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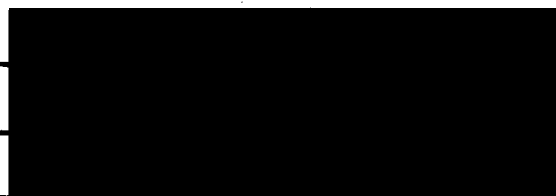
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TORQUE, CONJUGATE LATERAL EYE MOVEMENTS, AND SCORES ON THE
MINNESOTA MULTIPHASIC PERSONALITY INVENTORY (MMPI)

by

Russell G. Winterbotham

B.Ed., Simon Fraser University, 1978

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF ARTS
in the Department
of
Psychology

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SIMON FRASER UNIVERSITY
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TORQUE, CONJUGATE LATERAL EYE MOVEMENTS, AND SCORES ON THE

MINNESOTA MULTIPHASIC PERSONALITY INVENTORY (MMPI).

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ABSTRACT

It has been suggested that the Torque Test is a simple, external measure of hemispheric dominance, and that it can be useful in identifying individuals who have a high risk of developing schizophrenia and other psychological problems. Torque has been defined simply as the tendency to draw circles in a clockwise direction, which is contrary to the norm. A study of 97 right-handed elementary school children revealed that the incidence of torque was significantly higher among subjects whose conjugate lateral eye movements (CLEM) were predominantly to the left. In a second study, 56 right-handed students in undergraduate psychology courses were assessed for torque, CLEM, and tendencies towards psychopathology as measured by the MMPI. A discriminant function analysis enabled the correct classification of 87% of the subjects according to the presence or absence of torque, solely on the basis of their MMPI scores. Subjects with torque and left CLEM had the highest incidence of elevated scores on the Sc (schizophrenia) scale. The results are discussed in the context of a model which suggests that directionality in drawing behaviours is subject to cultural and educational influences, and that the inability to adapt to cultural norms may be due to an hemispheric imbalance mediated by a neurological deficit in which the developmental process is impeded and vulnerability to psychopathology is increased.

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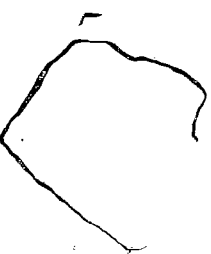
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A. Introduction

In recent years there has been an increase in the amount of research concerning functional asymmetries of the human brain. The existence of these asymmetries has been widely accepted, but their implications for our understanding of psychological function and dysfunction have yet to be fully understood (Bakan, 1978; Bogen, 1977; Galin, 1974). To a large degree, the brain remains a "black box" and, as ethical considerations rarely permit tampering with the interior, researchers require non-intrusive techniques for assessing hemispheric asymmetry in normal subjects. This has led to a search for behavioural correlates which may be related to the lateral organization of the brain. This thesis is concerned with two recently proposed laterality indicators, the torque test (Blau, 1977b) and conjugate lateral eye movements (CLEM; Bakan, 1978). The relationship between these two variables will be examined, and the validity of the torque phenomenon as an indicator of risk for psychopathology will be investigated. A brief description of torque and CLEM follows.

The Torque Test

Blau (1977a) has devised a simple measure based on the direction in which people draw circles, either clockwise or counterclockwise. Subjects are asked to draw a circle around each of three "Xs", first with the preferred hand, and then with the non-dominant hand. Any test performance in which one or more circles are drawn in a clockwise direction is labelled as torque. The circling task is usually accompanied by a copying task and a signature task, but only the circling task is scored in determining the presence of torque (Blau, 1977b). Blau claims that torque has been shown to be a reliable phenomenon over periods ranging from 3 days to 2 1/2 years, with most of the shifting occurring in the clockwise to counterclockwise direction, which is the expected developmental trend (Blau, 1977a).



Blau (1977b) states that during his clinical work he gradually became aware that children with academic and behavioural difficulties drew circles in a clockwise fashion more frequently than "normal" children did. Systematic observation revealed that clockwise circling was characteristic of left-handed children, a fact which had been established by Ilg and Ames (1972), but Blau makes no reference to any of their

early developmental studies.

Apparently all very young children exhibit some torque, but the incidence of torque decreases with age, reaching a suggested base rate of 30% by late adolescence (Blau, 1977b). Developmental studies offer some support for a relationship between handedness and directionality of drawings. Rotations and reversals are frequent up until around age six and show a maturational decrease thereafter (Bannatyne and Wichiarajote, 1969). The directionality of drawn circles gradually changes from clockwise at age five to counterclockwise by age ten (Ames and Ilg, 1951; Gesell and Ames, 1946; Ilg and Ames 1972). Although there are few normative data on left-handers, Ilg and Ames (1972) suggest that they show a developmental trend in the opposite direction to right-handed children, although many do draw in the normal direction. These studies and Blau's data (1977a) seem to support the notion that the torque response is related to handedness, with 65% of left-handers vs. 32% of right-handers exhibiting torque in one study (Blau, 1977a).

In his Presidential Address to the American Psychological Association, Blau argued that torque may be a clinically significant response (Blau, 1977b). He found that children showing torque exhibited more aberrant behaviour than children without torque. In a sample of over 300 children, torque was found to be significantly related to scores on a neuroticism index and a neurologic index at the .003 and .0009 levels of

significance respectively (Blau, 1977a). Unfortunately, Blau does not report any measures of the strength of association. Some of the behavioural anomalies that Blau (1977a) reports as being related to torque are listed below, along with their levels of significance:

Stubbornness (.034)

Variable emotional behaviour (.0005)

Excess energy (.00001)

Cannot follow directions (.001)

Variable intellectual performance (.054)

Continued bedwetting (.04)

Blau conducted a follow-up study on 54 children with no torque and 52 children with torque who had been to see him a decade earlier. He reports that 11 (21%) of the torque children had been diagnosed as schizophrenic by age 21, whereas only 1 child in the no-torque group received that diagnosis (Blau, 1977b). Ratings of adjustment level were compiled for all of the subjects. Among the subjects with good to fair adjustment ratings, the incidence of torque was 36%, while among those with poor to bad ratings the incidence of torque was 77% (Blau, 1977b).

The torque test definitely seems to be picking up on something, but it is not at all clear what is being manifested in the directionality of the circles that a person draws. Blau (1977 a,b) believes that directionality reflects handedness and

lateral hemispheric dominance. He suggests that mixed cerebral dominance, sinistrality, torque, and the predisposition to schizophrenia may share similar genetic antecedents, possibly involving a defect in the corpus callosum or its function, the corpus callosum being the major connection between the two cerebral hemispheres (Blau, 1977b). Torque is seen as being an external manifestation of a neural integrative deficiency which prevents the development of sufficient language, cognition, skill acquisition, and socialization during the developmental years. Experiential distortions and omissions result in an escalating developmental lag.

This lag may account for "...an adult pattern of extreme fear reactions, inability to think and communicate adequately, distortion, and the miserably poor quality of life so characteristic of the clinical syndromes of schizophrenia." (Blau, 1977b: p. 1003). Stress from environmental and social pressures would supposedly increase the probability of an eventual breakdown.

Blau's speculations about a corpus callosum dysfunction seem to be derived from the numerous associations between left-handedness, mixed cerebral dominance, and aberrant behaviour that he finds in the literature (Blau, 1977b). He suggests that "...clockwise turning represents right cerebral hemisphere dominance and counterclockwise turning primacy of the left cerebral hemisphere." (Blau, 1977a: p.29). Apparently it is

this inferred inappropriate reliance on the right hemisphere in left-handers and torquers that led Blau (1977b) to suggest a defect in the integration and transmission functions of the corpus callosum.

Blau (1977b) admits to serious methodological and base rate problems in his study. He is selective in reporting his data analyses. For example, he does not reveal what proportion of the subjects who were diagnosed as schizophrenic were left-handed, stating only that a phi coefficient for handedness versus schizophrenia was significant at about the .10 level (Blau, 1977b). The high incidence of torque among the schizophrenic subjects may have been due to a high incidence of left-handedness among them, as torque seems to be more prevalent in the left-handed population. His interpretation would be much stronger if all or most of the subjects were right-handed. Blau also fails to give a sex breakdown for the schizophrenic subjects.

Blau offers no evidence for the validity of his assumptions about the relationship between torque and hemispheric dominance other than the moderate correlation with handedness. He notes that studies comparing torque with direct measures of hemispheric activity have yet to be accomplished (Blau, 1977 a,b).

