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The Relationship of Biorhythm to the Occurrence and Severity of Athletic Injuries

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THE RELATIONSHIP OF BIORHYTHM TO THE OCCURRENCE AND SEVERITY OF ATHLETIC INJURIES

by

Craig Martin Rand

An Abstract

of a project submitted in partial fulfillment

of the requirements for the degree of

Master of Science in the School

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and Recreation at

Ithaca College

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Project Advisor: Dr. Veronica L. Eskridge

ABSTRACT

The purpose of this investigation was to determine if the occurrence and/or severity of athletic injury is significantly related to the position of the injury date on the biorhythm cycles. Subjects for this investigation were all male varsity football players who reported an athletic injury during the 1972 through 1976 seasons at Ithaca College. Information about the nature of the injuries were taken from the records of the head athletic trainer and birthdates were obtained from the Ithaca College registrar's office. The dates were analyzed by means of a computer program designed for calculating the position of the physical, emotional, and intellectual biorhythm cycles in numerical form for the dates of interest. The data were then submitted to a CROSSTABS program from the Statistical Package for the Social Sciences. A .05 level was selected for ascertaining significance. Three goodness of fit chi-squares were calculated for occurrence of athletic injuries by position on each biorhythm cycle to determine if any significant relationship exists. The chi-square values for the emotional cycle ($X^2(2) = .27$) were found to be statistically not significant. The chi-square values for the physical ($X^2(2) = 14.26$) and the intellectual ($X^2(2) = 19.28$) cycles were found to be statistically significant. Two-way chi-squares were also calculated for severity of

athletic injury by position on the biorhythm cycle to determine if any significant relationship exists. The chi-square values for the physical ($X^2(2) = .363$) and the intellectual ($X^2(2) = 1.04$) cycles were found to be statistically not significant. The chi-square value for the emotional cycle ($X^2(2) = 6.02$) was statistically significant at the .05 level. The investigation of the rejected null hypotheses indicates that much of the statistical significance is located on the critical days. For injury occurrence, the critical days of the physical and intellectual (not of the emotional cycle) yielded more injuries than would have been expected. Conversely, for seriousness of injury, the critical days of the emotional cycle alone yielded more serious injuries, though not minor injuries, than would be expected.

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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

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by
Craig Martin Rand

August 1984

Ithaca College
School of Health, Physical Education and Recreation
Ithaca, New York

CERTIFICATE OF APPROVAL

MASTER OF SCIENCE PROJECT

This is to certify that the Master of Science Project of

Craig Martin Rand

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 Program in Physical Education: _____

Dean of Graduate Studies: _____

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Chapter 1

INTRODUCTION

The concept that all life is influenced by some internal and/or external life rhythms has been studied for more than a century. Biorhythm theory is one approach to explaining and identifying these life rhythms. The application of biorhythm theory to explain human behavior has been made since the early 1900's. Only in the last 15 years has the concept really begun to gain support and today its use can be found in airlines, industry, athletics, and the day-to-day routines of countless people (Thommen, 1976).

Huygens, in the early 18th century, observed that when two clocks that run separately at different speeds were both hung on the same wooden board, eventually they became synchronized and kept the same time. Huygens labeled this as entrainment: the coming together of two different rhythms to form one identical rhythm (Oatley & Goodwin, 1971).

Another early attempt at explaining the rhythms which influence humans was the 24-hour circadian rhythm theory. Kleitman (1963) explained the 24-hour circadian rhythm theory as the physiological activities of the human body that are influenced by a constant 24-hour rhythmical cycle.

The present theories represent biorhythms as life rhythms. Every human is said to be influenced by three

biorhythm cycles: physical, emotional, and intellectual. Gittleson (1975) explained the three cycles as they theoretically exist today. The physical cycle is 23 days long and affects resistance to disease, strength, coordination, speed, and other basic body functions. The emotional cycle is 28 days long and governs sensitivity, creativity, mood, mental health, and perceptions of self. The intellectual cycle takes 33 days to complete and regulates memory, alertness, and the logical processes of the mind.

In theory, at birth each cycle starts at a baseline. It then climbs in the positive sphere--the sphere in which the abilities associated with each cycle have a positive influence on the individual. After reaching the positive peak the cycle declines, crossing the baseline and entering the negative sphere--that sphere in which associated abilities will theoretically have a negative influence on the individual. Each cycle has a different length, so that the individual is usually influenced by mixed rhythms which govern that person's energies.

The days that are theorized as having the most significant effect on the individual are neither the positive nor the negative days, but rather those days on which any cycle crosses over between the positive and negative sphere. Each time a cycle cross-over occurs, the day is termed a critical day. Biorhythm theory suggests

that during critical days a person appears to be unstable in some sense and thus is more vulnerable to errors, accidents, and injuries. While each individual goes through all phases of each cycle, the critical day is the most often mentioned and studied. Thommen (1976) indicated that a critical day occurs once every 6 days on the average. Theoretically, these are the days on which accidents are most likely to occur.

During the 1920's Judt developed calculation tables to project a person's biorhythm simply from the individual's birthdate. He suggested that, by using a person's birthdate, one could calculate where any day in question falls on that individual's biorhythm cycles. By knowing where a person is or will be on the physical, emotional, and/or intellectual cycle for a particular day one could explain and/or predict many aspects of human behavior and performance (Thommen, 1976).

