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An investigation of the relationship between biorhythm theory and swimming or track performances

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AN INVESTIGATION OF THE RELATIONSHIP BETWEEN BIORHYTHM THEORY AND SWIMMING OR TRACK PERFORMANCES

A Project Presented to the Faculty of
the School of Health, Physical
Education, and Recreation
Ithaca College

In Partial Fulfillment of the
Requirements for the Degree
Master of Science

by
Raymond H. Rostan

December 1977

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Ithaca, New York

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MASTER OF SCIENCE PROJECT

This is to certify that the Master of Science Project of

Raymond H. Rostan

submitted in partial fulfillment of the requirements for the degree of Master of Science in the School of Health, Physical Education, and Recreation at Ithaca College has been approved.

Project Advisor:

Candidate:

Chairman, Graduate Programs in Physical Education:

Director of Graduate Studies:

Date: January 23, 1978

AN INVESTIGATION OF THE RELATIONSHIP BETWEEN BIORHYTHM THEORY AND SWIMMING OR TRACK PERFORMANCES

by

Raymond H. Rostan

An Abstract

of a project submitted in partial fulfillment
of the requirements for the degree of
Master of Science in the School
of Health, Physical Education
and Recreation at
Ithaca College

December 1977

Project Advisor: Dr. Veronica L. Eskridge

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ABSTRACT

The purpose of this investigation was to determine if any significant relationship exists between track or swimming performances and days identified as "positive" or "negative" by biorhythm theory. College-level male athletes were investigated during normal, competitive, and uncontrolled situations. A total of 26 male varsity swimmers from the State University of New York (SUNY) at Cortland and Ithaca College, and 27 varsity trackmen from SUNY at Cortland were utilized as subjects. Subjects' birthdates and the dates of the competitive meets for the 1976-77 seasons were analyzed by an Ithaca College computer program designed to show the positions of the "physical-," "emotional-," and "intellectual-" biorhythm cycles of each individual subject for a specific date. Each subject was tested for one competitive event. A mean performance time was calculated for each subject. All of a subject's performance times that were higher than the mean were considered to be "poor" times, while all performance times lower than the mean were designated as "superior" times. Each cycle was tested independently for both track and swimming performances.

The chi-square test of independence in contingency tables was utilized to determine the relationship between swimming or track performances and biorhythmic cycles. More specifically, for each individual cycle, the chi-

square test was employed to determine if a significant relationship existed between a positive-biorhythmic position and the lower, "superior" times, or between a negative-biorhythmic position and the higher, "poor" times.

The chi-square values for the physical, emotional, and intellectual cycles of the track subjects were .006, .100, and 1.247, consecutively. The chi-square values for the physical, emotional, and intellectual cycles of the swimming subjects were 2.145, 1.619, and .441. At the .05 level of significance, with one degree of freedom, a chi-square value of 3.84 must be attained for significance. Within the limitations of this study, the conclusion was drawn that no relationship existed between any one of the individual-biorhythmic cycles and swimming or track performances.

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Chapter 1

INTRODUCTION

The rhythmic occurrence of events tends to be overlooked and has not until recently been considered as fundamental to living systems. Though, for instance, growth and division of cells are inherently periodic, the oscillatory nature of some of the processes involved have not been considered in explanations of the events in question. Instead, experimenters have tried to stabilize the system that they are investigating, and to pay attention to the effect of a stimulus on controlled, rather passive systems.

Rhythms provide clues to the possible existence of oscillators, internal or external clocks, which have important properties about which many people are ignorant. One such property is that of entrainment, first noticed by Huygens in the 18th century (13). Huygens observed that when two clocks which separately ran at different speeds were both hung on the same thin wooden board, they became synchronized and kept the same time. The tendency to become entrained by even very weak signals, so long as they are periodic, is a general property of non-linear oscillators.

The observation that body functions vary in a 24-hour cycle has been accepted for years. Body temperature, for example, is low upon awakening, climbs during the day, and recedes during the evening (6).

However, a new understanding of body cycles has emerged. Researchers have reported that there are independent cycles of physical, emotional, and intellectual activity. When any of these cycles pass a midpoint between high and low, a critical day is said to occur. Accidents and errors in judgment have been found to be far more likely to occur on days in which one or more cycles are in the critical phase than random chance would predict. United Airlines, Swissair, Scandanavian Airlines, major trucking companies, and leading United States and foreign companies are applying the concepts which are outgrowths of European research (22).

Hagan (22) asserted that with the dawn of the 20th century came the observations of Swoboda of the University of Vienna, and Fleiss, a physician who became President of the German Academy of Sciences. Swoboda and Fleiss both noticed that physical and emotional phenomena consecutively seemed to follow a 23- and 28-day cycle. Both researchers had been attracted by the fact that a person whose fever would drop, or who resisted a disease at one time, would succumb to high fever or disease at another time. Their extensive publications from 1900 to 1910 sparked the interest of a third researcher, Alfred Teltscher. Teltscher taught engineering and noticed that students' performances on exams seemed to follow a regular pattern. After years of meticulous record keeping, Teltscher reported that a 33-day intellectual cycle existed.

In the book, Is This Your Day?, Thommen (15) reported that, during the 1920s, Judt devised calculation tables to project a person's biological rhythms simply from a birthdate. Thommen elaborated upon the three human cycles developed by Swoboda, Fleiss, and Teltscher, and also upon the calculation tables devised by Judt. The present study was undertaken to investigate the relationship between these calculation tables and athletic performance. More specifically, the experimenter investigated the relationship between college-level track and swimming performances, and the hypothetical rhythms of the individual athletes, as indicated by the tables.

Scope of Problem

The purpose of this investigation was to determine if any significant relationship existed between track or swimming performances and days identified as "positive" or "negative" by biorhythm theory. The study was designed to investigate college-level male athletes during competitive and uncontrolled situations. Subjects utilized for study were 26 male varsity swimmers from the State University of New York (SUNY) at Cortland and Ithaca College, and 27 varsity trackmen from the (SUNY) College at Cortland. Subjects' birthdates, along with the dates of the competitive meets, were analyzed by an Ithaca College computer program designed to show the positions of the physical, emotional, and intellectual cycles for a specific date. Although individual subjects may have competed in more than one event every meet, each subject was tested for only one event, upon random selection by the experimenter. A mean performance time was calculated for each subject. All of a subject's performance times that were higher than the mean were separated from the superior performance times that were below the mean. The chi-square test of independence in contingency tables was utilized to determine the relationship between swimming or track performances and biorhythmic cycles. More specifically, the chi-square test was employed to investigate the increase in predictability of the dependent variable (performance times) when the independent variable (biorhythmic-cycle positions) was known. Each cycle was examined independently for both track and swimming.

