite of that heard in each ear in the first trial. The results of the experiment indicated that all but one of the right-handed people exhibited counterclockwise circling behavior, while 14 of the left-handed individuals torqued. Torque by ear preference was not, however, statistically significant. In each ear preference category, approximately the same number of subjects produced circles in a clockwise manner. The researchers suggest that the results of their study lent support to the relationship of torque and left-handedness. A failure to find a significant relationship between torque and language lateralizations in adults may be an indicator that "torque and cerebral dominance may be related during childhood but independent and uncorrelated in adults" (p. 157). They felt that a more viable alternative might be to explore the relationship between torque and the muscle mechanics of the hand. They suggested that the physiological mechanics of drawing a circle in a counterclockwise manner was more efficient in right-handers and vice versa for left-handers. This being the case the question of the high incidence of non-torquing among sinistrals was raised. Could it be, they asked, that sociocultural factors have influenced left-handers to act like right-handers and that non-torquing on their part is a reflection of this?

Conjugate lateral eye movement responses of 225 male undergraduate college students were investigated to see if there was a significant difference in eye movement between those students who torqued and those who did not (Woods & Oppenheimer, 1980). Conjugate lateral eye movement is the tendency of a subject to break eye contact and look either left

or right when asked a reflective question. Consistency in right or left looking is taken to reflect heightened hemispheric contralateral activity and consequently lateral dominance (Balkin, 1969). In the study, subjects were asked 20 questions of both an emotional and neutral nature. Tests for handedness were conducted to see if Blau's hypothesis regarding torque and sinistrality could be replicated. As well as being administered the Torque Test, students were given tests of social competence and levels of anxiety to see if those who torque scored significantly higher in anxiety rating and lower in social skills. Of the 225 students tested, 76 (33.8%) torqued at least once. Of those who did torque, 17 (22.4%) torqued with the dominant hand only (hand used in writing). Fifty-two (68.4%) torqued with the non-dominant hand only and 7 (9.2%) displayed torque with both hands. The handedness questionnaire was used to classify, in a more extensive manner than preferred writing hand, the left and right dominance of the subject population. The questionnaire classified subjects into those who used left-right or both hands for ten behaviors. Results indicated that 124 (55.1%) were right hand dominant, 95 (42.2%) were mixed-hand dominant, and 6 (2.7%) were left-dominant according to the criteria. It was found that 41 of the 124 right-dominant subjects (33%) and 35 of the 101 left-dominant (34.7%) torqued. These results produced a non-significant result regarding left and right dominance. Torquing did occur more frequently with the non-dominant hand, with right-handed subjects tending to have more torque with their non-dominant hand, than left-handed students. Torque subjects displayed a greater tendency ($p < .06$) towards right looking than did non-torquers across all questions but significantly stronger tendencies toward right looking ($p. < .02$) during emotional questions. Non-torque subjects

displayed an equal right/left eye movement with both types of questions. Torque subjects demonstrated a significant bias towards right looking when questions of an emotional nature were asked. It suggested that this indicates greater left hemispheric involvement, and as emotion is a right hemisphere activity (Schwartz et al., 1975) this lent further support to Blau's hypothesis regarding torquing and cerebral dominance. No significant relationships could be found between torque and the measures of anxiety level and social competence.

The results of Woods and Oppenheimer's study afforded support for the association between torque and cerebral dominance. Using their criteria for dominance it was found that when subjects drew circles with their dominant hand, torque occurred more frequently among left-dominant subjects. The opposite effect occurred with the non-dominant hand where more right-dominants torqued than left-handers. The fact that torque occurred less frequently with right-handed subjects using their dominant hand and far more often when the left hand was used, plus their findings that left-handers torque more frequently with both hands, "indicates a relationship between torque and cerebral dominance" (p. 571).

The possibility that heredity might have a bearing on circling directionality was proposed by Matheny (1979). His sample population consisted of 289 twin children and their siblings. For the determination of genetic influences of torque, the torque scores of 54 identical and 30 fraternal twins of the same sex were examined. Due to sample size, the results of ages were collapsed for identical and fraternal twins. Correlation data indicated that identical twins had higher correlations than did fraternal twins. However, a significant difference was found for the left hand only. Genetic analysis was done (twin to twin) to determine

if identical twins had greater consistency of between hand circling directionality than did fraternal twins. Results indicated that the "identical twins were more concordant than the fraternal pairs for the pattern of scores across hands" (p. 754).

Torque, Learning Disability and Psychosis

In a study conducted by Zendel and Pihl (1980), 47 children labelled "learning disabled" and 47 children considered normal (between the ages of eight and ten years of age) were administered a battery of tests to determine if a higher incidence of torque would be found among those experiencing learning problems, and whether lower intelligence scores, more deviant personality scores, below average achievement levels, and below average perceptuomotor task scores would be found in those children who torqued. As well, handedness and complete crossed lateralization data were obtained to see if a significant correlation could be found. The criteria for "learning disabled" consisted of having normal intelligence and failure on at least one subtest of the Metropolitan Achievement Test. Subjects were considered normal if they passed all the subtests of the Metropolitan Achievement Test and had normal intelligence. Students were administered the Torque Test, WISC-R, neural pathology tests, and modality integration assessments. Mixed laterality was defined as inconsistencies among eye, hand, and foot. One should caution that the authors referred to crossed lateralization rather than mixed lateralization. As would be expected torque was associated with their measure of mixed laterality as 30% of the population at large are left-eyed and between 8 and 13% left-handed. Less clear evidence could be found ($p < .07$) for

torque and handedness. Torque was not found to have a significant relationship with learning disability and on the WISC-R the only significant difference was found in the math subtest in which the torque group scored significantly higher than the non-torque group. As well, no significant relationships could be found on measures of the Halstead-Reitan Battery or the modality integration tasks. Based on their findings the authors concluded that the "usefulness of assessing torque, either by itself or in the context of a larger battery, is not apparent, and its application must be further considered" (p.604).

To date only one study involving schizophrenia and torque has been reported (Luchins et al., 1979). In this study, 55 schizophrenic patients were diagnosed as being chronic (current episode of at least one year's duration, or incomplete recovery from previous episodes), n = 49; or acute (current episode of less than one year's duration or complete recovery from previous episodes), n = 6. The sample was administered the Torque Test. As well, a subgroup of 66 similar schizophrenia patients were given tests laterality using measures of hand, foot, and eye dominance. Of the 55 patients tested for torque, 34 (62%) showed no torque and 21 (38%) torqued. All 34 subjects without torque were from the chronic category. The six acute patients all showed torque. Those patients who did not torque had a longer duration of illness, more years in hospital compared to those who did torque.

In the laterality group of 66 patients, 55 (83%) were right-handers and 11 (17%) were left hand dominant. All but 3 (95%) of the 55 right-handers were in the chronic category while only 7 (64%) of the left-handers were similarly categorized. In this group the right-handed group spent a significantly longer period of time in the hospital due to illness and

had a trend toward more years in hospital. The results of the study indicated that mixed (crossed) lateralization and torquing appeared to be associated with a milder form of schizophrenia. It is suggested that "in severely ill schizophrenic patients laterality disturbances may not be more prevalent than in the general population" (p. 1598). Other implications of their study related to handedness as they suggested that the proportion of sinistrals will vary according to the severity of the illness and in some cases left-handedness may be a predisposition to schizophrenia.

Kay (1979) conducted a study in which 39 patients who had been diagnosed as having both clear cut psychotic manifestations and mental retardations were given the Torque Test. By studying torque in relation to "multidimentional, historical, psychometric, and psychophysiological evaluation" (p. 358) it was hoped that Blau's proposal might be clarified in relation to the role of developmental, neurological, and psychological factors. Formal case records were examined by a psychologist to evaluate three areas of pathology: neurological abnormalities, early childhood psychosis, and prenatal and perinatal problems. Levels of social and cognitive maturation were obtained by administering tests of verbal functioning, perceptual motor development, early conceptual development, maturation of left-right positional orientation, and social age. Other areas of clinical functioning were assessed without reference to developmental origin through the use of ratings and psychometric and psychophysiological methods. The specific procedures used were: ward behavior as rated by a patient's primary therapist, an index of distractibility, and a level of sleep arousal.