There are many questions to be answered before the usefulness of biorhythm theory can be validated. For instance, one must ask whether or not biorhythm theory adequately covers all possible influences on human life cycles. Do the calculation tables allow for fluctuations in the cycle? These fluctuations may be caused by illness, depression or other variations in human behavior. Also, one must determine whether or not these rhythms affect behavior in an observable and/or predictable fashion.

Statement of the Problem

This study was designed in an attempt to ascertain if biorhythm theory has any relationship to athletic injuries.

Purpose of the Study

This investigation was conducted to determine if the occurrence and/or the severity of athletic injury is significantly related to the position of the injury date on the biorhythm cycles. The severity of injury, identified as minor or serious, was investigated to determine if the severity of injury had a relationship to a specific cycle.

It is, perhaps, obvious that one must ascertain if there is a relationship between the day on which a behavior or occurrence is observed and the location of the day on the biorhythm cycles. Analyzing data in retrospect is one method of accomplishing this. Athletic injuries, due to their specific nature, ease of ascertaining day and time of occurrence, as well as the details of the available records, make this type of information appealing and appropriate for analysis. Should a relationship be established through post hoc analysis, then similar data could be used to make predictions about the future.

Theoretical Hypotheses

It was hypothesized that there would be no significant relationship between the position of the injury date on the biorhythm cycles and the occurrence or severity of an athletic injury. However, if a relationship exists, it

would be expected that this relationship would have occurred in either the physical or emotional cycles. From biorhythm theory, it would be predicted that when an athlete is experiencing a critical day in the physical cycle, there would be a greater chance for an injury to occur of great enough severity to be reported. When an athlete is in either a negative or critical day in the emotional cycle there could be a greater tendency to be aggravated by a minor injury if it occurred and, therefore, a greater likelihood that the injury be reported to the athletic trainer. The intellectual cycle, with its associated abilities, would appear to be the least likely of having a significant relationship to the occurrence or seriousness of athletic injuries.

Assumptions of the Study

The following are the assumptions used in this study:

1. The records of the varsity football injuries maintained by the athletic training office appear to be consistently and efficiently maintained. It is therefore assumed that the records are accurate in terms of injury diagnosis and day of occurrence.

2. The neccessary birthdate information obtained from the registrar's office is accurate.

Definition of Terms

The following are stipulative definitions:

1. Negative Day. One of any number of days in the individual's pattern when the physical, emotional, and intellectual cycles and their related abilities have their least positive or least efficient effects.

2. Positive Day. One of any number of days in the individual's pattern when the physical, emotional, and intellectual cycles and their related abilities have their most useful and beneficial effects.

3. Critical Day. One of any number of days in the biorhythm pattern when the sine curve that each rhythm follows crosses over from the negative to the positive or from the positive to the negative. During this period the individual is theoretically in a confused state, less efficient and, therefore, more likely to suffer injuries and/or accidents.

4. Minor Injury. Any injury that results in the individual ceasing practice or participation in a game from one play to 8 days. The injury must have been reported to the athletic trainer (e.g., contusions, mild sprains, and strains).

5. Serious Injury. Any injury that results in the individual ceasing practice or participation in games for 8 days or longer. The injury must have been reported to the athletic trainer (e.g., surgery, fractures, third degree sprains, and strains).

Delimitations of the Study

The following are the delimitations applied to this study:

1. Injury data consisted of all athletic injuries that were reported to the athletic trainer by male varsity football players at Ithaca College during the five seasons from 1972 through 1976. These records were maintained in the athletic training department files.

2. Dates of birth were obtained from records maintained by the registrar's office at Ithaca College.

Limitations of the Study

Interpretations of the results and conclusions for this study must be made in light of the fact that extraneous variables related to sports participation and associated injuries were not controlled. In addition, the data are being analyzed in a post hoc design, not in a predictive one.

Chapter 2

REVIEW OF RELATED LITERATURE

The review of related literature is presented in the following sections for clarity and ease of reading: (a) introduction to biorhythm theory, (b) biorhythm research, (c) biorhythm research and sport application, and (d) discussion of biorhythm theory.

Introduction to Biorhythm Theory

Thommen (1976) defined biorhythm as a compound of the common Greek terms, bios, meaning life, and rhythmos, which indicates a regulated beat. Biorhythm theory presents the concept that there are certain life rhythms, which are basic to all living organisms.

In the early 1900's a theory about the body being influenced by three independent cycles--physical, emotional, and intellectual--was developed. Thommen (1976) indicated that biorhythm theory was developed in Europe almost a century ago. Observations by Swoboda, a professor at the University of Vienna, and Fliess, a Berlin physician, led to the theory that all humans are governed by a physical cycle and an emotional cycle (Thommen, 1976). The physical cycle appeared to span 23 days, and the emotional cycle appeared to span 28 days. Hagan (1977) reported that Teltscher was influenced by Swoboda's and Fliess' earlier research to the extent that he devised a third cycle, the intellectual cycle, which spans 33 days.

Kelterborn (1977) discussed the cycles as the full swing from neutral to high to neutral to low and back to neutral. This results in a pattern that graphically resembles the sine function from zero to 360 degrees.

