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BIORHYTHM AND INTELLECTUAL FUNCTIONING

by

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A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF EDUCATION

IN

COUNSELLING PSYCHOLOGY

DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

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THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled Biorhythm and Intellectual Functioning submitted by Anne Loewan in partial fulfillment of the requirements for the degree of Master of Education.

Geo. Fitzsimmons
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Date 17 July 1979

ABSTRACT

The main purpose of this study was to investigate the possible existence of an intellectual biorhythm which influences intellectual performance.

The intellectual biorhythm under investigation comes from the theory, "Biorhythms," which states that human behaviour is influenced by a twenty-three day physical cycle, a twenty-eight day emotional cycle and a thirty-three day intellectual cycle. A biorhythmic cycle is described as a period of time during which the energy level, physical, emotional or intellectual, fluctuates from high to low to high. In specific, the intellectual biorhythmic cycle is believed to be a cycle of high and low levels of intellectual energy. The high intellectual energy phase is associated with a period of time during which the capacity to think clearly and quickly is maximal while the low intellectual energy phase is associated with a period of time during which the same capacity is reduced.

Students from grades four, five and six of an Edmonton inner city school participated in the study. Each subject's intellectual biorhythmic cycle was calculated by using an electronic calculator, the "Casio Biolator." Half of the subjects were tested twice during the same high phase of their intellectual biorhythmic cycle. This group was named High-high biorhythmic group. The other half of the subjects were tested first during a high phase of their intellectual biorhythmic cycle and then during a low phase of their intellectual biorhythmic cycle. This group was named High-low biorhythmic group. Parallel forms J and K of the Otis-Lennon Mental Ability Test were used to

obtain two intellectual performance level scores for each subject.

The data were analyzed by comparing the obtained IQ scores of the High-high biorhythmic group and the High-low biorhythmic group. Further data analyses were made to determine whether or not the hypothesized intellectual biorhythm had a varying effect on males and females.

Analyses of the data revealed the following:

1. No significant difference was found between the intellectual performance levels of the High-high biorhythmic group and the High-low biorhythmic group.

2. No significant difference was found between males and females within the same biorhythmic group.

It was concluded that, within the specified sample and under the test conditions, there was no evidence to support the intellectual biorhythm theory.

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Acknowledgments are also due to my friends: Patti Browne for her criticism and support during the final stages of this work; Sheila Lejnieks for her help in editing the document; and Clari Cowan for her patience in typing this manuscript.

Special appreciation goes to my mother who gave me the spirit of optimism and perseverence.

To everything there is a season,
And a time to every purpose under heaven:
A time to be born, and a time to die;
A time to plant, and a time to reap....

Ecclesiastes 3:1-2

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CHAPTER I

INTRODUCTION

It is essential to a clear understanding of this study that certain concepts be initially defined. In order to maximize the relatedness of these concepts as well as enhance understanding of them, a certain sequence has been observed. For this reason, the following section on terminology has been included as part of the introduction.

Terminology

Biorhythms. The term derives from the Greek words "bios" meaning life and "rhythmo" meaning regulated beat. Biorhythms here refers to three theorized biological cycles, a 23-day physical cycle, a 28-day emotional cycle, and a 23-day intellectual cycle.

Cycle. A period of time during which the energy associated with a rhythm rises and falls in a predictable and regular way is called a cycle.

Physical biorhythm. This term refers to a 23-day theorized cycle affecting physical strength, endurance, resistance and physical confidence. The first half of the cycle represents a period of high physical energy during which vitality and endurance are increased. The second half represents a period of low physical energy and recharge of physical energy during which vitality and physical endurance are reduced.

Emotional biorhythm. Emotional biorhythm is defined as a 28-day theorized cycle which governs the nervous system. The first half of the cycle represents a period of high emotional energy during which a person is more inclined to be optimistic and cheerful. The second half represents a period of low emotional energy and recharge during which a person is more inclined to be negative and irritable.

Intellectual biorhythm. This term refers to a 33-day theorized cycle which appears to originate in the brain cells. The first half of the cycle represents a period of high intellectual energy during which the capacity to think clearly and remember are enhanced. The second half represents a period of low intellectual energy and recharge during which the capacity to think clearly and remember are reduced.

Biorhythmic phases. These are periods of equal length which divide a biorhythmic cycle into two periods.

High biorhythmic phase. This term refers to the first half period of a biorhythmic cycle associated with a high level of energy.

Low biorhythmic phase. The second half period of a biorhythmic cycle associated with a low level and recuperation of energy is called a low biorhythmic phase.

Critical day. A twenty-four hour period of neutrality between a high and a low biorhythmic phase, during which the biorhythm changes from high to low phase or from low to high phase is called a critical day.

High-high biorhythmic group. The group of subjects tested twice while in a high intellectual biorhythmic phase is referred to as the High-high biorhythmic group.

High-low biorhythmic group. The group of subjects tested first while in a high intellectual biorhythmic phase and then while in a low intellectual biorhythmic phase is referred to as the High-low biorhythmic group.

Circadian rhythm. A regular twenty-four hour metabolic activity cycle is called a circadian rhythm.

Ultradian rhythm. A 90 to 100 minute activity cycle associated with sleep, measured from rapid eye movement to rapid eye movement, is called an ultradian rhythm.

Rapid eye movement (REM). A phase of the ultradian rhythm associated with dreaming, during which the eyes are in a state of rapid movement, is known as REM.

Circumsual rhythm. This rhythm represents a cycle of hormonal changes occurring over a one-month period.

Circannual rhythm. This rhythm represents a cycle of hormonal changes occurring over a one-year period.

Intelligence. Wechsler's (1958) definition of intelligence is "the capacity of the individual to act purposefully, to think rationally and to deal effectively with his environment." The definition as used here refers to abilities as measured by performance on intelligence tests.

Intelligence test. This term refers to a set of problems designed to measure mental abilities.

Intelligence quotient (IQ). A ratio of mental age, as measured by performance on an intelligence test, to chronological age and multiplied by one hundred is called IQ.

Deviation IQ. A score derived from performance on an intelligence test which gives the relative position of a person compared to his age peers in terms of normal curve standard deviation units is called deviation IQ.

Test-score variance: The amount of test score fluctuation between parallel test forms due to environmental and/or personal causes is termed test-score variance.

Hierarchical model of intelligence. This is a theory of intelligence developed by P. E. Vernon (1950) which postulates a general intelligence factor (g) which can be divided into two major group factors, Verbal-Educational and Practical-Mechanical, of which both major group factors can be further broken down into minor group factors.

Background to the Study

Twenty-four hundred years ago Hippocrates advised his associates to be aware of body fluctuations. He stated that regular fluctuations are a sign of health; irregular fluctuations a sign of disease.

Extensive research made over the past twenty years has revealed the existence of many short body rhythms. Unfortunately, a lack of financial resources as well as a lack of subjects willing to be observed for long periods of time have kept research of long body rhythms to a minimum. For this reason most of the data concerning long body rhythms have come from examining medical charts of patients.

The Biorhythm Theory began with research done by a nose and throat specialist, W. Fliess (1906). Fliess observed that many children who were exposed to a contagious disease would remain immune for days, only to succumb to the disease at a recurring "critical" time. By tracing illnesses, outbreaks of fever and deaths back to birth, Fliess became convinced of the existence of a twenty-three day cycle and a twenty-eight day cycle as being fundamental to human life. During the 1920's A. Teltscher, a doctor of engineering and a teacher, is reported to have collected and analyzed a large number of performance reports of high school and college students. The paper Teltscher supposedly prepared concluded that students' high and low peaks of performance fluctuate in a definite thirty-three day cycle.

Biorhythmic cycles have two equally long phases, a high energy phase and a low energy phase. Biorhythms begin at a point of neutrality, also called "critical day" (a point between the high and low phases), proceed through the high energy phase, return to the point of neutrality, proceed further through the low energy phase, and finally return to the point of neutrality, thereby beginning a new cycle (Figure 1).

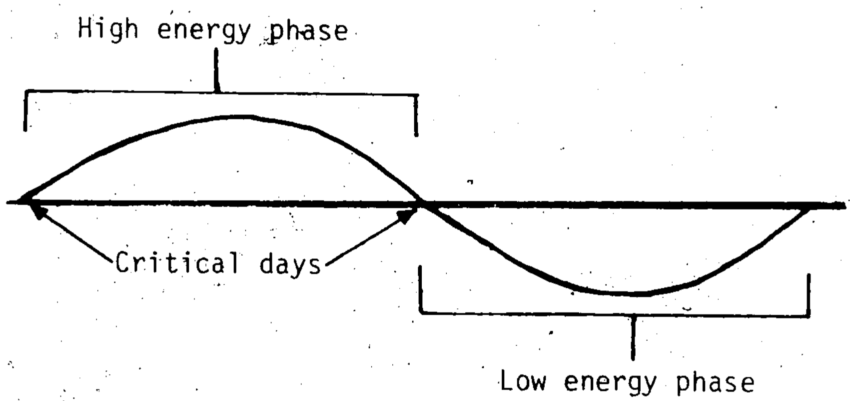


Figure 1. Model cycle of a biorhythm. The cycle is drawn in a sine wave form for the purpose of illustrating the high and low energy phases.