Torque was observed in 25 (64.1%) of the sample, which was more

than twice the rate suggested by Blau for subjects of this age. Statistically significant results were not forthcoming on measures of handedness, sex, race, age of first institutionalization, or duration of institutional history. A significant relationship was found, however, in patient age with the torque group being significantly younger than their counterparts. The neurological implications of torque were not supported; to the contrary, fewer documented cases of organic involvement and birth problems occurred in the torque group. A significant relationship occurred between torquing and a history of early childhood psychosis. Torque was present in 92% of the patients with this prior condition. This led the authors to the conclusion that the "antecedent condition of psychosis rather than neurological dysfunction . . . seemed to presage adult manifestation of torque" (p.). The relationship between torque and developmental factors showed that those subjects who torqued scored consistently lower on all measures of functional age with significant differences occurring in the areas of perceptual motor development, conceptual development, and maturity of positional orientation. The measures of psychiatric adjustment indicated that there was no evidence that current psychopathology was associated with torque.

Kay suggested that torque was "an abnormal phenomenon of both developmental and clinical significance" (p. 361). His data, however, did not support Blau's hypothesis of neural defects, but to the contrary, found that the torque group had fewer incidences of perinatal problems and known brain disorders. As well, no significant relationship could be found between handedness and torque. What did distinguish torque patients was a history of autism or early childhood schizophrenia. It was hypothesized that adult torquing may derive from ontogenic deficits

specific to positional orientation, conceptualization, and perceptual motor functioning deficits that have been increasingly linked to childhood autism (Ornitz, 1979; Rutter et al., 1971). The results of Kay's research led him to the conclusion that torque was related to early childhood psychosis and development but not associated with adult psychotic manifestation, nor past or present neurological impairments. It was also suggested that present defects in sensorimotor and early cognitive development of both torque and childhood psychosis may account for their simultaneous occurrence. Kay felt that his results were consistent with studies that showed that torque was more prevalent among children with behavior problems and those who were eventually diagnosed as schizophrenic. However, rather than relate causality to neurological dysfunction, Kay suggested torquing might be the result of impaired development, the source of which might be multidimentional.

Torque and Cognitive Ability

The studies to date regarding torque and cognitive abilities in normal populations of children are limited. Jarman and Nelson (1980) studied Blau's proposals of circling directionality in reference to cognitive ability in children. Three hypotheses were examined: a) in complex spatial and language processes children who do not torque would perform significantly better than those who do torque, b) in spatial and language tasks, due to hemispheric specialization, girls who torque should not perform as well as boys who torque, c) the variance in scores on spatial and language tasks should be greater in children who torque.

Jarman and Nelson's sample consisted of 45 boys and 61 girls in grade three from two suburban schools. Children were given three tests:

Progressive Matrices (Raven, 1965), Jarman's Sequential Shapes (measures of cognitive ability), and the Torque Test. The results of the Torque Test indicated that 45.28% of the children exhibited some torque with either hand. Torque testing with the preferred hand showed 15.09% of the students torqued, and this increased to 22.64% when the mixed category (torquing and non-torquing) was included. Testing with the non-preferred hand indicated that 23.58% torqued and when the mixed category was included, 34.90% torqued. Analyses of the data regarding torquing with either hand indicated that statistically significant but marginal relationships existed ($r = .21$, $p < .05$) between the torque measures taken with either hand. In light of the low correlation between the preferred and non-preferred hand, separate analyses were conducted in order to identify "any effects that were unique to either hand" (p. 461).

The results based on the preferred hand were similar to those of the non-preferred hand although the preferred hand more clearly defined differences between groups. The hypothesis that torque children would have lower cognitive ability was not supported. In fact, there was some indication that the opposite may have been true. In regard to the hypothesis that there would be a significant difference by sex, analyses indicated that both boys and girls who torqued out-performed the students who produced circles in a counter-clockwise fashion. A significant effect was found, however, with the mixed group where the boys produced the highest scores and the girls the lowest. The authors felt that this finding contradicted the importance Blau placed on the direction chosen for circling. By using the torque, non-torque groups, the third hypothesis that there should be more variance in scores between girls who torqued and boys who torqued was not supported. It was noted, however,

that if the mixed circling group was included in the analysis there would have been a significant difference. Jarman and Nelson suggest that the inclusion of subjects who torque a minimum of one time causes an artificial effect that cannot be attributed to clockwise circling per se and allows for an inappropriate interpretation of the data.

The results of their first study were so contradictory to Blau and yet indicative of possible clinical significance that Jarman and Nelson conducted another study regarding torque (1981). The first purpose of this investigation was to replicate their earlier study. Of particular interest were the results concerning cognitive abilities of the torque, non-torque groups and the consistency of circling directionality in both groups. A second rationale for the study was the examination of particular cognitive abilities that might relate to torque, namely, visual spatial and perceptual motor development. A final purpose was to examine the age related cognitive aspects of torque. These aspects of torquing were considered important because Blau's theory is developmental in nature in that cognitive problems were thought to be due to a developmental lag or some progressive defect situation. The issue then was not whether torque varied with age but whether it varied in its relationship with age according to developmental lag or cognitive defect.

The sample consisted of 180 elementary school children divided equally into two age groups, seven and nine. In each of the two levels there were 45 boys and 45 girls. The tasks consisted of the following: a) that part of the Torque Test that consisted in the production of circles around six X's, three with the preferred hand, and three with the non-preferred hand; b) Visual Spatial: ten tests which examined in detail the processes used by Jarman and Nelson (1980) in their first study. The

tests administered were visually presented and spatial in format. The Torque Test also includes these components as well as a perceptual motor task (drawing the circles).

The results relating to the developmental nature (age and frequency of torque) indicated that for the seven year old boys, 42.44% torqued completely with the preferred hand and this increased to 55.55% if those who produced both clockwise and counterclockwise circles (mixed category) were included. Of the girls, 15.55% torqued completely with the preferred hand and this increased to 24.44% if mixed circling was considered. When all types of torquing were considered, 67.08% of the subjects torqued which is consistent with Blau's projections for this age group. For nine year old boys, torquing with the preferred hand produced an incidence of 17.77% complete torquing, 26.66% mixed. The girls were far lower with .04% and .08% respectively. When all torquing for this age group was considered, 41.87% torqued, which again is consistent with Blau's proposal.

When discussing the question of the consistency of measurements between the preferred and non-preferred hand, Jarman and Nelson stated, "that with the advances in age, circling behavior increases in consistency between the preferred and nonpreferred hand. However . . . even within the older group it does not appear warranted to conclude that the hands are equivalent for the purposes of clinical assessment" (p. 458). This conclusion was given more direct support when the relationships between circling behavior and cognitive ability were examined as a function of hand preference in the main analysis. Jarman and Nelson were convinced that "for children of this age group at least, measures apparently should be confined to the preferred hand" (p. 553).

The measures of cognitive ability in Jarman and Nelson's second study (1981) indicated that contrary to their first study in which a marginally significant trend was found suggesting that torque may be associated with higher cognitive abilities, such was not the case this time. Both of their studies, however, do not support Blau's theory of diminished cognitive processing by those who torque.

As in their first study, the authors found that there was no significant relationship between males and females who were "full-torquers," that is, all their circles were drawn in a clockwise manner. Significant results only occurred for Jarman and Nelson when the mixed category was included.

The cognitive tasks were separated into two main categories, visual-spatial integration and visual-spatial motor. Different profiles were produced for sex groups when they were divided into torquers, non-torquers, and mixed categories. It was the mixed group who demonstrated the greatest interaction, with the boys being, as in their first study, notably superior to the girls. It was suggested that this apparent advantage of boys may be due to hemispheric specialization. Mixed circling, Jarman and Nelson felt, may be a manifestation of deficiencies in frontal lobe functions which show up as disruptions in planning and decision making and do not present problems to boys due to their right hemispheric specialization at this stage in their development. This is not the case for girls who may be characterized as having more interhemispheric symmetry. If Blau's hypothesis regarding defects or developmental lag in the corpus callosum were true this would be more disruptive to girls who torque in tasks that involve both language and spatial processes.

