Critical Analysis of Biorhythms and Their Effect on Industrial Accidents in Agra Casting Manufacturing Units

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Abstract

Biorhythm critical days have been suggested as a possible cause of industrial accident. Biorhythm theory postulates that variations in human abilities are governed by three consistently recurring cycles of 23, 28, and 33 days length. The study assessed the validity of biorhythm by analyzing 462 industrial related accidents in Agra casting manufacturing units in the last 5 years. A variety of biorhythm critical day definitions and accident types were analyzed. Significant results were obtained, also statistical Chi-square analysis of the data found significant influence on the computed physical, emotional, and intellectual cycles. It concluded that biorhythm theory has a strong basis to justify its application to strenuous work in casting manufacturing units and acts as an information system in predicting the accident occurrence.

Relevance to industry

Some industrial activities involve lifting and carrying heavy loads or working in dusty, fummy, and heated environment. Such tasks may lead to various types of accidents to the workers. This study investigated the effects of biorhythm on industrial accidents, so that the workers could be kept away from the hazardous tasks on critical days. The results may provide useful information for further study in the prevention of industrial accidents.

Keywords: *Biorhythm, Physical, Emotional, Intellectual, Accidents*

1. Introduction

The Biorhythm model consists in the assumption that our psychological and physical state is not a steady flow, but suffer up’s and down’s as time goes by and our voluntary acts cannot do anything to avoid it. Biorhythm theory suggests that people’s behavior is affected by three biological cycles that start at birth and continue through life. Biorhythm cycles are believed to originate from the day of birth and from a base line begin their cyclical variation with an initial upward swing. These cycles have been termed: (1) the physical cycle which lasts 23 days includes strength, energy, endurance, resistance to disease; (2) the emotional cycle which lasts 28 days includes periods of elation, sadness, moodiness, creativity; and (3) the intellectual cycle which lasts 33 days includes alertness, memory, reasoning ability [17]. These cycles have traditionally been depicted as sine curves, as shown in Figure 1. According to the theory each cycle has three distinct phases. The first, or positive, phase i.e, above the birth base line is said to be associated with strong, creative, stimulating activity while the second, or negative, phase i.e, below the base line is said to be associated with weak, irritable, indecisive activity. The third is the critical or transition phase that cross the base line means the period during which the biorhythm changes from positive to negative or vice versa. This phase is said to be an unstable or turbulent period during which "a person's predisposition to react to vital situations is not at an optimal level" [3]. Taking each cycle in turn it is, then, possible to predict the state of the individual. However, as the cycles are not of the same length they very rarely coincide with one another. Hence, on any particular day you have a mixture of rhythms that have to be interpreted accordingly. There are two critical days for each cycle [16]. Popular claims have been made that traffic and industrial accidents are more likely to occur during a person's critical days and that the biorhythmic model can be used to prevent these incidents. A number of studies have found evidence to support this view [1, 9, 13, 18, 19]. Others have reported a lack of correlation of accidents and the designated critical days [2, 4, 8, 10, 12, 14, 15, 20, 21]**.** A comparison between these studies is impossible because many of them have not been specific about the methodology used and deficiency in the literature [4, 5]. The current study was attempted to resolve some of these contradictions and analysis the effects of biorhythm on industrial accidents in Agra casting manufacturing units.