The three hypothesized biorhythms are a twenty-three day physical rhythm, a twenty-eight day emotional rhythm and a thirty-three day intellectual rhythm.

Although very little research has been published on these rhythms, they have gained tremendous popular attention since Thommen (1973) published the research done by Fliess and Teltscher in his book, <u>Is This</u>

Your Day? Unfortunately, the daily "Biodex," a graph found in many daily newspapers which charts the biorhythms of the general population according to month of birth, has created the concept that "Biorhythms" is similar to astrological charting. This overgeneralization in the application of the theory has made the theory subject to much skepticism.

Each biorhythmic cycle is stated as beginning at the exact hour of birth. In order to determine the status of a particular rhythm, emotional, physical or intellectual, for a given day, specific calculations are made. The total number of days a person has lived is divided by the number of days in the biorhythmic cycle. The product of this division yields the number of cycles completed plus the number of days the rhythm has passed into its current cycle. This calculation can be made very quickly by using a pocket-sized electronic calculator, the "Casio Biolator," available at some city stationers at the approximate cost of $30.00.

Overview of the Study

Sixty students from grades four, five and six of an Edmonton inner city school were used in the study. Each student's intellectual biorhythm was calculated using the Casio Biolator. Students were divided into two groups, the High-high biorhythmic group which was tested twice during a high biorhythmic phase, and the High-low biorhythmic group which was tested first during a high biorhythmic phase and then during a low biorhythmic phase. Parallel forms J and K of the Otis-Lennon Mental Ability Test, Elementary II Level, were used to obtain two measures of intellectual performance for each student.

Purpose of the Study

The purpose of this study is to examine the theory of the intellectual biorhythm to determine whether or not the hypothesized rhythm exists and influences performance on a standardized intelligence test. It appears possible that some of the test-score variance associated with IQ scores might be caused by rhythmic fluctuations in intellectual performance. If results of the study support the hypothesized rhythm, it would create an awareness that students tested during a low phase of intellectual biorhythm may be disadvantaged while the reverse may apply to students tested during a high phase.

Two research questions are formulated in this study:

1. Does evidence exist to indicate a thirty-three day intellectual biorhythm which influences performance on a standardized intelligence test?

2. Is there a sex of subject difference in the measurement of the dependent variable?

As the Biorhythm theory hypothesizes the influence of an intellectual biorhythm, the first research question was restated into the following positive hypothesis: Mean scores of the High-high biorhythmic group will be significantly higher than the mean scores of the High-low biorhythmic group.

As there is no reason to believe that the intellectual biorhythm produces differential effects on different sexes, the second question was restated into the following null hypothesis: There is no significant difference between the mean scores of different sexes within the same biorhythmic group.

Assumptions Made in the Study

The following assumptions were made in the study:

1. If the hypothesized intellectual biorhythm exists, it will influence performance on a standardized intelligence test.

2. The Otis-Lennon Mental Ability Test provides a sensitive-enough instrument to detect fluctuations of intellectual performance caused by the hypothesized biorhythm.

3. The hypothesized biorhythm begins at birth, even where birth has been premature or artificially induced.

4. The hypothesized intellectual biorhythm is a regular thirty-three day cycle and cycle length is not altered by environmental or personal variables.

Limitations to the Study

The study is limited by its sample group. Students in the sample group are largely from lower-class, transient, one-parent families. The overall academic achievement level, as measure by city-wide achievement tests, is lower than that of the general Edmonton population. The sample group can therefore not be considered to be a representative sample.

Instructions given prior to the test were expanded to include an explanation of a monetary reward system devised by the researcher. The introduction of a monetary reward system to a test is known to affect subjects' motivation to perform. This change was made because the examiner felt that such a reward would produce a higher level of motivation. It seemed important to measure the highest possible intellectual output. However, this change may have affected the IQ scores.

CHAPTER II

SURVEY OF THE LITERATURE

Human Rhythms

A fundamental thesis of biology is that all life consists of the discharge and creation of energy. Rhythms appear to be inherent in all living matter. Rhythmic changes occur over 90-minute periods, 24-hour periods, monthly periods and yearly periods.

The circadian rhythm, a twenty-four-hour rhythm, has been the most extensively researched. It is found throughout the nervous and endocrine systems, in liver enzymes, in biochemicals of brain and spinal cord and in DNA within cells. Klein (1970) constructed a phase map of circadian changes and related these changes to performance. He found that psychomotor coordination peaks between 2:00 p.m. and 4:00 p.m. and is at its lowest between 2:00 a.m. and 4:00 a.m. Mental performance and physical fitness peak between 1:00 p.m. and 7:00 p.m. and are at their lowest between 2:00 a.m. and 6:00 a.m. Folkard (1975) found performance on over-learned repetitive tasks (e.g., colour naming) better in the morning than in the afternoon, but found the reverse for perceptual-restructuring tasks (e.g., Embedded Figures Test). EEG's show more sensitivity to photic stimulation in the afternoon than in the morning (Mackenberg, Broverman, Vogel and Klaiber, 1974). Pulse pressure and oxygen consumption is greater in the afternoon than in the early morning. The body is 80 per cent more resistant to anoxia at 3:00 a.m. than at 3:00 p.m. Body temperature is one and a half to two degrees higher in the later afternoon than around 4:00 a.m. Psychotherapeutic research shows circadian patterns in emotional stability and anxiety (Poirel, 1975).

Times of the rising and falling of rhythms changes under different environmental conditions, but cycle length remains constant. This has been demonstrated with the sleep cycle. With normal night-time sleep, the amino acid concentration peaks between noon and 8:00 p.m. When the sleep pattern is reversed to day-time sleep, the amino acid concentration peaks between 4:00 a.m. and 8:00 a.m. Upon reverting to night-time sleep, amino acid concentration reverts to its original schedule (Feigin, Klainer and Beisel, 1967). During a twenty-four-hour period, different body rhythms peak at different times. This creates an overall appearance of steadiness within body functioning.

The ultradian rhythm more commonly known as "sleep cycle" is measured from REM to REM, a 90- to 100-minute cycle. REM periods seem to be periods of higher brain metabolism (Mandell, Spooner and Brunet, 1969). Broughton (1975) suggests that this rhythm represents the basic rest-activity cycle and is biologically older than the circadian rhythm. Although this rhythm is much more obvious during sleep, EEG records of muscle tone and eye activity have ascertained its presence around the clock. Infants during the REM periods engage in sucking, grimacing, have penile erections and show expressions of emotion. Stomach contractions associated with hunger have also been noted to have 90-minute cycles (Luce, 1971).

The circumensual (monthly) rhythm is best known to women as the menstrual cycle. Monthly rhythms have now also been documented for men in relationship to hormone secretion, performance and weight (Halberg, Engeli, Hamburger and Hillman, 1965).

Circannual rhythms have mainly been researched with animals. Animals show annual cycles in the structure of liver cells, in sugar level and in levels of adrenal hormone corticosterone (von Mayerbach, 1967). Human research done with Eskimos at Wainwright, Alaska showed annual cycles in urinary calcium excretion which seemed directly related to periods of temporary psychosis, "arctic hysteria" (Bohlen, 1969). There is evidence of a "summer hormone," a thyroid product which helps to reduce body heat. Rate of hair growth increases slightly in autumn and winter; rate of conception is highest in autumn, onset of menstruation is more frequent in autumn and early winter (Luce, 1971). Halberg (1969) found circannual rhythms in the number of suicides (peak around May) and deaths from arteriosclerosis (peak around January).

Although rhythmicity appears to be a basic factor to physiological functioning, its cause is unknown. Some research points to small bodies within the DNA molecules, chronons, which regulate the speed with which RNA is synthesized, as regulating physiological rhythms. Different chronon configurations may be interacting to influence different biological rhythms (Gittelson, 1975). The adrenal gland appears to exert control over rhythmic biological changes. Where the adrenal gland has been removed, subjects do not display many of the rhythmic changes (Halberg and Reinberg, 1967).

Biorhythms

Over the past twenty years much research has been published concerning biological rhythms. Most research has, however, dealt with short rhythms while long rhythms have remained relatively unexamined.