The crossover days, when the cycles switch from the positive to the negative spheres or vice versa, are designated as "critical days." MacKenzie (1973) stated that when a cycle crosses over a critical period begins because the associated abilities are neither at a peak nor a low, but rather in a state of confusion. In biorhythm theory, critical days are the most vulnerable periods.

Carvey and Nibler (1977) discussed the physical cycle as affecting the physical ability, energy, endurance, and resistance to disease. In the positive sphere, physical abilities appear to be at a higher performance level. Conversely, during the negative sphere, the body is said to be recovering and recharging its energy stores, thus performance is at a lower level.

The second cycle in biorhythm theory is the emotional cycle. Carvey and Nibler (1977) stated that this cycle governs emotions, sensitivity, creativity, mental health, mood, and the efficiency of the nervous system. During the positive sphere, related abilities have a stronger, more positive effect on the individual. Conversely, during the negative sphere related abilities are weaker.

The 33-day intellectual cycle influences an

individual's intelligence, memory, and mental alertness (Carvey & Nibler, 1977). Gittleson (1976) stated that one's ability to put together separate ideas is best in the positive sphere, and lowest in the weakest sphere.

Biorhythm Research

Much of the research on biorhythm theory yields contrasting results and opinions on the value and usefulness of biorhythm theory. Gittleson's (1976) and Thommen's (1976) books on biorhythms report many tragic examples of accidents and deaths that occurred on critical or negative days of any of the biorhythm cycles. Unfortunately these are anecdotal and used only to illustrate their belief in the importance of this theory.

In two studies conducted by Anderson Associates Safety Engineers, 300 accidents in four different settings were analyzed: a metal working plant, a chemical plant, a textile mill, and a knitting mill. The results show that almost 70% of the accidents occurred on critical days. They continued their study by looking at 1200 human-error accidents. The results again indicated that 70% of these accidents occurred on critical days (Gittleson, 1976).

Zito (1975) discussed the results from a study utilizing the employees from the Washington National Airport in which biorhythms for all ground crew staff were plotted. After supervisors stressed the importance of increased safety awareness on critical days, incidence of reported

accidents decreased by 50%. Carvey and Nibler (1977) used information from R. K. Anderson Associates, a safety consulting firm. The analysis of more than 1,000 industrial accidents over a 2-year period revealed that over 90% of the accidents occurred on critical days.

Halverson (1976), at the University of Rochester, examined biorhythms for a variety of possible uses by hospital nurses. The investigation focused on 68 open heart patients, 16 of whom had surgery on a critical day. Of those 16 patients, 13 (81%) had post-surgical cardiac complications. Of the 52 patients that had surgery on non-critical days, only 30 (57%) patients had post-surgical complications. Their conclusion was that nurses should be aware of their patient's biorhythms and should observe patients more carefully on certain post-operative days for complications.

Biorhythm Research and Sport Application

Many studies have investigated the relationship of biorhythm theory and sport performance and many of these studies were not supportive of biorhythm theory.

Rostan (1977) investigated biorhythm relationships to swimming and track performances. The results of the statistical analysis indicated that no relationship existed between any one of the individual biorhythm cycles and swimming or track performances. Reilly, Young, and Seddon (1983) investigated world class women track and field

athletes and the effect of biorhythm cycles on performance. No statisically significant results were found to indicate that biorhythm cycles had an effect on the performance of world class track and field athletes.

Louis (1978) examined the relationship of biorhythms and performance in baseball and boxing. He examined the baseball pitchers who had thrown no-hit games (N = 100, 1934-1975), and boxers in heavyweight championship fights (N = 100, 1899-1976). There were no significant correlations between biorhythm cycles and individual performance found in either study.

Mance (1976) examined the relationship of the 23-day physical cycle to motor performance and motor proficiency. He tested six players from the 1974-1975 Washington Bullets professional basketball team. Fine motor performance was measured by the Purdue Pegboard Test. Cooper's 12-Minute Walk/Run Test was employed to measure gross motor skill performance. Motor proficiency was determined by utilizing field goals and foul shot percentages. No significant relationships were obtained on the physical cycle for the gross motor performance or motor proficiency areas. Evidence, however, was found within the fine motor skills category to support the concept that a 23-day physical cycle does exist.

Klug (1973) studied the relationship between critical days and athletic injuries and found no statistically

significant relationship between occurrence of athletic injury and critical days.

Other studies examined reaction and movement times. Donnelly (AAHPER, 1978) studied reaction time and movement time measures in the lab. These performance measures were obtained from subjects who were on the varsity swimming, rifle, and men's and women's gymnastics teams. A minimal relationship existed between the intellectual cycle and performance, but he concluded that biorhythm theory generally was not supported as it relates to human performance.

Sachs and Belowich (1978) studied the relationship of biorhythm theory to the swimming performance of 21 members of Florida State University varsity men's swimming team. The coaches' subjective and objective evaluations of swimmers' performance were compared to the athletes' biorhythm charts. The results were not supportive of biorhythm theory.

Discussion of Biorhythm Theory

After reviewing the available research that deals with biorhythm theory, it appears that certain life rhythms do exist (Gittleson, 1976). These rhythms do affect living organisms and may have uses in medicine, sports, industry, and ones daily routine (Thommen, 1976).

Johnson (1977) stated if coaches and athletes are serious about bodily rhythms, they would discard their

computer printouts of biorhythm cycles and keep a detailed diary of their athletes' moods and habits. He suggested that after many months they may indeed discover personal regularities that may be useful to them.