To date, there appears to have been only one other study of the relationship between torque and psychopathology. Kay (1979)

notes that the correlations Blau relies upon do not necessarily imply causality, and that his conclusions are neither necessary nor sufficient to explain schizophrenic etiology, since it has not been shown that there is any class of neurological defects necessarily linked to schizophrenia. In a study of a small, heterogeneous sample of psychotics, Kay failed to find evidence to support a neurological interpretation of torque. On the contrary, there was an inverse relationship between torque and organic involvement, and no significant relationship with soft signs of organicity (Kay, 1979). However, torque was found to be related to history of early childhood psychosis, perceptual-motor development, conceptual development, and maturity of positional orientation. Interestingly, 64% of the sample exhibited torque, which is twice as high as the population base rate of 30% projected by Blau (1977b).

Kay (1979) concludes that his findings are not inconsistent with the reports of torque being associated with abnormal adjustment and pathology, but that there is little support for neurological dysfunction being the common factor since the sources of abnormality could be multiple and exogenous. Kay's study offers little support for Blau's (1977b) specific interpretation of torque, but it does support the idea that torque may have value as a marker variable for identifying individuals at high risk for developing psychopathology. As Blau (1977b) notes, an accuracy of 21% in predicting schizophrenic

outcome compares favourably with the rates obtained in genetic studies.

Conjugate Lateral Eye Movements (CLEM)

In an interview situation, most people have a tendency to look away from the interviewer when they are asked a question. Day (1964) noted that as people begin to engage in reflective thought they tend to initiate their eye movements consistently in the same direction. Day was the first to characterize individuals as being either Right-movers or Left-movers, and he noted that there were psychological differences between the two types, with right-movers tending to experience anxiety as panic with an external cause, while left-movers experienced anxiety as tension with an internal base.

Duke (1968) verified that eye movements were characteristic for individuals, the direction being consistent approximately 85% of the time. Bakan and Strayer (1973), Etaugh and Rose (1973), and Libby (1970) assessed the reliability of CLEM over periods ranging from a few hours to two weeks and found moderately high correlations in the .70's. In a recent review, Ehrlichman and Weinberger (1978) concluded that CLEM patterns are reliable characteristics of persons.

It was Bakan (1969) who first suggested that the direction of a person's conjugate lateral eye movements was related to a

preference for the use of a particular hemisphere in the individual's cognitive and affective functioning. Bakan presented evidence from studies of electrical brain stimulation which showed that stimulation of certain sites in one hemisphere can cause conjugate lateral eye movements to the opposite (contralateral) side. Bakan suggested that the nervous system of the individual is organized in such a way that activity in the preferred hemisphere is facilitated either by lower latency, lower threshold, or greater strength of excitation. Bakan (1978) uses the term "hemisphericity" to denote the concept that individuals have a preference or bias towards activation of one hemisphere rather than the other. CLEMS are an indication of easier activation of the hemisphere that is contralateral to the direction of the eye movements, and are therefore seen to be an index of hemisphericity. Right-movers are therefore "left-brained" and left-movers are "right-brained" (Bakan, 1978).

There is a large body of literature dealing with functional asymmetries between the hemispheres. As Bakan (1978) notes,

...There is evidence of left hemisphere superiority in tasks involving grammatically organized word sequences, mathematics, analysis, logic, sequences over time, and motor coordination. Right hemisphere function seems dominant in tasks involving imagery, certain visual and constructive activities such as drawing, copying, assembling block designs, perception and manipulation of spatial relations of and between objects or configurations, and the simultaneous grasping of fragments or particulars as a meaningful whole. (p.163).

A logical extension of the evidence is that the two hemispheres have different modes of processing information, leading to different modes of consciousness and thought. The left hemisphere mode has been described as being linear, rational, symbolic, analytic, abstract, focal, propositional, secondary process, conceptual, digital, and logical. The right hemisphere mode has been described as being concrete, perceptual, analogue, passive, synthetic, holistic, iconic, diffuse, appositional, and primary process (Bakan, 1978; Bogen, 1977; Diamond and Beaumont, 1974; Kinsbourne and Smith, 1974; Nebes, 1974).

According to Bakan's model, right-movers should exhibit characteristics that correspond with the cognitive/emotive style of the left-hemisphere, and left-movers' characteristics should correspond with the cognitive/emotive style of the right hemisphere. The literature on the psychological correlates of CLEM direction has been reviewed elsewhere (Bakan, 1978; Ehrlichman and Weinberger, 1978). Despite certain inconsistent results which may be attributable to methodological problems, there is a fair amount of support for Bakan's typology, at least to the extent that reliable differences have been found between groups of right-movers and groups of left-movers. Some of the relevant findings are listed below.

In a clinical population, Day (1968) found a tendency for right and left movers to suffer from different types of

diseases, as well as a tendency for them to benefit from different types of psychotherapy.

Extending Day's (1964) findings regarding anxiety, Gur and Gur (1975) found that right-movers prefer the defense mechanisms of projection and outward turning of aggression, whereas left-movers are more likely to use denial, repression, or reaction formation, and are more likely to suffer psychosomatic symptomology.

Left-movers have been shown to have a greater susceptibility to hypnosis than right-movers (Bakan, 1969; DeWitt and Averill, 1976; Gur and Gur, 1974), and a greater amount of EEG alpha (Bakan and Svorad, 1969), which tends to be more abundant over the right hemisphere and is correlated with hypnotic susceptibility (Bakan, 1978).

Bakan (1969) found that right-movers had a relatively superior performance on the mathematics sub-test of the Scholastic Aptitude Test (SAT), and also that they preferred mathematics/science majors in university. These findings were replicated by Weiten and Etaugh (1973), who also found right-mover superiority on a concept-identification task that required verbal and analytic skills, and superior left-mover performance on a task requiring perceptual-spatial ability. They concluded that the pattern of differences between right and left movers that they had found was internally consistent with Bakan's model of the relationship between CLEM and cerebral

dominance (Bakan, 1978).

Gur (1975) has found that interviews in which subject and experimenter are seated face to face yield the most consistent results. Several studies have suggested that the content of the questions that the interviewer asks the subjects can bias the directions of the eye movements by requiring the functions of one hemisphere more than the other, as in verbal material questions versus spatially oriented questions (Galin and Ornstein, 1974; Kinsbourne, 1972; Kocel, Galin, Ornstein, and Merrin, 1972; Weitan and Etaugh, 1974 a,b). It has been shown, however, that the effect of question type is very weak when compared with the tendency of the individual subject to have consistent CLEM, which accounts for twice as much variance as question type (Bakan, Coupland, Glackman, Putnam, 1974).

Bakan et al, (1974) developed a set of "neutral" questions that did not show any tendency to influence eye-movement direction in a college population. This set of neutral questions was used in the second study to be described here.

B. Rationale for Study I.

Torque and CLEM

As mentioned earlier, the Torque test seems to differentiate between right-handers and left-handers, with a higher proportion of left-handers showing torque (65%) than right-handers (32%) (Blau, 1977a). One would be better off, however, using the absence of torque to predict handedness (rightness), rather than the presence of torque, due to the fact that a substantial number of right-handed people had torque in Blau's study, and the population tends to be roughly 90% right-handed. According to Blau's (1977a) data, using presence of torque to predict left-handedness would result in 32% of right-handers being mis-classified, or 125 subjects. Using absence of torque to predict right-handedness, 35% of left-handers would be mis-classified, or only 21 subjects. If we were only interested in accurately predicting right-handedness the base rate phenomenon would ensure that we could achieve 90% accuracy merely by classifying everyone as right-handed. Obviously there is something more involved in Torque than handedness, and something more involved in handedness than whatever it is that accounts for Torque.

Blau's data shows that 77% of the people who had torque were right-handed (Blau, 1977a). These right-handed people with torque had something in common with 65% of the left-handed people in Blau's study. One thing they have in common by virtue of being torquers is that they may have "...some degree of difficulty in developing and responding to the culture's requirements for cognition, language, motor motility, peer-group acceptance, and success/accomplishment." (Blau, 1977b). Compare that description of torquers with Hildreth's (1949) observation that

...inconsistent hand dominance, mixed laterality, delay or difficulty in establishing manual dominance, or conflicts due to efforts to change dominance in habituated skills can cause motor handicaps and serious difficulties in social adjustment. Resistance, negativism, stubbornness, tension, and nervous instability are observed in children who are late in establishing dominance or whose handedness has been partially converted. (p. 217).