Further speculation was presented as to why boys who exhibited mixed

circling behavior scored higher than the other groups, male and female, for their age. The authors suggested that mixed circling indicated a tendency to code spatial data from all perspectives resulting in a superior ability to code spatial materials. Further analysis indicated that mixed circling was a factor of age and when combined with sex effects, as was mentioned earlier, may be an indication of developmental lag in girls relative to boys for the seven year old group. This was not the case in the nine year olds as girls had no disadvantage relative to the other two female groups.

Based on their two studies, Jarman and Nelson make the following suggestions:

1. Assessments based on the use of the preferred hand and non-preferred hand do not make behaviorally significant distinctions.
2. The distinction between full clockwise and counterclockwise circling appears to be unimportant.
3. The most important distinction in regard to circling directionality is between consistent circling and mixed circling (clockwise and counterclockwise circle production).
4. Mixed circling appears to be related to some distinct types of cognitive processes and very little to others.

Torque and Sensorimotor Development

Prior to the study of torque in relation to neurological deficits, circling directionality was researched in conjunction with handwriting. The 1930's and 40's brought about a great interest among educators in handwriting due in no small measure to the introduction of manuscript

handwriting to North America from England by Marjorie Wise (Conrad, 1935). Prior to this time cursive writing had been the principal method of handwriting by school children and one can imagine the impact that such a radical departure from the norm would have had. Manuscript writing soon became popular and with it controversy as to the benefits and problems of both styles (Little, 1943).

Due to the inherent separation of letters in manuscript writing the tendency to reverse letters is said to be present in the early stages of handwriting development. The investigation of this phenomenon in the 1930's led to a rash of rationales as to the cause(s) of these reversals. Some felt reversals were due to faulty teaching and/or learning (Wilson, 1935). Others, that the letter reversals were a developmental characteristic common to children (Hildreth, 1935).

As part of a study on handwriting, Ames and Ilg (1950) looked at the circling patterns of children three to nine years of age. Their results were as follows:

1. 3 years — circle drawn counterclockwise starting at the top
2. 3.5 — circle drawn clockwise starting at the top
3. 4 — circle drawn clockwise starting at the bottom
4. 5 — circle drawn clockwise starting at the top
5. 5.5 — circle drawn clockwise starting at the top
6. 6 — circle drawn (and from now on) counterclockwise starting at the top

Due to the nature of the subjects and the method of data collection, these results are questionable. What was interesting was the conclusion that circling directionality was developmental in nature and should not be viewed as any more or less than a natural part of a child's maturation

process.

The work of Thomassen and Teulings (1979) was the first research that could be found that related circling directionality to handwriting. The purpose of their study was to determine whether or not directionality and writing (drawing) had common attributes. In particular they explored to what extent directionality was a factor of neuromuscular development and to what extent it was determined by higher cognitive processes which are subject to influences such as handwriting. Although the authors viewed neuromuscular and cognitive processes as being on different levels, their view is not shared by a wide body of psychologists, etc., who see the distinction between the two as being artifical (Goodnow & Levine, 1973).

Thomassen and Teulings suggest "it may be that the neuromuscular processes involved in the sequential intervention of the muscle system play an important part in the origin of directional preferences" (p. 303). Thomassen and Teulings' contention was that the scope of handwriting activities ranges from scribbling to accurate handwriting and it is likely, they say, that along this continuum there is an increase in cognitive control. It was suggested that in the case of mechanical continuous writing tasks, directionality is determined more by the motor system than by cognitive control.

The experiment of Thomassen and Teulings involved subjects from four age groups ranging from 4.5 years to 7.6 years. The size of each group was small, six or seven students in each. As well there was one adult group. The children performed four writing and drawing tasks, two precise and symbolic requiring a high degree of cognitive control and two rapid non-figurative movements representing pure motor performance.

All the tasks were performed on an XY writing tablet hooked up to a computer. The experiment consisted of four parts: a) drawing circles and crosses, b) drawing a rhombus, a triangle, and an inverted V, c) prolonged rapid scribbling, d) continually drawing circles at rapid speeds. The results of their study indicated that:

1. There was an increasing tendency to draw circles in a counterclockwise direction between the ages of 5 and 7 years. A deviation in development was reported with five year old results. Here Thomassen and Teulings found that with the left hand the subjects showed a tendency to produce clockwise circles. Due to the sample size of the study one would have to question this finding as Blau (1977c) indicates that over 75% of five year olds torque and with a sample size of six they could have easily obtained a significant torquing population.

2. The authors employed and added to the research of Goodnow and Levine (1973) who had proposed a set of rules describing the sequence followed when a geometric pattern is drawn. Rule one, the starting rule, states that the apex will be selected as the starting point. Rule two, the progression rule, states that if rule one is followed the first line will be drawn in a left downward direction. The results of Thomassen and Teulings' study showed similar patterns, top counterclockwise left progression, for the circling directionality task.

3. In scribbling, the direction of the strong age effect depended entirely on the hand performing the scribbling. "If a child's right hand preferably makes counterclockwise circles his left hand seems to prefer the exact opposite" (p. 310).

4. Only the oldest groups produced circles at a rapid speed. It was found that the children had a tendency to make non-torquing circles with

their right hand while the adult group made the most rapid counterclockwise circles with their left hand. Based on these results the authors concluded that "although a fully developed counterclockwise preference has been shown to exist in drawing single circles accurately, the latter turns into a clockwise preference when more liberal and rapid movements are performed" (p. 302).

To explain this phenomenon Thomassen and Teulings speculated that there may be two motor systems, one for rapid and non-figurative tasks and the other for accurate and symbolic purposes. The first was described as more primitive in nature and is concerned with an early neuromuscular tendency which tends towards "flexion first" and from about the age of four or five develops into an "extension first" tendency. Flexion first system produces counterclockwise circles and the extension first system clockwise circles. This could be, the authors state, why very young children produce counterclockwise circles, and adults, when scribbling, make circles clockwise. The second motor system they suggest has a bias toward a counterclockwise movement and is less dependent on the performing hand.

Findings of Torque to Date

Hartlage and Mains (1981) have stated, "we may be entering a second era of neuropsychology in which many more new instruments will be available for validation against newer assessment approaches being developed by neurology, neuroradiology and neurosurgery" (p. 161). They see the Torque Test as an instrument of this second era and comment, "the Torque Test, for example, which is currently being studied in more than a dozen

theses and dissertations (Blau, 1980) is one of the more recent approaches and hopefully heralds an era of many such new experimental approaches" (p. 161).

The research to date has examined torque under a variety of conditions with a diversity of populations. Although no firm conclusions have been drawn by researchers, torque does appear to be indicative of the following:

1. There is an age related decrease in torquing as measured by the Torque Test. At age five up to 80% of children torque using both hands, this decreases until a base rate of about 30% of the adult population produce one or more clockwise circles using the Torque Test.
2. There is a possible genetic influence relating to torque.
3. There is a higher incidence of torque in exceptional populations.
4. Those who torque have a strong tendency toward right looking eye movement for questions of an emotional nature.
5. Torquing is likely not changed by having subjects make counterclockwise circles or perform counterclockwise circling exercises.
6. There is a possible relationship between torquing and left-handedness.
7. Torque might be indicative of behavior difficulties and peer relations.
8. A link may exist between torquing and developmental lag in girls.
9. There may be a possibility that those who torque past a certain age are more prone to schizophrenic tendencies but of a mild form.
10. Torque might be a measure of lateral dominance.
11. Torque may be an indication of defects in the corpus callosum.
12. Mixed circling behavior may be the best indicator of the torquing phenomenon.
13. The question of Torque Test test-reliability has been raised.
14. Torque does not appear to be a measure of ear dominance.
15. Questions have been raised as to the relationship of torquing during childhood and torquing as an adult.
16. Torquing does not appear to be a measure of heightened anxiety levels and social competence in normal adult populations.
17. Torque may be associated with childhood autism.
18. Torque may be a factor of early childhood psychosis rather than neurological defects.
19. Torque might be indicative of possible sensorimotor defects.