Grim (1974), in his review of the related literature, discussed the lack of vigorous research controls, suceptibility of statistical tools and evaluation of the data involved, and the lack of replication within completed research. Based on this evaluation, Grim (1974) argued that biorhythm theory must be considered with skepticism, at least until careful testing of large numbers of subjects with vigorous statistical evaluation is conducted.

Cavanaugh (1975) discussed biorhythm theory and stated that the main value is the awareness factor it offers. Biorhythm theory offers a plausible explanation for some human behavior and performance. Cavanaugh postulated that if biorhythms do indeed help to reduce accidents and loss of work time, and serve as a warning to be careful on certain days, then perhaps that is enough to make them justifiable.

Crowley (1975) interviewed Bernard Gittleson, author and owner of Biorhythm Computer's INC. In this interview Gittleson stated: "We know they do work, not all of the time, but neither does asprin." This appears to be a fair and reasonable point of view about the use of biorhythm theory and its influence on human behavior. It enables prediction of when people are experiencing a potential high,

low, or critical period, and thus offers an opportunity to adjust their activity accordingly. Biorhythms need more investigation before a blanket statement about their use is offered. Research indicates that biorhythms may have some value to people interested in explaining human behavior (Crowley, 1975).

Chapter 3

METHODS AND PROCEDURES

The procedures that were used to gather data for this study are presented here under the headings: (a) data collection, (b) general directions for calculations of biorhythms, (c) calculation of biorhythm data, and (d) analysis of data.

Data Collection

The data collection for this study was conducted during the summer and fall of 1979. The injury data were obtained from athletic training room records with the permission and cooperation of the head athletic trainer. The subjects' dates of birth were obtained from the Office of the Registrar at Ithaca College.

The form (Appendix A) completed by the Ithaca College athletic training staff during the 1972 through 1976 football seasons provided the data on type of injury, date of injury, time of injury, air temperature, field conditions, and whether the injury occurred in a game or practice setting. The completed forms also indicated the name of the injured athlete, whether the athlete was seen by a doctor either on the field or at a hospital, and whether the athlete was confined to the college health center.

Each subject was assigned a subject number to maintain confidentiality, and for each injury that a subject sustained over the 5-year period a letter was assigned

(i.e., if Subject 1 had 10 injuries over the 5-year period, each injury was listed as 1A, 1B .... 1J). Also listed for each subject were date of birth, date of injury, and whether the injury was minor or serious.

General Directions for Calculations of Biorhythms

The process for obtaining an individual's personal biorhythm can be rather tedious. First, it is necessary to calculate the total number of days the person has been alive, including the needed adjustments for leap years. This number is then divided by the length of each of the cycles, 23 for physical, 28 for emotional, and 33 for intellectual. This yields a whole number representing the total number of completed cycles with the remainder representing the number of days (and hence the location if plotted) into the next cycle. The tediousness of this procedure led to the development of more efficient tools for determining a person's biorhythm. These improvements include such developments as calculation tables, circular slide rules, biorhythm watches, desktop computers, and computer programs. For the purpose of this investigation a computer program devised by Morris and Plank (1975) was used.

Calculation of this Biorhythm Data

For each injury a computer card was coded with the following information: subject number, date of birth, date of injury (date of interest), severity of injury (minor or serious), and the specific injury number for that subject

(represented by a letter). These computer cards were then submitted to a biorhythm computer program developed by Morris and Plank (1975), which calculated position on each cycle for the date of interest, using the concepts discussed in the previous section. The following were printed out for each injury: (a) subject's number, (b) birthdate, (c) date of injury, (d) position of injury day on each cycle, with each cycle listed in a numerical form, (e) a "+", "-", "X", indicating positive, negative, or critical days, respectively, and (f) severity of injury (Table 1).

Analysis of Data

The data obtained were used to test the null hypotheses concerning the relationships between biorhythm cycles and the severity and occurrence of athletic injuries. The data from the Morris and Plank (1975) computer program were then submitted to a CROSSTABS program from the Statistical Package for the Social Sciences (SPSS). Three chi-square tests for goodness of fit (one for each of the biorhythm cycles: physical, emotional, and intellectual) investigated injury occurrence by type of day. Additionally three chi-square tests for independence (one for each of the biorhythm cycles: physical, emotional, and intellectual) investigated severity of injury by type of day (positive, negative, or critical). A .05 level was determined for ascertaining significance.

Table 1

Example Data for Biorhythmic Cycles

for Injured Athletes

Subject	Birthdate	Date of Injury	Position of each Cycle	Serious or Minor
S1	10/18/56	5/17/79	23[a]13X[b]	Serious
			28[c]15X	
			33[d]30-[e]	
S2	11/04/58	8/8/79	23 01X	Minor
			28 18-	
			33 31-	
S3	6/21/59	9/29/79	23 23-	Minor
			28 14+[f]	
			33 14+	

[a] length of physical cycle

[b] indicates critical day

[c] length of emotional cycle

[e] indicates negative day

[d] length of intellectual cycle

[f] indicates positive day

Summary

Data utilized for this study were athletic injuries reported by varsity football players to the athletic training department during the 1972 through 1976 seasons at Ithaca College. Information regarding injuries were taken from the records of the head athletic trainer and birthdates were obtained from the Ithaca College registrar's office. The data were analyzed by means of a computer program developed by Morris and Plank (1975) for calculating the position of the physical, emotional, and intellectual cycles in a numerical form for the date of interest. Three chi-square tests (one for each cycle) for goodness of fit were used to explore the relationship of the occurrence of atheletic injuries to the injury day position on the biorhythm cycle. In addition, three chi-square tests for goodness of fit explored the relationship of the injury severity (serious or minor) to the injury day position on the biorhythm cycle. A .05 level was employed to ascertain significance.

