

Game Analysis of Table Tennis in Top Japanese Players of Different Playing Styles

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Abstract

This study was planned to analyze factors of table tennis games such as space, time and physiological load to players. Four top Japanese players of different playing styles participated in this study as experimental subjects. Some of the results were as follows:

1. The playing area of one fast attacker with a Chinese-style penhold grip bat was positioned close to the table and two Japanese-style penhold grip fast attackers employing nimble footwork were a bit farther off the table. One shakehand grip chopper was still farther off the table, perhaps, in order to gain time for more advantageous moves.

2. The total rally time occupied no more than half of the game. The mean heart rate during the game was in the range of 71 to 86 % of maximum heart rate of each subject during the game which occurred during the rally period. So the rally period was the main cause of increased heart rate.

3. It was tentatively concluded that explosive and powerful hitting against the opponent during a rally lasting for several seconds would be anaerobic exercise. It follows that a table tennis player, especially a fast attacker, performs anaerobic exercise with intermittent breaks during a game.

4. It was confirmed that the time available for table tennis ball shift was just near the physiological limit in which a man can react.

Key words: Japanese table tennis players, anaerobic exercise, physiological load

Introduction

Singles and doubles matches are played in table tennis. And players face each other in front of a table (1.525 by 2.740 meters) set up in an area of 49 square meters per player. Characteristically, table tennis players position themselves closer to each other for a smaller, lighter ball than any other sport such as lawn tennis, basketball, volleyball and baseball. Consequently, a table tennis ball, hit by one side, reaches to the other side relatively sooner and also can be returned easier than any other sports. From these general points of view, what will be the characteristics of Japanese table tennis games can we draw? This study was planned to analyze such factors of table tennis

Table 1
Physical characteristics of the four players

Player	Age (years)	Height (cm)	Weight (kg)	HRmax (bpm)	Vo ₂ max	
					l/min	ml/ kg • min
A	27	166.1	59.8	205	3.65	61.0
B	25	177.3	61.5	193	3.60	57.9
C	24	169.4	63.5	196	3.86	60.7
D	30	172.0	61.5	194	3.56	57.8
X	26.5	171.2	61.6	197	3.67	59.4
S.D	2.29	4.10	1.31	5	0.116	1.50

Table 2
Results of the matches and required time for the matches

match	1	2	3	4	5	6
winner	A	B	C	B	B	C
	3	3	3	3	3	3
results	21 21 21	21 21 21	22 21 15 21	21 19 21 21	21 21 21	21 21 21
	17 18 17	18 17 10	20 17 21 13	19 21 18 18	17 9 18	9 14 19
loser	0	0	1	1	0	0
	D	C	A	D	A	D
RT *	28	27	29	44	25	19

* Required Time (min)

Table 3
Rally time, the number of strokes and waiting time for the matches

match-set	players (score)	(1)	(2) (sec)	(3) (sec)	(4) (3)/(2) (%)	Rally time (sec) (5)			Number of strokes (6)			Waiting time (7)		
						X ± SD	Max	Min	X ± SD	Max	Min	X ± SD	Max	Min
1-1	A-D (21-17)	38	555	259	47	6.8±4.23	16.4	1.8	8.5±4.93	20	2	0.79"±0.094"	0.94"	0.60"
2-1	B-C (21-18)	39	378	116	31	3.0±1.40	6.6	0.6	4.4±2.31	11	1	0.71"±0.140"	1.07"	0.47"
3-1	C-A (22-20)	42	265	122	46	2.9±1.46	7.2	1.3	3.9±1.98	11	2	0.75"±0.171"	1.25"	0.47"
4-2	D-B (21-19)	40	525	264	50	6.6±4.10	17.2	1.2	8.1±5.10	21	1	0.84"±0.196"	1.73"	0.63"
5-3	B-A (21-18)	39	317	133	42	3.4±2.11	10.8	1.4	4.8±2.92	14	2	0.72"±0.130"	1.10"	0.57"
6-3	C-D (21-19)	40	248	184	74	4.6±3.24	20.2	2.8	6.1±4.47	28	2	0.79"±0.184"	1.60"	0.53"

