The Tempo of the Universe Related to Performance in Sports

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Galileo stated that «Mathematics is the alphabet with which God has written the Universe». Pythagoras stated that «Everything is arranged according to numbers and mathematical shapes». The Greeks recognized a specific proportion that was pleasing to the eye, and the ratio of 62% to 38% was called the «Golden rectangle» (2). This proportion was used by architects, painters, sculptors, astrologers, and musicians, and was called the «Golden Mean» and the «law of beauty». The various shapes, based on this proportion, were called the «Golden triangle», «Golden spiral», and «Golden pantogram». All of these shapes are not only man made, as in buildings, art, and music, but they are the basis for all things in nature and the Universe. The Disney television channel showed an animated film- «Donald in Mathmagic Land» on March 16, 1987. It showed how this proportion was the basis for flowers, sea shells, trees, spider webs, snow flakes, the honey bee hive, and the relationship of the planets to the sun. The PBS television series on «The Brain» — «Rhythms and Drives» showed how the human body is affected by certain frequencies of the senses which affect growth and development, how people feel, and how people perform.

For centuries, scholars have recognized a mysterious force permeating the Universe and affecting all plants and animals on earth. Gradually the reason for these feelings has unfolded. The first experiments in electricity, by Volta and Galvani, took place in the early 19th century. Faraday and Maxwell continued the work in the 1860's and 70's, and Edison invented the lamp in 1879. Tesla started the electrical industrial revolution at the end of the century with many inventions (1). In 1894 telegraphy, the wireless electromagnetic radiation waves, was invented, and in 1895 radient energy of invisible rays, called X-rays, was discovered. In 1902 electrically charged particles were found in the ionosphere from 30 to 250 miles up. The new astronomy had arrived, and the field is still exploding like a super-nova. In 1932 Jansky discovered radio waves coming from the cosmos, and in 1940 Reber confirmed Jansky's finding (6). Southworth discovered centimeter wavelengths coming from the sun in 1945, and now the solar wind, a constant stream of matter coming from the sun, is being measured (12). In the 1950's, the first large radio telescope was built in England to study radio waves emitted by the stars (9). In 1967 the discovery of the first «pulsar» was made by Jocelyn Bell and Antony Hewish, and Hewish was awarded the Nobel Prize in 1974 (10). A «pulsar» emits regular pulses of radio waves and is called a «neutron star» because it spins and sends out precisely spaced electromagnetic waves like a revolving lighthouse. The first one revolved every 1.337 seconds, and now over 400 have been measured having periods from .03 to 4 seconds (10, 12).

In 1968 a neutron star was found in the Crab Nebula by the Arecibo Observatory in Puerto Rico (10). At 6000 light years away, it is by far the closest bright pulsar to the earth, and has a period of .033, or a spinning rate of 30.3/second. In 1969 Cocke, Disney and Taylor, at the Steward Observatory in Arizona, confirmed the pulsar in the Grab Nebula optically, and this was one of the greatest events in the history of modern astronomy (10).

In 1202 Leonardo Fibonacci introduced a set of numbers that increased by 61.8% that came close to the mathematical basis for the creation of all things from the atom to the total galaxy (2, 8). He only used whole numbers, however, and the relationship of the «Golden Mean» to frequencies requires a sequence of numbers based specifically on the «Golden proportion». These corrected Fibonacci numbers can be amplified by using the square root of the numbers as well, which are in harmony with the «Golden Mean» (13). Table 1 shows the corrected numbers to be used.

TABLE 1

* Fibonacci Numbers	** Corrected Fibonacci Numbers
1	1
2	1.27201965 = square root of 1.618
3	*** 1.6180339 = $1 + \sqrt{5}/2$
5	2.058
8	3.33
13	4.236
21	5.388
34	6.854
55	8.718
89	11.09
144	14.106

* Each Fibonacci number is obtained by adding the previous two numbers.
** Each corrected number is obtained by multiplying the previous number by 1.272.
*** The formula ($1 + \sqrt{5}/2$) is for a line divided in a way that the proportion of each to the other is the same as each to the whole.