Nevertheless, "Biorhythms" have gained popular attention through the "Biodex" of daily newspapers. The overgeneralization of the "Biodex" in its application of the Biorhythm theory has, however, harmed the credibility of the theory as it has created the concept that the Biorhythm theory is a charting system similar to astrological chartings.

The man credited with founding the Biorhythm theory is Wilhem Fliess, Doctor of Medicine, 1859-1928. A review of lectures and medical reports which Fliess published between 1895 and 1905 show that he studied the fluctuation of immunity to disease. He wanted to find out why children would remain immune to contagious diseases on some days and succumb to them on other days. He traced illnesses, outbreaks of fevers, and deaths back to birth, and became convinced of a twenty-three day physical rhythm related to physical strength and endurance. He also found a twenty-eight day rhythm related to emotional sensitivity. He theorized that these cycles begin at the time that life starts independently outside the womb and run in consistent cycles until death. The cycles manifest themselves in abundance of and lack of physical and emotional vitality.

During the 1920's Alfred Teltscher, Doctor of Engineering, reportedly collected a large number of performance reports of high school and college students at Innsbruck, Austria. His interest was to ascertain whether or not cyclic patterns could be established in the intellectual capabilities of students. The research documents were lost during World War II. However, Teltscher reportedly concluded that there is a thirty-three day cycle during which intellectual performance fluctuates. There is a high peak performance period during which students grasp and absorb new material with relative ease, and there is a comparable period when the capacity to think quickly and clearly is diminished. Teltscher's associates and medical contemporaries ascribed this rhythm to periodic secretions of glands, possibly of the thyroid gland, affecting the brain cells.

The three biorhythms all begin with a period of high vitality, rising and declining during the first half of the cycle and then go through a period of low vitality during which energy is low, but becomes restored. As the cycles are of different lengths, the vitality of one cycle usually counteracts the lack of vitality of another cycle, thus obscuring the effects of any one rhythm and giving an appearance of overall stability (Figure 2).

More investigations of biorhythms have been made with the physical and emotional cycles. Studies of athletic events show outstanding performances where athletes' biorhythmic chart had two or three biorhythms in a high biorhythmic phase. Thommen (1973) quotes examples of athletic performances correlating with biorhythmic phase. The well-known golfer, Arnold Palmer, during the first week of July, 1962 when all his biorhythms were in high biorhythmic phase, displayed record performance during his golf matches. Two weeks later, when all his biorhythms were in low biorhythmic phase, performance was surprisingly poor. On February 3, 1962 John Uelses set a new world record with a pole vault of sixteen feet and one-quarter inch. Two weeks later he failed to clear fourteen feet. His biorhythm chart shows a peak phase for physical and emotional rhythms during his success and a low phase for the same rhythms two weeks later. Documented research by Willis (1972) and

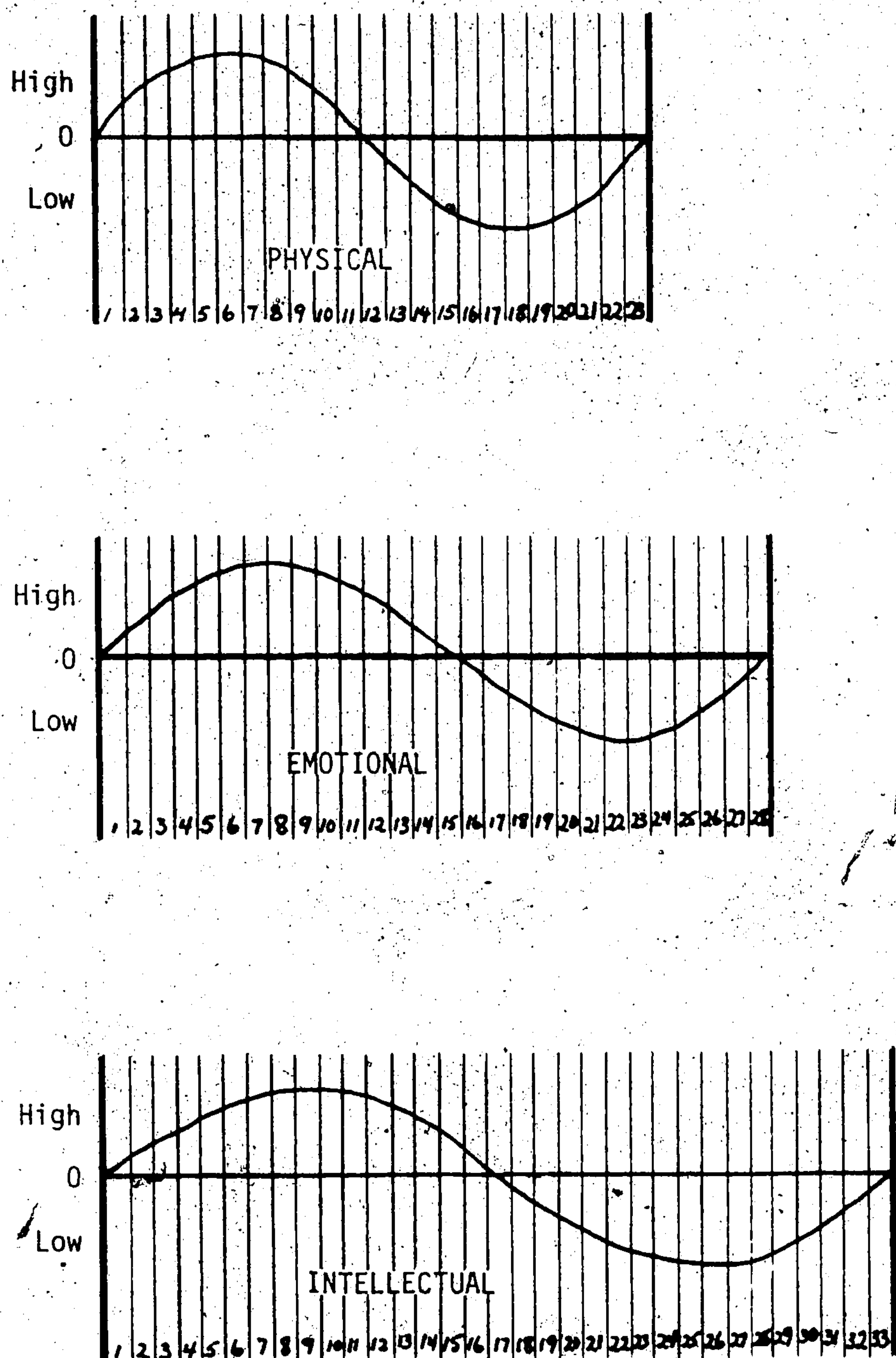


Figure 2. Charts showing the Physical, Emotional and Intellectual biorhythms.

Gittelson (1975) cite numerous more cases where athletes' biorhythms were charted and predictions were made with above average accuracy. A study relating biorhythms to performance on skill tests (shuttle run, standing broad jump and basketball free throw) showed slightly better performance on all tests during peak phases, but the differences were not significant (McPhail, 1976).

Gittelson (1975) discusses a study made of the intellectual biorhythm in which academic performance of graduate students was charted over a 14-month period in fifteen different courses. His findings were as follows: (a) average academic performance tended to occur at many different points of students' intellectual biorhythm and did not appear to be affected by the intellectual biorhythm, (b) over 75 per cent of above average academic performance occurred during high biorhythmic phase, and (c) 70 per cent of below average academic performances occurred during low biorhythmic phase. This study shows a positive correlation between high and low intellectual phases and intellectual performance.

Much of the biorhythm research has centered around "critical days" (twenty-four-hour periods of neutrality, between the high and low biorhythmic phases, during which the biorhythm changes from a high to a low phase or from a low to a high phase). These days seem to correspond to a greater number of deaths due to illness and accidents (motor and industrial, where accidents are a result of human error) (Schwing, 1939; Gittelson, 1975; Latman, 1977).

According to Gittelson (1975), the Biorhythm theory is being applied in Japan, Germany and Switzerland. SwissAir, for the past ten years, has not allowed pilots to fly on critical days unless accompanied by a co-pilot who is not on a critical day. In Germany the Zurich and Hannover municipal transport companies have taken similar action with conductors. In Japan insurance companies issue charts to customers making them aware of their critical days. Gittelson reports that accident rates have been significantly reduced where an awareness of biorhythms has been applied.

O'Neil and Phillips (1975) suggest that biorhythm be applied in planning surgery (conducting operations on peak days of the physical rhythm). According to O'Neil and Phillips, some hospitals in Europe already do this whenever possible. Advocates of the theory suggest that psychologists, psychiatrists, and physical therapists might apply biorhythms when planning therapy. Furthermore, as biorhythm charts show optimal times for receptivity and assimilation of new material as well as times best used for review, the Biorhythm theory could be applied in classroom teaching.