Statement of Problem

This study was conducted to determine if any significant relationship existed between the quality of track or swimming performances and days identified as "positive" or "negative" by biorhythm theory, for male college-level swimmers and trackmen, during normal, competitive, and uncontrolled situations.

Theoretical Hypothesis

In the book, Is This Your Day?, Thommen (15) elaborated upon the three human cycles independently discovered by Swoboda, Fleiss, and Teltscher. Fleiss and Swoboda reported that the emotional cycle governed the nervous system, while the physical cycle was responsible for strength, endurance, and energy. Teltscher, a university professor, observed fluctuations in the performances of students that were periodic in nature and asserted that the cycle corresponded with intelligence. Thommen also cited a number of post-hoc cases of superior athletic performances during periods of positive-emotional and/or -physical rhythms. However, during "negative" periods, identified as "recharging" days, the individual may experience lessened physical abilities.

Although these reports were interesting, they were typical of much of the post-hoc analyses and case-study literature supporting biorhythm analysis. More detailed study was necessary to determine if a causal relationship exists between biorhythms and sport performance.

Based upon these and other reports, the experimenter hypothesized that biological rhythms may be a factor in the quality of athletic performance. The sports of swimming and track were selected for study due to the precise nature of performance evaluation. Only subjects competing in events that were measured by time were utilized for investigation. Therefore, it was hypothesized that a significant relationship may exist between track and swimming performances and days identified as "positive" or "negative" by biorhythm calculations. Specifically, there would be an increase in the predictability of the performance times (dependent variable) when the biorhythmic-cycle positions (independent variable) were known.

Assumptions of Study

The following assumptions were drawn for this study:

1. The official timekeepers accurately recorded the performance times for swimming and track subjects.

2. The coaches of the subjects utilized accurately re-recorded the official performance times.

3. The subjects performed to the best of their abilities during the competitive meets used for analysis.

Definition of Terms

The following terms were defined for the purpose of this study:

1. Biological Rhythms. A general scientific term referring to the rhythmic cycles of life.

2. Biorhythms. For the purpose of this paper the theoretical physical, emotional, and intellectual rhythms of human beings that may be calculated from an individual's birthdate according to the theories of

Swoboda, Fleiss, and Teltscher, as described in, Is This Your Day? (15).

3. Circadian Rhythms. Rhythms with a period of approximately 24 hours.

4. Critical Day. Otherwise referred to as a "switch" day. A theoretical time when the individual is prone to accident. Occurs when a person's "positive" cycle changes to a "negative" cycle, or vice-versa (5,15).

5. Diurnal. Rhythms pertaining to the day rather than the night, i.e., the flower that opens in daylight and closes at night.

6. Endogenous. A rhythm maintained from within the organism independently of external stimuli.

7. Entrainment. Property of non-linear oscillators; when two signals with similar rhythms become one.

8. Exogenous. As oppossed to endogenous. Dependent upon rhythmic stimuli from without the organism.

9. Infradian. Cycle spanning more than a 24-hour day, such as the female-menstrual cycle.

10. Negative Day. Theorized as the point in the physical, emotional, or intellectual rhythm when a person is least efficient.

11. Oscillator. Theoretical timing device that transmits stimuli at regular intervals. May be endogenous or exogenous in nature.

12. "Poor" Performance. A definition utilized for

testing purposes. All of a subject's performance times that were above the season mean (his own) were designated to be "poor" performances.

13. Positive Day. Theorized as the point in the physical, emotional, or intellectual rhythm when a person is the most efficient (5,15).

14. "Superior" Performance. A definition utilized for testing purposes. All of a subject's performance times that were below the season mean (his own) were designated to be "superior" performances.

15. Swimmer. For the purpose of this study, all members of the State University of New York at Cortland and Ithaca College men's swimming teams, excluding diving members.

16. Trackmen. All members of the State University of New York at Cortland men's track team, excluding weightmen (events not measured by time).

17. Triple Peak. According to biorhythm theory, the point at which all three of an individual's rhythms are at their peaks at the same time.

18. Ultradian. Cycle with a duration of less than a 24-hour day. Most frequently appear in 90-minute patterns, such as digestion and sleep.

Delimitations of Study

The delimitations were as follows:

1. Male varsity-level swimmers and trackmen from

the State University of New York at Cortland and Ithaca College served as subjects during the 1976-77 winter and spring seasons.

2. Data were gathered under normal, competitive, and uncontrolled situations for Ithaca College and the State University of New York at Cortland varsity-level male swimmers and trackmen during the 1976-77 winter and spring seasons.

Limitations of Study

Generalizations of the results and conclusions for this study are limited due to the facts that subjects were not randomly selected and the data collection was not carried on in a controlled situation.

Chapter 2

REVIEW OF RELATED LITERATURE

The review of related literature was concentrated in the following areas: (1) general research in biological rhythms, (2) sources of oscillators affecting biological rhythms, (3) biorhythm theory and human performance, and (4) criticism of biorhythm analysis.

General Research in Biological Rhythms

The theory of biological rhythms postulated that there are certain life rhythms which are basic to all living organisms. There are rhythms of gravity, light waves, electromagnetic fields, solar rotations, and seasonal changes, which entrain life processes. The living organism has been described as an open system with energy flowing across its boundaries (13).

Brown, Hastings, and Palmer (2:4) stated:

> So ubiquitous is the distribution of persistent processes throughout the living kingdom, that rhythms should probably be considered a fundamental characteristic of life, and should be added, along with such others as metabolism, growth, irritability, reproduction, etc., to the elementary-textbook definition of life.

These rhythms of life tended to be overlooked, and have not until recently been considered fundamental to living systems.

The concept that body functions vary in a 24-hour cycle has been suggested for years. Kleitman (6) gave 1842 as the date of the first systematic study of the circadian variation in body temperature by Gierse. Any number of bodily functions, from body temperature and pulse rate to the level of hormones in the blood, have been found to change regularly within the framework of a daily cycle.

In addition to circadian rhythms, humans undergo other cycles that may take longer or shorter than a single day. The female menstrual cycle, of roughly 28 days, appeared to be the best researched of this infradian cycle. Ultradian cycles have been found to have a duration of less than a day. These cycles most frequently appeared in 90-minute patterns. Digestion and sleep have been found to operate within a 90-minute schedule (6,26).