So it seems that torquers, the majority of whom are right-handed, are subject to the same difficulties in adjustment as left-handers. Note that Blau defined torque as clockwise circling behaviour, which appears to be characteristic of left-handers (Blau, 1977a; Ilg and Ames 1972).

Several researchers have noted that this is a Right-handed world, in which the left-hander is handicapped and has difficulty achieving an optimum adjustment (Kovac and Horkovic, 1970; Hildreth, 1949). The development of lateral dominance, like the directionality of circle-drawing, follows a

developmental curve, and the maturing left-hander has to cope with an increasingly complicated and oppressive environment, with the result that symptoms of maladjustment tend to become exaggerated in the adolescent years (Hildreth, 1949). This is a plausible and acceptable explanation of the difficulties encountered by left-handers, but how does one explain Blau's similar poor prognosis for the majority of torquers who happen to be right-handed? These people seem to be susceptible to complaints that have been attributed to problems of laterality and cerebral dominance, and yet they appear to be normal, at least in terms of being right-handed. The possibility suggests itself that these people have a problem related to laterality and cerebral dominance that does not manifest itself in terms of handedness and is therefore less salient.

If we live in a right-handed world then it is also true that we live in a left-hemisphere world, for it is well known that the left hemisphere of the brain controls the right side of the body, while the right hemisphere controls the left. In addition, as Galin (1974) has noted, the left hemisphere "has preemptive control over the main stream of body activity as well as of propositional speech". Bakan (1978) sees the left hemisphere as critically moderating the output of both hemispheres, ensuring socially acceptable products. Modern society, with its sophisticated technologies, standard of living, and complicated lifestyles requires a consciousness

heavily weighted with left hemisphere adjectives such as linear, rational, digital, logical, and analytic. But as recent research on hemispheric asymmetry has shown, the right-hemisphere has its functions also, and it has been suggested that optimum functioning, both in terms of mental health and creativity, depends on the successful integration of hemispheric functions (Bakan, 1978; Bogen, 1977; Galin, 1974). As Bakan (1978) has suggested, "The two modes are antagonistic and complementary, suggesting that a unity and struggle of opposites is characteristic of mental functioning."

Recalling the literature on Conjugate Lateral Eye Movements, it seems that right-movers perform better on tasks that ostensibly tap functions of the left hemisphere, while left movers perform better on tasks that are purported to tap right hemisphere functions. These superior performances are presumably due to the predisposition to activate or utilize the appropriate hemisphere for the task. A predisposition to activate an inappropriate hemisphere results in an inferior performance relative to individuals who are predisposed towards the appropriate hemisphere. Regarding the CLEM literature, one will recall that left-movers report more psychosomatic symptoms and are more likely to resort to repression and denial (Gur and Gur, 1975); they react more strongly to persuasion (Sherrod, 1972); and they are more likely to be alcoholics, introverts, daydreamers, and asthmatic, although not all at the same time

(Bakan, 1971; 1978). Galin (1974) offers an explanation for the advantages that may accrue to right-mover/left-brained people:

As the left hemisphere develops its language capacity in the second and third years of life, it gains a great advantage over the right hemisphere in manipulating its environment and securing reinforcements. It seems likely to me that this is the basis for the left hemisphere's suzerainty in overt behaviour in situations of conflict with the right hemisphere. (p. 575).

Taking into account the earlier suggestion that we live in a left hemisphere oriented society, and Bogen's (1977) assertion that the Western educational system lacks balance through emphasizing left hemisphere skills, one might suggest that the right-movers, being left hemisphere oriented, would have fewer problems in adjusting and coping than left-movers, who would be more frequently "appealing to" or activating an inappropriate hemisphere.

The CLEM typology offers a possible explanation for the Torque phenomenon, in which torquers, the majority of whom are right-handed, are prone to problems which are held to be typical of left-handers. Earlier it was suggested that people with torque suffer from a condition related to laterality and cerebral dominance which does not necessarily manifest itself in hand preference. It may be that torquers have a problem with hemisphericity, in that they have a tendency to activate, or rely upon, an inappropriate hemisphere in their behaviours.

Hemisphericity, as defined in Bakan's (1978) model, shows no clear relationship with handedness as there appears to be

approximately an even split between right-movers and left-movers, although most of the studies conducted have eliminated left-handers because their behaviour appears to be less lateralized (Bakan, 1978). It is therefore suggested that right-handed torquers are prone to problems of adjustment by virtue of an inappropriate reliance on the right hemisphere in an environment which is left hemisphere oriented, resulting in problems similar in outcome to those experienced by left-handed persons. If this were true, one would expect a large percentage of torquers to be left-movers. Conversely, one would expect few right-movers to exhibit torque.

Study(I) was designed to investigate the relationship between Torque and CLEM direction in elementary school children, a sample chosen to permit comparison with the studies referred to by Blau (1977b). The following hypotheses were tested :

1. There are more left-movers than right -movers amongst subjects with torque.
2. A greater proportion of left-movers will exhibit torque than right-movers.

Left-handed subjects were excluded from the study because their small number complicates statistical analysis, and the resources available for the study were insufficient to obtain a representative sample.

C. Method

Subjects

The subjects of the study consisted of all the students in Kindergarten to Grade Three classes in an elementary school in the Lower Mainland of B.C.. The total number of subjects tested was 122, of which 5 were eliminated from the study because they were left-handed, and 20 were excluded because they failed to demonstrate a directional preference of eye movements. Of the remaining 97 subjects, 57 were male and 40 were female. Ages ranged from 53 months to 155 months. The sample was heterogeneous in terms of social and ethnic background.

Procedure

Subjects were interviewed individually, and were told that they would be given some tests which were in no way connected with their marks in school. They were given no hint as to the purpose of the study, but a number of them concluded that it had to do with handedness. As the school is an open area, the interviews were conducted in an area surrounded by storage cupboards. The interviews were conducted informally, and data

were collected on handedness, torque, CLEM, eye dominance, and eyelid motility. The data on eye dominance and eyelid motility were part of a separate study and will not be discussed here.

Each subject was seated directly opposite the interviewer, with a small table, 1 meter wide, in between. A blank, symmetrical wall was behind the interviewer. Subjects were asked to print their names on a piece of paper which then became the data sheet for that individual. A test for torque, modelled after the one described by Blau (1977b), was then administered. Subjects were asked to draw circles around three "X's", one at a time, which had been drawn on the data sheet. Subjects used a pencil which had been placed equidistant from either hand. The interviewer noted which hand was used to draw the circles, and recorded the number of circles drawn in a clockwise direction (his value was used to measure "amount" of torque). Subjects were then asked to repeat the task with the non-dominant hand.

An additional test of handedness was then administered, which consisted of the subject throwing a tennis ball to the interviewer over four trials. Subjects who used the left hand to print, draw circles on the initial torque test, or throw the ball were excluded from the study.

The subject's direction of CLEM was then determined by observing the direction of the eye movements immediately after the interviewer asked a question. Subjects were told that they were going to be asked some questions and that they should think

carefully about the answers.

Four questions were asked which had been suggested by Bakan (personal communication):

What is your favourite colour?

What did you do last night after supper?

Who is the smallest person that you know?

What is the hardest thing for you to do in school?

Movement in the same direction on three out of four questions was defined as denoting a preference for that direction.

After all the data had been collected, subjects were thanked for their cooperation and sent back to their classes. All data were recorded in code, and subjects were generally unaware of what was being observed and recorded.

D. Results

Table I shows the number of subjects with torque as a function of the direction of eye movements (CLEM). The majority of the subjects with torque were left-movers, and the incidence of torque was lowest among those subjects with Right CLEM.

TABLE 1
FREQUENCIES OF SUBJECTS WITH TORQUE
AS A FUNCTION OF CLEM. (N=97)

	LEFT	RIGHT	TOTAL
TORQUE	26	11	37
NO TORQUE	29	31	60
TOTAL	55	42	97

A Chi-square analysis of the data revealed that the proportion of Right-movers with torque (26%) was significantly different from the proportion of Left-movers with torque (47%) ($\chi^2 = 4.48$, $p < .05$). As a measure of association between CLEM and Torque, a phi coefficient was calculated to be .21. All chi-square values

reported are uncorrected for continuity.

70% of the subjects with torque were left-movers, whereas only 48% of the subjects with no torque were left movers. Overall, 38% of the sample exhibited torque.