CHAPTER THREE

DESIGN OF STUDY

In this chapter, information is presented on materials, population selection, procedures of test administration, the pilot study, and scoring and projected analysis of data.

Materials

The materials for this study consisted of two torque tests (the Circling Directionality Test and a modified Blau Test), materials for laterality testing, achievement tests in language, reading and mathematics.

The Tests

1. The Circling Directionality Test (C.D.T.) was designed to test circling directionality under the following conditions.
   a) The production of six circles in the form of the letter O embedded within a word in as accurate a manner as possible.
   b) The production of six circles as separate entities in as accurate a manner as possible.
   c) The production of six circles in the form of the letter O embedded within a word in as rapid a manner as possible.
   d) The production of six circles as separate entities in as rapid a manner as possible.

   For an examination of the C.D.T. (see Appendix B).

2. Laterality (Harris modified). Laterality tests for hand, foot, and eye were administered.
3. The Torque Test (modified Blau). In this test children were required to draw three circles with the preferred hand around three X's (see Appendix A).
4. The Metropolitan Achievement Test (Primary I, II, and Elementary). Tests in reading, language, and mathematics were administered to children in grades one, two, and three

Population Selection

As torquing is considered to be a developmental phenomenon, and as the tests had been administered to students according to grade level in which children of different age levels were enrolled, a decision was made to select 75 five year olds in kindergarten, the same number of six year olds in grade one, 75 seven year olds in grade two, and 75 eight year olds in grade three. At all levels there were more than 75 to choose from so random selection was used to obtain the required number (Kirk, 1978).

Procedures of Test Administration

1. The Circling Directionality Test (C.D.T.). In this test each subject was tested individually. A pencil was placed in front of the subjects and they were asked to pick it up. In the first picture, they were shown a picture of a train and beside it the words, "toot, toot, toot." The instructor pointed to the train and said, "This is a train. The train goes toot, toot, toot" (he then pointed to the words toot, toot, toot).

Below and to the left of the train were the "toot" words minus the O's (t--t). The child was asked to print in the missing O's. If the child was unaware of what was missing, the teacher coached him/her until the instructions were understood.

In the next section of the C.D.T. the child was shown a picture of a circle and asked to reproduce six of them in the appropriate slots. Again, if there was uncertainty on the part of the child, further coaching was given.

Section three of the C.D.T. was similar to section one except this time the child was shown the picture of a squirrel and beside it were written the words, "look, look, look." Again, the instructor pointed to the picture and said, "This is a squirrel. The squirrel says, 'look, look, look'." Below and to the left of the animal were the "look" words minus the O's (l--k). The child was asked if he knew what was missing from the words and if he knew he was given the following instructions: "When I tap my hand on the desk I want you to fill in the missing O's as quickly as you can. Are you ready? Go!" If the child was uncertain as to the procedure, further instruction and teaching were given until the child understood what was expected.

In the fourth and final section of the test the child was shown a circle and asked to reproduce it in as rapid a manner as possible. The instructions given were: "Do you see the circle? I want you to make a circle here, here, here, here, here, and here (pointing to the six different slots) as quickly as you can when I tap the desk. Are you ready? Go!" As in the other tests if there was a problem with the child knowing what was expected, further instruction and coaching was given.

For each section, the tester observed the number of circles that were constructed in a clockwise manner and noted the total 0 to 6.

Commencement of circle. After the children had completed the Circling Directionality Test, each circle was assessed as to its starting point. Five possibilities were considered: 1) Over 80% of the circles drawn from the top; 2) over 80% of the circles drawn from the bottom; 3) over 80% of the circles drawn from the left side; 4) over 80% of the circles drawn from the right side; and 5) an equal distribution of circles top and bottom.

2. Laterality (Harris' test of laterality was modified and abbreviated).

a) Test for handedness. The measure of handedness was the preferred hand used during the Circling Directionality Test. This information was noted and entered on the child's profile.

b) Foot dominance test. Each child was asked to stand in front of the tester. A small pillow was held in front of the tester, knee high, and the child was asked to kick it. If there was any hesitation the child was given the opportunity to kick the pillow several times and the most consistent foot used was entered as the dominant foot. This needed to be done with very few children as most were quite anxious to give the pillow a good kick and knew full well what foot they were going to use. The dominant foot used was entered in the child's profile.

c) Eye dominance test. The degree of inconsistency between the preferred hand and foot and the preferred hand/eye warranted that a second eye test (modified Harris) be administered.

In the first test the child was told to look at a large object on the wall opposite to the one he/she was near. He/she was then asked to cover one eye and look at the object on the wall. The use of the left or right eye was noted and recorded.

In the second test, the child was again asked to look at a

particular object on a far wall. This time he/she was given a cardboard telescope and told to put it up to one eye and look at the object on the wall. The reason for giving a second eye test was because there appeared to be a high variance between hand and eye in the first eye test, and this led the researcher to suspect that perhaps the first test was not accurate and a test widely used to test eye dominance should be applied.

3. The Torque Test (Blau's original Torque Test was modified). His test for torque had the subject use both the dominant and non-dominant hand. In the test, a child was required to draw six circles, three with the preferred hand and three with the non-preferred hand. Each of the circles was drawn around an X and the direction of the circling noted. In light of the research evidence presented by Jarman and Nelson (1981) and described in chapter two, the children were asked to draw circles around three X's using the preferred hand only and the direction of the circling noted (see Appendix A).

4. The Metropolitan Achievement Tests (Form JS) were administered:

a) Grade One Primary One Subtests Reading, Language, Mathematics;

b) Grade Two Primary Two Subtests Reading, Language, Mathematics;

c) Grade Three Elementary Subtests Reading, Language, Mathematics.

The achievement tests were given to the home room teachers to administer in as many sittings as was thought necessary, provided they did not exceed the maximum recommended time for any one testing period. Teachers were given manuals for administration. Included with the manual were instructions as to the importance of not exceeding the time limits, not assisting children with their answers, and the fact that some of the questions would be meaningless to the children due to such factors as the money questions in the mathematics section showing American coinage

and bills.

Some teachers wanted to score the tests themselves as in many instances this was the first time their children had been exposed to norm referenced tests and they were anxious to find out how their children would do. Included were explicit instructions on how to score the tests as well as the appropriate numerical data to transform raw scores. In cases where the tests were corrected by the teacher, the researcher checked the results to insure that they were scored accurately. Rater reliability was to the maximum. Approximately 30% of the tests were corrected by the teachers. All the other tests were corrected by the researcher. Similar cross checking of scoring with these tests revealed maximum reliability efficiency.

For the purposes of the study, percentile scores in each of the subtests and in the total, formed the basis of academic assessment.

Kindergarten assessment. Kindergarten children were given no formal tests of academic assessment. The teachers were asked to rate the children on a scale of one to four using the following criteria:

1. Very ready for grade one, is reading now or is on the verge of reading.
2. Ready for grade one and will probably proceed through the first grade at a normal pace.
3. Will need some readiness before student is ready to proceed with grade one work.
4. Will need extended readiness of at least one half of the school year before proceeding to grade one work.

Pilot Study

A pilot study was undertaken for the following reasons.

1. To assess the stability of the Circling Directionality Test. Two testings given six weeks apart and coefficients of stability were obtained.
2. To provide an opportunity for revision of the Circling Directionality Test.
3. To become familiar with the torquing phenomenon across the various grade levels.
4. To see if factors such as the size of the pencil, arrangement of the test booklet, inclass testing assessment, similarity of instructions to all age groups would make a difference to the child's ability to complete the tasks.
5. To see if hand preference changed when a child printed his/her name and then constructed a series of circles.