- (1) the total point in each game
- (2) consumed time for the one set (second)
- (3) the sum of rally time for the one set (second)
- (4) (3)/(2) (%)
- (5) rally time
- (6) the number of strokes for gain or loss of one point
- (7) waiting time for the ball

Table 4
The frequency distribution and the proportion of rally time required for gain or loss of one point
upper: number of strokes
lower: percentage (%)

match-set	players (score)	0.0"	2.1"	4.1"	6.1"	8.1"
		2.0"	4.0"	6.0"	8.0"	
1-1	A-D (21-17)	3 7.9	12 31.6	5 13.2	4 10.5	14 36.8
2-1	B-C (21-18)	11 28.2	21 53.8	3 7.7	4 10.3	0 0
3-1	C-A (22-20)	12 28.6	20 47.6	8 19.0	2 4.8	0 0
4-2	D-B (21-19)	3 7.5	12 30.0	6 15.0	5 12.5	14 35.0
5-3	B-A (21-18)	8 20.5	24 61.5	4 10.3	1 2.6	2 5.1
6-3	C-D (21-19)	3 7.5	22 55.0	9 22.5	0 0	6 15.0
Total (238)		40 16.8	111 46.6	35 14.7	16 6.8	36 15.1

Table 5
The frequency distribution and the proportion of the number of strokes
upper: number of strokes
lower: percentage (%)

match-set	players (score)	1	4	6	8	10	12
		3	5	7	9	11	
1-1	A-D (21-17)	6 15.8	9 23.7	4 10.5	3 7.9	6 15.8	9 23.7
2-1	B-C (21-18)	17 43.6	15 38.5	2 5.1	3 7.7	2 5.1	0 0
3-1	C-A (22-20)	21 50.0	13 31.0	6 14.3	1 2.4	1 2.4	0 0
4-2	D-B (21-19)	8 20.0	8 20.0	6 15.0	5 12.5	5 12.5	8 20.0
5-3	B-A (21-18)	14 35.9	15 38.5	6 15.4	0 0	2 5.1	2 5.1
6-3	C-D (21-19)	12 30.0	8 20.0	12 30.0	2 5.0	3 7.5	3 7.5
Total (238)		78 32.8	68 28.6	37 15.5	14 5.9	19 8.0	22 9.2

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Table 6
The frequency distribution and the proportion of waiting time
upper: number of strokes
lower: percentage (%)

match-set	players (score)	0.000"	0.600"	0.650"	0.700"	0.750"	0.800"	0.850"	0.900"	0.950"	1.000"
		0.599"	0.649"	0.699"	0.749"	0.799"	0.849"	0.899"	0.949"	0.999"	
1-1	A-D (21-17)	0 0	4 10.5	1 2.6	7 18.4	6 15.8	7 18.4	5 13.2	8 21.0	0 0	0 0
2-1	B-C (21-18)	9 23.1	6 15.4	6 15.4	5 12.8	2 5.1	2 5.1	4 10.3	3 7.7	1 2.6	1 2.6
3-1	C-A (22-20)	7 16.7	2 4.5	10 23.8	4 9.5	5 11.9	2 4.5	5 11.9	3 7.1	0 0	4 9.5
4-2	D-B (21-19)	0 0	3 7.5	3 7.5	4 10.0	9 22.5	7 17.5	6 15.0	3 7.5	0 0	5 12.5
5-3	B-A (21-18)	3 7.7	12 30.8	4 10.3	9 23.1	3 7.7	2 5.1	1 2.6	3 7.7	0 0	2 5.1
6-3	C-D (21-19)	2 5.0	4 10.0	4 10.0	8 20.0	6 15.0	7 17.5	4 10.0	0 0	0 0	5 12.5
Total (238)		21 8.8	31 13.0	28 11.8	37 15.5	31 13.0	27 11.3	25 10.5	20 8.4	1 0.4	17 7.1