Table 2 shows the frequencies of right and left movers exhibiting torque as a function of age.

TABLE 2
FREQUENCIES OF TORQUE FOR CLEM
AND AGE CATEGORIES. (n=97)

AGE	LEFT-NO TQ.	LEFT-TORQUE	RIGHT NO-TQ.	RIGHT-TORQUE
6	3	6	4	3
7	9	8	12	6
8	9	9	12	2
9	8	3	3	0
TOTAL	29	26	31	11

Chi-square analysis revealed that the relative frequencies did not vary significantly across age categories, ($\chi^2(9df) = 10.52$, $p > .25$), which suggests that it was legitimate to compare the proportions of right and left movers with torque pooled over age groupings.

Table 3 shows the frequencies of right and left movers with torque, broken down according to sex.

TABLE 3

CLEM VS. TORQUE BY SEX

MALES (N=57); FEMALES (N=40)

	LEFT	RIGHT	LEFT	RIGHT	TOTAL
TORQUE	16	5	10	6	37
NO TORQUE	16	20	13	11	60
TOTAL	32	25	23	17	97

The proportion of males with torque was 37%, whereas 40% of the females exhibited torque. For the males, 76% of the torque subjects were left-movers and 44% of the no-torque subjects were left-movers. A phi coefficient measuring the relationship between CLEM and torque was calculated to be .29, which was significant at the .05 level, $X^2(1df)=4.80$. Among the females, 63% of the torque subjects were left-movers, as compared to 54% of the no-torque subjects. Chi square for the females was not significant, $X^2(1df)=.27$, $p>.05$).

E. Discussion

The results of this study clearly indicate a relationship between the direction of conjugate lateral eye movements and torque. 38% of the sample exhibited torque. These subjects were all right-handed, yet they manifested a behaviour (clockwise circling) that is characteristically found in left-handed persons. This behaviour, torque, has been associated with a developmental lag (Blau, 1977; Ilg and Ames, 1972). Of these subjects with torque, 70% had left CLEM, which would suggest a tendency for people with torque to be Right-brained, according to Bakan's (1978) hemisphericity model. The percentage of right-movers with torque was 26%, compared to 47% for the left-movers, which suggests that whatever conditions are responsible for torque are more prevalent among left-movers. If Blau's (1977b) conclusions about torque are valid, the results of this study suggest that left movers are more likely to have problems adapting in life than are right-movers, and that left-movers are more likely to be at risk for schizophrenia, as determined by the high incidence of torque they exhibited.

Although males and females had a similar incidence of torque, 40% and 37% respectively, the relationship between CLEM and torque appears to be stronger among males; the direction of CLEM does not seem to be as much of a factor in the incidence of

torque among females, although the trend is in the same direction. This is consistent with the literature suggesting that the female brain is less functionally lateralized than the male brain (Bakan and Putnam, 1974; Hannay and Malone, 1976; McGlone and Kertesz, 1973).

There are two main methodological problems with this study. The direction of CLEM was measured using only four questions, which may have led to error in distinguishing right from left movers.

In addition, the method of determining handedness may have allowed converted left-handers and ambilateral subjects to be included in the study, which might have biased the incidence of torque. Attempts were made to control these possible sources of error in Study II.

Further discussion of the results of this study will take place in conjunction with the discussion of the results of the second study.

F. Rationale for Study II

Torque vs. CLEM and MMPI

Study II was designed to test if results similar to those of the first study would be found in an older sample, namely university students. In addition to examining the relationship between Torque and CLEM, data were gathered to test the validity of torque as a predictor of tendencies toward schizophrenia, as measured by the Minnesota Multiphasic Personality Inventory (MMPI).

The first study was conducted using kindergarten and elementary school children. Ames and Ilg (1951), Gesell and Ames (1946), Ilg and Ames (1972) and Blau (1977a,b) all agree that some degree of clockwise circling behaviour is normal in young children. This being the case, the presence of torque in the children's sample may not have been a pathological sign. The above authors are also in agreement that clockwise circling behaviour (torque) after the age of ten is abnormal and indicates immaturity, although the case is not clear for left-handers according to Ilg and Ames (1972). University students were therefore used as subjects in the second study, on the grounds that the presence of torque would be a more critical

sign in an older and theoretically more mature sample.

Assuming that the presence of torque in a mature sample is a critical sign, one would expect torque to be correlated with high scores on the Schizophrenia (Sc) scale of the MMPI. The MMPI is the most widely used and researched instrument for objective personality assessment. The MMPI can be used to identify a range of psychopathology that meets the Research Diagnostic Criteria in non-hospital settings such as university campuses. (Haier, Rieder, Khouri, and Buchsbaum, 1979). High scores on MMPI scales (i.e. T-scores over 70) suggest psychological difficulties, and extreme scores often indicate serious psychiatric problems (Haier et al, 1979).

Fine (1973) used the MMPI to identify "non-psychotic" schizophrenia in a college setting. He used a 3-point code system to identify subjects whose MMPI profiles were characterized by elevation on Scales 2, 7, and 8, which are depression, psychasthenia, and schizophrenia, respectively. Dworkin and Widom (1977) suggest that the MMPI can be used in this fashion to identify and study subclinical samples, such as the schizoid or schizotypic personality.

In a longitudinal study, Hathaway, Monachesi, and Salasin (1970) found that ninth-grade students with high Sc scale profiles had lower high school performance, completed less schooling, and had lower socioeconomic status by age 25 than their peers who had normal profiles. Dworkin and Widom (1977)

concluded that MMPI profile types indicative of subclinical schizophrenia (i.e. Sc scale the highest or second highest elevated score) are sensitive to underlying predispositions to adverse social outcomes in a college sample.

In view of criticisms regarding the traditional interpretations of individual MMPI scales, Hedlund (1977) reviewed and compared seven independent studies of the behavioural or symptom correlates of the individual MMPI scales. He concluded that there was consistency in the behavioural or symptom correlates for the individual scales, and that the correlates tended to provide considerable construct validity for traditional interpretations. However, he also noted that the significant relationships found were usually of a low order of correlation, and that it is difficult to obtain unique discrimination from the use of single scales (Hedlund, 1977).

Admittedly, a high score on the Sc scale is not sufficient to predict a specific diagnosis of schizophrenia: such diagnoses generally require that several criteria be met. However, high scores on the Sc scale presumably indicate degree of similarity with patients who demonstrate bizarre and unusual thoughts or behaviour, and in fact, such scores are significantly correlated with hallucinations, formal thought disorder, unusual thought content, inappropriate affect, peculiar mannerisms, bizarre behaviour, psychomotor retardation, confusion, withdrawal, and detachment (Hedlund, 1977). Accordingly, it seems reasonable to

interpret high Sc scale scores as being characteristic of a subclinical, schizotypic personality, and indicative of some psychological difficulty. (Dworkin and Widom, 1977; Haier et al, 1979) .

If, as Blau (1977b) suggests, children who exhibit torque after age five are prone to a developmental lag which impedes competence and adjustment, one would expect evidence of a relationship between psychological problems and torque in adulthood.

Additionally, if torque is indicative of a predisposition or high risk for the development of schizophrenia, one might expect psychological difficulties to be manifested by elevation of the Sc scale on the MMPI.

Several hypotheses were therefore generated. Comparing MMPI profiles, subjects with torque should tend to have higher scores on the Sc scale than subjects without torque. More particularly, subjects with torque should be more likely to have elevated Sc scores than subjects without torque, elevation being defined as greater than or equal to a T-Score of 70, which is 2 standard deviations above the standardized mean and suggestive of psychological difficulties. (Haier et al, 1979) .

Finally, if torque and its related problems are correlated with a bias for right-hemisphere (Left CLEM) activation as suggested in Study I, subjects with torque and Left CLEM should have the highest incidence of Sc scores greater than or equal to

70.

G. Method

Design

In order to get a clearer picture of the relationship between torque and CLEM, it was decided that equal numbers of right and left movers would be desirable, as they are thought to be represented fairly equally in the population (Bakan, 1978). Sex was balanced also. Strict criteria were established for determining CLEM and handedness, and only right-handed subjects were included in the study. Scores on the Sc (Schizophrenia) scale of the MMPI represented an additional variable.