Other human functions were found to exhibit rhythmic periodicity. Physiological functions as heart rate, blood pressure, blood-hormonal levels, peak-expiratory flow, and body temperature, have displayed rhythmicity (7,10,27,29). Rhythms of physical and intellectual skills have also been assessed through the use of simple tests. Addition speed, logical reasoning short-term memory and time estimation, as well as ratings of mood and vigor, have shown regular cyclic changes (5,12,21,23).

Rhythmometry has become a necessary science in the treatment and therapy of patients. Rhythmic variables have been evaluated, not only for health assessment, but also in order to adjust the kind and timing of treatment, according to their characteristics. For example, the same dose of medication may be too large early in the morning, yet, too small late in the afternoon. The Syracuse Herald American (30:41), quoted Levine, chief of medicine and medical education at New Britain General Hospital, as saying, "When science is more sophisticated about rhythms, the minute data can be reanalyzed and perhaps contribute to a better understanding of the ways our bodies operate in time."

Rhythms have been observed in the process of cell-division and have led scientists to investigate possible cyclic activity in cancer cells. Although rhythmicity in cancer-cell division has since been confirmed (5,30), the periodicity of the rhythms varied widely from case to case. Dale (5) reported an experiment by Halberg and Garcia-Sainz where one subject showed and eight-hour rhythm. Almost invariably these rhythms were non-circadian. However, the experimenters noted that breast-cancer cells appeared to divide concordantly with daily rhythms.

Research into biological rhythms has led to useful discoveries in industry, medicine, psychology, and education. From a new ability to predict epileptic seizures or asthma attacks to better methods of treating manic-depressive patients, the medical profession has already benefitted (5). Industrial management has increased production by scheduling work shifts in tune with intellectual and physical periodicity (12). Through continued research in biological rhythms, the fields of education, medicine, industry, psychology, psychiatry, and biology will become more precise. Hopefully, scientists will also attain a broader perspective of human performance as related to competition and athletics.

Sources of Oscillators Affecting Biological Rhythms

There seemed to be little disagreement between biologists, psychologists, and physiologists that some timing mechanism does stimulate biological rhythms. Ward (16:3) stated, that, "From earliest times it has been known that plants and animals displayed periodically recurring activities." However, the origin and nature of these timing mechanisms have been a source of disagreement among researchers in the field. The two most widely accepted hypotheses considered biological rhythms to be either: (1) endogenous (intrinsic) in origin, that is, the organism may initiate the rhythm, or (2) exogenous (extrinsic) in origin, that is, the environmental rhythm may affect the organism. A third possibility, that appeared to be the most plausible, was that the organism had an endogenous rhythm that was affected by an exogenous rhythm. This was the case of multicellular organisms where the endogenous cell-division cycle was entrained by exogenous 24-hour periodicity.

Bunning (3), after years of research with fruit flies, bees, and plants, concluded that the timing mechanisms of most, if not all, organisms were endogenous in nature. Hastings (2) found that biological systems functioned autonomously as clocks based on physio-chemical cellular mechanism. The seemingly endogenous-menstrual cycle appeared to support the hypothesis of Hastings and Bunning.

The cycle of growth and division of cells has been considered to be one of the fundamental periodicities of living organisms (4). Deoxyribonucleic acid (DNA), in the cell, begins to be replicated at a particular, well-defined time in the overall cell-division cycle. Therefore, there would appear to be a "clock" of some type, an oscillator which completes its circuit once every cell-division cycle (4,5). This oscillator would appear to be endogenous in nature.

Wernli (17) speculated a possible biological relationship between the cerebral-cortex cell-division cycle, in the embryo, and the 33-day intellectual cycle, as reported by Thommen (15). Wernli (17:47) stated, "the 9,000,000,000 pyramidal cells of the cerebral cortex in the embryo are formed after exactly 33-cell divisions, and they determine the mental powers of man for the rest of his life." Although some relationship may exist, the connection of this process with the biorhythmic-number 33 has not been confirmed.

According to other theorists (2), biological rhythms were the result of the capability of an organism to receive timing information from the environment. Strughold (14), the "father of space medicine," was a proponent of the external-timer theory. Strughold found changes in physiological rhythmicity as a result of airplane and aerospace flights.

After three decades of researching biological rhythms with plants and animals, Brown (2) concluded that there was not sufficient evidence to exclude either the endogenous or exogenous theories. Brown postulated that perhaps an internal oscillator existed that is also subject to entrainment by an external "master clock." Ward (16) reported that Thompson, an internationally reknowned authority on biological rhythms, asserted that rhythmic activity could be explained in three ways. The organism could either have learned the rhythm, inherited the rhythm, or be reacting to cosmic stimuli.

Many physiological rhythms have persisted even after the exclusion of obvious environmental factors. Richelle (28) reported that a French speleologist spent several periods in a cave, wired for the measurement of a variety of physiological responses. In one test lasting 58 days, 57 periods of sleep and waking were noted although the subject was isolated from the cycles of day and night.

Mills (11) reported a dissociation among normally endogenous, physiological rhythms, due to an entraining-environmental influence. After being placed in a space-capsule simulator, one subject displayed a constant rhythm from the adrenals and kidneys, while body temperature lost its periodicity. Mills also asserted that, although the pulse rate has been held to be environmental in origin, there has been some evidence of an endogenous oscillator. Although the pulse rate has been primarily subject to skeletal-muscle movements, airline pilots have displayed slower pulse rates at times when the subjects would normally be sleeping.

There appeared to be little question that the organism was affected by internal as well as external stimuli. There seemed to be some debate over the alternatives, but for the case of some circadian rhythms, at least, the periodicities were generated within the organism, independently of environmental stimuli. However, Oatley and Goodwin (13) asserted that the evolutionary origin of the behavioral rhythm is to be found in the adaptive response of the organism to environmental rhythms. The entraining tendency of environmental stimuli appeared to stress the dominance of exogenous stimuli.

Biorhythm Theory and Human Performance

In the book, Is This Your Day?, Thommen (15) reported the discoveries of an infradian cycle by Fleiss and Swoboda. In the late 19th century, Fleiss, through extensive study, tedious recordings, and numerous calculations, identified a 28-day "emotional" cycle. Independently of Fleiss, Swoboda reported the same findings, and agreed that the 28-day cycle seemed to govern the nervous system, and was responsible for emotions, feelings, intuitions, cheerfulness, and creativity.

Becker, Bachman, and Friedman (19) found a definite cyclic pattern evident in four-psychiatric patients, with a periodicity of approximately 28 days. The experimenters postulated the likelyhood that the organized DC activity of the brain was in some way closely related to general behavior.