Chapter 4

ANALYSIS OF DATA

The purpose of this study was to determine, for each biorhythm cycle, if any significant relationship existed between the occurrence or the severity of athletic injury and the type of biorhythm day on which the injury occurred. The results of this analysis are presented here. Each null hypothesis is stated, followed by the results of the chi-square analysis. The topics are presented in the following sequence: (a) occurrence of injury by type of day on the physical cycle, (b) occurrence of injury by type of day on the emotional cycle, (c) occurrence of injury by type of day on the intellectual cycle, (d) severity of injury by type of day on the physical cycle, (e) severity of injury by type of day on the emotional cycle, (f) severity of injury by type of day on the intellectual cycle, and (g) the summary of the results.

Occurrence of Injury by Type of Day on the Physical Cycle

There is no significant relationship between occurrence of athletic injury and the type of day on the physical biorhythm cycle. A goodness of fit chi-square was calculated on occurrence of injury by position of day of the reported injury on the physical biorhythm cycle (Table 2). In all chi-square analyses, the expected value for any type of day was determined by dividing the length of the positive, negative, and critical time period for each cycle

Table 2

Occurrence of Injury by Type of Day on the Physical Cycle*

Type of Day	Expected	Observed	Chi-Square
positive	355.6	332	1.56
negative	355.6	350	.08
critical	67.8	97	12.60

*$X^2(2) = 14.26$, $p < .05$.

into the total number of reported injuries. The calculated chi-square was $X^2(2) = 14.26$, $p < .05$. The results of the chi-square indicated that the occurrence of reported injuries was not consistent with the expected proportion of reported injuries on positive, negative, and critical days. Therefore, one way chi-squares were calculated. The chi-square for the positive cycle was $X^2(1) = 1.5$, $p > .05$; for the negative cycle $X^2(1) = .08$, $p > .05$; and for the critical cycle was $X^2(1) = 12.6$, $p < .05$. The significance of the original chi-square value was therefore due to the high occurrence of athletic injuries found on critical days, when 97 injuries actually occurred, as compared to the 67 injuries that were expected. Therefore, the null hypothesis that there is no significant relationship between occurrence of athletic injury and the type of day on the physical biorhythm cycle was rejected.

Occurrence of Injury by Type of Day on the Emotional Cycle

There is no significant relationship between occurrence of athletic injury and the type of day on the emotional biorhythm cycle. A goodness of fit chi-square was calculated on occurrence of injury by position of day of the reported injury on the emotional biorhythm cycle (Table 3). The calculated chi-square was $X^2(2) = .27$, $p > .05$. This indicates that the occurrence of reported injuries was consistent with the expected proportion of reported injuries on positive, negative, and critical days. Therefore, the

Table 3

Occurrence of Injury by Type of Day on the Emotional Cycle*

Type of Day	Expected	Observed	Chi-Square
positive	361.7	366	.05
negative	361.7	355	.12
critical	55.6	58	.10

*$X^2(2) = .277$, $p > .05$.

null hypothesis that no significant relationship exists between occurrence of athletic injury and the type of day on the emotional biorhythm cycle was accepted.

Occurrence of Injury by Type of Day on the Intellectual Cycle

There is no significant relationship between occurrence of athletic injury and the type of day on the intellectual biorhythm cycle. A goodness of fit chi-square was calculated on occurrence of injury by position of day of the reported injury on the intellectual biorhythm cycle (Table 4). The calculated chi-square was $X^2(2) = 19.28$, $p < .05$. This indicates that the occurrence of reported injuries was not consistent with the expected proportions of reported injuries on positive, negative, and critical days. Therefore, one way chi-squares were calculated. The chi-square values were for the positive cycle was $X^2(1) = 4.57$, $p > .05$; for the negative cycle $X^2(1) = .62$, $p > .05$; and for the critical cycle was $X^2(1) = 14.09$, $p < .05$. The significance of the original chi-square was therefore due to the high occurrence of athletic injuries found on critical days, when 73 injuries actually occurred as compared to the 47 injuries that were expected. Therefore, the null hypothesis that no significant relationship between occurrence of athletic injury and type of day on the intellectual biorhythm cycle was rejected.

Severity of Injury by Type of Day on the Physical Cycle

There is no significant relationship between severity

Table 4

Occurrence of Injury by Type of Day on the Intellectual Cycle*

Type of Day	Expected	Observed	Chi-Square
positive	365.9	325	4.57
negative	365.9	381	.62
critical	47.2	73	14.09

*$X^2(2) = 19.29$, $p < .05$.

of athletic injury and type of day on the physical biorhythm cycle. A two-way chi-square test was calculated on severity of injury by position on the cycle (Table 5). The calculated chi-square was $X^2(2) = .363$, $p > .05$.