Subjects

Subjects were undergraduate students in Psychology courses who had been solicited during lectures and tutorials at Simon Fraser University. Out of a pool of 95 volunteers, 56 subjects were sequentially selected according to the criteria described in the procedure section. Fourteen subjects were assigned to each of 4 combinations of CLEM and Sex: Right CLEM/Male, Right CLEM/Female, Left CLEM/Male, Left CLEM/Female.

Materials

To control for possible effects of question-type on direction of CLEM, and to minimize error in differentiating between right and left-movers, a set of 20 "neutral" questions developed by Bakan, Coupland, Glackman, and Putnam (1974) were used to elicit eye movements. These questions were shown not to elicit a systematic tendency to CLEM in either direction in a sample of right-handed subjects similar to those used in this study (See Appendix A).

A modified version of the Annett handedness questionnaire was used to select right handed subjects. Twelve items are scored on a 5-point scale ranging from "always left" to "always right", which produces scores on a continuum from -24 to 24. A score greater than or equal to plus 9 is interpreted as indicating right handedness. (Nebes and Briggs, 1975).

Subjects were administered the complete version of the Minnesota Multiphasic Personality Inventory (MMPI-Form R), and scores were computed using the materials provided by the Psychological Corporation.

Procedure

Subjects were recruited on the pretext of participating in a study of laterality and personality characteristics. They were told that measures of laterality, response patterns, and personality would be taken. Subjects were informed ahead of time that interpretation of specific individuals' test results would not be made available, but that subjects would be given access to a copy of the study's results after its completion. A coding system was used to protect the identity of subjects, and confidentiality of information was guaranteed.

The study was conducted over two sessions. The first session, during which the screening took place, lasted for ten to fifteen minutes. Subjects were tested individually, in a 9 ft. by 9 ft. windowless room with symmetrical, gray, concrete walls. The room had been chosen because it offered subjects a symmetrical field of vision, so as not to bias the direction of eye movements through distracting stimuli.

The direction of CLEM was first assessed, using the set of questions devised by Bakan et al (1974), which presumably stimulated thought, thereby eliciting eye movements. The first eye movement after completion of the question was scored with reference to a clock face, such that positions of 1,2,3,4 and 5 were left movements, 7,8,9,10 and 11 were right movements, and 6 and 12 represented an invalid trial. Vacant stares, closed eyes,

and looking away before the end of the question were also scored as invalid trials. Consistent CLEM subjects were defined as those who made valid responses to 75% of the questions, with at least 70% of these responses in the same direction, either right or left. Only consistent subjects were retained for the second phase of the study. Subjects were seated at a small table, (1 meter sq.), directly across from the interviewer, who took care to maintain a steady gaze, so as not to bias the subjects eye movements through the direction of his own. Care was taken to appear to be merely checking off the questions so as not to alert the subject to what aspect of behaviour was being recorded.

The handedness questionnaire was administered next; a score of at least 9 defined right-handedness. Only right-handed subjects were retained for the second phase of the study.

A modified version of Blau's (1977a) Torque test was then administered. As Blau admits that only the circling task is scored in determining torque, it was decided that the copying and signature tasks could be dispensed with. Each subject was presented with a piece of paper with three X's inscribed upon it and asked to draw a circle around each of the X's, with the right hand. The interviewer noted and recorded the number of clockwise circles. The process was repeated for the left hand, on a separate piece of paper.

Data on eyelid motility and the Muller-Lyer illusion were also collected, as part of a separate study. As the procedures involved in collecting this data could in no way have biased the results of this study, they will not be reported here.

The data on CLEM and handedness were scored immediately, and subjects who failed to meet the criteria for these variables were thanked for their cooperation and informed that no further participation would be required.

Subjects who met the criteria for CLEM and handedness were given an appointment to return and complete the MMPI under supervision. This procedure was continued until there were 14 subjects for each combination of CLEM and Sex.

All of the subjects wrote the MMPI within a week of their initial screening, and were again assured of confidentiality before the administration of the test. Subjects were debriefed in such a way as to avoid giving them information which might confound the results if passed on to other subjects.

The MMPI answer forms were scored by hand, and converted to T-scores, which were corrected for 'K', which is one of the validity scales. None of the subjects had validity scale scores high enough to invalidate the profiles obtained.

H. Results

Torque by CLEM

There was little difference in the overall frequencies of torque between the elementary school sample (38%) and the university sample (41%). Table 4 shows the incidence of torque according to CLEM by Sex groups.

TABLE 4

Sex by CLEM by Torque Frequencies

(N=56)

	Left CLEM		Right CLEM		Total
	Males	Females	Males	Females	
Torque	7	8	3	5	23
No Torque	7	6	11	9	33
Total	14	14	14	14	56

There was a lower incidence of torque in males than females, 36% vs. 46%, but this difference was not significant. Separate chi-square analyses of the torque by CLEM relationship

were performed for each sex.

For the males, 70% of the torque subjects were left-movers, whereas only 39% of the no-torque subjects were left-movers. The phi coefficient for strength of association was .30, but this was not significant, ($X^2(1df)=2.48$, $p<.15, >.10$). The corresponding phi coefficient in the elementary school sample was .29.

Among the females, 62% of the torque subjects were left-movers, whereas 40% of the no-torque subjects were left-movers. A phi coefficient of .21 was not significant, ($X^2=1.29$, $p>.20$).

As the differences between the sexes were not significant, the data were collapsed over Sex to yield Table 5.

TABLE 5
Torque by CLEM Frequencies (N=56)

	Left CLEM	Right CLEM	Total
Torque	15	8	23
No Torque	13	20	33
Total	28	28	56

The incidence of torque among left-movers was 54%, compared with 28% for the right-movers. 65% of the torque subjects were left-movers, as opposed to 39% of the no-torque group.

Chi-square with 1 df was calculated to have a value of 3.62, with a probability level of .07. The phi coefficient, as a measure of correlation, was calculated to have a value of .25. The corresponding phi for the first study had been .21. Table 6 compares the proportions of torque for Right and Left-movers across the two studies.

TABLE 6

Comparison of percentages of Right and Left-movers with Torque across Studies I and II.

	Study I (N=97)	Study II (N=56)
% of Right-movers		
with Torque	26%	28%
% of Left-Movers		
with Torque	47%	54%
% of Torque subjects		
who were		
Left-movers	70%	65%

The percentages for the two studies are fairly similar, with Study II showing a slightly higher incidence of torque among the Left-movers, which is reflected in the slightly higher phi coefficient for the Study II data.

Left-hand Torque Vs. Right-hand Torque

Torque was exhibited more frequently in circles drawn with the left hand than circles drawn with the right. 14 subjects had torque with the left hand only, 6 subjects had torque with both hands, and 3 subjects had torque with the right hand only. An analysis by CLEM would not be meaningful because of the small number of right-movers who had torque. Males were more likely to have torque in both hands, 5 males vs. 1 female; females were more likely to have left-hand torque only, 9 females vs. 5. All 3 of the subjects who had torque only with the right hand were female.

Torque and The MMPI

All of the MMPI data was subjected to a discriminant function analysis in order to determine if the profiles for Torque versus No-Torque subjects were sufficiently different to warrant investigation of individual scales. Version H, Release 7.2 of SPSS was used to conduct the analysis (Nie, Hull, Jenkins, Steinbrenner, and Bent, 1975). A direct solution method was used which enters all variables into the solution concurrently. The analysis provided a set of discriminant function coefficients for the scores on the MMPI scales, which when combined in an equation yielded maximum discrimination

between the Torque and No-Torque subjects. Table 7 shows the standardized and unstandardized coefficients for the MMPI Variables.

TABLE 7
Summary of Discriminant Function Coefficients
For separating Torque from No-torque Groups

MMPI Scale	Standardized	Unstandardized
L	-.23543	-.02795
F	.20034	.02874
K	.62366	.07032
Hs	-.40047	-.04589
D	-.07873	-.01123
Hy	.31692	.04731
Pd	-.20489	-.02777
MF	.41863	.03299
Pa	.23384	.02723
Pt	-.26303	-.04156
Sc	-.57380	-.05530
Ma	.47216	.05375
Si	-.03762	-.00594
Constant		-2.74407

Disregarding the sign, these coefficients can be interpreted as representing the relative contribution of the variable to the discriminating function. A classification

analysis was performed, combining each subject's MMPI scores and the discriminant coefficients to predict whether the subject belonged to the Torque or No-Torque group. Table 8 presents the results of this analysis.