Thommen (15) also reported that Swoboda, a psychologist, observed a 23-day cycle in which patients showed a greater physical resistance. Fleiss, a medical doctor, observed periodic changes in fevers, heart attacks, and respiratory diseases. This cycle has been regarded as the physical cycle responsible for physical strength, endurance, energy, resistance, and confidence.

Thommen (15) cited Teltscher, a university professor, as discovering a 33-day cycle associated with intelligence. Teltscher observed fluctuations in the performances of students, that were periodic in nature. The 33-day cycle was proported to correspond to intelligence, memory, mental alertness, logic, and judgement.

Thommen (15) elaborated upon the three cycles identified by Swoboda, Fleiss, and Teltscher. The first half of a particular cycle were "discharge" days, while the second half were identified as "recharging" days. For example, a person should be at one's best for the first 11 1/2 days of his physical cycle, whereas a lower physical performance should be expected during the last 11 1/2 days. Thommen further identified "critical" days, that is, the days in which the cycles switch from positive to negative energies, and vice-versa. Birthdates were the starting point for biorhythms. Thommen (15) included calculation tables, that were reportedly devised by Judt, which projected from a birthdate the biorhythms of a person on a particular day. The cycles reported by Thommen, and the Judt formula, have led to a number of investigations of biorhythms and human performance.

Using biorhythm analysis, Schnepper (37) predicted the final grades of students on a final examination. Along with three other accounting teachers, Schnepper developed a "biocurve" for each student. Of 14 students experiencing triple peaks, 10 exceeded expectations by more than 10 points. Of nine students with triple-low rhythms, all nine were at least 10 points below teacher expectations. Schnepper concluded that biorhythm analysis was able to predict performance.

Zito (33) reported that Washington National Airport has charted biorhythms for its grounds crew since 1973. Supervisors cautioned employees to be more careful on critical days. Accidents were reportedly cut in half. The author also cited many similar accident reductions by companies, such as, Trans-World Airlines, Truck Underwriter's Association, and Allstate Insurance Company. Lewis (25) reported similar findings. A number of European airlines with impressive safety records have been using biorhythm analysis for over 20 years. No two pilots experiencing critical days were scheduled to fly together. Lewis also reported that a Tokyo taxi-cab company has reduced accidents 60 percent, by giving drivers a reminder on critical days.

Anderson (18), a consultant for the American Board of Industrial Hygiene, studied 300 accident victims, and found that 70 percent of the accidents occurred when the bio-curves of the victims indicated a critical day. Anderson also asserted that critical days were identifiable by changes in mood, physical capabilities, and mental capacities.

Klug (34) investigated the relationship between critical days and the dates of athletic injuries for 80 university athletes. A chi square-analysis revealed that no significant relationship existed between the dates of occurrence of an injury and critical days.

Wallerstein and Roberts (32) plotted team bio-curves for the 1972 season of the Los Angeles Rams. Defensive and offensive predictions for the season were correct with only one exception. A post-hoc analysis revealed that Franco Harris, of the Pittsburgh Steelers, was in a triple peak when Harris was credited with the "play of the century," during the Atlantic Football Conference playoffs. Harris was experiencing a triple low just two weeks earlier, and failed to rush 100 yards for the first time in seven weeks, against Houston, one of the weakest teams in the league.

Although these were interesting findings, they were typical of much of the post-hoc analyses and case-study literature supporting biorhythm analysis. More detailed study was needed to determine if a causal relationship exists between biorhythms and sport performances. In similar criticism, Wallerstein and Roberts (32) questioned the validity of their own investigations. It was feasible that triple peaks signaled the likelihood, rather than a guarantee, that a superior performance would occur.

Wallerstein and Roberts (32) concluded that above average performances could be expected when two or more curves were above the midpoint. When two or more curves were below the midpoint, below average performances could be expected. Consistent superior performances resulted when all three curves formed a triple peak. Finally, when all three curves were at a triple-critical level, persons were most vulnerable to failure. The authors summarized that while the basic tenents of biorhythmic analysis appeared oversimplistic, they were able to predict performances with "amazing" success.

Criticism of Biorhythm Analysis

Biorhythm analysis as purported by Thommen (15) has received some very strong criticism from some current researchers of biological rhythms. Zito (33:16) cited that Pittendrigh, a Stanford University biological sciences professor, considered "biorhythms," "an utter, total, unadulterated fraud." Luce (8) stated, "Fleiss' blatantly unsophisticated understanding of simple mathematics was evidenced in his formula, which was transparent junk." On the other hand, Brown (2), the Director of the National Institute for Mental Health, asserted that biorhythms appeared to have substantial validity.

After reviewing much of the current physiological, biological, psychological, and medical research on biological rhythms, there has been little question that life rhythms do exist, and do affect the human organism. In problems of human performance, one needs to be aware of them and their properties, in order to take advantage, or at least not to be put at a disadvantage, by these periodicities. The validity of the "biorhythm theory," as proported by Thommen (15) appeared to be in dire need of research based data. Many of the claims that have been made lack this form of support and seemed to hurt the science of biological rhythms.

Chapter 3

METHODS AND PROCEDURES

This chapter outlines the procedures used in gathering the data for this study. Specifically, this chapter deals with the following topics: (1) selection of subjects, (2) methods of data collection, (3) scoring of data, (4) treatment of data, and (5) summary.

Selection of Subjects

This study was conducted during the Spring term of 1977. Subjects utilized were 26 male varsity swimmers from the State University of New York (SUNY) at Cortland and Ithaca College. Also, 27 varsity trackmen from the SUNY at Cortland were employed. Weightmen and divers were not utilized for study. Only team members that competed in events measured by time were utilized. Eliminated from data collection were athletes not competing in two or more season meets.

Methods of Data Collection

Swimming subjects competed during the winter of 1976-77 and track subjects competed during the spring of 1977. Prior to their respective seasons, the experimenter approached each subject and verbally collected and recorded their birthdates. The coaches of each team accepted the responsibility of collecting the official performance times of each subject for every scheduled meet. During each track or swimming meet, the home team was responsible for supplying official scorekeepers. The coaches collected the official times for every competitor from the scorekeepers and recorded them in the team scorebook. Then, at the finish of each respective season, the experimenter collected the data by re-recording the official times from the coaches' scorebooks.