Table 7
The heart rate during the matches

:%

Player	A			B			C			D		
1) HRmax	205 (bpm)			193 (bpm)			196			194		
Opponent H.R.	B (25')	C (29')	D (28')	A (25')	C (27')	D (44')	A (29')	B (27')	D (19')	A (28')	B (44')	C (19')
180- bpm	8.3	29.9	36.9	0.0	0.0	0.6	10.3	0.0	4.0	0.0	0.0	0.0
170-179	26.2	41.9	46.8	1.2	0.0	11.9	35.3	10.6	33.3	0.9	1.2	0.0
160-169	38.1	23.1	10.8	6.2	7.5	29.4	38.8	37.5	56.0	13.4	17.3	2.6
150-159	25.0	4.3	5.4	42.0	25.2	35.0	13.8	28.8	6.7	23.2	28.3	9.2
140-149	2.4	0.9	0.0	42.0	35.5	18.1	1.7	19.2	0.0	25.9	32.4	28.9
130-139	0.0	0.0	0.0	7.4	21.5	5.0	0.0	3.8	0.0	26.8	13.9	35.5
120-129	0.0	0.0	0.0	1.2	9.3	0.0	0.0	0.0	0.0	8.9	6.9	18.4
-119	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.9	0.0	1.3
2) HRmax	185	192	196	170	168	178	188	176	188	178	172	160
3) HRmin	139	144	158	122	155	132	144	130	151	118	121	118
4) HRmean	165	173	176	148	146	159	168	158	167	145	148	137
%HRmax (%)	80	84	86	77	76	82	86	81	85	75	76	71

- 1) Maximum heart rate (bpm)
 - 2) Maximum heart rate during the games (bpm)
 - 3) Minimum heart rate during the games (bpm)
 - 4) Mean heart rate
- %HRmax: percentage of the mean heart rate to the maximum heart rate during the matches

games as space, time and physical load regarding the top Japanese players.

Materials and Methods

Four top Japanese players with different playing styles participated in this study as experimental subjects. They were classified according to 1) right-handed or left-handed, 2) defensive or offensive, 3) kinds of rubber, and 4) styles of grip.

Table 1 shows physical characteristics of the four players.

Player A was the Men's singles champion of All Japan Table Tennis Championships in 1979. He was a right-handed attacker with a reverse sandwich rubber bat.

Player B was the Men's singles champion of the 35th World Championships in 1979. He was classified as a left-handed attacker with a reverse sandwich rubber bat.

Player C was the Men's singles 3rd place of All Japan Table Tennis Championships in 1981. He was a right-handed attacker with a pimple rubber Chinese bat.

Player D was the Men's singles 3rd place of the 34th World Table Tennis Championships in 1977, and also the Men's singles champion of All Japan Table Tennis Championships in 1972, 1978 and 1979. He was a right-handed defensive chopper with a shakehand grip bat.

The four players, with devised leather helmets on, were requested to play 5-set match singles games by round robin under two video cameras on 19th December in 1981 (Fig.1). In total six matches were played, and the players took one hour recess between the second and the third match. Each camera, at 60-frame per second, traced the motion of an infrared lamp on the helmet. And this motion we have interpreted as each player's movement in this study.

Heart rates were measured for the purpose of estimating the extent of physical load to a player during the match by a telemetering method with CARDIOSUPER 2E31A made in SANEI CO., Ltd. of JAPAN.

In this study only the closest set in each match was replayed for analysis. A player's motion on a picture reproduced by a motion analyzed SVM1110 (by SONY Cl., Ltd. JAPAN) was analyzed by our own method of tracing a track of the flare lamp on a clear vinyl sheet spread on the TV screen, with a marker pen. The track was traced from the beginning (a toss in service) to the end of a rally at every point. In this way, we can catch each player's motion through the movement of his head.

Results and Discussion

Table 2 shows results of the matches and the required time for the match.

Player A was 1-2 (won-lost), B was 3-0, C was 2-1 and D was 0-3. The mean time and the standard deviation for the one game were $28'40 \pm 7'35''$ and the numbers were 6.

Fig.2 shows typical movements of the four players during their games. A solid line shows a track of the longest rally, and a dotted line shows the shortest one.

Fig.2-1 is player A's motion. His against opponent was player D. The dotted line shows A's motion, while he made a service and missed his second shot. He could not hit the D's return successfully because of fading away toward his forehand. The solid line shows that A missed the fourteenth stroke smashed by player D.