TABLE 8
Prediction Results for Group Membership

Actual Group	No. of Cases	Predicted	Predicted
		Torque	No Torque
Torque	23	19 (83%)	4 (17%)
No Torque	33	3 (9%)	30 (91%)

Total percentage of subjects
classified correctly: 87%

As Table 8 shows, analysis of the MMPI profiles allowed a fairly high degree of discrimination between Torque and No-Torque subjects, with 87% of all subjects being classified correctly.

Means, standard deviations, and the results of between group comparisons of the means for the MMPI scales appear in Table 9.

TABLE 9

Means, SDs, and F-ratios For Between-Group
Differences on MMPI Scales: Torque vs. No-Torque

Scale	Torque (N 23)		No Torque (N 33)		F	P
	Mean	SD	Mean	SD		
L	45.69	11.51	46.31	5.42	.07	NS
P	56.48	7.64	53.66	6.30	2.24	NS
K	52.56	8.60	57.71	8.55	4.84	.05
Hs	60.39	8.26	55.53	8.61	4.41	.05
D	58.52	5.27	56.81	8.03	.79	NS
Hy	59.34	6.68	59.25	6.82	.003	NS
Pd	62.65	8.21	60.49	6.71	1.14	NS
MR	50.52	12.98	55.91	12.18	2.47	NS
Pa	58.56	8.67	55.49	8.43	1.73	NS
Pt	61.48	5.91	56.21	5.75	10.94	.005
Sc	66.57	8.74	56.62	9.52	15.60	.001
Ma	64.70	11.67	65.84	6.10	.23	NS
Si	53.17	6.13	49.78	6.17	4.06	.05

Note: All scores corrected for K.
All tests were univariate Fs with 1 and 54 df,
and were obtained as part of the output of the
SPSS Discriminant Analysis Program.

An analysis of Table 9 reveals that the Torque and No-Torque groups had significantly different mean scores on 5 MMPI scales. The Torque group scored significantly higher on the Hs, Pt, Si, and Sc scales, and significantly lower on the K scale.

Given the significant discrimination between the MMPI profiles of Torque and No-Torque subjects, further investigation of the Sc scale scores seemed warranted. A $2 \times 2 \times 2$ ANOVA was conducted on the Sc scale data, using Torque, CLEM, and Sex as the factors. Table 10 provides the means, standard deviations, and number of subjects for each group.

TABLE 10
Means, SDs, and Ns For Torque by CLEM BY Sex
Groups on Sc scale

		Left CLEM		Right CLEM	
		Male	Female	Male	Female
Torque	Mean	72.57	64.87	66.00	61.20
	SD	2.42	12.26	4.36	5.97
	N	7	8	3	5
No Torque	Mean	59.42	55.83	57.09	53.33
	Sd	9.70	11.08	6.98	9.30
	N	7	6	11	9

As can be seen in Table 10, subjects with Torque had the highest scores at all levels of CLEM and sex; subjects with Left CLEM had the highest scores at all levels of Torque and Sex, and male subjects had the highest scores at all levels of Torque and CLEM. Male subjects in the Left CLEM/Torque group had the highest mean of all, 72.57, with the smallest standard deviation, 2.42. To test for main effects and interactions,

F-ratios were obtained through the SPSS (Release 7.2) ANOVA program, using the Classical approach.

None of the tests of interaction yielded an F-ratio greater than 1, which facilitates interpretation of the main effects. The main effect for sex was significant at the .048 level ($F(1,48)=4.12$), and the main effect for Torque was significant beyond the .001 level, with $F(1,48)=14.68$. The main effect for CLEM was not significant, $F(1,48)=1.87$, $p=.18$.

To test which combination of factors yielded the highest incidence of elevated SC scores (greater than or equal to 70), proportions were calculated for each of the cells, as shown in Table 11.

TABLE 11
Frequencies of Elevated Sc Scale Scores
For Torque by CLEM by Sex Groups.

N=56

	Left CLEM		Right CLEM	
	Male	Female	Male	Female
Torque ≥ 70	6	5	1	1
≤ 70	1	3	2	4
No-Torque ≥ 70	1	1	0	0
≤ 70	6	5	11	9

Male and female Left-movers with Torque had the highest frequencies of elevated Sc scores, 6 out of 7 and 5 out of 8 respectively, while none of the Right CLEM subjects in the No-Torque cells had elevated scores.

The data in Table 11 were collapsed over Sex so as to facilitate an Elevation by Groups comparison (2 x 8), and a Chi-square analysis was conducted to see if the proportions differed significantly across Torque by CLEM groups. The value of chi-square with 7 df was found to be 26.63, which was significant beyond the .001 level. The Contingency coefficient

for this comparison was calculated to be .57, which suggests a moderately strong degree of association.

Because the chi-square analysis provides limited information about the nature of possible interactions, an analysis of variance ($2 \times 2 \times 2$) was conducted after performing an arc-sine transformation on the proportions for each cell. The F-ratios for all of the interactions and the main effect for Sex had values less than 1. The main effect for Torque was significant at the .005 level, $F(1,7)=17.50$. The F to test the effect of CLEM was significant at the .02 level, $F(1,7)=10.31$. The error term used for all comparisons was an estimate obtained by taking the reciprocal of the number of subjects in each cell, then summing the reciprocals across all cells and dividing by the number of cells.

I. Discussion

A relationship between torque and CLEM direction has been found in two studies, one with elementary school children and one with university students. All of the subjects in both studies were right-handed. These studies show a positive relationship between the existence of torque and the tendency to move the eyes to the left upon initiating reflection.

The close similarity between the studies, in terms of incidence rates and proportions, suggests that the failure of the torque/CLEM relationship to reach significance at the .05 level in the university sample ($p=.07$) was due to the reduced sample size, which lowered the value of chi-square. It should be noted that the strength of association, as measured by the phi coefficient, was slightly greater in the university sample. The relationship could be considered to be significant using a one-tailed test, which is arguably justifiable, considering the predicted direction of the relationship, and the prior confirmation of the predicted direction in the first sample.

The sex difference in the relationship between torque and CLEM which had been suggested by the data from the first study was not confirmed in the second study. If such a difference exists, and the literature would seem to predict it (cf Bakan, 1978), a fairly large sample size may be required to detect the

relationship.

There was a clear difference between the torque and no-torque groups in a number of the scales of the MMPI, with significant differences (.05 or better) on the K, Hs, Pt, and Sc scales. Even for the scales which did not significantly differentiate the torque from the no-torque group, the direction of the differences was suggestive of greater pathology in general for the torque group.

On the basis of the MMPI profiles, discriminant function procedures led to successful prediction of torque vs. no-torque group membership for 87% of the subjects. However, the true value of the discriminant function obtained would be better be assessed by applying the unstandardized discriminant coefficients to the MMPI scores of subjects from an independent sample, and then checking the accuracy of classification.

Of all the MMPI scales, the largest and most significant (.001) difference between the torque and no-torque groups was found on the Sc scale, thus confirming the prediction based on Blau's work of a relationship between torque and tendency toward schizophrenia. This finding extends the work of Blau, since the relationship between torque and Sc scores was found for apparently normal, functioning university students. A significant sex difference was found, with male subjects tending to have higher Sc scores than did the females, but this difference had not been specifically hypothesized.

In a subsequent analysis of elevated Sc scores (greater than 70), it was found that 13 of the 15 subjects with elevated scores had torque. In addition, 13 of the 15 subjects with elevated scores consistently produced left CLEM. Sex was not a significant factor in the distribution of elevated scores.

The data seem to support the hypothesized relationship between torque, left CLEM, and high scores on the Sc scale of the MMPI. 56% of the subjects in the torque group had Sc scores of 70 or above, whereas only 6% of the no-torque subjects had elevated scores. If elevation on the Sc scale is indicative of a tendency to have psychological problems, the data lend considerable support to Blau's (1977b) hypothesis that the torque test has predictive validity in identifying a population that is at risk for developing serious psychological problems such as schizophrenia.

The data also seem to offer some support for the theory that torque is somehow related to hemispheric factors. The majority of subjects with torque were left-movers, which, according to Bakan's (1978) model, indicates a preference among those subjects for right hemisphere activation. However, a hemispheric model does not readily account for the presence of torque in right-movers, who are theoretically left-brained.