Scoring of Data

As reported by Thommen (15), calculation tables were developed by Judt, in order to facilitate the computation of a person's physical, emotional, and intellectual rhythms. In order to calculate the position of an individual's rhythms for a particular date, it was necessary to divide the total number of days from birth by the length of the cycle. For example, a person wanting to know one's biorhythms for October 1, 1972, having been born on August 10, 1940, would divide the total number of days since birth (11,741) by 23, and find that the person had completed 510 cycles with a remainder of 11 days. The subject would be in the 11th day of the physical cycle.

The tables by Judt were designed with a relationship between the day of birth, the year of birth, and the day of the event in question. Each table provided the researcher with one value for each cycle. A value for the person's birth year was provided in the first table. The second table provided a value for the person's birthdate. These values remained constant. The third table provided the individual with a single value for the first day of the month in question. The values of all three tables were then added and the total divided by the number of days in a particular cycle. This final value indicated the number of cycles completed with a remainder. This remainder was the position of the cycle in question on the first day of that particular month (15).

A biorhythm computer program was developed by Plank (36), an Ithaca College physical education graduate assistant, and Morris (35), to aid in the calculations. Plank reported that necessary information and directions were drawn from Thommen (15) and Wernli (17).

Plank (36) asserted that the reliability of the program was checked by testing 25 birthdates and event dates. The cycles for these events were calculated by hand and computed by the program. For example, Plank may have calculated by hand the rhythms of a person born June 26, 1951 for a predicted date of May 29, 1977, and found that the person was at a positive point in the physical cycle and a negative point in the emotional cycle. Then the same birthdate and event-date information was punched on program cards, added to the stack of biorhythm-program cards, the whole submitted to the computer, and the findings were compared. The computer readout also showed the test subject to be at a positive point in the physical cycle and a negative point in the emotional cycle. After comparing 25 birthdates and event dates, calculated by hand and computed by the program, the correlation was 1.00 and the program was determined to be reliable.

The data cards for the computer program included the following information: (1) subject number, (2) birthdate of the subject, (3) date of event, (4) distance of the event, and (5) finishing time. A data card was made for every performance date of each subject. A subject competing in 12 meets had 12 separate data cards. Upon execution of the program, the computer readout indicated the following: (1) subject's number, (2) each cycle's name and the position of the curve in integer form, plus one of the three signs, positive (+), negative (-), or critical (X), (3) the day of the event, (4) finishing time, and (5) the distance of the event. The integer stood for the number of days that the subject had been in a particular cycle.

For an illustrated comparison of the computer readout and hand-calculated emotional rhythm for swimming-subject number one, the reader may turn to Table 1 (p. 27). The birthdate of subject one was February 22, 1956. The computer readout displayed two predicted event dates of January 18 and January 29 of 1977. The computer readout for the emotional cycle indicated that from the birthdate of February 22, 1956 to January 18, 1977 subject

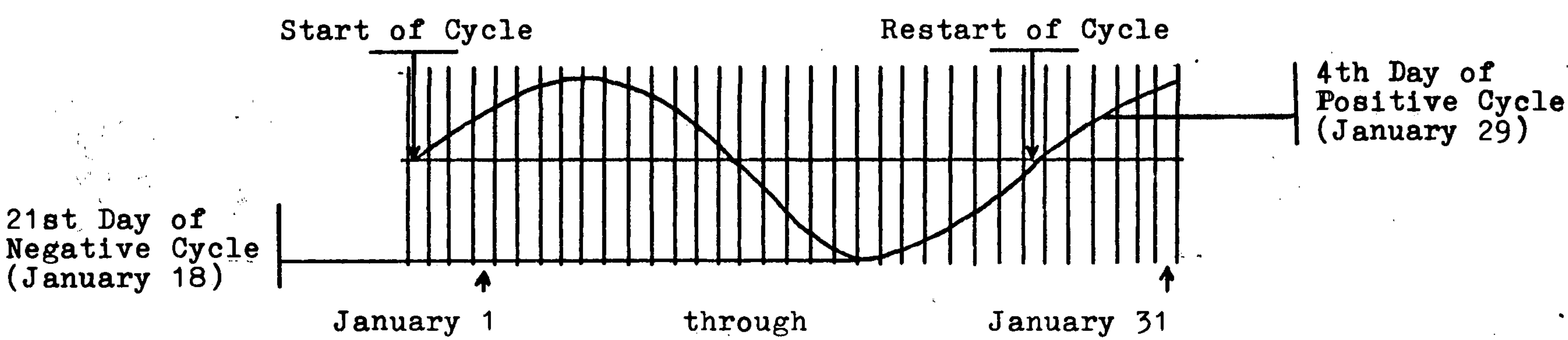
Table 1

Comparison of Computer Readout and Hand-Calculated
Emotional Rhythm for Swimming-Subject Number One

Computer Readout, Subject One
Day of Birth 2/22/56

Subject 1	Cycle 23	Day in Cycle 1X	Day of Event 1/18/77	Time 2:11.4	Event 200 BS
Subject 1	Cycle 28	Day in Cycle 21-	Day of Event 1/18/77	Time 2:11.4	Event 200 BS
Subject 1	Cycle 33	Day in Cycle 14+	Day of Event 1/18/77	Time 2:11.4	Event 200 BS
Subject 1	Cycle 28	Day in Cycle 4+	Day of Event 1/29/77	Time 2:13.3	Event 200 BS

Hand-Calculated Emotional-Cycle Chart
Month of Events, January 1977
Subject One



one had completed "X" number of 28-day cycles with a remainder of 21 days. The 21st day of the cycle was in the negative area and was, therefore, denoted "21-." The cycle restarted on January 26, a critical day, and was in the fourth day of the positive-emotional cycle on January 29.

Treatment of Data

To test the null hypotheses, the experimenter selected one event to be tested for each subject. Many subjects competed in two or more events during every meet. The event that was performed the greatest number of times was the basis for selection. When two or more events were performed an equal number of times, a random-numbers table was utilized for an unbiased selection.

The physical, emotional, and intellectual cycles were tested independently. Also, swimming and track performances were independently tested.

A computer readout for each subject indicated each cycle by name, the dates of every meet in which the subject competed, and the position of the cycle for each meet date (Table 2, p. 29). A mean score was calculated for each subject and are presented in Tables 3 and 4 (pg. 33 and 34). For each competitor, event times that were higher than the mean were designated to be "poor" times. Scores that were lower than the mean were considered to be "superior" event times.