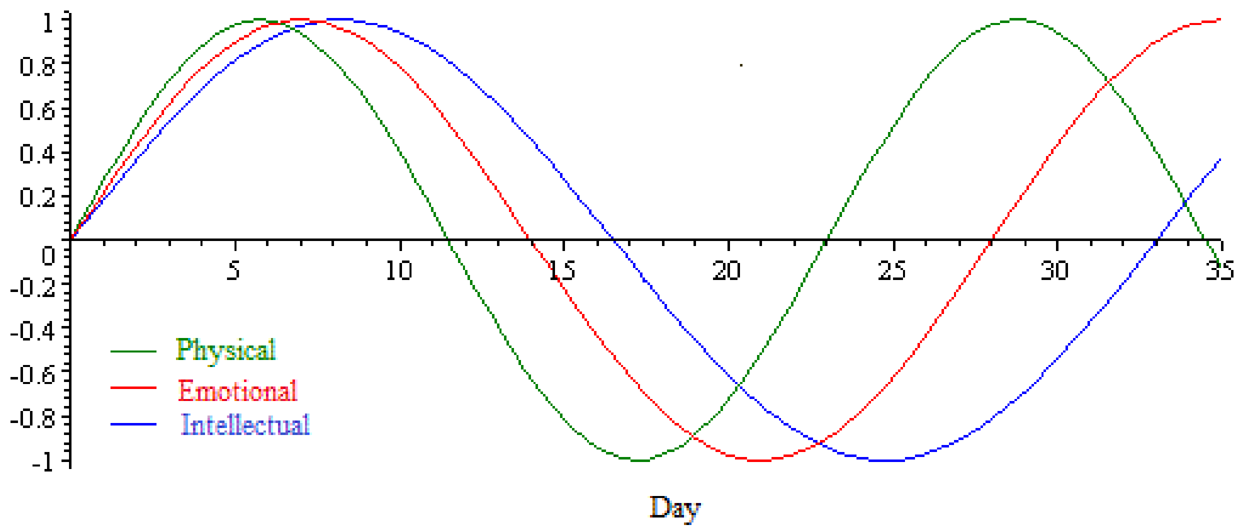

Fig. 1. Biorhythm Cycles

2. Methods

Details of 530 accidents and Individual employee details, such as birth dates, were taken directly from personnel records at the industry's head office. Accidents and personnel records were matched, and 68 accidents were rejected because of missing information or because no birth date was recorded, As a result of these exclusions, a total of 462 accidents were selected for the biorhythm analysis. The accidents included all the injuries related to musculoskeletal disorders and amputations necessitating prolonged medical treatment or hospitalization. The accidents were of a type normally associated with heavy manual work, high speed machines, and mobile equipment. Injuries resulting from long term exposure, such as hearing losses were excluded.

2.1 Data Analysis

The physical, emotional and intellectual biocurves were produced for each worker by means of a biorhythm calculator and the actual frequencies of the accidents were obtained. Data is calculated in two ways:

1. The frequencies of accidents were determined for the positive, negative, and critical phases of each cycle.
2. The frequencies of accidents were determined for Critical day definition method. In this method, first three definitions are the same as suggested by Khalil and Kurucz [8] and a fourth alternative definition was added in which last day and two mid days of negative phase of each cycle was added to the original definition of critical days because at the mid of each negative phase of the cycle a person have efficiency at lowest, so these two days of the cycles were also considered as the critical days of the cycle. Four definitions and their related critical days for each cycle are shown in Table 1. "3-day" definition is most appropriate since it is more consistent with and best reflects biorhythm theory [8, 21]. Nevertheless, in order to provide the fullest test of biorhythm theory, all four definitions were used in the present study, with expected and actual accident incidence being altered to reflect the changed number of critical days in each cycle.

Table 1 Alternative critical day definition

Biorhythm Cycle	**Critical Days in Cycle**			
	Definition 1	**Definition 2**	**Definition 3**	**Definition 4**
Physical	1,12,13	1,2,12,13,23	1,2,11,12,13,14,23	1,12,13,17,18,23
Intellectual	1,17,18	1,2,17,18,33	1,2,16,17,18,19,33	1,17,18,25,26,33
Emotional	1,15	1,2,15,28	1,2,14,15,16,28	1,15,21,22,28