All students for the pilot study were selected from Tillicum School in Vancouver (n = 85, K, grades 1 and 2). Intact classrooms were selected. Class sizes varied but the average assessment time per class was 40 minutes. This was consistent throughout the entire study. Students came one at a time to the tester at the back of the class and were asked to sit down. Two pencils were placed in front of the child, a big one, the kind used in some grade one classrooms, and a regular one of the same colour. When a pencil had been selected, the child was asked to look at the two lines near the top of the page (tester pointed to lines). They were then asked to print their names between the lines. In some cases where the children could not do the task they were asked to pretend to make their name.

They were then asked to look at the picture of a clown. Below the clown was written the word boozo. Subjects were told "This is boozo, say boozo. I would like you to write the word boozo here (points to spot)." The purpose of this procedure was to see whether some children would have difficulty in printing the word and whether this might become a consideration in circling directionality assessment. (See Appendix D.)

Children were then shown a circle and asked to make six circles. The tester observed the directionality of the circle and recorded the results.

The following results and observations were made based on the findings of the pilot study:

1. The size of the pencil did not make a difference as children selected either one on an equal basis. (Big pencil 36, regular pencil 49.)
2. Children consistently used the same hand to produce their name and circles, making it unnecessary to have them print their name in order to determine handedness.
3. Children of all ages could understand the instructions. Kindergarten children had some difficulty with the arrangement of tasks on the page and for the principal research changes in test format were made accordingly.
4. The test-retest results for torque produce the following coefficients of stability: kindergarten $r = .71$, grade one $r = .59$, grade two $r = .83$. These results indicated that the coefficients of stability were strong enough to proceed with the testing using a modified format which would be quicker to administer and give more data. Data obtained in the pilot testing are to be found in Appendix C.

Dates of testing administration. The first pilot tests were administered the last week of October 1981. This was followed six weeks later (the week of December 6th to 12th) by a second testing to assess test stability.

The schedule for the principal study was as follows:

1. Circling Directionality Test. Monday, April 5, St. Jude; Monday, April 5, St. Marys; Tuesday, April 6, St. Francis de Sales; Wednesday, April 7, Holy Cross; Wednesday, April 12, St. Francis of Assisi.

2. Metropolitan Achievement Tests. All tests were administered between April 20th to the 29th.

3. Torque Test (modified Blau). This test was administered in two days (May 24th and 25th) to the entire sample.

Scoring and Projected Analysis of Data

Circling Directionality Tests were administered and scored by the researcher and a team of trained assistants. The Torque Test was administered and scored by the researcher. The Metropolitan Achievement Tests were all administered by the classroom teachers. Scoring was done by the researcher and teachers. In cases of teacher scoring, results were verified by the researcher.

The plan for the analyses of the data was by the use of the Pearson Product Moment Correlation. Where appropriate, mean scores, n, and percentage were to be presented.

CHAPTER FOUR

ANALYSIS OF THE DATA

Introduction

The U.B.C. computer program MTS/SPSS Version H. was used to calculate Pearson Products Moment Correlations. A decision was made to accept a .05 level of significance for accepting or rejecting the relationships. It was thought that the lack of clarity in the research to date on the torque phenomenon made this an acceptable criterion with which to work.

This researcher was aware that correlation does not imply causality and this fitted the statistical model for this study. Torque was viewed as a phenomenon indicative of certain developmental and cerebral factors but not the cause of such factors. Where appropriate, the number of subjects, a percentage rating, and mean scores are given. The results of the data are described within the framework of the questions posed in chapter one.

Questions

Question. 1. Is there a significant relationship between academic achievement and torquing in children six, seven, and eight years of age?

One of the principal questions relating to this research was to determine if a significant relationship exists between academic achievement and torquing. There was no significant relationship between the

Metropolitan Achievement Test and torquing in six year olds in grade one and seven years olds in grade two in any measures of academic achievement. This would suggest that for these age groups the fact that a child torques is not likely to affect his academic success in school. Table 1 presents mean scores of these groups.

Table 1

Mean Percentile Scores in Academic Achievement
Ages 6-7-8

	Total	Language	Mathematics	Reading
Grand Mean, n=225	50.4	51.9	47.0	50.1
C.D.T. Torquing, n=41	46.6	44.4	43.0	49.6
Torque Test Torquing, n=50	45.6	47.5	43.2	46.9
Total Mean by Age				
Age 6	44.8	45.7	41.2	48.6
Age 7	50.8	50.4	46.7	50.0
Age 8	55.6	59.5	53.3	52.8
C.D.T. Torquers				
Age 6, n=26	45.5	42.8	43.0	51.0
Age 7, n=11	54.7	53.8	46.5	50.0
Age 8, n=4	32	29.5	34.2	38.0
Torque Test Torquers				
Age 6, n=27	41.4	44.2	39.0	44.6
Age 7, n=17	55.7	55.7	51.4	52.8
Age 8, n=6	35.8	39.3	35.0	40.0

In the eight year old group, however, significant correlations were found (Table 2). This suggests that children eight years old who torque do have a significant tendency to have lower academic achievment. The Circling Directionality Test (C.D.T.) produced significant results in total scores and reading only. The relationships between the Metropolitan Achievement Test and torquing for the six year olds in

grade one and seven year olds in grade two, produced no significant results in any measures of academic achievement (Table 3). This would suggest that for these age groups the fact that a child torques is not likely to affect his academic success in school. Tables one, two, and three as they related to the eight year old torquers demonstrate the

Table 2

Correlations of Torquing and Academic Achievement--8 Year Old Group

	Total	Language	Mathematics	Reading
Circling Directionality Test	r=-.19(p=.05)*	r=-.23(p=.02)*	r=-.08(p=.23)	r=-.12(p=.15)
Torque Test	r=-.25(p=.01)*	r=-.21(p=.03)*	r=-.19(p=.05)*	r=-.19(p=.05)*

Table 3

Pearson Product Moment Correlations--Torquing and Academic Achievement for Ages 6-7-8

	Total	Language	Mathematics	Reading
C.D.T.				
Age 6	r=.01 (p=.43)	r=.08 (p=.32)	r=.06 (p=.28)	r=.05 (p=.24)
Age 7	r=.06 (p=.29)	r=.04 (p=.34)	r=.01 (p=.44)	r=.02 (p=.43)
Age 8	r=-.19 (p=.05)*	r=-.23 (p=.02)*	r=-.08 (p=.23)	r=-.12 (p=.15)
Total	r=-.05 (p=.20)	r=-.03 (p=.03)*	r=-.06 (p=.18)	r=-.00 (p=.44)
Torque Test				
Age 6	r=-.08 (p=.33)	r=-.09 (p=.20)	r=-.00 (p=.49)	r=-.08 (p=.24)
Age 7	r=.15 (p=.09)	r=.15 (p=.09)	r=.08 (p=.22)	r=.11 (p=.15)
Age 8	r=-.25 (p=.01)*	r=-.21 (p=.03)*	r=-.19 (p=.05)*	r=-.19 (p=.05)*
Total	r=.17 (p=.12)	r=.13 (p=.19)	r=.12 (p=.21)	r=.00 (p=.49)

*p ≤ .05

differences in academic achievement of this group from the rest of the eight year olds in the sample. This suggests that torquing in eight year olds is indicative of a potential for lower academic achievement.

Question 2. Is there a significant relationship between readiness for grade one, as measured by teacher assessment and circling directionality?

Blau commented that as young as age five, children who torque might experience academic and/or social problems (Blau, 1977c). This led the researcher in this study to question whether the five year olds in the present sample who torqued would demonstrate any significant manifestation of academic difficulty.

At age five, a large number of children produce circles in a clockwise manner. In the present study, using the preferred hand only, 42 (56%) of the children torqued in the Circling Directionality Test and 44 (58.67%) torqued in Blau's Torque Test.