In Fig.2-2, the dotted line shows player B's motion till he received his opponent C's service and he made a miss (the ball went over the end line on his opponent's side without a bound). The solid line shows that player B missed the eleventh stroke smashed by player C with backhand. This solid line was very rare case. It might be the reason that his opponent player C always positioned close-to-table and adopted Chinese-style tactics, and so player B had to gain time for more advantageous movement at a farther off the table.

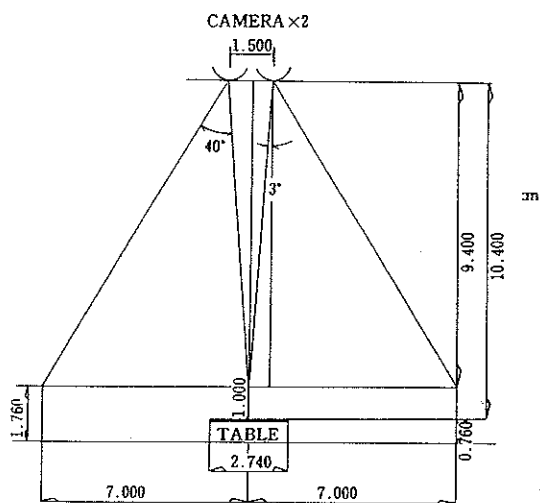


Fig. 1 Situation of the cameras and the table

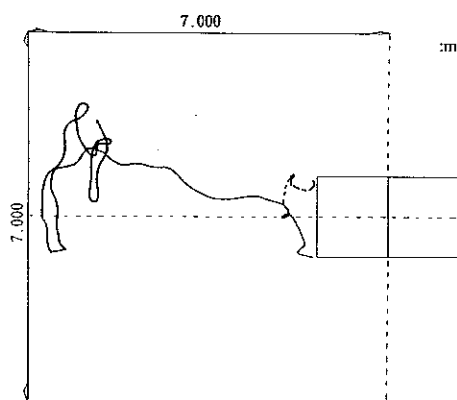


Fig. 2-1 Player A (right-handed attacker with reverse sandwich rubber bat)

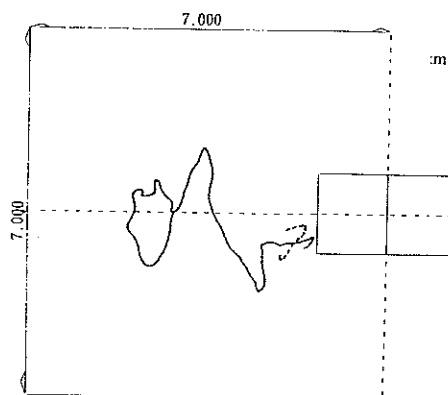


Fig. 2-2 Player B (left-handed attacker with reverse sandwich rubber bat)

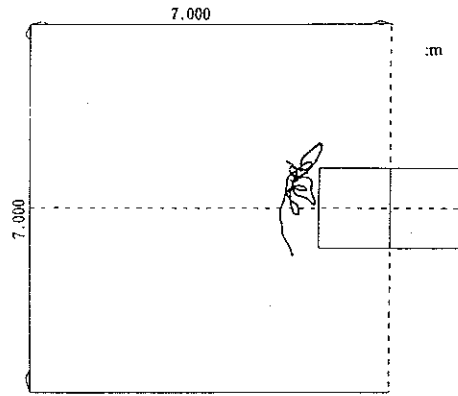


Fig. 2-3 Player C (right-handed attacker with a pimple rubber with a Chinese bat)

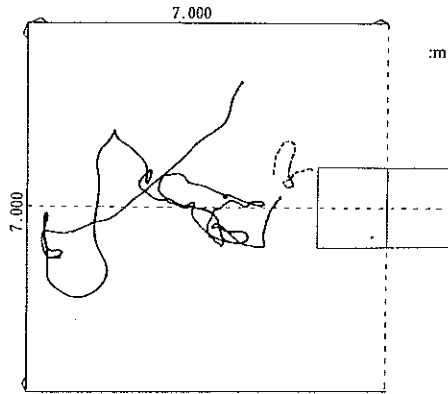


Fig. 2-4 Player D (right-handed defensive chopper)