Table 2

Example Data on Physical Cycle for Track-Subjects One and Two

Subject	Birthdate	Event Dates	Position of Cycle	Time in Seconds	Mean Score	Evaluation of Scores	Event
S_1	01/28/54	04/16/77	Negative	117.40	118.64	Superior	880-Yards
		04/20/77	Negative	116.90	118.64	Superior	
		04/23/77	Negative	121.30	118.64	Poor	
		04/30/77	Positive	119.10	118.64	Poor	
		05/04/77	Positive	119.50	118.64	Poor	
		05/07/77	Negative	118.20	118.64	Superior	
		05/14/77	Negative	118.10	118.64	Superior	
S_2	09/18/56	04/16/77	Negative	010.41	010.41	None	100-Yards
		04/20/77	Negative	010.50	010.41	Poor	
		04/23/77	Positive	010.47	010.41	Poor	
		04/30/77	Positive	010.29	010.41	Superior	
		05/04/77	Critical	010.32	010.41	Superior	
		05/07/77	(Did not	compete)	010.41	None	
		05/14/77	Negative	010.44	010.41	Poor	

The chi-square test for independence in contingency tables was selected to determine if there was any relationship between biorhythmic positions and swimming or track performances. More specifically, the chi-square test determined if a significant relationship existed between a a positive-biorhythmic position and the lower, "superior" times, or between a negative-biorhythmic position and the higher, "poor" times. Chi-square values were calculated for each hypotheses.

Summary

Subjects utilized for this investigation were 26 male varsity swimmers from the SUNY at Cortland and Ithaca College, and 27 varsity trackmen from the SUNY at Cortland. Subjects' birthdates, along with the dates of the competitive meets, were analyzed by an Ithaca College computer program designed to show the positions of the physical, emotional, and intellectual cycles for a specific date. Although individual subjects may have competed in more than one event every meet, each subject was tested for only one event, upon selection by the experimenter. A mean-performance time was calculated for each subject. All of a subject's performance times that were higher than the mean were separated from the "superior" times that were below the mean. The chi-square test of independence in contingency tables was utilized to determine the relationship between swimming or track performances and biorhythmic-cycle positions. More specifically, the chi-square test was employed to investigate the increase in predictability of the dependent variable (performance times) when the independent variable (biorhythmic-cycle positions) was known. The .05 level of significance was selected.

Chapter 4

ANALYSIS OF DATA

The purpose of this investigation was to determine if any significant relationship existed between track or swimming performances and days identified as "positive" or "negative" by biorhythm theory. The results of the study are presented in this chapter. Results obtained included means for the performance times of each track and swimming subject, and the analyses of the 'superior' and 'poor' performances as related to the "positive" and "negative"-biorhythmic positions for each subject. Each null hypothesis will be presented followed by the results of the chi-square analysis for statistical significance. The topics will be presented in the following order: (1) the null hypotheses and results for track subjects, (2) the null hypotheses and results for swimming subjects, and (3) summary of results.

Null Hypotheses and Results for Track Subjects

1. There will be no significant difference between the quality of track-running performances and days identified as "positive" or "negative" by the position of a performer's physical rhythm.

Individual-mean scores and events were calculated (see Table 3, p. 41). The obtained frequencies for the

Table 3

Mean Scores and Events
of Track Subjects
(Mean in Seconds)

Subject	Mean	Event	Subject	Mean	Event
S_1	118.64	880-yd. run	S_{15}	271.18	mile run
S_2	010.41	100-yd. dash	S_{16}	267.50	mile run
S_3	023.17	220-yd. run	S_{17}	271.14	mile run
S_4	051.24	440-yd. run	S_{18}	051.73	440-yd. run
S_5	120.30	880-yd. run	S_{19}	056.93	440-inter. h.
S_6	015.53	120-high hurd.	S_{20}	010.62	100-yd. dash
S_7	014.91	120-high hurd.	S_{21}	010.42	100-yd. dash
S_8	912.55	3-mile run	S_{22}	265.44	mile run
S_9	014.59	hurdle relay	S_{23}	115.81	880-yd. run
S_{10}	886.09	3-mile run	S_{24}	010.09	100-yd. run
S_{11}	056.80	440-inter. h.	S_{25}	1930.82	3-mile run
S_{12}	023.53	mile relay	S_{26}	010.41	100-yd. dash
S_{13}	114.34	880-yard run	S_{27}	909.97	mile run
S_{14}	864.79	3-mile run			

chi-square test in contingency tables and the results were calculated (see Table 4).

Table 4

Comparison of the Physical Cycle to the Quality of Track Performances and Statistical Results

Quality of Performance	Position of Cycle		Statistical Results			
	Positive	Negative	N	df	p	X^2
Superior	38	38	155	1	.05	.00573
Poor	38	41				

The numbers in the contingency table above represent the frequency of cases jointly satisfying a particular set of conditions specified by the variables, namely, "superior" or "poor" performances, across two categories, positive- and negative-physical cycles. The chi-square value for track-running performances as related to the physical cycle was .0057. At the .05 level of significance with one degree of freedom a chi-square value of 3.84 was needed to attain significance. Therefore, the null hypothesis was accepted.

2. There will be no significant relationship between the quality of track-running performances and days identified as "positive" or "negative" by the position of

a performer's emotional rhythm.

Individual-mean scores and events are presented in Table 3 (p. 33). The obtained frequencies for the chi-square test in contingency tables and the statistical results are presented in Table 5.

Table 5

Comparison of the Emotional Cycle to the Quality of Track Performances and Statistical Results

Quality of Performance	Position of Cycle		Statistical Results			
	Positive	Negative	N	df	p	X^2
Superior	42	43	160	1	.05	.10039
Poor	38	37				

The numbers in the contingency table above represent the frequency of cases jointly satisfying the conditions specified by the variables. The chi-square value for track-running performances as related to the emotional cycle was .10039. At the .05 level of significance with one degree of freedom a chi-square value of 3.84 was necessary for significance. Therefore, the null hypothesis was accepted.

3. There will be no significant relationship between the quality of track-running performances and days

identified as "positive" or "negative" by the position of a performer's intellectual rhythm.

Individual-mean scores and events are presented in Table 3 (p. 33). The obtained freauencies for the chi-square test in contigency tables and the statistical results are presented in Table 6.

Table 6

Comparison of the Intellectual Cycle to the Quality of Track Performances and Statistical Results

Quality of Performance	Position of Cycle		Statistical Results			
	Positive	Negative	N	df	p	X^2
Superior	45	34	154	1	.05	1.2473
Poor	35	40				

The numbers in the contingency table above represent the frequency of cases jointly satisfying a particular set of conditions specified by the variables, namely, "superior" or "poor" performances, across two categories, positive- and negative-intellectual cycles. The chi-square value for track-running performances as related to the intllectual cycle was 1.2473. At the .05 level of significance, with one degree of freedom, a chi-square value of 3.84 was needed to attain significance.