A highly speculative explanation might be that right-movers with torque are individuals who have somehow resolved their hypothesized hemispheric imbalance, but have retained the habit

of drawing circles in a clockwise direction. As Blau (1977b) notes, not all children with torque have problems, some of them seem to develop exceedingly well. An explanation for this may be related to the differences between right-movers and left-movers, with right-movers having an easier time adapting to our left-hemisphere oriented society. This explanation assumes that torque is indicative of an underlying deficit that generally results in a right hemisphere bias, but less severe deficits may not prevent an individual from achieving a supposedly more adaptive left hemisphere bias.

It is important to be cautious against over-interpreting the significance of the direction that one draws circles in. Blau (1977a,b) has defined torque as the drawing of circles in a clockwise direction, and he has suggested that this represents a dominance of the right cerebral hemisphere, while the counter-clockwise direction represents left hemisphere dominance. However, it is premature to interpret the direction of circling itself as being controlled by one hemisphere or the other. Torque, after all, is a drawing behaviour, and there is evidence to suggest that it is a learned habit, subject to the influence of educational practices and the development of reading and writing preferences. Dremar (1977) studied directionality of drawing horizontal lines in English and Hebrew readers, Hebrew being read and written in a right-left direction, which is opposite to English. He concluded that

left-handers' directionality was influenced by the direction that their languages are written in, whereas right-handed subjects in both language groups tended to draw lines in a left-right direction.

Recalling that torque seems to be characteristic of left-handers, and that torquers are similar to left-handers in a number of other characteristics (Blau, 1977a,b), one might speculate that persons with torque are influenced by the direction that their language is read and written in. The subjects in the two studies reported here were English-speaking. English is written from left to right; circling in a clockwise direction requires a left-right motion. If the similarities between torquers and left-handers are more than coincidental, Dreman's (1977) findings would suggest that torque is influenced by the direction of the script. It is difficult to deduce why this might be so, and one can only wait for additional evidence to clarify the issue.

Noting that the subjects of the two studies presented here were English-speaking, and that the characteristics of a language's script may possibly influence directionality in drawing behaviours (including torque), one must consider whether or not torque is a stable phenomenon across cultures.

Goodnow, Friedman, Bernbaum, and Lehman (1973) suggest that "...inferences from natural behaviours to natural sources may be misleading unless more than one culture is considered." (p.

278). Goodnow et al studied the directional characteristics of the English and Hebrew scripts and found some common developmental trends, but they also found some important differences, one of them being the way circles are drawn: Israeli children are taught to draw circles in a clockwise direction, and show no developmental trend to draw circles in a counter-clockwise direction. This finding is contrary to the findings for English-speaking children reported by Ilg and Ames (1972) and Blau (1977b). Using Blau's definition, approximately 80% of the Israelis would exhibit torque. The author is aware of no reports of greater developmental problems or higher risk for schizophrenia in Israelis, and one therefore has to question the importance that Blau (1977a) attaches to the specific direction that circles are drawn in. The meaning of the torque response is thus likely to be different in the English and Israeli cultures.

These considerations lead to the testable hypothesis that, in an Israeli sample, a preference for counter-clockwise circling will be associated with elevated scores on the schizophrenia scale of the MMPI. A positive finding in such a study would strengthen the argument that torque should be defined as circling behaviour that is contrary to cultural norm, rather than in terms of a specific direction such as clockwise. As Hildreth has suggested,


"The apparent ease of writing from 'left to right' as opposed to 'right to left' direction in ~~native~~ writers may be due more to training and practice than to any

inherent difficulty in the direction." (quoted in Ames and Ilg, 1951:40).

As there were no significant interactions the results from this study suggest that the effects of Torque and CLEM are additive, at least with regard to elevation of the Sc scale of the MMPI. One has to wonder about the causal pathway involved in the relationship between these two variables. If the hemispheric activation model of CLEM (Bakan, 1978) is valid, and Torque is related to Right-brainedness, the possibility of one or more common etiological factors suggests itself. Blau's (1977b) suggestion of a genetic factor in torque does not preclude the possibility of neurological insult due to perinatal stress having similar results.

Bakan, Dibb, and Reed (1973), among others, have suggested a relationship between handedness, birth stress, and neurological insult to the left hemisphere, which seems to be highly sensitive to trauma. Right-handed subjects with Left CLEM tend to exhibit Torque, which is a characteristic behaviour of left-handed people. It may be that there are "pathological" left-movers who have suffered some neurological insult that is not serious enough to affect their handedness, but biases them towards right hemispheric activation by virtue of dysfunction in either the left hemisphere or the corpus callosum.

The relationship between Torque, Left CLEM, and elevated Sc scores takes on added significance in view of the growing



evidence suggesting dysfunction of the left hemisphere and corpus callosum in schizophrenia. Flor-Henry (1974, 1976) has summarized much of the evidence, noting that neuropsychological tests do not discriminate very well between brain-damaged and chronic schizophrenic samples. Rosenthal and Bigelow (1972) reported that the corpus callosum was 18% thicker in schizophrenic brains when compared to controls. Laitinen (1972) reported a reduction of symptoms in schizophrenics after partial commissurotomy. Gur (1977) reported that schizophrenics were significantly different from normals on tests of laterality. Greenberg (1979) summarized the recent research on structural abnormalities in the brains of schizophrenics, and concluded that the research offered

"...some of the strongest evidence yet that certain types of schizophrenia may be linked to slight but significant deviations in brain structure." (p. 116).

Abnormalities involving the cerebral ventricles, mirror-image hemispheric asymmetries, thicker corpus callosums in early-onset schizophrenics compared to late-onset, wider Sylvian fissures, and differences in certain sulci have been found (Greenberg, 1979). Some of the most interesting research has been reported by Daniel Weinberger, of the National Institute of Mental Health, who found parts of the cerebellar vermis to be atrophied in some schizophrenic brains. The vermis is located between the cerebral hemispheres and is linked anatomically and functionally to parts of the limbic system that

have been implicated in schizophrenia. Of special relevance to the discussion of this study is the fact that lesions of the vermis in rats result in increased production of the neurotransmitter 'dopamine' in the limbic system, a condition which is integral to one of the major explanatory theories of the etiology of schizophrenia, (Greenberg, 1979).

Of special interest are several studies which compared right and left hemisphere brain-damaged subjects on scores of the MMPI. Black (1975) compared the mean profiles of left damaged patients with those right damaged patients, and found that the left damaged group had significantly higher elevation of the Sc (schizophrenia) scale and that their mean profile characterized by increased depression, paranoid ideation, and deviant thinking. All scales for the right damaged group were within the normal range. Gasparrini, Satz, Heilman, and Coolidge (1978) found that left damaged subjects had a greater number of scores in the pathological range (over 70). The left damaged group had the highest scores on the Sc scale but the difference between groups was not significant. Louks, Calsyn, and Lindsay (1976) found that patients with left hemisphere dysfunction tended to score in the psychotic range on the Goldberg Index of the MMPI, while right dysfunction patients scored in the neurotic range.

Conclusions

A summary seems to be in order. Individuals tend to exhibit a bias for attending to the world in either a left hemisphere mode or a right hemisphere mode. This may be determined genetically, or by subtle neurological insult, or perhaps by education. Ours is a left-hemisphere society: people who rely inappropriately upon the right hemisphere are likely to experience difficulties in adapting. Torque seems to be a marker variable for individuals who have difficulty in adapting to social and cultural norms of behaviour, and who experience a developmental lag, presumably as a result of some neurological deficit. Such persons are likely to experience psychological difficulties, which may be related to a tendency to rely upon the right hemisphere. A tendency to rely upon the right hemisphere implies an integrational deficit and/or left hemisphere dysfunction. There is growing support for a relationship between schizophrenia and abnormalities involving the left hemisphere and the corpus callosum. Torque and right-brainedness (left CLEM) seem to be of value in predicting schizophrenic tendencies. To a certain extent, torque and right-brainedness may share the same, or similar, antecedents.

However, it seems likely that Torque and CLEM are separate phenomena, otherwise the pattern of means obtained in the data would have been different. A group of right-movers can be expected to have perhaps a 28% incidence of Torque. A comparable group of Left-movers is bound to have a higher incidence because

it has two possible sources of Torque: the hypothesized neural integration deficit, and the consequential psychological problems due to being right-brained in a left-brained society. Accordingly, one would expect the groups to be ranked on level of adjustment as follows (from best to worst): Right CLEM/No Torque, Left CLEM/No Torque, Right CLEM/Torque, Left CLEM/Torque. This is exactly the pattern of means that was obtained for the Sc scale data. The Torque factor (whatever it is) has a greater weight than CLEM, and the Left-CLEM/Torque group can be expected to have the poorest adjustment due to the two sources of psychological difficulty.