Reliable measures of school readiness are difficult to obtain at this age level due to rapid developmental changes that are occurring. Rather than depend on measures from a group test a decision was made to meet with each kindergarten teacher and by using a four level rating scale (see Appendix E) come to a decision as to the readiness for grade one of each child. As the teachers were all experienced and knew the children well it was felt that their assessment would provide a reasonable academic rating of each student.

Correlational data indicated that there was no significant relationship between torquing and grade one readiness as measured by teacher assessment. Specifically, C.D.T. and assessment scores showed $r=-.10$ ($p=.18$). The Torque Test results showed even less correlation $r=-.04$

(p=.36). It can be concluded therefore that torque does not appear to be an accurate measure of grade one readiness as assessed by kindergarten teachers.

Question 3. Is the point of commencement in circle construction and circling directionality significantly related?

As an adjunct to the main thrust of the study, the researcher was interested in discovering if a significant relationship existed between the commencement of a circle and circling directionality. The importance of the question was twofold, its phenomenological implications and its role in the handwriting process.

No studies using large sample data could be found in the literature which related circling directionality to the point of commencement. It is beyond the scope of this researcher to do any more than report the findings and it is left to others to explore the phenomenon in more depth.

From a handwriting perspective, circling directionality plays a significant role in the teaching of manuscript handwriting. It is common practice to teach children manuscript using what is referred to as the "ball and stick" method. In this system, students are instructed to draw both the ball and the stick (line) starting at the top, and in the case of the circle proceed in a left downward motion. The results of this study indicated that most torquers commenced their circles at the bottom and proceeded in a clockwise right upward motion (r=.51, p=0.000). The correlation would have been higher if the left and right side commencement group were included with those who begin making their circles at the bottom.

This result suggests that there are many five and six year old children being instructed in handwriting in a manner that is behaviourally

opposite to their developmental status. No studies could be found which discussed the relationship of torquing to the long term effects on the quality of penmanship. Could it be that the initial handwriting experiences of some children set the stage for poor penmanship in consequent years?

Results indicated that 60 (or 72.3%) of the 84 students who torqued produced circles not beginning at the top, with the greatest majority, 52 (or 62%) beginning their circles at the bottom. As indicated in Table 4 there was a decrease in the number of torquers who began their circles at the bottom. A possible reason for this decrease is that school instruction may have had an effect. Of the 216 non-torquing students, 210 (97.2%) began their circles in a counterclockwise manner. This suggests that if a person produces clockwise circles he will almost certainly commence at the top.

Table 4

Frequency of Circle Commencement

	Age 5		Age 6		Age 7		Age 8	
Start of Circle	freq.	%	freq.	%	freq.	%	freq.	%
1=Top	35	46.7	56	75	70	93.3	72	96
2=Bottom	30	40.0	16	21.3	5	6.7	1	1.4
3=Left side	3	4	2	2.6	0	-	0	-
4=Right side	5	6.7	0	-	0	-	0	-
5=Top & Bottom	2	2.7	1	1.4	0	-	2	2.6
Start circle at Bottom & Torque	34	81	19	73	5	45.5	1	16.7

Question 4. Is there an equivalent increase, according to age, in the production of counterclockwise circles as has been found in related studies?

As was reported in other studies, the results of this research indicated a highly significant negative relationship between age and torquing. As the subjects in this study used the preferred hand only, the number of subjects who torqued was less than that found in most other studies and is more in line with the results of Jarman and Nelson (1981), who measured results using the preferred hand.

The decrease in torquing (Table 5) demonstrates that by the time they are eight most children produce counterclockwise circles in tasks involving printing, the production of independent circles, and circles constructed around shapes. The results of Blau's study and other research produced a higher incidence of torquing compared to the sample used in this study. These studies, however, used both preferred and non-preferrred hands while the current study used the preferred hand only and produced a more rapid decrease than was found in other studies. Table 5 gives a breakdown of torque, non-torque by age for this study and clearly indicates a rapid decrease in the torquing phenomenon for the age group 5 to 8.

Table 5

Frequency of Torquing by Age

	Age 5		Age 6		Age 7		Age 8	
	freq.	%	freq.	%	freq.	%	freq.	%
C.D.T. Test								
0-6 Non-Torque	33	44	49	65.3	64	85.3	71	94.7
7-24 Torque	42	56	26	34.7	11	14.7	4	5.33
Torque Test								
0 Non-Torque	31	41.3	48	64	58	77.3	69	92
1-3 Torque	44	58.7	27	36	17	22.7	6	8

Question 5. Is there a significant relationship between gender and circling directionality?

The results of the study indicated that there was a statistically significant relationship between the sex of the subjects and circling directionality. In both the Circling Directionality Test and the Torque Test, correlations indicated that significantly more boys torqued than girls for the five, six, and eight year olds (C.D.T., $r=-.15$, $p=.005$; Torque Test, $r=-.18$, $p=.001$). As indicated in Table 6, the seven year olds were an exception where approximately the same number of boys and girls torqued.

Of particular interest to this study is the finding that in the eight year old group 75% of the torquers were boys. As the scores of academic achievement indicated, a significant decrease for the torque group and all but one were boys, we have a possible clinical implication for male torquers of this age group.

Table 6

Population of Boys and Girls by Age and Frequency of Torquing, in the Torque Test and the Circling Directionality Test

	Population	Torque Test	C.D.T.
Age 5			
M	34 (45%)	24 (57.1%)	26 (62%)
F	41 (54%)	18 (42.9%)	16 (38%)
Age 6			
M	34 (45%)	19 (70.4%)	16 (61.5%)
F	41 (54%)	8 (29.6%)	10 (38.5%)
Age 7			
M	35 (46.7%)	8 (44.4%)	5 (45.5%)
F	40 (53.3%)	9 (55.6%)	9 (54.5%)
Age 8			
M	34 (45.3%)	5 (83.3%)	3 (75%)
F	41 (54.7%	1 (16.7%)	1 (25%)

Question 6. Is there a significant relationship between laterality and circling directionality?

The researcher was interested to discover if the results of the research would support the hypotheses that there was a significant relationship between torquing and measures of hand, foot, and eye dominance. In both the C.D.T. ($r=.11$, $p=.03$) and the Torque Test ($r=.20$, $p=.000$) there was a significant relationship between torquing and handedness, and suggested that the incidence of clockwise circling was significantly higher among left-handed subjects. There was, however, no significant relationship found between torquing and footedness in both the C.D.T. ($r=.03$, $p=.25$) and the Torque Test ($r=.05$, $p=.18$). The data indicated that there was a significant relationship between hand and foot ($r=.41$, $p=0.000$). It was somewhat surprising therefore, to discover that only handedness appears to relate significantly to torque for this population.

Of particular interest were the eight year olds (n=6) who torqued in either the C.D.T. or the Torque Test. The degree of variation between hand and foot dominance (Table 7) suggests a significant deviation from the norm for this age group. All but 4 of the 69 non-torquers (94.2%) as opposed to 4 of the 6 torquers (66.6%) had identical hand/foot dominance. Of the 6 eight year old torquers, 4 (66.7%) were left-handed. This finding lends strong support to other studies which relate left-handedness to torquing for this age group.

Table 7

Hand and Foot Preferences of 8 year old Torquers

Student	Hand	Foot
1	Right	Right
2	Right	Right
3	Left	Left
4	Left	Left
5	Left	Right
6	Left	Right

As discussed earlier, two eye tests were done to insure that the lack of correlation which seemed apparent in the first eye test was not due to faulty design. The results of the data indicate that eyedness in both tests had no significant relationship with either hand, foot, the Circling Directionality Test, or the Torque Test (Table 8). Unlike other studies which found torque related to crossed laterality using the preferred eye and the preferred hand, such was not the case in this study.

Table 8

Correlations Between Hand, Foot, and Eye for the Total Population

Hand	Foot	r=.41	(p=0.000)*
	First Eye Test	r=-.03	(p=.25)
	Second Eye Test	r=.11	(p=.02)*
Foot	First Eye Test	r=.03	(p=.29)
	Second Eye Test	r=-.03	(p=.26)
Eye	Second Eye Test	r=.18	(p=.001)*

*$p \leq .05$

Question 7. Does rapidity in the construction of circles affect directionality?