The researcher has noted some contradicting results in the published research of the Biorhythm theory. Data supporting the theory seem to come mainly from retrospective studies while experimental studies have primarily shown inconclusive or negative results. Nevertheless, the claims made by advocates of the theory pertaining to the theory's application in the field of education stimulated the present research. The study examines the existence of the intellectual biorhythm and its possible influence on performance on a standardized intelligence test, namely, the Otis-Lennon Mental Ability Test.

The Otis-Lennon Mental Ability Test

Selection of an instrument to measure intelligence was based on the following needs:

1. To be a reliable measure of intelligence.

2. To be suitable for grades four, five and six, with a reading level not exceeding grade four.

3. To have parallel forms showing high positive correlation.

4. To require no longer than one hour to administer.

5. To allow for quantitative quick scoring.

Tests considered were the Lorge-Thorndike, the Primary Mental Abilities Test and the Otis-Lennon Mental Ability Test. The Primary Mental Abilities Test has not been well researched. The Lorge-Thorndike has been used extensively by schools and many of the subjects had previous exposure to it. The Otis-Lennon Mental Ability Test appears well constructed, is well researched and has received good reviews. The test was designed to cast Binet-type test items into a paper and pencil version. It measures verbal, numerical and abstract reasoning abilities. The test shows high correlations (.70-.90) to other mental ability tests, e.g., Iowa Test of Basic Skills, California Achievement Test, Stanford Achievement Test (Mehrens and Lehmann, 1975). Statistics in the Manual for Administration show the following reliability estimate at the Elementary II level: for alternate forms (administered at a two-week interval), correlations of .86, .92 and .93 for ages 9, 10 and 11, respectively, and standard error of measurement (in deviation IQ's) of 6.0, 4.5 and 4.2, respectively. Split half correlations are .94, .95 and .95 for grades four, five and six, respectively, while the Kuder Richardson 20 estimates are .93, .95 and .95 for grades four, five and six, respectively. Other positive features of the Otis-Lennon Test were:

(a) total administration time of Elementary II level is approximately 50 minutes, with 40 minutes of actual working time, (b) the test booklets are pleasing and easy to follow, (c) the Elementary II test is designed for grades four, five and six and has a mean reading level of below grade four, (d) parallel forms correlate highly to each other, and (e) scoring is quantitative and quick. The Otis-Lennon Test does not claim to measure "innate" intelligence but, rather, scholastic aptitude as reflected by the verbal-educational component of the hierarchical structure-of-intellect model.

Theories of Intelligence

The hierarchical structure-of-intellect model allows for an integration of the two seemingly contradictory theoretical concepts of intelligence which preceded it. These were concepts of intelligence postulated by Spearman and Thurstone. In 1927 Spearman was first to study the components of intelligence through mathematical formulas (intercorrelations and factor-analysis). He formulated the "general factor theory of intelligence," stating that intelligence is primarily a general ability to deduce relationships. He further stated that different tests of intelligence show positive high correlations to each other, which supports the concept of a general mental trait. Less than perfect positive correlations between different intelligence tests can be attributed to different tests measuring different specific intellectual traits. Through a process of factor-analysis, Spearman determined how much of each test measured general intellectual ability and how much it measured specific intellectual traits. The "general factor theory of intelligence" supported the concept of measurable intelligence introduced by Terman in 1916.

In contrast to the "general factor theory" is the "multiple factor theory of intelligence" developed by Thurstone in 1931. Thurstone argued that there is no general intelligence but there are, instead, different mental abilities which comprise intelligence. He classified seven different abilities which came to be known as Thurstone's Primary Mental Abilities. These are: (a) number fluency, (b) word fluency, (c) verbal meaning, (d) memory, (e) reasoning, (f) space, and (g) perceptual speed. Thurstone postulated that there is minimal relationship between different mental abilities. However, in his later work Thurstone found high correlations between some abilities and admitted to the existence of a more general intelligence factor. However, a difference remains between Spearman's and Thurstone's theories of intelligence in that, for Spearman, the general factor was the primary component of intelligence whereas, for Thurstone, it was a minor component and different abilities were the major component. This seeming controversy was resolved by a hierarchical model of intelligence postulated by Vernon in 1950. Vernon's model postulated a general factor of intelligence which can be subdivided into two major group factors (verbal and practical). The two major group factors divide further into multiple minor factors and then into numerous specific factors (see Figure 3). The hierarchical model fits the unitary concept of the Intelligence Quotient by emphasizing intelligence to be a "general ability" which can be subdivided.

Many different theories have been presented for intelligence. The above theories are limited to only one approach to intelligence, namely, the psychometric approach which arose from the intelligence test move-

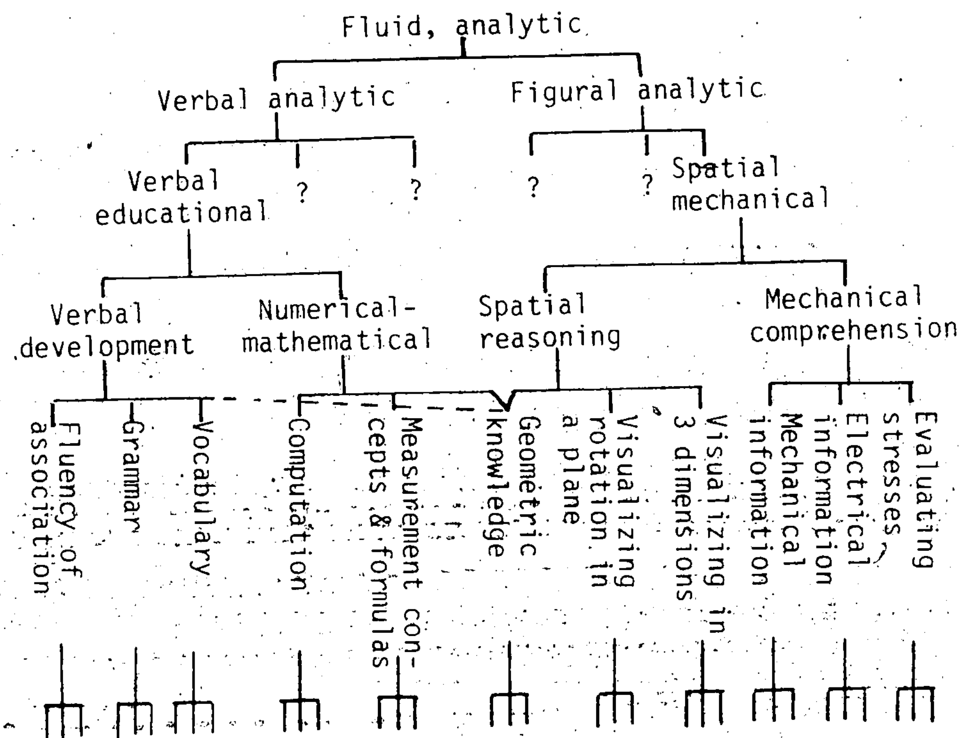


Figure 3. Hierarchical model of intelligence.

ment. This approach is extremely quantitative in contrast to qualitative approaches to intelligence advocated by developmental theories of intelligence. The psychometric approach does not focus on general laws of learning or development but, instead, it defines intelligence in terms of measurable factors.

The current status of the psychometric approach to intelligence is a recognition that intellectual functioning changes with age. Intelligence seems to be more of a general trait in children but changes into numerous specific traits in adults.

Measuring Intelligence

Intelligence testing came into psychology from medicine. Clinicians dealing with mental defectives needed diagnostic tests. Alfred Binet, a physician by training, experimented with a variety of mental tests (recall of digits, suggestibility, size of cranium, moral judgment, tactile discrimination, mental addition--even palmistry) and gradually identified the essence of intelligence as "the tendency to take and maintain a definite direction, the capacity to make adaptations for the purpose of attaining a desired end, and the power of auto-criticism" (translation by Terman, 1916). Binet's first test (1904) was revised a few times to adapt it for the use of schools so that they could identify "bright" and "dull" children. In 1910 L. M. Terman began experimenting with the Binet tests and in 1916 he produced the Stanford Revision which extended Binet's scale to normal and superior children. The Stanford-Binet test became a standard for mental ability tests and is still used today.

Today's intelligence tests could almost be considered to be samples of life performance. They are used to predict scholastic performance and adjustment to work. The nature of questions used in intelligence tests is a controversial issue. Most tests attempt to measure reasoning, judgment and verbal fluency, traits which determine success in our culture and, more specifically, in our educational system. Many tests have been designed and discarded; others have received recognition as good measures of intelligence. Some widely accepted intelligence tests are the Stanford-Binet Intelligence Test, the Wechsler Tests (WISC-R, WAIS and WPPSI), the Lorge-Thorndike Intelligence Test and the Otis-Lennon Mental Ability Test.