The Torque factor may be tapping the overall level of psychological difficulties, while the CLEM factor may be measuring the weakness of the left hemisphere, which is consistent with the relationship between left hemisphere dysfunction and schizophrenia that was postulated earlier.

There are numerous possibilities for alternative interpretations of the data regarding Torque, CLEM, and the Sc scores, if one wishes to argue about the validity of the CLEM model or the speculative existence of the neural integrative deficit. The results are clear, however, to the effect that some sort of deficit exists, neural or otherwise, which is manifested in the increased deviance found in the personality profiles of subjects with torque.

Modifying the educational curriculum to include a right-hemisphere orientation might alleviate some of the problems to which children with Torque, Left-CLEM, or learning disorders may be prone. Presentation of learning materials in an appropriate cognitive mode could be beneficial. On the other hand, perhaps intensive remedial training in a left-hemispheric mode is necessary to restore, or provide, a cognitive balance. Williams (1978) reports that dyslexics improve academically and behaviourally when they are taught to listen with the right ear, whereas normally they show a left-ear superiority, which is contrary to the general population.

Integration is the key-word. Each hemisphere must have access to the other and be able to process the input appropriately. Acquiring such integration would seem to be an important step in minimizing risk and vulnerability, as suggested by the fact that those subjects with Right CLEM and no torque showed the least evidence of schizophrenic tendencies.

Suggestions for Future Research

The design of the study could be improved, depending on what questions were being asked of the data. The number of subjects in the torque and no-torque cells had been purposefully left free to vary according to the population parameters. However, the unequal n's may have led to violations of the

assumptions made in carrying out the F-tests.

The sample size could and should have been bigger to ensure enough power for the statistical investigations. There were no obvious sources of systematic error in the design or procedures. University students tend to score higher on the MMPI than other subjects, but this could not have affected the between group differences.

Scores should be analyzed with and without the 'K' correction, as the correction factor tended to narrow the separation between groups. The Sc scores can not be used to claim that one group was more schizophrenic than the other. An alternative phrasing might be "...answered significantly more items in a fashion similar to schizophrenics."

An obvious direction for future research is to follow a group longitudinally to see how the relationship between CLEM and Torque changes over a wide age range. Factor analyses of various other personality measures and laterality measures should be made so as to see where Torque and CLEM would load on the factors. Clinical populations need to be sampled and cross-cultural comparisons conducted. Perhaps most importantly, some direct measure of hemispheric activation should be used to confirm these results.

J. Appendix A

The 20 neutral questions used to elicit eye movements:

1. What is the meaning of the proverb: A watched pot never boils?
2. What is the meaning of the proverb: It is an ill wind that blows no one good fortune?
3. Make up a sentence using two forms of the same verb.
4. Tell me two verbs beginning with "N."
5. What is the meaning of the proverb: A poor worker blames his tools?
6. Spell "therapeutic."
7. What is the meaning of the proverb: Call no man happy till he's dead?
8. List two adverbs.
9. What is the meaning of the proverb: Lend your money and lose your friends?
10. What is the meaning of the proverb: More than enough is too much?
11. List two prepositions.
12. What is the meaning of the proverb: Words should be weighted not counted?
13. What is the meaning of the proverb: He is rich who has few wants?
14. Define inflation.

15. What is the meaning of the proverb: A rolling stone gathers no moss?
16. Make up a sentence using two adverbs.
17. Tell me two verbs beginning with "R."
18. What is the meaning of the proverb: The hardest work is to go idle.
19. What is the meaning of the proverb: What saddens the wise man, gladdens a fool?
20. Define the word economics.

K. Appendix B

MMPI and Torque Scores for all Subjects

	S#	TQ	L	F	K	HS	D	HY	PD	MF	PA	PT	SC	MA	SI
FEMALE LEFT MOVERS															
	1	2	40	55	57	59	60	52	64	52	68	67	70	63	51
	2	6	47	54	44	60	55	64	66	44	70	65	75	61	60
	3	0	47	68	42	44	63	64	71	51	73	66	77	72	54
	4	3	56	62	47	52	55	60	53	38	56	60	74	70	52
	5	0	40	48	49	58	47	59	53	47	53	51	54	73	52
	6	0	43	55	62	68	47	57	69	47	50	48	47	70	44
	7	2	56	44	63	58	57	63	54	45	38	57	60	43	56
	8	0	63	64	48	56	73	57	53	49	70	56	54	73	58
	9	2	40	73	38	62	59	63	84	43	62	66	75	78	65
	10	0	43	53	46	44	46	50	55	49	47	55	47	53	58
	11	3	50	53	53	57	59	52	50	47	59	66	51	58	56
	12	0	50	53	59	53	44	57	60	51	50	53	56	63	46
	13	3	53	60	42	58	49	61	64	34	59	45	43	70	50
	14	3	40	55	42	72	53	63	62	34	67	69	71	83	61
MALE LEFT MOVERS															
	15	0	43	68	44	39	69	46	57	80	53	54	61	75	53
	16	0	53	62	63	70	57	73	57	73	65	56	65	63	44
	17	3	56	55	46	70	60	58	67	51	65	64	73	89	48
	18	6	0	68	49	65	65	53	57	63	53	73	76	55	56
	19	0	40	48	61	52	47	53	64	61	53	52	56	70	52
	20	0	40	55	48	49	51	44	50	63	56	46	44	68	51
	21	3	54	68	47	69	69	46	66	71	63	59	73	70	54
	22	6	42	63	53	72	59	58	67	65	58	63	70	75	45
	23	6	44	53	45	48	60	57	55	66	53	51	69	65	50
	24	0	51	64	62	64	61	61	63	56	64	58	70	63	52
	25	0	50	49	57	56	68	54	50	65	50	47	51	63	44
	26	0	49	60	46	61	62	47	53	72	57	56	69	68	48
	27	3	42	64	56	53	58	59	50	64	56	64	73	67	55
	28	6	47	53	48	70	65	54	64	61	69	62	74	65	56

	S#	TQ	L	F	K	HS	D	HY	PD	MF	PA	PT	SC	MA	SI
FEMALE	RIGHT	MOVERS													
	29	0	44	53	55	43	55	56	72	48	62	49	53	72	64
	30	0	50	59	58	59	70	57	50	48	62	49	60	69	64
	31	3	44	50	53	64	65	77	60	32	73	61	71	70	44
	32	0	46	50	58	54	51	57	64	43	47	51	51	70	40
	33	2	40	55	48	47	51	52	52	47	41	63	56	45	62
	34	0	41	50	60	58	63	65	56	32	73	63	66	69	56
	35	1	47	59	59	64	59	62	71	33	61	59	62	73	51
	36	0	53	51	56	42	45	63	69	32	46	51	43	56	48
	37	3	53	53	57	48	61	59	60	48	62	60	57	55	62
	38	0	51	48	53	44	45	58	61	50	58	65	47	70	49
	39	0	46	61	59	64	63	73	51	32	70	61	68	70	47
	40	0	52	50	57	52	52	59	64	40	43	54	48	60	42
	41	3	53	62	67	50	53	59	72	33	59	59	60	53	50
	42	0	40	55	52	47	53	54	60	51	41	64	44	69	52
MALE	RIGHT	MOVERS													
	43	0	40	54	59	54	65	63	57	61	51	61	59	60	43
	44	0	50	48	74	59	60	69	71	63	59	62	61	50	44
	45	0	44	53	63	69	62	67	65	66	48	54	50	55	53
	46	0	46	50	72	70	63	64	57	67	50	62	69	63	43
	47	0	40	46	65	65	56	64	68	65	55	65	69	67	60
	48	6	50	44	61	55	64	68	69	69	53	66	71	72	48
	49	0	43	48	72	57	53	62	69	68	53	60	65	58	42
	50	3	54	46	68	64	61	56	64	59	50	57	63	60	49
	51	0	42	47	64	59	54	59	63	60	48	53	53	69	47
	52	0	53	48	70	49	60	54	57	65	53	62	44	65	54
	53	0	42	50	44	46	59	65	59	58	61	55	51	68	49
	54	0	43	50	66	53	47	55	58	61	48	56	64	56	47
	55	0	47	52	49	63	53	60	65	69	54	59	43	70	51
	56	2	43	50	66	72	49	69	70	63	52	58	64	48	42

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