Thomassen and Teulings (1979) hypothesized that there may be two motor systems operating in drawing. One system, "flexion first" is used in tasks such as scribbling and rapid circling and becomes "extension first" between the ages of five and seven. The second system is more controlled and is used in higher level cognitive processes such as handwriting. They found that with the older group of children age seven, and adults, counterclockwise circling was predominant but when rapid circling occurred this turned into a clockwise rotation (see chapter two).

To test Thomassen and Teulings' (1979) results, students were asked to draw 24 circles, task one required children to draw 12 circles under no time restraints (six O's within a word and six circles). Task two required the children to draw 12 circles as rapidly as they could (six O's within a word and six circles) (see Appendix A). During the first task, the children were encouraged to take their time and make the best circles they could. In the second task, speed was of the essence and they were encouraged to go as rapidly as possible.

Having completed task one with a high degree of cognitive awareness (O's made as accurately as possible), the second almost identical task (O's made as quickly as possible) should, it was thought, have elicited the more primitive motor system described by Thomassen and Teulings. If this should occur it would supposedly result in the production of counterclockwise circles by some torque children.

The results indicated that no age group showed any tendency to change direction from task one to task two. The $r=.98$ ($p=0.000$) correlation between circles drawn in task one and task two of the Circling Directionality Test clearly demonstrated that in almost all cases students produced circles in a similar direction, clockwise or counterclockwise when performing either task ($r=.98$, $p=0.000$). No support, therefore, could be found for Thomassen and Teulings' hypothesis. One should note, however, that the data were gathered in Thomassen and Teulings' study and in this study under different conditions. Thomassen and Teulings used a free scribbling and continuous rapid circling tasks, while this study had children execute rapid circling in the manner described.

Question 8. Is there a difference in circling directionality when circles are constructed as O's embedded within words or as separate entities?

The artificial nature of circling in Blau's Torque Test led the researcher to question the construction of circles under that condition and subsequently devised an alternative means of assessing directionality using an embedded task within words (the letter O) and a series of free circles.

The two circling approaches that were the basis for the Circling Directionality Test were compared. The results of the research clearly

showed (r=.91, p=0.000) that directionality was not influenced by the particular task that the child performed. This result led to the conclusion that torquing is not associated with the particular circling task and that if a person is going to torque the particular format under which the circle is drawn will not alter the directionality.

Question 9. Is there a relationship between the Torque Test and the Circling Directionality Test?

The literature to date refers to the Torque Test as the only measure of circling directionality. The construction of circles around a series of X's is not a usual activity for young children and the researcher wanted to see if there was an equivalent transfer of circling directionality during other circling tasks.

A Circling Directionality Test was developed which involved the production of 24 circles under differing conditions as opposed to the Torque Test which has the subjects produce three circles with the preferred hand and three circles with the non-preferred hand. Blau's Torque Test was modified to the extent that children produced circles only with their preferred writing hand. The two tests were compared.

The results of the research indicated that there was a significant correlation between the C.D.T. and Torque Test (r=.73, p=0.000). This high correlation led to the following conclusions:

1. The need to have the children produce 24 circles to adequately verify the presence to torque is not necessary.
2. The need to have children produce circles around an X as opposed to simply drawing a series of circles is questioned.
3. Both the C.D.T. and the Torque Test produced significant correlations

on most of the same measures. This is not surprising as the correlation between measurements on the same factor is high (Table 9).

4. If a child is going to torque he/she will usually torque under all conditions where there is no external factor preventing what is a normal circling pattern.

Table 9

Examples of Correlations Between C.D.T. and Torque Test

STCIR	Age	Sex	Eye	Foot	Hand	CTBS	Read	Math	Lang
C.D.T.									
r=.51 p=0.000*	r=-.44 p=0.000*	r=.15 p=0.005*	nsc	nsc	r=.11 p=.03*	nsc	r=-.12 p=.03*	nsc	nsc
Torque Test									
r=.39 p=0.000*	r=.39 p=0.000*	r=.18 p=0.001*	nsc	nsc	r=.20 p=0.000*	nsc	r=-.08 p=.09	nsc	nsc

$p \leq .05$ nsc = no significant correlation

Conclusion

The research questions posed in this study covered a wide range of factors relating to circling directionality. The conclusions based on the data and implications for further research addressed in chapter five demonstrate that the torquing phenomenon is indicative of certain developmental factors, cognitive processes, neuro muscular functions, and cerebral anomalies that warrant further investigation.

CHAPTER FIVE

CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

This study sought to find answers to the following questions:

1. Does a significant relationship exist between academic achievement and circling directionality as measured by a norm referenced test used in grades one, two, and three?
2. Is there a significant relationship between readiness for grade one, as measured by teacher assessment, and circling directionality?
3. Is the point of commencement in circle construction and circling directionality significantly related?
4. Is there an equivalent increase, according to age, in the production of counterclockwise circles as has been found in related studies?
5. Is there a significant relationship between gender and circling directionality?
6. What is the relationship of laterality, as measured by foot, hand, and eye dominance, to circling directionality?
7. Does rapidity in the construction of circles affect directionality?
8. Is there a significant difference in circling directionality when circles are constructed as O's embedded within words or as discrete entities?
9. Is there a significant relationship between the Torque Test and the Circling Directionality Test?

The population consisted of 300 children; five year olds in kindergarten, six year olds in grade one, seven year olds in grade two, and eight year olds in grade four (n=75 per age level). Correlational statistics were used to see if significant relationships existed between factors of age, circling directionality, academic achievement, hand-foot-eye dominance, commencement of circle, two different torque tests, sex, and readiness for grade one.

Conclusions and Implications

The relationship of torque to academic achievement was a major concern of this study. The results indicated that for the five year old kindergarten group torque was not an accurate indicator of readiness for grade one as assessed by teacher judgement. As well, for the six year old group in grade one, no significant correlations could be found in measures of circling directionality and academic achievement. Similar results were found for the seven year old group in grade two. The achievement scores of the eight year old torquers indicated that they were significantly below the academic norm for their age group. The high incidence of left-handedness and crossed laterality along with their lower language, mathematics, and reading scores led the researcher to the conclusion that perhaps for this age group, torquing is an indicator of possible cerebral dysfunction and warrants further investigation.

It may be that like so many other traits torquing is developmental and quite within normal parameters to a certain age. At that time the phenomenon would be indicative of abnormal development. This present study indicated that grade three (eight year olds) is that time.

(Questions 1 and 2)

The data clearly indicated that torquers had a propensity to commence their circle at the bottom, particularly the five and six year old age group. The non-torquers in almost all cases began their circles at the top. The consistency of either top or bottom circle commencement is extremely high as only 15 of the 300 children altered from this pattern.

(Question 3)

The data indicated that there was a dramatic decrease in torquing from age five to age eight. The lower base rate of torquing in this study compared to other studies can possibly be attributed to the fact that the preferred hand only was used in both the Circling Directionality Test and the Torque Test. This result led the researcher to the conclusion that torquing with the preferred hand produced a proportionally equal decrease in torquing for age groups 5, 6, and 7 compared to those studies in which both hands were used to determine the presence of torque. In the eight year old group, however, the incidence of torquing was significantly lower than that found in previous research.

(Question 4)

In all but the seven year old group, boys had a significantly higher incidence of torque. For the five and six year old group no academic conclusions are drawn as to torque and gender. In the eight year old group, however, the large percentage of torquers were boys. This combined with their academic achievement level, left-handedness, and higher incidence of crossed laterality warrants the further investigation of torquers in this age group.

(Question 5)

There was a significant relationship between left-handedness and torque in both the Circling Directionality Test and the Torque Test. This was particularly true for the eight year old group of torquers. Of the six torquers in this age group four were left-handed. There was a high correlation between measures of hand and foot but this did not extend to a significant relationship in measures of torque and footedness. In both eye tests no significant measures could be found between any variable dominance or torquing.