Group intelligence tests (i.e., Lorge-Thorndike Intelligence Test and the Otis-Lennon Mental Ability Test) provide paper and pencil formats which require only initial directions to be given by the examiner. Individual intelligence tests, on the other hand, require constant interaction between the examiner and the person to be tested. This makes individual intelligence tests impractical for assessing a group of individuals and, where this is the situation, group intelligence tests are preferred. Individual intelligence tests are, however, considered to be more reliable measures of intelligence than group intelligence tests because they provide manual performance tasks as well as verbal performance tasks.

An intelligence test score (Intelligence Quotient) is a ratio of mental age to chronological age times one hundred (IQ = MA/CA x 100). Today deviation IQ's are widely used. Deviation IQ's give the relative position of a person compared to his age peers in terms of normal curve standard deviation units.

Test scores are considered to be representative samples rather than true indicators of intelligence. Test performance varies from one test to another due to "test-score variance." Thorndike (1949) presents a multitude of possible causes for test-score variance (Table 1).

Table 1

Sources of test-score variance classified

I. Lasting and general characteristics of the individual

1. General skills (e.g., reading).
2. General ability to comprehend instructions, testwiseness, techniques of taking tests.
3. Ability to solve problems of the general type presented in this test.
4. Attitudes, emotional reactions, or habits generally operating in situations like the test situation (e.g., self-confidence).

II. Lasting and specific characteristics of the individual

1. Knowledge and skills required by particular problems in the test.
2. Attitudes, emotional reactions, or habits related to particular test stimuli (e.g., fear of high places brought to mind by an inquiry about such fears on a personality test).

III. Temporary and general characteristics of the individual (systematically affecting performance on various tests at a particular time)

1. Health, fatigue, and emotional strain.

2. Motivation, rapport with examiner.
3. Effects of heat, light, ventilation, etc.
4. Level of practice on skills required by tests of this type.
5. Present attitudes, emotional reactions, or strength of habits (insofar as these are departures from the person's average or lasting characteristics, e.g., political attitudes during an election campaign).

IV. Temporary and specific characteristics of the individual

1. Changes in fatigue or motivation developed by this particular test (e.g., discouragement resulting from failure on a particular item).
2. Fluctuations in attention, coordination, or standards of judgment.
3. Fluctuations in memory for particular facts.
4. Level of practice on skills or knowledge required by this particular test (e.g., effects of special coaching).
5. Temporary emotional states, strength of habits, etc. related to particular test stimuli (e.g., a question calls to mind a recent bad dream).
6. Luck in the selection of answers by "guessing."

Source: After R. L. Thorndike, 1949.

In considering a possible relationship of the intellectual biorhythms to intellectual performance, the intellectual biorhythms may be seen as instrumental in causing test-score variance related to "fluctuation in attention, coordination or standards of judgment," or "fluctuations in memory for particular facts."

CHAPTER III

TESTING PROCEDURES

The intellectual biorhythm is a thirty-three day rhythm. The first sixteen and one-half days of the rhythm represent the positive phase, a period of high intellectual vitality during which students supposedly think more quickly and clearly, remember better and perform better on academic tasks. The second sixteen and one-half days represent the negative phase, a period of low intellectual vitality during which the capacity to think clearly and quickly and to remember are supposedly reduced and students' performance on academic tasks is not as good as during the positive phase.

As energy rises and declines during the positive phase, this study is considering only the nine highest days of the positive phase, days 5 to 13, to represent the high intellectual phase. Likewise, as energy declines and becomes restored during the negative phase, this study is considering only the nine lowest days of the negative phase, days 21 to 29, to represent the low intellectual phase. Therefore, for testing purposes, days 5 to 13 of the intellectual rhythm are here referred to as the high intellectual phase and days 21 to 29 of the intellectual rhythm are here referred to as the low intellectual phase (see Figure 4).

The first presentation of the test was administered during each subject's high intellectual phase. For the second presentation, half of the subjects were retested, again during a high intellectual phase, while the other half was retested during a low intellectual phase. Both tests were administered within a fourteen-day period (Figure 4).

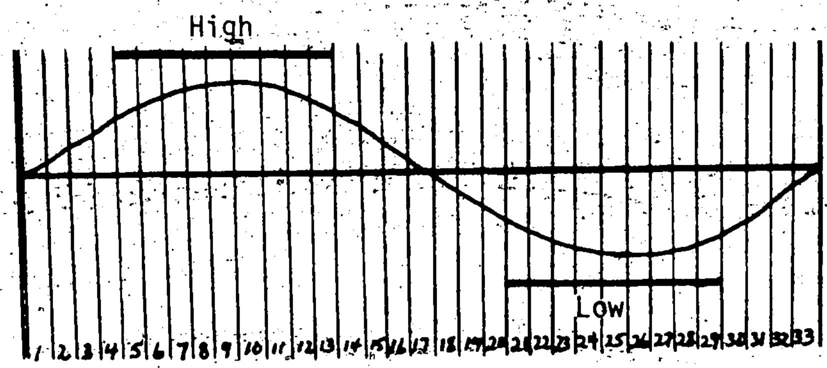


Figure 4. High and low phases of the intellectual biorhythm used for testing days.

All testing was done during a ten-week period, January 17, 1978 to March 7, 1978 on Tuesdays from 1:00 p.m. to 1:50 p.m. Although this time of day (1:00 p.m. to 1:50 p.m.) is not considered to be a time of maximum intellectual efficiency, for administrative purposes it was the preferred time. As time of day was held constant for all subjects, this time did not create a concern.

All subjects' intellectual biorhythms were calculated with the Casio Biolator. As each subject was to be tested twice within a two-week period, subjects' rhythms were examined for two high biorhythmic days or one high and one low biorhythmic day falling within a two-week period at some time between January 17th and March 7th. Subjects showing two high biorhythmic days within the two-week period were placed into the High-high biorhythmic group; subjects showing one high and one low biorhythmic day within the two-week period were placed into the High-low biorhythmic group. Subjects showing both combinations, high-high and high-low, were placed into the group which had less subjects until both groups were even-numbered.

In order for the high-high combination to fall inside a two-week period, this combination needed to be within the same high phase of one intellectual cycle combining either days 5 and 12 or days 6 and 13 for test days. For this reason, the High-high biorhythmic group has only a one-week interval between test presentations. The high-low combination, on the other hand, could only be established with a two-week interval between test presentations as the time required to shift from high biorhythm phase to low biorhythm phase is more than one week.

Selection for J-K or K-J sequences was made by assigning J-K sequence or K-J sequence alternately to alphabetically ordered class lists.

Testing took place in the science room of an inner city school. The room, situated in the basement of the building, was quiet, adequately heated and well-lit. Long tables and chairs were used for working. Each table accommodated four students, two sitting side-by-side and two at the table ends. Students were seated according to a seating plan which provided for students sitting next to each other to be writing different forms of the test. No student was within a visual range which would allow copying answers from another student who had the same test form. Each student had two sharp pencils and an eraser for working. Maximum working time was 40 minutes. Students finishing early left the room quietly. All testing sessions were uninterrupted and testing conditions seemed favourable to mental concentration. To motivate the children to perform at maximum capacity, each correct answer was rewarded by one-half cent and a $1.00 prize was given to the student who received the highest score for his/her grade level. Directions were as follows:

> You will receive a booklet in which there are problems for you to solve. This is not for report cards or for your teacher. I want to see how well you can solve problems when you are earning money to solve them. For each problem you solve correctly you will earn one-half cent.
>
> You will have two tries, one today and a second try in one or two weeks from today, but with a different set of problems. Your score each day will be added together and you will earn one-half cent for the total number of problems solved today and on your next try. Each day you will have eighty problems to solve. If you get all problems correct you can earn forty cents each day or a total of eighty cents for both days.
>
> In addition to your pay, a $1.00 prize will be given to the grade four student who solves the most problems from all grade fours, the grade five student who solves the most problems from all grade fives, and the grade six student who solves the most problems from all grade sixes.
>
> Are there any questions?
>
> I will now call your name to come and get your booklet. Your booklet already has your name on it and you do not need to write anything else on the front cover. When

you receive your booklet, return to your seat and place the booklet in front of you with the back cover up. Do not open the booklet.

Are there any questions?

(Booklets were then passed out.)

Now let us read the "Directions" on the back cover of your booklet. I will read aloud and you follow silently.

(Directions as provided on Forms J and K test booklets.)