The Tempos of Sports

Knowing that man is totally linked to the environment, and that functional efficiency is dependent upon living in harmony with the Universe, this knowledge can be applied to performance in sports. It is easiest to apply to those sports that have a foot-fall tempo that can be counted, such as walking or running, or a turn-over tempo to the movement, such as bicycling, swimming, rowing, or kayaking. The rate of turn-over is counted by the mind either on every beat, on every other beat, or on the first beat of a measure. A person dancing a waltz should feel the emphasis on the first beat of the three, and not single out each beat. The runner or bicycler going fast probably has the mind attuned only to the first beat of four beats, while the slower turnover of a swimmer or kayaker probably has the mind attuned to every two beats. The mind's tempo determines what time interval is selected for performance. Table 2 shows the prime and harmonic tempos of the corrected Fibonacci numbers. Table 3 presents the beats per minute when the mind is attuned to 1, 2 or 4 beats. Table 4 presents work to rest ratios based on Table 2.

There is also a rhythm to the movement itself, such as in golf or tennis, where the backswing of the motion should take 62% of the total time, and the forward motion shoald take 38% of the time. When the forward motion is rushed, and the «Golden proportion» is broken, performance will be worse and the athlete will not feel the «rhythm». There is a rhythm to the steps of a high jumper, the turns of a hammer thrower, the swing of a batter, and even to the pattern of team movements in hockey, soccer and basketball.

The application of the «Golden proportion» to the work/rest ratio of the sport is essential. A person walking should rest a certain length of time per hour. Using Table 4, a slow walker could use the ratio of 85.4% walk to 14.6% rest. This would require a rest of nine minutes every hour. Long distance performances should have a certain percentage of «coasting» when it is not possible to stop. Sports that are intense for short periods of time require longer rest periods. A runner doing interval work should rest 85.4% and run 14.6% of the time, or select another ratio based on fitness. The more energy expended, the greater the rest period needed. Tables 5, 6 and 7 present the information needed to select a tempo of performance and a work to rest ratio for some selected sports. Similar numbers can be calculated for any activity using Tables 2, 3 and 4.

TABLE 2

Corrected Fibonacci Series

Prime tempo sec	Harmonic tempo sec	*Tempo/59.76 sec	Tempo/60 sec
	.1017	587.6	590
.1147		521	523
	.1294	462	464
.1459		409.6	411
	.1645	363.2	365
.1856		322	323
	.2093	285.5	287
.2361		253.1	254
	.2662	224.4	225
.3003		199	200
	.3387	176.5	177
.382		156.5	157
	.4308	138.7	139
.4859		123	123.5
	.548	109.1	109.5

.618		96.7		97	
	.697		85.7		86
.7861		76		76	
	.88665		67.4		68
1.0		59.76		**60	
	1.1278384		53		53
1.272		47		47	
	1.435		41.7		42
1.618		36.9		37	
	1.825		32.7		33
2.058		29		29	
	2.321		25.7		26
2.618		22.8		22.9	
	2.953		20.2		20.3
3.33		17.9		***18	
	3.756		15.9		16
4.236		14.1		14.2	
	4.778		12.5		12.6
5.388		11.1		11.1	
	6.077		9.8		10
6.854		8.7		8.8	
	7.73		7.73		7.8

* The Fibonacci Series must be changed from a 59.76 second minute to 60 seconds.
* If the prime tempo is 1 beat per second, there would be 60 beats per minute.
*** If the prime tempo is 3.33 seconds per beat, there would be 18 beats per minute.

TABLE 3

Mind's Tempo on 1, 2 or 4 Beats

	Emphasis on every beat	
Time of 1 beat	Four beat meas/min	Beats/min
.3	50	200
.339	44.2	177
.382	39.3	157
.431	34.9	139
.486	30.9	123

.548	27.4	109
.618	24.3	97
.697	21.5	86
.786	19.1	76
.887	16.9	68
1.0	15	60
1.127	13.3	53
1.272	11.8	47

Emphasis on 2 beats (1st and 3rd)

Time of 2 beats	Four beat meas/min	Beats/min
.43	69.6	278
.486	61.75	247
.548	54.75	219
.618	48.5	194
.697	43	172
.786	38.2	153
.887	33.8	135
1.0	30	120
1.128	26.6	106
1.272	23.6	94
1.44	20.8	83
1.618	18.5	74
1.83	16.4	66
2.058	14.6	58
2.321	12.9	52