A test of the relationship between critical days and industrial accidents requires the calculation of expected frequencies of accidents on these days if accidents were occurring randomly. The number of accidents expected to occur by chance on the critical days of each cycle were assumed to be 2/23 x N for the physical cycle, 2/28 x N for the emotional cycle and 2/33 x N for the intellectual cycle and the expected frequencies of accidents for alternative critical day definitions was obtained by calculating probabilities for the various combinations of critical day definitions [8]. From these probabilities the expected numbers of accidents for each combination of critical day definitions were determined**.** A Chi-square analysis of significance $P<0.05$ was used to compare the observed frequencies with those expected frequencies of the accidents. In this case chi square statistic can be shown as:

$$\chi^2 = \sum_{j=1}^{n} [(f_{oj} - f_{ej})^2 / f_{ej}] \quad \text{---- (1)}$$

Where

f_{oj} = observed accidents for biorhythm day type j
f_{ej} = expected accidents for biorhythm day type j
n = number of biorhythm days

In working with biorhythm data, another method of analysis for establishing whether a significant relationship can be shown between accident occurrence and biorhythm critical days based on a sample is to determine the Confidence Interval (CI) for the true mean proportion of accidents occurring on critical days ("hits") to the total number of accidents. The range or confidence interval is defined by:

$$A + a(\sqrt{A(1-A)/N}) \geq \mu \geq A - a(\sqrt{A(1-A)/N}) \quad \text{---- (2)}$$

Where

A = ratio of "hits" to total number of accidents
N = sample size
$a = 1.96 / \sqrt{N}$
μ = true mean proportion of hits to total accidents

3. Results and Discussion

Initially all accidents were examined. Table 2 gives a comparison of actual and expected values representing the incidence of injuries in the positive and negative phases of each cycle and critical days of each cycle. The frequency of injuries to be expected from the hypothesis is set out against the actual frequency at each stage of the cycle. The incidence of injuries is distributed relatively evenly between positive and negative cycle phases. And it was found that most of the accidents were occurred on Critical days and negative phase of the cycle. The results obtained on the basis of random expectation differed from the frequencies observed. The actual and expected data were compared by applying the chi-square test. A chi-square value for physical cycle was 18.3, for emotional cycle was 16.6, and for an intellectual cycle was 20.6. Chi-square values were significant at $p<0.05$ for all biocycles as the values are much more than the critical value of 6.0. Thus the result showed that physical, emotional, and intellectual biocycles have a significant effect on the frequencies of accidents and the accidents are occurring not by chance alone.

Actual accidents and accidents expected by chance are shown in table 3 for each critical day definition. It was found, using definition 1, 2, 3, and 4 that 40.3%, 48%, 62.3%, 67.5% of accidents were occurred on critical days of the biocycles. This percentage showed a great impact of biorhythm days on the occurrence of accidents. Definition 3 and 4 showed a greater impact in comparison of definition 1 and 2. These results confirmed the findings of Reinhold Bochow [17]. The actual and expected data were compared by applying the chi-square test. Chi square values for definition 1 was 116.96, for definition 2 was 26.05, for definition 3 was 39.12, and for definition 4 was 99.17. Chi-square values were significant at $p<0.05$ for all biocycles as the values were much more than the critical value of 14.1. To examine the relationship between the actual and expected frequencies for the four of definitions of critical days in greater detail 95%CI was applied. The value of 95%CI for Definition 1 was $40.5\% \geq \mu \geq 40.1\%$, for definition 2 was $48.2\% \geq \mu \geq 47.8\%$, for definition 3 was $62.5\% \geq \mu \geq 62.1\%$, and for definition 4 was $67.7\% \geq \mu \geq 67.3\%$. Hence the calculated values of 95%CI were much more than the percentage of accidents which may be expected to occur on critical days purely by chance is 20.4%. Interestingly, the results were significant for both the chi square and 95%CI. Thus it is cleared by the definitions of critical days that critical days affect the incidence of accidents more than any other reason affected the accidents overall.