After "Directions" were read students were asked if they had any questions. After questions were answered students were asked to turn to the front of their booklet, open it to page 2 and begin their work.

The Sample Group

The sample group was drawn from an inner city school situated in the central core of Edmonton, Alberta. The student population of this school is in large part transient, moving frequently from one school to another as students' families move from home to home. Many students come from one-parent families. Many students have experienced great emotional turmoils and many are frequently under emotional stress. These factors undoubtedly contribute to many students showing significant discrepancy between conronological age and academic skills. On Edmonton system-wide tests these students rank significantly lower than the average Edmonton student population. The reasons for the sample population being drawn from this school were: (a) this group is most accessible to the researcher, and (b) the researcher has a particular interest in the performance of this group.

The original sample group consisted of eighty-five subjects drawn from grades four, five and six. However, data were incomplete and subsequently discarded for twelve subjects due to absences at one or both testing sessions. Missing data resulted in a sample group of 73 subjects, 40 males and 34 females. Forty subjects were tested in the High-high biorhythm group and 33 subjects were tested in the High-low biorhythm group. Forty subjects completed the J-K sequence and 33 subjects completed the K-J sequence.

In order to examine the effects of the intellectual biorhythm on a model representing the normal population, different subgroups were equalized. Thirteen subjects were randomly discarded by using a random numbers table to equalize the number of males and females and the number of High-highs and High-lows. Equal cells of fifteen subjects per cell resulted for each of the following categories: High-high males, High-high females, High-low males, High-low females. Of these subjects, 29 had completed the J-K presentation and 31 the K-J presentation. For frequencies at different ages and grade levels, see Tables 2 and 3.

All subjects were considered to be in fair health and without physical impairments.

Scoring

Test booklets were scored with a scoring key. Scores were obtained by summing up the number of correct responses from each page. The Otis-Lennon Mental Ability Test Norms Conversion Booklets, Forms J and K were used to convert raw scores to deviation IQ's.

Hypothesis Testing

Deviation IQ scores were statistically analyzed to support or reject, at a significant level of .05, the following hypotheses:

1. Mean scores of the High-high biorhythmic group will be signi-

ficantly higher than mean scores of the High-low biorhythmic group.

2. There will be no significant difference between the mean scores of different sexes within the same biorhythmic group.

Table 2

Frequency table of subjects' age and gender

Age	Males	Females	Total
9	6	3	9
10	6	8	14
11	14	13	27
12	2	4	6
13	2	2	4
Total	30	30	60

Table 3

Frequency table of subjects' grade level

Grade	Frequency
4	27
5	23
6	16

CHAPTER IV

FINDINGS AND CONCLUSIONS

The primary purpose of this study was to determine whether or not the intellectual biorhythm influences intellectual performance as measured by the Otis-Lennon Mental Ability Test. A secondary purpose of the study was to determine whether or not there is a sex of subject difference in the effect of intellectual biorhythm.

Parallel Forms J and K of the Otis-Lennon Mental Ability Test were administered to students in grades four, five and six. All students were first tested during a high phase of their intellectual biorhythm. Half of the students were retested, again during the same high phase, while the other half was retested during a low phase.

The first analysis was made to determine whether or not the sequence of parallel forms had an effect on performance. All completed data were used for this analysis (n=73). Means and standard deviations were calculated for Form J when it was presented first and when it was presented second, and for Form K when it was presented first and when it was presented second (see Table 4). The means of the two sequences were further analyzed using a Two-Way Analysis with repeated measures (Table 5). The computed F resulting from comparing the means of the two sequences is .13. This is less than the critical F (3.98). Therefore, the sequence of parallel forms does not appear to have affected performance.

Graph 1 plots the means for Sequences J-1, K-2 and K-1, J-2. A positive change is apparent from first to second scores in both sequences. The Analysis of Variance with repeated measures (Table 5) shows a

Table 4

Means and standard deviations of performance scores

on J and K parallel forms

when forms were used for Score 1 and when used for Score 2

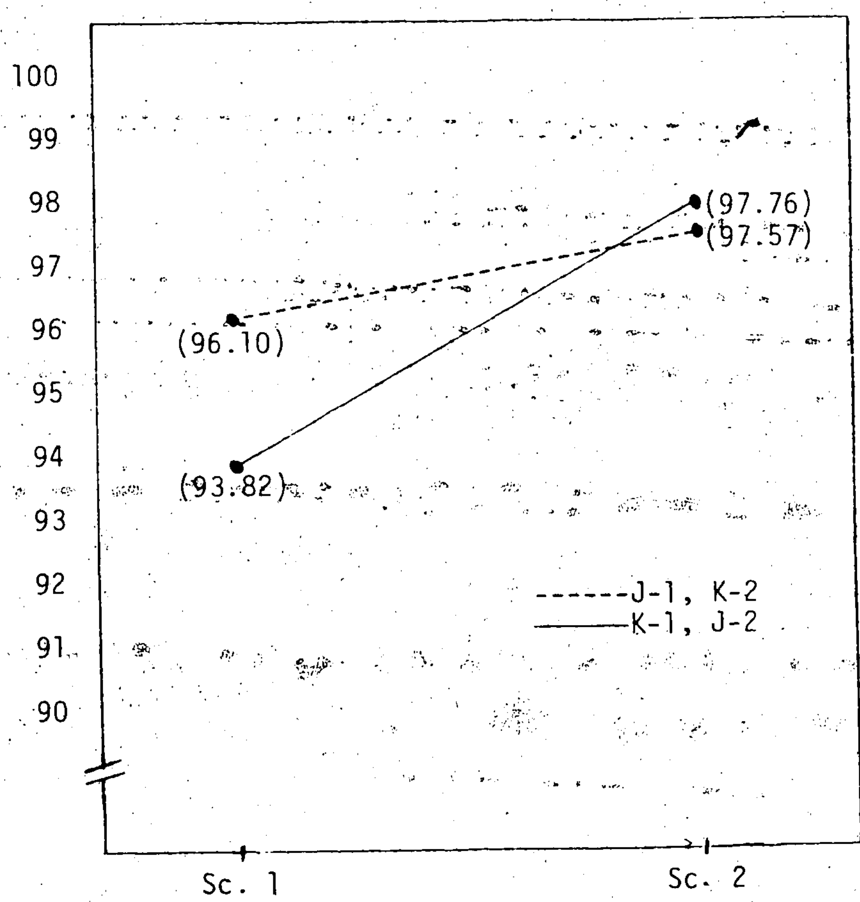
Form	Score 1	Score 2
J	$\bar{x}$ = 96.10 σ = 13.77 n = 40	$\bar{x}$ = 97.76 σ = 11.88 n = 33
K	$\bar{x}$ = 93.82 σ = 12.05 n = 33	$\bar{x}$ = 97.57 σ = 13.77 n = 40

Table 5

Two-Way Analysis of Variance with repeated measures comparing means between Sequence J-1, K-2 and Sequence K-1, J-2

Source	Sum of Squares	Degrees of Freedom	Mean Square	F obs.	F crit.
Sequence J-1, K-2 K-1, J-2	39.55	1	39.55	.13	3.98
Error Term within groups (Sequence)	22363	72	314.97		
Time	264.45	1	264.45	19.04*	3.98
Interaction	55.52	1	55.52	3.99*	3.98
Error Term within groups (Time)	986.00	71	13.89		

*significant at .05 significance level



Graph 1. Mean scores for Sequence J-1, K-2 and Sequence K-1, J-2.

significant difference (F=19.04) between Scores One and Two. Cronbach (1970) observed that practice effect on IQ tests resulted in average gains of two to three IQ points from the first to the second test. This finding is supported by the present study which shows an average gain of 2.7 IQ points.

The Analysis of Variance with repeated measures (Table 5) shows a significant F (3.99) for Interaction. The Interaction is illustrated in Graph 1 which shows more positive change from Score One to Score Two for the K-1, J-2 sequence than for the J-1, K-2 sequence. Form K may be slightly more difficult than Form J and, where Form K was presented first, resulting scores were slightly lower than where Form J was presented first. However, practice acquired on Form J may have helped to deal with the difficulty of Form K as second scores for Form K are approximately the same as the second scores for Form J. Although the means of the different sequences were not significantly different at the .05 level, the greater increase between Scores One and Two of Sequence K-1, J-2 produced the two-way interaction.

The sample group formed two major groups, the High-high biorhythmic group which was tested twice during the same high biorhythmic phase, and the High-low biorhythmic group which was tested first during a high biorhythmic phase and then during a low biorhythmic phase. These two groups were further divided into four subgroups by dividing each group into subgroups of males and females. To equalize the number in each subgroup so that they would approximate the general population, thirteen subjects were randomly discarded. This resulted in subgroups of fifteen males performing during two high biorhythmic phases, fifteen females performing during two high biorhythmic phases, fifteen males performing first during a high biorhythmic phase and then during a low biorhythmic phase, and fifteen females performing first during a high biorhythmic phase and then during a low biorhythmic phase.