Emphasis on 4 beats (1st beat only of 4)

Time of 4 beats	Four beat meas/min	Beats/min
.887	68	272
1.0	60	240
1.1278	53	212
1.272	47	188
1.44	42	168
1.618	37	148
1.83	33	132
2.058	29	116

2.32	26	104
2.618	22.9	92
2.95	20.3	81
3.33	18	72
3.76	16	64
4.24	14.2	57
4.78	12.6	50

TABLE 4

Golden Mean- Work/Rest Ratios

Primary ratios (%)	Secondary ratios (%)	*Ratios based on 60 seconds	
		Work	Rest
14.6 - 85.4		14	83
	16.5 - 83.5	16	81
18.6 - 81.4		18	79
	21 - 79	20	77
23.7 - 76.3		23	74
	26.7 - 73.3	26	71
30.1 - 69.9		29	68
	33.9 - 66.1	33	64
38.3 - 61.7		37	60
	43.1 - 56.9	42	55
48.6 - 51.4		47	50
	54.8 - 45.2	53	44
61.8 - 38.2		60	37
	69.7 - 30.3	67	30
78.6 - 21.4		76	21
	88.7 - 11.3	86	11

* These ratios can be interpreted in seconds or minutes of work to rest. For one minute of work, the rest should be 37 seconds.

Work/Rest Ratio with Time Increase

Total Seconds	Work Seconds 62%	Rest Seconds 38%
29	18	11
33	20	13
37	23	14
42	26	16
47	29	18
53	33	20
60 (1 min)	37	23
68	42	26
76	47	29
86	53	33
97	60 (1 min.)	37
109	67	42
123 (2.05 min.)	76	47
139	86	53
157	97	60
177 (2.95 min.)	109	68
200	124	76
225	139	86
254 (4.23 min.)	157	97
287	178	109
323 (5.38 min.)	200	123

TABLE 5

Walking Tempo

Mind's tempo on every beat

Prime tempo		*Harmonic* tempo	
4 beat meas/min.	Steps/min.	4 beat meas/min.	Steps/min.
31 = perfect tempo	123	27 = slow	109

Mind's tempo on 1st beat of every 2 beats

		34 = very fast	135
30 = perfect tempo	120	27 = slow	106

Mind's tempo on 1st beat of every 4 beats

		33 = fast	132
29 = good	116	26 = slow	104

Swimming Tempo

Mind's tempo on *every* beat

31 = 50 meter	123	27 = 100 meter	109
24 = 100 back	97	22 = 800/1500 m.	86
19 =	76	17 = 100 m. breast	68
15 = 100 m. fly or breast	60	13 = slow	53

Mind's tempo on 1st beat of every *2* beats

		34 = 50 meter	135
30 = 50 meter	120	27 = 100 meter	106
24 = 100 meter	94	21 = 800/1500 m.	83
19 =	74	16 = 100 m. breast	66
15 = 100 m. fly or breast	58	13 = slow	52

Mind's tempo on 1st beat of every *4* beats

		33 = 50 meter	132
29 = 50 meter	116	26 = 100 meter	104
23 = 100 meter	92	20 = 800/1500 m.	81
18 =	72	16 = 100 m. breast	64
14 = 100 m. fly or breast	57	13 = slow	50

TABLE 6
Running Tempo

* Mind's tempo on 1st beat of every *4* beats

Prime tempo		*Harmonic* tempo	
4 beat meas/min.	Steps/min.	4 beat meas/min.	Steps/min.
		68 = sprint 100 meter	272
60 = sprinting	240	53 = 1/4 to 1/2 mile	212
47 = distance	188	42 = distance	168

Mind's tempo on 1st beat of every *2* beats

4 beat meas/min.	Steps/min.	4 beat meas/min.	Steps/min.
		70 = sprinting	278
62 = sprinting	247	55 = 1/4 to 1/2 mile	219
49 = distance	194	43 = distance	172

Bicycling Tempo

* Mind's tempo on 1st beat of every *4* beats

4 beat meas/min.	Steps/min.	4 beat meas/min.	Steps/min.
60 = sprinting	240	53 = sprinting	212
47 = medium dist.	188	42 = distance	168
37 = distance	148		

Mind's tempo on 1st beat of every *2* beats

4 beats meas/min.	Steps/min.	4 beat meas/min.	Steps/min.
62 = sprinting	247	55 = sprinting	219
49 = medium dist.	194	43 = distance	172
38 = distance	153		

* The turnover rate is so fast that the numbers for every beat are not given, and the mind is most likely attuned to the first beat of every four beats.