It is noted that the distributions of the row percentages for each type of day on the physical cycle are nearly identical for minor (43%, 45%, and 12%) and serious injuries (43%, 43%, and 14%). The pattern of occurrence then for minor and serious injuries on the physical cycle are considered identical. Therefore, the null hypothesis that there is no significant relationship on the physical cycle between severity of athletic injury and type of day was accepted.

Severity of Injury by Type of Day on the Emotional Cycle

There is no significant relationship between severity of athletic injury and type of day on the emotional biorhythm cycle. A two-way chi-square test was calculated for severity of injury by position on the cycle (Table 6). The calculated chi-square was $X^2(2) = 6.02$, $p < .05$.

As the two-way chi-square was significant for the emotional cycle, one-way chi-square tests were run to determine where the significance existed. With regard to injuries which occurred during the positive cycle, the occurrence of minor as compared to serious injuries was not significantly different $X^2(1) = 1.45$, $p > .05$. The same was found for injuries occurring on negative biorhythm days

Table 5

Type of Day by Type of Injury on Physical Cycle*

Type of Injury	Type of Day			
	Positive	Negative	Critical	Row totals
Minor injuries				
Count	255.0	273.0	73.0	601.0
Row percentage	42.4	45.4	12.1	77.2
Serious injuries				
Count	77.0	77.0	24.0	178.0
Row percentage	43.3	43.3	13.5	22.8
Column totals				
Count	332.0	350.0	97.0	779.0
Total percentage	42.6	44.9	12.5	100.0

*$\chi^2(2) = .363$, $p > .05$.

Table 6

Type of Day by Type of Injury on Emotional Cycle*

Type of Injury	Type of Day			
	Positive	Negative	Critical	Row totals
Minor injuries				
Count	292.0	271.0	38.0	601.0
Row percentage	48.6	45.1	6.3	77.2
Serious injuries				
Count	74.0	84.0	20.0	178.0
Row percentage	41.6	47.2	11.2	22.8
Column totals				
Count	366.0	355.0	58.0	779.0
Total percentage	47.0	45.6	7.4	100.0

*$\chi^2(2) = 6.02$, $p < .05$.

$X^2(1) = 1.46$, $p > .05$. The significance appeared in the pattern of injuries occurring on critical days $X^2(1) = 4.46$, $p < .05$. Table 6 indicates that 6% of minor injuries occurred on emotional critical days where 11% of serious injuries occurred on emotional critical days. This indicates that significantly more serious injuries occurred on critical days in the emotional cycle. Therefore, the null hypothesis that there is no significant relationship on the emotional cycle between severity of athletic injury and type of day was rejected.

Severity of Injury by Type of Day on the Intellectual Cycle

There is no significant relationship between severity of athletic injury and type of day on the intellectual biorhythm cycle. A two-way chi-square was calculated on severity of athletic injury by position on the cycle (Table 7). The calculated chi-square was $X^2(2) = 1.04$, $p > .05$.

It is noted that the distributions of the row percentages for each type of day on the intellectual cycle are nearly identical for both minor (41%, 50%, and 9%), and serious athletic injuries (45%, 47% and 8%). This indicates that the pattern of occurrence for minor and serious njuries on the intellectual cycle is the same. Therefore the null hypothesis that there is no significant relationship between severity of athletic injury and type of day on the intellectual biorhythm cycle was accepted.

Table 7

Type of Day by Type of Injury on Intellectual Cycle*

Type of Injury	Type of Day			
	Positive	Negative	Critical	Row totals
Minor injuries				
Count	245.0	298.0	58.0	601.0
Row percentage	40.8	49.6	9.7	77.2
Serious injuries				
Count	80.0	83.0	15.0	178.0
Row percentage	44.9	46.6	8.4	22.8
Column totals				
Count	325.0	381.0	73.0	779.0
Total percentage	41.7	48.9	9.4	100.0

*$\chi^2(2) = 1.04$, $p > .05$.

Summary of Results

Three goodness of fit chi-squares were calculated for occurrence of athletic injury by position on each biorhythm cycle to determine if any significant relationship exists. The chi-square values for the emotional cycle was $X^2(2) = .27$, $p > .05$. Therefore, the null hypothesis for the emotional cycle was accepted.

The chi-square value for the physical cycle was $X^2(2) = 14.26$, $p < .05$ and for the intellectual cycle was $X^2(2) = 19.28$, $p < .05$. One way chi-squares indicated that the significance was located on critical days for both of these cycles as more injuries occurred on critical days than was expected. Therefore, the null hypothesis that no significant relationship exists between occurrence of athletic injury and type of day on the physical and intellectual biorhythm cycles was rejected.

Two-way chi-squares were calculated for severity of athletic injury by position on the biorhythm cycle to determine if any significant relationship exists. The chi-square value for the physical cycle was $X_2(2) = .363$, $p > .05$ and for the intellectual cycle was $X^2(2) = 1.04$, $p > .05$. Therefore, the null hypotheses for both the physical and intellectual cycles were accepted. The chi-square value for the emotional cycle, however, was $X^2(2) = 6.02$, $p < .05$. Data, therefore, from the emotional cycle was then used to perform three one-way chi-square tests, to explore the

relationship between severity of athletic injury (minor, severe) and type of day (positive, negative, critical). The pattern of occurrence of minor and serious injuries on positive and negative days was not significant. However, a statistically significant pattern occurred on the critical days ($X^2(1) = 4.46$, $p < .05$). More serious injuries than minor injuries occurred on critical days for the athletes' emotional cycle. Therefore, the null hypothesis that there is no significant relationship on the emotional cycle between severity of athletic injury and type of day was rejected.