Therefore, the null hypothesis was accepted.

Null Hypotheses and Results for Swimming Subjects

4. There will be no significant relationship between the quality of swimming performances and days identified as "positive" or "negative" by the position of a performer's physical rhythm.

Individual-mean scores and events are presented in Table 8 (p. 38). The obtained frequencies for the chi-square test in contingency tables and the results are recorded in Table 7.

Table 7

Comparison of the Physical Cycle to the Quality of Swimming Performances and Statistical Results

Quality of Performance	Position of Cycle		Statistical Results			
	Positive	Negative	N	df	p	X^2
Superior	57	64	245	1	.05	2.1452
Poor	69	62				

As in the previous tables, the numbers in the contingency table represent the frequency of cases jointly satisfying a particular set of conditions specified by the

Table 8

Mean Scores and Events
of Swimming Subjects
(Mean in Seconds)

Subject	Mean	Event	Subject	Mean	Event
S_1	136.90	200-backstroke	S_{14}	024.34	50-freestyle
S_2	061.54	400-medley relay	S_{15}	323.90	500-freestyle
S_3	055.27	100-freestyle	S_{16}	160.83	200-breaststroke
S_4	024.75	50-freestyle	S_{17}	023.05	50-freestyle
S_5	140.17	200-I. M.	S_{18}	136.52	200-I. M.
S_6	023.52	50-freestyle	S_{19}	122.03	200-backstroke
S_7	126.35	200-I. M.	S_{20}	116.91	200-freestyle
S_8	136.44	200-backstroke	S_{21}	052.94	100-freestyle
S_9	345.27	500-freestyle	S_{22}	139.97	200-butterfly
S_{10}	050.39	100-freestyle	S_{23}	153.52	200-breaststroke
S_{11}	118.94	200-freestyle	S_{24}	146.22	200-breaststroke
S_{12}	025.14	50-freestyle	S_{25}	133.59	200-I. M.
S_{13}	114.10	200-freestyle	S_{26}	023.97	50-freestyle

variables. For instance, given the contingency of performing below one's mean time in a swimming event (a "superior" performance) during a positive-physical cycle, 57 swimmers out of 245 subjects are to be found (see Table 8, p. 38). The chi-square value for swimming performances as related to the physical cycle was 2.1452. At the .05 level of significance, with one degree of freedom, a chi-square value of 3.84 was necessary for significance. The null hypothesis that no significant relationship exists between the quality of swimming performances and days identified as "positive" or "negative" by the position of a performer's physical rhythm was therefore accepted.

5. There will be no significant relationship between the quality of swimming performances and days identified as "positive" or "negative" by the position of a performer's emotional rhythm.

Individual mean-scores and events for swimming subjects are presented in Table 8 (p. 38). The obtained frequencies for the chi-square test in contingency tables were tallied and tested for significance (see Table 9, p. 40).

The numbers in the contingency table (see Table 9, p. 40) represent the frequency of cases jointly satisfying the conditions of performance quality and the position of the swimmers' emotional cycles. The chi-square value for swimming performances as related to the emotional cycle was 1.6191. At the .05 level of significance, with one degree of freedom, a chi-square value of 3.84 was necessary to attain significance. The null hypothesis was accepted.

Table 9

Comparison of the Emotional Cycle to the Quality of Swimming Performances and Statistical Results

Quality of Performance	Position of Cycle		Statistical Results			
	Positive	Negative	N	df	p	X^2
Superior	67	62	239	1	.05	1.6191
Poor	53	59				

6. There will be no significant relationship between the quality of swimming performances and days identified as "positive" or "negative" by the position of a performer's intellectual rhythm.

Mean scores and events were recorded (see Table 8, p. 38). The obtained frequencies for the chi-square test in contingency tables were tallied in relationship to the individual means. For example, a performance that had a higher time than the individual's mean time was tallied as a "poor" time. This evaluation was tallied according to the position of the subject's intellectual cycle (see Table 10, p. 41).

Table 10

Comparison of the Intellectual Cycle to the Quality of Swimming Performances and Statistical Results

Quality of Performance	Position of Cycle		Statistical Results			
	Positive	Negative	N	df	p	X^2
Superior	65	63	243	1	.05	.4408
Poor	59	56				

The chi-square value for swimming performances as related to the intellectual cycle was .4408. At the .05 level of significance, with one degree of freedom, a chi-square value of 3.84 was necessary for significance. The null hypothesis was accepted.

Summary of Results

The purpose of this investigation was to determine if any significant relationship existed between track or swimming performances and days identified as "positive" or "negative" by biorhythm calculation. Each subject was tested for one competitive event. A mean performance time was calculated for each subject. All of a subject's performance times that were higher than the mean were considered to be "poor" times, while performance times that were lower than the mean were designated "superior" times. Each cycle was tested independently for both track and swimming.

The chi-square test of independence in contingency tables was utilized to determine the relationship between swimming or track performances and biorhythmic cycles. More specifically, for each individual cycle, the chi-square test was employed to determine if a significant relationship existed between a positive-biorhythmic position and the lower, "superior" times, or between a negative-biorhythmic position and the higher-performance times. The increase in predictability of the dependent variable was investigated when theindependent variable was known.

The chi-square values for the physical, emotional, and intellectual cycles of track subjects were .006, .100, and 1.247, consecutively. The chi-square values for the physical, emotional, and intellectual cycles of the swimming subjects were 2.145, 1.619, and .441. At the .05 level of significance, with one degree of freedom, a chi-square value of 3.84 was necessary for statistical significance. Therefore, all of the null hypotheses were accepted.

Chapter 5

DISCUSSION OF RESULTS

This chapter includes a discussion and interpretation of the results reported in Chapter four. The biorhythm results for swimming and track performances will be discussed.

From the results of statistical analysis, it would appear that no relationship existed between any one of the individual biorhythmic cycles and swimming or track performances, and that the null hypotheses were true. The chi-square values for the physical, emotional, and intellectual cycles of the track subjects were .006, .100, and 1.247, consecutively. Chi-square values for the physical, emotional, and intellectual cycles of the swimming subjects were 2.145, 1.619, and .441. At the .05 level of significance, with one degree of freedom, a chi-square value of 3.84 was necessary for significance.