TABLE 7

Flatwater Kayak Tempo

Mind's tempo on *every* boat

Prime tempo 4 beat meas/min	Strokes/min	*Harmonic* tempo 4 beat meas/min	Strokes/min
31 = fast sprint	123	27 = sprint	109
24 = 500 meter	97	22 = 1000 meter	86
19 = 10,000 meter	76	17 = slow	68

Mind's tempo on 1st beat of every *2* beats

30 = fast sprint	120	27 = sprint	106
24 = 500 meter	94	21 = 1000 meter	83
19 = 10,000 meter	74	17 = slow	66

Mind's tempo on 1st beat of every *4* beats

29 = fast sprint	116	26 = sprint	104
23 = 500 meter	92	20 = 1000 meter	81
18 = 10,000 meter	72	16 = slow	64

Olympic Canoe = the same tempo as the kayak with one half the strokes per minute.

Rowing

Mind's tempo on 1st beat of every *4* beats

11 = very fast	44	10 = fast	40
9 = fast	35	8 = fast	31
7 = moderate	28	6 = slow	24

Standard Canoe-Racing

Mind's tempo on *every* beat

19 = fast sprint	76	17 = up to 2 hours	68
15 = up to 3 hours	60		

Mind's tempo on 1st beat of every *2* beats

18 1/2 = fast sprint	74	16 1/2 = to 2 hours	66
14 1/2 = to 3 hours	58		

How to Select a Tempo for Any Sport

The tempos given in Tables 5-7 were determined by first measuring the tempo's of athletes during competition. This gives a general range of times of foot-falls or turn-overs per minute. It can be done with a stop watch, films, or video. Table 3 shows the «Golden Mean» beats per minute for performance attuned to 1, 2 or 4 beats. One can determine how the mind is thinking by counting your own steps. Do you count from 1 to 100 consecutively, or 1,2- 2,2- 3,2- 4,2 so it is necessary to multiply by 2 to get the number of steps. Most people count 1,2,3,4- 2,2,3,4- 3,2,3,4, and then multiply by four. The time interval is the «magic number» and the best tempo is based on column one of Table 3.

It is very easy in some sports to determine the tempo. When running in competition, the breathing pattern fits the foot-fall pattern. Because the turnover rate is so high, most everyone will count by 4's. A rower touches the water with the blade on the first beat of every four. When listening to music, the mind will be attuned to the first beat of a measure. Table 3 shows that dancing will feel the best if the music has 18, 23 or 29 four beat measures per minute. The next best, in harmony, are 20, 26 or 33 four beat measures per minute. If there are 18 measures, the dance is slow, and if there are 33 measures, the dance is fast. Therefore, dancing is usually most enjoyable at 23, 26 or 29 four beat measures per minute.

To match movement patterns to the correct tempo, the tempo must be set with a metronome, or piece of music. Kayaking is a good example of how different music tempos may be used. If the music is sufficiently *slow* to place each blade in the water on every beat, the boat is in a sprint. The mind would be attuned to every beat, and Table 7 shows that 97 or 109 strokes per minute would be best. If the music is *fast*, every two beats would synchronize with each blade entry, and 94 or 106 strokes per minute would be best. This is one sport where music can be played during the paddling, and a chossen tempo can assure a rhythmic pattern that will enhance performance.

There are certain tempos that are best for daily use that many people use without knowing about the «Golden Mean». Walk at 29 four beat measure per minute. Don't change the tempo, change the stride length to fit your ability. Run distances at 188 steps or 47 four beat measures per minute. This is the tempo of most marathoners. Swim at 21 four beat measures for distance work, or ride your bike at 42 four beat measures for distance work. Best of all, you can dance all night at the magic tempo of 23 four beat measures per minute.

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