Chapter 5

DISCUSSION OF RESULTS

This chapter includes a discussion and an intrepretation of the results reported in Chapter 4. The ability to determine when an athlete is at a higher risk of severe athletic injury would be a very useful tool for all persons associated with athletics: the athlete, the coach, and the athletic trainer.

Biorhythm theory may be beneficial in determining when an injury may occur. There are three cycles--physical, emotional, and intellectual--each with their associated abilities. Each of these abilities are involved in the performance of an athletic activity. During the negative sphere of any of the cycles, the associated abilities are low while the associated abilities are high in a positive sphere. The most studied aspect of biorhythm theory is the critical day, when a cross-over from positive to negative or negative to positive occurs. This is the time period when the body is said to be recharging.

The present results indicate that there are significant relationships between some aspects of all three cycles. The results are also supportive of the importance biorhythm theory attributes to the critical days, since all of the significant findings are related to critical days.

The physical cycle theoretically influences ability, energy, endurance, and resistance to disease. This cycle

would be expected to be related to athletic injuries. The results of the statistical analysis determined in this study support this theory. A greater number of athletic injuries occurred during the critical days for the physical cycle than would be expected from chance alone.

The intellectual cycle is said to influence an individual's intelligence, memory, and mental alertness. It is not surprising that these qualities, and particularly mental alertness would be related to injuries. This study found that there were more injuries that occurred on the critical days for the intellectual cycle than would have been expected from chance alone. Although not reaching significant levels, it is also worth noting that there were somewhat fewer athletic injuries during the positive sphere of the intellectual cycle. This nonsignificant trend is in the direction that would be predicted by biorhythm theory.

Biorhythm theory maintains that the emotional cycle influences emotions, mood, mental health, and the efficiency of the nervous system. This cycle would be expected to also be related to athletic injuries. The results indicate that there were significantly more serious injuries on the critical days for the emotional cycle then would be anticipated from chance alone.

These results, collectively, provide some support for biorhythm theory, and especially for the "critical days" aspect of the theory. The theory states that during these

days individuals are recharging their bodies, and the findings of this study show a significant relationship between occurrence and severity of athletic injury and critical days.

The theory of biorhythms is based upon the concept that a 23-day physical, 28-day emotional and 33-day intellectual cycle exists. The results of this study are based on this supposition and support the conceptualization of critical days and their significance to biorhythm theory. In this study, the occurrence of athletic injury was significantly more frequent on the critical days of the physical and intellectual cycles but not the emotional cycles. However, significantly more serious injuries (though not minor injuries) were reported on critical days on the emotional cycle only.

One of the major barriers for athletes to deal with and overcome in their quest for athletic success and personal satisfaction in athletic participation is the incidence of injury. Biorhythms appear to be significantly related to the occurrence and severity of athletic injury. It therefore seems reasonable to increase the athlete's awareness of personal biorhythm cycles, and to provide education about the possible ramifications of these cycles on athletic performance.

Chapter 6

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS FOR FURTHER STUDY

The following areas are discussed in this chapter: (a) summary, (b) conclusions, and (c) recommendations for further research.

Summary

This study investigated the occurrence and severity of athletic injury and position of injury date on the biorhythm cycles. College level male varsity football players who had been injured during practice or games during the 1972 through 1976 football seasons were used as subjects. Subjects' birthdates and the dates of injury were analyzed by a computer program (Morris & Plank, 1975). The program's design was to show the positions of the three biorhythmic cycles for the date in question (date of injury). These data were then submitted to three goodness of fit chi-squares to determine if a relationship existed between occurrence of athletic injury by position on each biorhythm cycle.

The chi-square values for the emotional cycle ($X^2(2) = .27$) were found to be not significant at the .05 level. Therefore, the null hypothesis for occurrence of athletic injury on the emotional cycle was accepted.

The chi-square values for the physical ($X^2(2) = 14.26$) and the intellectual ($X^2(2) = 19.28$) cycles were significant

at the .05 level. Significance was located on critical days for both the physical and intellectual cycles, and more injuries occurred on critical days than was expected. Therefore, the null hypothesis that no significant relationship exists between occurrence of athletic injury and type of day on the physical and intellectual biorhythm cycles was rejected.

Two-way chi-squares were calculated for severity of athletic injury by position on the biorhythm cycle to determine if any significant relationship existed. The chi-square values for the physical ($X^2(2) = .363$) and the intellectual cycle ($X^2(2) = 1.04$) were not found to be significant at the .05 level. Therefore, the null hypothesis for both the physical and intellectual cycles regarding severity of athletic injury and type of day on those biorhythm cycles was accepted.

The chi-square value for the emotional cycle ($X^2(2) = 6.02$) was significant at the .05 level. Three one-way chi-square tests were run to determine the location of the significance. The pattern of occurrence of minor and serious injuries on positive and negative days was not significant. The significant pattern occurred on the critical days ($X^2(2) = 4.46$). More serious than minor athletic injuries occurred on critical days on the athletes' emotional cycles. Therefore, the null hypothesis that no significant relationship on the emotional cycle between

severity of athletic injury and type of day was rejected.