Table 2 Statistical comparison of actual versus expected injury frequencies for individual cycle

Cycle position	Actual		Expected
Physical			
Positive	195		210.92
Critical	66		40.16
Negative	201		210.92
Chi-square		**18.3**	
p		**P<0.05**	
Emotional			
Positive	180		214.5
Critical	51		33
Negative	231		214.5
Chi-square		**16.6**	
p		**P<0.05**	
Intellectual			
Positive	198		217
Critical	51		28
Negative	213		217
Chi-square		**20.6**	
p		**P<0.05**	

$\chi^2 = 5.99$ for df = 2 and $p < 0.05$

Table 3 Statistical comparison of actual versus expected injury frequencies by critical day combination

Critical day combination	Definition 1		Definition 2		Definition 3		Definition 4	
	Actual	Expected	Actual	Expected	Actual	Expected	Actual	Expected
Physical (P)	72	26	63	66	75	54	120	60
Intellectual (I)	48	34	54	43	54	54	69	48
Emotional (E)	42	51	51	67	75	87	66	77
(P)+(E)	6	3	21	12	24	15	15	13
(E)+(I)	7	4	9	18	12	24	12	21
(I)+(P)	9	5	21	12	42	23	24	18
(P)+(E)+(I)	2	0	3	3	6	6	6	5
None	276	339	240	241	174	199	150	220
Total	462	462	462	462	462	462	462	462
Chi square	**116.96**		**26.05**		**39.12**		**99.17**	
95% CI	**40.5%≥μ≥40.1%**		**48.2%≥μ≥47.8%**		**62.5%≥μ≥62.1%**		**67.7%≥μ≥67.3%**	

$\chi^2 = 14.1$ for df = 7 and $p < 0.05$

Note:- Expected days rounded for ease of presentation but not for calculating the chi square statistic.

The results of the study agree with the findings of other authors. In emphasizing the importance of critical days, Buttery [3] suggested that they are associated with an increased potential for human error and consequently with an increased likelihood of accidents. Reinhold Bochow [17] investigated only 2.2 percent of the accidents occurred on "normal days", while a startling 97.8 percent fell on critical days among agricultural workers. Another project done in the United States found that almost 70 percent of the accidents were occurred on critical days in factories [1]. Hendrick and Jones [6] reported an association between physical biorhythm and pilot error accidents and incidents. MacKenzie [11] cited the success of a Japanese railway company which reduced the number of driver accidents by 50% in a year by predicting bad days from biorhythm charts. Business enterprises have also displayed interest, and some companies have been reported to use biorhythms in an attempt to reduce accidents [7]. Such selective evidence convinced that the current findings are effective in reducing the accidents among the industrial workers.

4. Conclusion

A study was undertaken to determine whether or not there was a relationship between biorhythm critical days and the incidence of industrial accidents among the industrial workers. The results obtained suggested that biorhythm critical days play a vital role in predicting the industrial accidents. In the current study critical days were measured in a variety of ways. The sequence of observed was different than might have been expected for accidents occurring randomly. It was predicted that human biological system is affected by the biocycles and the ability of human to perform a certain job changes with the change of phase of the biocycles. Level of performance was high in positive phase and decreases in the negative phase and becomes critical in critical phase of the cycle. From table 2 and 3 it was found that biorhythm theory is important in finding the effects of critical days on industrial accidents. Current study has an edge over the findings of Khalil and kurucz [8] for the critical day definitions. According to definition fourth of critical days 67.5% of total number of accidents falls on critical days which were higher than the other definition of the critical days. Thus, definition fourth may be used for predicting the accidents occurrence and workers may be stayed away from the hazardous work on these critical days for reducing the number of accidents.

Hence, the present work suggests that biorhythm theory acts as an information system and may be implemented in the industries in which chances of workers to get stuck with accidents are more. The use of biorhythm theory in preventive work connected with industrial safety in industries and strict adherence to this theory make it possible to reduce the incidence of industrial accidents and ensure safe and productive work.

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