Chapter 6

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS FOR FURTHER STUDY

The following areas are discussed in this chapter: (1) summary, (2) conclusions, and (3) recommendations for further study.

Summary

This study investigated the relationship between track or swimming performances and days identified as "positive" or "negative" by biorhythm theory. College-level male athletes were studied during normal, competitive, and uncontrolled situations. Subjects utilized were 26 male-varsity swimmers from the State University of New York (SUNY) at Cortland and Ithaca College, and 27-varsity trackmen from the SUNY at Cortland. Subjects' birthdates, along with the dates of the competitive meets, were analyzed by an Ithaca College computer program designed to show the positions of the three biorhythmic cycles for a specific date.

Although individual subjects may have competed in more than one event during each meet, each competitor was tested for only one event, upon random selection by the experimenter. A mean-performance time was calculated for each subject. All of a subject's performance times that were higher than the mean were separated from the superior performance times that were lower than the mean.

The chi-square test for independence was employed to determine if a relationship existed between a positive-biorhythmic position and the lower, "superior" times, or between a negative-biorhythmic position and the higher performance times. Each cycle was examined independently for both track and swimming subjects. Chi-square values of .006, .100, and 1.247 for the physical, emotional, and intellectual cycles of track subjects, and 2.145, 1.619, and .441 for the biorhythmic cycles of swimming subjects indicated that no statistically significant relationship existed between biorhythm theory and these sport-specific performances. At the .05 level of significance, with one degree of freedom a chi-square value of 3.84 was necessary for significance. The null hypotheses were accepted and the conclusion was drawn that no statistically significant relationship existed between any one of the biorhythm cycles and swimming or track performances.

Conclusions

In view of the results presented, and within the limitations of this study, the conclusion was drawn that no significant relationship exists between biorhythm theory and college-level swimming or track performances. However, the validity of biorhythm theory and calculation should not be totally discounted on the basis of one experiment. The purpose of this study was to investigate the relationship between biorhythm theory and swimming- or track-athletic performances during normal, competitive, and uncontrolled test conditions. Under these conditions, any significant relationship would be invaluable information to the athlete and coach.

The design of this study may not have been adequately limited to be sensitive to real differences between performances on positive days as compared to performances on negative days. In more stringent tests of biological rhythms, the sleeping and eating cycles of the subjects are among the first factors to be controlled. There is little question that the sleeping and eating habits of the college athlete are, at the least, sporadic. Also, the recording of performance-time data may not have been sufficiently precise. Track times, for example, possibly should have been recorded to the hundreth of a second. Finally, the athletes may not have competed to the best of their abilities during less competitive meets, or against less competitive or highly superior individual competition.

The nonparametric, chi-square statistic may lack the power to detect statistical significance in such an uncontrolled study. Although it is doubtful that the extremely low chi-square values that were obtained would have shown a significant relationship under a different test, a stronger statistical tool is recommended for further study.

Proponents of biorhythm theory have made a significant number of empirical claims about the practicality of using biorhythm theory and calculations as an aid in everyday living. There is a substantial market for biorhythm-pocket calculators and fifty-cent slot machines that provide the customer with superior foresight in business dealings, etc. These promoters have a major sales asset in the obvious and precise timing of nature. Many of the circadian- and ultradian-biological rhythms have been scientifically researched by the fields of medicine, psychology, and physiology, to name just a few. There are innumerable paths and methods of investigating the interesting and essential domain of biological rhythms. It is "high time" that the proponents of the infradian cycles of "biorhythm theory" support the hypotheses with researched based data. By discovering the precise timing of nature's rhythms, the scientist, and possibly even the athletic coach, will be better prepared to acknowledge and obey those rhythms, resulting in superior treatments and performances.

Recommendations for Further Study

The following recommendations for further study of biorhythm theory are suggested:

1. This study should be repeated with some minor changes. The problem would be to determine if any significant-performance differences existed on days

identified as "negative" as compared to days identified as "positive" by biorhythm calculation for swimmers and/or trackmen. By collecting data from a larger number of athletes, the experimenter could utilize subjects that are all performing the same task, for example, 30 subjects performing the 100-yard dash. This would allow the experimenter to employ a stronger statistical tool, such as analysis of variance.

2. A long range study of accidents in the elementary school would be interesting and possible valuable as a method of accident reduction in the school. Independent reports by Zito (33) and Lewis (25) claimed that accidents were cut in half, or better, by a number of American and European industries, by simply cautioning employees to be more careful on "critical" days. The resourceful elementary-school physical-education teacher could provide a test group with knowledge of individual biorhythms, warn the students to be more careful on "critical" and/or "negative" days, and compare accident reports over a five-year period. All accident reports should contain birthdates and careful attention should be paid to the type of accident. Was the accident self-induced or were two people involved?

3. A better indication of the relationship between biorhythm theory and athletic performance may be obtained by employing a variety of testing methods. The performances of basketball players, for example, may be

more accurately determined by testing the athlete, the coach, and the game statistics. A "mood" questionaire could be developed and taken by the athletes two hours prior to the contest. The coach and the athlete could fill out overall-performance questionaires after each game. Finally, the actual statistics of each athlete could be evaluated. A design as this would require a more advanced technique of determining statistical significance and would be superior to the simple performance-testing design.

4. Many intervening variables could be eliminated by testing the relationship between the physical and/or emotional cycle and a direct athletic performance such as weightlifting. By testing competitive weightlifters, the experimenter may be afforded the luxury of having subjects with relatively consistent eating, sleeping, and activity habits. Also, competitive weightlifters perform only a small number of lifts, and keep precise, day-to-day measurements of those lifts.

5. Much of the research and general literature on biorhythm theory has presented post-hoc, after the fact, experiments. It is suggested that an experiment utilizing biorhythm calculation to predict performance, before the fact, would be more meaningful and a great contribution to the growing field of biological rhythms.

APPENDICES

APPENDIX A

1977 Men's Track Schedule for (SUNY) College at Cortland

Event Dates
04/16/77
04/20/77
04/23/77
04/30/77
05/04/77
05/07/77
05/14/77

APPENDIX B

1976-77 Swimming Schedules for (SUNY) College at Cortland and Ithaca College

(SUNY) College at Cortland	Ithaca College
12/01/76	01/15/77
12/04/76	01/18/77
12/08/76	01/22/77
12/11/76	01/24/77
01/22/77	01/26/77
01/26/77	01/29/77
01/29/77	02/02/77
02/02/77	02/09/77
02/12/77	02/12/77
02/16/77	02/15/77
02/23/77	02/26/77

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