(Question 6)

The link between the neuromuscular motor system and torque was addressed to see if circling directionality would be altered under different levels of cognitive control. The results indicated that the children did not alter their circling patterns under differing rates of circling construction or within different circling tasks.

(Question 7)

The researcher wished to discover if circling directionality would change as a result of circles being drawn as O's embedded in words or as discrete entities. The results indicated that practically no change occurred as a result of the different tasks. This led the researcher to the conclusion that circling directionality is probably not altered by a particular task and that a circling pattern will remain consistent until cerebral changes of a developmental nature occur. At this point it is hypothesized that for some children this may never change.

(Question 8)

As no studies could be found that used the preferred hand only, the researcher wished to find out if torquing with the preferred hand only would produce levels of significance in the various measures. As well, for the purpose of comparison, the factors of age, handedness, and sex, which had been reported as having a level of significance in other studies, were of particular interest. The results indicated that there were significant correlations in these variables of age, handedness, and sex, and this led the researcher to the conclusion that perhaps circling with the preferred hand only will produce results that are less susceptible to contamination of torquing data brought about by the use of the non-dominant hand.

Recommendations

1. Torquing appeared insignificant in its relationship to academic performance for kindergarten, grade one, and two children. With eight year olds it proved to be highly significant. Investigations need to be undertaken past this age by consequent age levels to confirm the continuance of this tendency. Benefits could accrue from case studies of torquers across academic measures.
2. The starting point of circling by torquers merits investigation. Why is it that the point of origin in the circles of torquers are so predominantly started at the bottom? Does this propensity transfer to the constructions of other shapes?
3. The higher incidence of torquing in boys over girls in this study merits further investigation. Is the torquing phenomenon simply one more trait exhibited by a disproportionate number of males over females?

4. In the group of eight year olds who torqued and had depressed academic measures, there was a significant incidence of left-handed and crossed hand-foot dominance. As these traits are suggestive of and frequently associated with neurological involvement it would seem that neurological assessment of torquers at this age and beyond might flesh out the trait profile of those who torque.
5. To date torquing has been assessed before this study by the use of the preferred and non-preferred hand using Blau's Torque Test. This study questioned the use of the non-preferred hand as a valid measure and used the preferred hand in all measures. Further research involving the preferred hand only is justified and recommended.
6. Verification of the results relating to the assessment of torque through the Circling Directionality Test needs to be made.

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Appendix A

Name _____

X X X

Name _____

X X X

Name _____

X X X

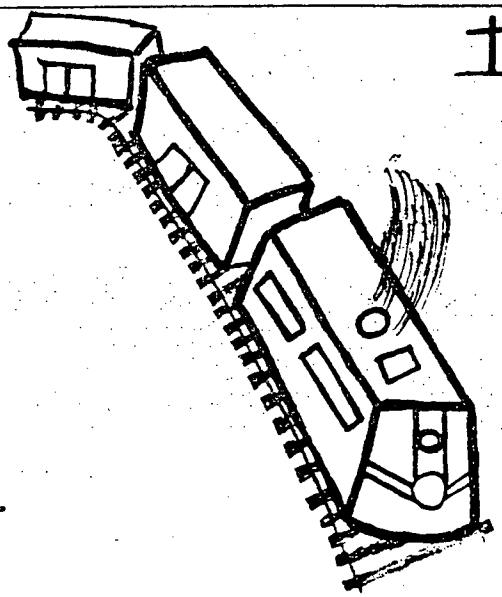
Appendix B

Students First Name & Initial_____ School_____ Teacher_____

Grade_____ Age_____ Sex_____ Torque Test A____ Torque Test B____ Total A.& B _____

Torque Test C ___ Torque Test D____ Total C & D___ Total A,B,C,D._____

DOMINANT----Hand_____ Foot_____ Eye_____



toot

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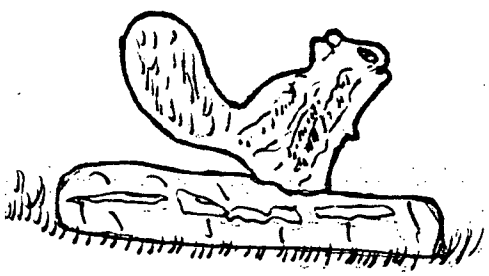
A_

O

B_



look

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C._

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D_

Appendix C

Pilot Study Circling Directionality Test Results

Grade Two

	Test Two	Test One	Teacher Evaluation
Yoon	0	0	B
Daniel	0	0	B
Darrius	0	0	C
Tiffney	0	0	B
Andrew	0	0	A
Gerry	0	0	D
Niki	0	0	C
Vahid	0	0	B
Joseph	1	9	B
Vicki	0	0	C
Nicki	9	9	D
Stephania	0	9	D
Lexie	0	0	B
Bobby	9	9	C
Jenny	0	0	B
Alten	0	0	B
Angie	0	0	B
Sean	9	9	D
Avinash	0	0	B
Eva	9	9	B
Lorena	9	9	B
Brandy	0	0	B
Kingsley	0	0	B
Jennifer	0	0	A
Fleur	0	0	A
Vita	0	0	B
Bonny	0	0	A
Jessica	0	0	A
John	7	9	D

Grade One

	Test Two	Test One	Teacher Evaluation
Danny	0	0	B
Ralph	9	9	D
Desiere	8	8	C
Tora	9	9	D
Arthur	9	7	C
Jenny	0	0	B
Stephen	0	0	B
Nancy	0	0	B
Tomoko	0	0	B
Kenny	9	9	C
Lisa	0	9	B
Rajab	4	9	C
Rachel	9	9	A
Jamey	3	9	C

Grade One (ctd.)

	Test Two	Test One	Teacher Evaluation
Westley	9	0	B
Holly	0	0	B
Steve	0	3	C
Chew Nig	0	0	B
Jennifer	0	0	C
Keirsten	0	0	A
Terra	9	9	D
Edna	9	9	B
Bradley	9	3	A
Roseabel	0	8	C
Jonney	0	0	C
Brett	0	9	C
Michael	6	0	D
Lisa P.	0	6	B
Peter	0	0	B
Fareez	0	0	C
Emely	9	9	C
Cristinia	0	0	B
Lisa	0	0	A

Kindergarten

	Test Two	Test One	Teacher Evaluation
Jeremie	0	9	B
Cardine	0	2	B
Guido	6	0	D
Ken	0	0	C
David	9	7	B
Jennifer	0	0	A
Nessa	0	0	D
Au Tung	0	0	B
Stacy	1	9	C
Phung	9	9	B
Lisa	0	1	B
Lexie	9	9	C
Margaret	5	2	B
Amanda	9	9	D
Jake	9	9	C
Amie	9	9	C
Lennie	9	9	B
Eren	9	9	D
Suzie	9	9	B
Sana	0	0	C
Cristine	9	9	B
Ayesha	9	9	B
Lee	6	0	B

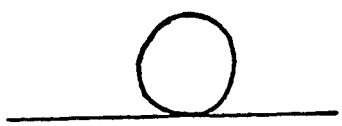
Appendix D

First Name_ _____ Kindergarten____ Grade One____ Grade Two_____ R.H.___L.H.___ N.D._

Boy____ Girl____ Torque____of six B.P.____N.P.____ Teacher Eval. A___B___C___ D___Age____

boozo

Torque of 3



Appendix E

TO KINDERGARTEN TEACHERS

I would like to obtain a rating of where you feel your pupils would fit as far as readiness for grade one is concerned.

To do this I do not want to give them a standardized test but will rely on your experience as teachers of young children.

The list I have provided contains scores relating to my study. In the column marked reading would you please rate the children according to the scale below.

1. Very ready for grade one reading now or on the verge of reading.
2. Average student will have the usual problems with grade one but will not encounter any very serious difficulty.
3. Not quite ready for grade one, will need several months of extended readiness but will catch up.
4. This student will need a long term readiness program and is not ready to cope with grade one work until well into the second school term.