The first hypothesis is that the mean score on the Otis-Lennon Mental Ability Test will be significantly higher when the test is administered during subjects' high biorhythmic phase than when it is administered during subjects' low biorhythmic phase. To support this hypothesis Mean Scores One should be similar between groups, both groups being tested during a high biorhythmic phase. However, Mean Scores Two should be significantly different between groups, with the High-high biorhythmic group showing a significantly higher mean than the High-low biorhythmic group.

The second hypothesis tested was that mean scores on the Otis-Lennon Mental Ability Test would not be significantly different between males and females within the same subgroup.

Hypotheses 1 and 2 were tested using a Three-Way Analysis of Variance with repeated measures on one factor. The hypotheses were tested at the .05 level of significance.

Findings

Biorhythmic effect. Hypothesis: Mean scores of the High-high biorhythmic group will be significantly higher than mean scores of the High-low biorhythmic group.

Means and standard deviations for the High-high biorhythmic group and the High-low biorhythmic group are as shown in Table 6. Results of the Three-Way Analysis with repeated measures is shown in Table 7. The Summary ANOVA Table (Table 7) shows an observed F of .11 for the difference between means of the High-high biorhythmic group and the High-

Table 6

Means and standard deviations

for High-high biorhythmic group and High-low biorhythmic group

and for males and females of biorhythmic groups

High-high		High-low	
$\bar{x}_1$ = 95.90	$\bar{x}_2$ = 98.53	$\bar{x}$ = 95.07	$\bar{x}$ = 97.07
σ_1 = 11.21	σ_2 = 12.64	σ_1 = 16.00	σ_2 = 13.59
High-high males	**High-high females**	**High-low males**	**High-low females**
$\bar{x}_1$ = 97.47	$\bar{x}_1$ = 94.33	$\bar{x}_1$ = 93.93	$\bar{x}_1$ = 96.20
$\bar{x}_2$ = 101.67	$\bar{x}_2$ = 95.40	$\bar{x}_2$ = 93.67	$\bar{x}_2$ = 100.47
σ_1 = 10.89	σ_1 = 11.31	σ_1 = 14.89	σ_1 = 16.97
σ_2 = 12.90	σ_2 = 11.57	σ_2 = 12.67	σ_2 = 13.63

Table 7

Summary ANOVA Table

Three-Way Analysis of Variance with repeated measures comparing means of biorhythmic groups and of males and females of biorhythmic groups

Source	Sum of Squares	d.f.	Mean Squares	F obs.	F crit. (.05 F 56)
<u>Between Subjects</u>					
Biorhythm Effect	40	1	40	0.11	4.02
Gender Effect	<1.00	1	<1.00	0.00	4.02
Biorhythm x Gender Effect	639	1	639	1.77	4.02
Subject within Group	20252	56	361.60		
<u>Within Subjects</u>					
Time Effect	161	1	161	14.36*	4.02
Biorhythm x Time Effect	2	1	2	.14	4.02
Gender x Time Effect	3	1	3	.21	4.02
Biorhythm x Gender x Time Effect	111	1	111	7.83*	4.02
Time x Subject within Group	794	56	14.18		

*significant at .05 significance level

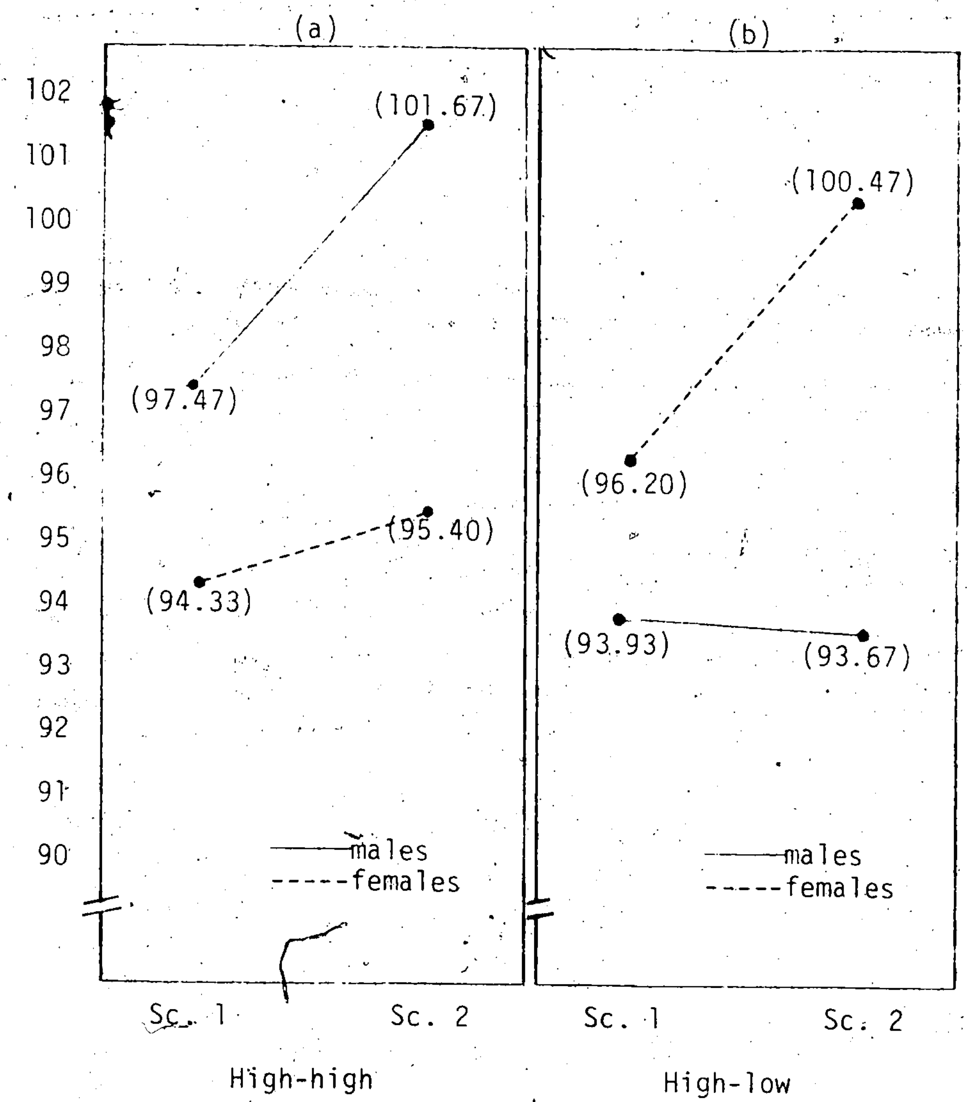
low biorhythmic group. This is less than the Critical F (4.02). Therefore, the positive hypothesis is rejected. There is no significant difference between mean scores of the High-high biorhythmic group and mean scores of the High-low biorhythmic group.

Gender effect. Hypothesis: There is no significant difference between mean scores of males and mean scores of females of the same biorhythmic group.

Means and standard deviations for males and females are shown in Table 6. Results of the Three-Way Analysis with repeated measures is shown in Table 7. Summary ANOVA Table (Table 7) shows an observed F of less than 1 for the difference between means of males and females. This is less than the Critical F (4.02). Therefore, the null hypothesis is not rejected. There is no difference between mean scores of males and mean scores of females of the same biorhythmic group.

The Summary ANOVA Table (Table 7) shows a significant F (11.36) for Time Effect and a significant F (7.83) for Interaction. The cause for a significant F for Time Effect appears to be the same as that noted in the Two-Way Analysis with repeated measures on the difference between Sequences J-1, K-2 and K-1, J-2 (Table 5). In both analyses, the significant F appears to be caused by practice effect.

Graphs 2a and 2b show the changes of individual subgroups. Three subgroups, namely, High-high males, High-high females and High-low females show a positive direction of change, while subgroup High-low males shows a negative direction of change (-.26 DIQ). As there is a slightly significant three-way interaction between Biorhythm, Gender and Time (F=7.83), a Scheffé Test was carried out on the means which appear to be the most plausible for creating the interaction, namely,



Graph 2. Mean scores for males and females of High-high and High-low biorhythmic groups

the means for igh-high males, High-low males and High-low females, High-low males. The Scheffé Test did not produce a significant F for either comparison (Table 8), thereby supporting the null hypothesis. There is no significant difference between mean scores of males and mean scores of females of the same biorhythmic group.