Conclusions

Man has always investigated the varying rhythms that influence human life. There are countless studies investigating circadian and biological rhythms. Biorhythm theory is an outgrowth of these earlier concepts. The three cycles--physical, emotional, and intellectual--and the influences of each cycle is an easily understood concept. The lay person is able to relate to the idea that the physical cycle influences physical ability, energy, and endurance; that the emotional cycle effects emotions, mood, and mental health; and that the intellectual cycle effects memory and intelligence. The ability to understand and relate to the concepts of biorhythm theory is why the concept has become so popular and used by countless people.

Biorhythm theory is inflexible. It assumes that each person has exactly the same three cycles: a 23-day physical cycle, a 28-day emotional cycle, and a 33-day intellectual cycle. It is not possible, according to the theory, to develop an area in any cycle and control that particular cycle or the influences it has on a person (i.e., a professional or world class athlete can not have a different length physical cycle than the average individual, nor can a nuclear engineer develop a different length intellectual cycle when compared to the average person). Biorhythm theory states that each cycle begins at birth and never

changes from its 23-, 28-, or 33-day cycle pattern until death.

This extreme inflexibility seems to be one of the more problematic aspects of the theory. It would be more reasonable to assume that individuals with different abilities could have different length cycles. In addition, one might expect that extraneous variables may influence the length of each cycle. Factors such as illness, depression, lack of sleep, diet, mental fatigue, and stress could have an effect on any cycle and alter its pattern. Biorhythm theory never accounts for any fluctuations in the cycles or the effects of the above mentioned variables.

The purpose of this study was to investigate biorhythm theory and determine if biorhythm theory could be used as a tool for coaches, athletes, and sports medicine personnel to reduce the occurrence and/or severity of athletic injury. The results indicate that no significant relationship exists between occurrence of athletic injury and the emotional cycle. The results also indicate that a relationship does exist between occurrence of athletic injuries and both the physical and intellectual cycle. Specifically, the results indicate that more injuries occurred on critical days for both the physical and intellectual cycles than would have been expected.

The results yielded no significant relationship between the physical and intellectual cycles and severity of

athletic injury. However, the results did indicate that a significant relationship does exist between severity of athletic injury and position on the emotional cycle, specifically that significantly more serious athletic injuries occurred during critical days of the emotional cycle.

It would be inappropriate after one study on the effect of biorhythms on the occurrence and seriousness of athletic injury to draw absolute conclusions about the validity of biorhythm theory. What this study attempted to determine was whether a relationship exists and, thus, if biorhythm theory could be used as a tool to prevent, or at least forewarn, an athlete about the possibility of injury and/or when the possibility for a serious injury could be greater. The results suggest that on critical days during the physical and intellectual cycles significantly more athletic injuries occur than would be expected by chance alone. The results also suggest that, on critical days during the emotional cycle, significantly more serious athletic injuries occur than would be expected. These findings lend some credence to biorhythm theory and its use as a tool in the prevention of athletic injury. Additional studies need to be conducted to further investigate this concept.

Recommendations for Further Study

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

1. Similar studies could be repeated using different subjects (i.e., contact versus non-contact sport participants, various age groups, and male versus female athletes).

2. Additional research in the area of biorhythms with the emphasis on prediction of the incidence and severity of injury would be useful.

3. It would be most interesting and useful to investigate the placebo effect and its relationship to biorhythm theory. It is commonly held that the credence the individual attributes to the effect of biorhythm cycles has a profound effect on the individual's behavior. Research in this area using blind and double blind research designs would be justified.

Appendix A

ITHACA COLLEGE ATHLETIC INJURY REPORT

SPORT ______ PRACTICE ______ GAME ______ SEASON ______ WEEK OF ______ YEAR ______

	INJURED PART OF BODY																												NATURE OF INJURY													DOCTOR REFERRAL HOSPITAL							TIME OF PRACT			WEATHER CONDITIONS AND PLAYING SURFACE								
NAME OF ATHLETE	SKULL	EYE	NOSE	MOUTH & CHIN	LIP	TEETH	NECK	BACK	CHEST	RIBS	SHOULDER	UPPER ARM	LOWER ARM	ELBOW	WRIST	HAND	FINGERS	THUMB	HIP	GROIN - TESTICLES	THIGH	HAMSTRING	KNEE	UPPER LEG	LOWER LEG	ANKLE	FOOT	TOE	BRUISE	CONCUSSION	CUTS	INFECTION	FRACTURE	HEAT EXHAUSTION	INTERNAL	SPRAIN	STRAIN	DISLOCATION	SEPARATION	LIGAMENTS	MUSCLE PULL	SEEN BY DR. ON FIELD	DOCTOR REFERRAL	SPECIALIST REFERRAL	X-RAYS	HOSPITALIZED	CONFINED TO H.C.	RETURNED AFTER SICKNESS	BEGINNING	MIDDLE	END	DRY	SLIPPERY WET	VERY HIGH TEMP. 80's-90's	HIGH TEMP. 70's-80	AVERAGE TEMP. 60's-70	LOW TEMP. 50's-60	LEVEL SURFACE	BUMPY SURFACE	COMMENTS

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