Conclusions of the Data

The present study examined the relationship of the intellectual biorhythm to intellectual performance as measured by the Otis-Lennon Mental Ability Test.

Based upon the findings within the framework of, and within the specified sample, the following was concluded: (a) performance was not significantly different for the group performing during a high biorhythmic phase than for the group performing during a low biorhythmic phase, and (b) males scored slightly higher than females when tested during a low biorhythmic phase but the difference was not significant at the .05 level of significance.

Table 8

Scheffé Test comparing means most plausible for creating an interaction

1. (H-H M_1 - H-H M_2), (H-L M_1 - H-L M_2) = (97.47 - 101.67), (93.93 - 93.67)

$$\frac{(\bar{X}_{D1} - \bar{X}_{D2})^2}{MSw \frac{\Sigma cj^2}{n}} = \frac{(-4.20 - .26)^2}{14.18\,(\frac{4}{15})} = \underline{5.89}$$

2. (H-L M_1 - H-L M_2), (H-L F_1 - H-L F_2) = (93.93 - 93.67), (96.20 - 100.47)

$$\frac{(\bar{X}_{D1} - \bar{X}_{D2})^2}{MSw \frac{\Sigma cj^2}{n}} = \frac{(.26 - (-4.27))^2}{14.18\,(\frac{4}{15})} = \underline{5.43}$$

$$F\ Critical = (J-1)\ F^{J-1}_{n-j} = 3F^{3}_{56} = \underline{8.28}$$

CHAPTER V

DISCUSSION

Results of the data analyses of the present study do not lend support to the theorized existence of a thirty-three day intellectual biorhythm. Hoever, the researcher does not come to any generalized conclusions from these results. A number of unanswered questions became evident during the study, questions relating to fundamental assumptions made by the Biorhythm Theory.

Biorhythms are stated to begin at the hour of birth. Studies on biorhythms originated approximately fifty to seventy years ago when medical knowledge had not advanced to the point where the birth process could be artificially induced and at a time when very few premature babies survived. It may, therefore, be assumed that almost all studies were made on children who had experienced a normal birth delivery. In contrast, many births today are induced and many children have premature deliveries. This is more common to the lower classes than the general population and, as our sample group was drawn from the former class, it may be assumed that some of the children experienced premature delivery or were born under conditions of induced labour. The question which arises is, "Does a premature or artificially induced birth influence the onset of biorhythm?" It may be speculated that biorhythms begin before birth or even at the time of conception. Might the conditionsof the children's births have influenced the results of the study?

We are very knowledgable about some of our body rhythms, for example, the menstrual cycle. This cycle is known to be a twenty-eight day cycle. However, its actual occurrence as a regular twenty-eight day cycle is rare. Some women have never experienced the cycle in twenty-eight day periods; some women experience it as fluctuating in length from cycle to cycle. Also, the menstrual cycle is known to be affected by the emotions and environment. Could this not also be the case for other body rhythms, specifically the hypothesized biorhythms? Many of the children in this study experience more than the usual amount of emotional tension arising from their home environments. Emotional stress may have affected the results of this study.

Again taking the menstrual cycle as an example, we are aware of its development as accompanying the maturation process. Perhaps a similar situation exists for the hypothesized intellectual biorhythm. J. Piaget discusses children's thinking as being very concrete up to the age of eleven and then developing into a capacity to conceptualize in an abstract world of hypothetical possibility. Might this development of intellectual ability be related to the maturation of the intellectual biorhythm? Might periodic secretions of glands affect the brain cells in such a way as to create periods of enhanced intellectual functioning which develops the capacity for abstract reasoning? It is interesting to note that support for the intellectual biorhythm has come from research done with older students (high school and college).

In developing further research with biorhythms, it may be worthwhile to examine the effects of the hypothesized rhythm on specific mental abilities (i.e., memory, visual alertness, analysis and synthesis of new material). The Wechsler subtests (Digit Span, Picture Completion, Block Design, Coding and Arithmetic) as well as the Detroit Tests of Learning Aptitudes (Visual Attention Span for Objects, Auditory Attention Span for Related Syllables and Auditory Attention Span for Unrelated Syllables) might serve as guides for developing appropriate tests to measure specific mental abilities. Specific mental abilities may show varying sensitivity to the hypothesized intellectual biorhythm. It may also be worthwhile to examine intellectual performance over a number of rhythmic cycles to see if patterns of fluctuation emerge.

The above are some of the unresolved issues which deter us from generalizing about the results of the present study. With the growing body of published research in the area of human rhythms it is hoped that "Biorhythms" will receive more scientific attention in the future than it has received in the past. It would be unfortunate to leave a theory which may be of value in the realm of human behaviour to speculation.

BIBLIOGRAPHY

Bohlen, J.G. Circadian and circannual rhythms in Eskimos. A prospectus of research submitted to the Faculty of the Graduate School of the University of Wisconsin, 1969.

Broughton, R. Biorhythmic variations in consciousness and psychological functions. Canadian Psychological Review, 16:217-239, 1975.

Buros, O. Intelligence tests and reviews. Institute of Mental Measurements, 7(370):878, 1975.

Cronbach, L.J. Essentials of Psychological Testing (3rd ed.). New York: Harper and Row, Publishers, Inc., 1970.

Colquhon, W.P. Biological Rhythms and Human Performance. New York: Academic Press, 1971.

Feigin, R.D., Klainer, A.S., Beisel, W.R. Circadian periodicity of blood amino-acids in adult men. Nature, 215:512-514, 1967.

Folkard, S. Diurnal variations in logical reasoning. British Journal of Psychology, 66:1-8, 1975.

Gittelson, B. Biorhythm: A Personal Science. New York: Arco Publishing Co., Inc., 1975.

Halberg, F., Luce, G. Techniques for assessing biological rhythms in medicine and psychiatry. Mental Health Program Reports, No. 3. National Institute of Mental Health, Publication No. 1876:111-210, 1969.

Halberg, F., Reinberg, A. Rhythme circadiens et rhythmes de basses frequences en physiologie humaine. Journal de Physiologies, 59(1): 117-200, 1967.

Klein, K.E., Bruner, H., Rehme, H., Stolze, J., Steinhoff, W.D., Wegman, H.M. Circadian rhythms of pilots' efficiency and effects of multiple time zone travel. Aerospace Medicine, 41(2):125-132, 1970.

Latman, N. Human sensitivity, intelligence and physical cycles and motor vehicle accidents. Accident Analysis and Prevention, 9:109-112, 1977.

Luce, G.G. Biological Rhythms in Human and Animal Physiology. New York: Dover Publications Inc., 1971.

Mackenberg, E.J., Broverman, D.M., Vogel, W., Klaiber, E.L. Morning-to-afternoon changes in cognitive performance and the electroencephalogram. Journal of Educational Psychology, 66(2):238-246, 1974.

Mandell, A.J., Spooner, C.E., Brunet, D. Whither the "sleep transmitter." Biological Psychiatry, 1(1):13-20, 1969.

McPhail, H. (ed.) The relationship of biorhythm cycles to performance on selected skill tests. University of Southern Mississippi, 1976 (Abstract).

Mehrens, W.A., Lehmann, I.J. Standardized Tests in Education (2nd ed.). Toronto: Holt, Rinehart and Winston Inc., 1975.

O'Neil, B., Phillips, R. Biorhythms: How to Live With Your Life Cycles. Pasadena: Ward Ritchie Press, 1975.

Palmer, J.D. An Introduction to Biological Rhythms. New York: Academic Press, 1976.

Poirel, C. Chronobiology in neurology and psychiatry: circadian rhythms in mental activity. Vie Médicale au Canada Francaise, 4(5):472, 1975 (Abstract).

Saunders, D. An Introduction to Biological Rhythms. East Kilbride, Scotland: Thomson Litho Ltd., 1977.

Sax, G. Principles of Educational Measurement and Evaluation. Belmont, California: Wadsworth Publishing Co., 1975.

Schwing, H. Ueber Biorhythmen und deren technische Anwendung. Dissertation presented at the Swiss Federal Institute of Technology. A.G. Gebr. Leemann & Co., 1939.

Thommen, G.S. Is This Your Day? New York: Avon Books, 1973.

Thorndike, R.L. Personnel Selections. New York: Wiley, 1949, p. 73.

Von Mayersbach, H. (ed.). The Cellular Aspects of Biorhythms. New York: Springer-Verlag, 1967.

Wechsler, D. The Measurement and Appraisal of Adult Intelligence (4th ed.). Baltimore: Williams and Wilkins, 1958.

Willis, H.R. Biorhythm and its relationship to human error. Proceedings of the Sixteenth Annual Meeting of the Human Factors Society, Santa Monica, California, 1972.