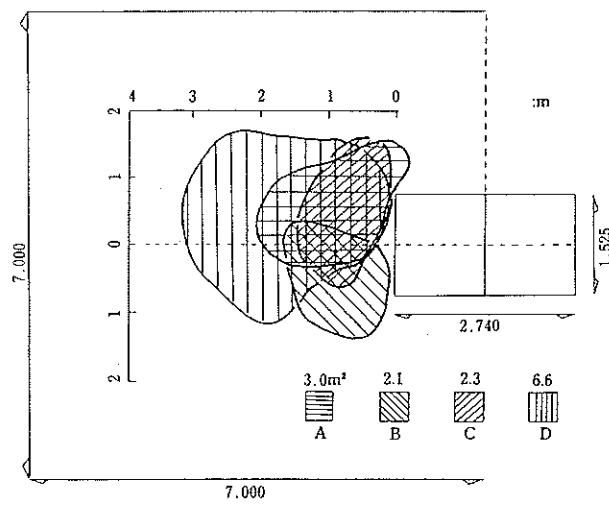


Fig. 3 Main tactical sphere in the match

In Fig.2-3, the dotted line traces player C's motion till he lost a point in the third stroke because the ball was caught in the net. The solid line traces till he missed a smash in the twelfth stroke. He always plays at a close-to-table position even in a long rally.

Fig.2-4 is a chopper D's motion. The dotted line traces his motion till he gained a point when player B made a miss in the stop receive.

Fig.3 shows the main tactical sphere in the match. Player A's tactical sphere was about 3.0u, player B' was 2.1u, player C's was 2.3u and player D's was 6.6u. The sphere was obtained by such a method as follows; First, the all tracked vinyl sheets were piled and imposed for each player, and an additional plain vinyl sheet was put on the pile. And then, only entirely blacked portions were encircled with a marker pen to be assumed as the main tactical sphere for the player. Moreover, a plain section paper ruled into 1-millimeter squares was again put up on it and the area was calculated by counting the number of the section.

As you see in Fig.3, player A, B and C remain in the narrower tactical area, positioned less than 2 m from the table, than player D (a chopper). Player C, one fast attacker with Chinese-style penhold grip was positioned close-to-table and player B, Japanese-style penhold grip fast attacker remained in the narrowest tactical sphere among those four players. And another attacker, player A was a bit farther off the table. And his tactical sphere was wider than those of the other two attackers. On the other hand, player D, a shakehand grip chopper, was still farther off the table, perhaps, in order to gain time for more advantageous movements. So, he played his game in the widest tactical sphere, about three times as large as a player B's.

Table 3 shows the total point in each game (1), the consumed time for the one set in each game(2), the sum of rally time for the one set(3), the proportion of the later to the former(4), the rally time and the number of strokes for gain or loss of the one point(5)(6), and the waiting time for a ball(7). The mean time of the consumed time for the one set was 381 ± 120 seconds, that of the sum of rally time was 180 ± 62 seconds. The average rally time for gain or loss of one point, except the games with player D, ranged from 2.9 to 3.4 seconds. And the average number of stroke ranged from 3.9 to 4.8. On the other hand, in the games with player D, both figures excluded. The average rally time was from 4.6 to 6.8 seconds, and the average number of stroke was 6.1 - 8.5. The average waiting time in a rally ranged from 0.71 to 0.84 seconds, and this figure was somewhat prolonged in the games with player D.

Table 4 shows the frequency distribution and the proportion of the rally time for gain or loss of one point. In the games with player D, especially in the games D - A and D - B, long rallies which went on more than 8.1 minutes account for more than 35 % of all the rallies. In the games of player A, B and C, short rallies which took less than 4 minutes, account for more than 80 % of all their rallies.

Table 5 shows the frequency distribution and the proportion of the number of strokes. Except for the games with player D, the number of strokes is more than 5 in 80 % of the rallies.

Table 6 shows the frequency distribution and the proportion of the waiting time. The most frequent figure of waiting time is 0.700 - 0.794 seconds in all the games. But in the three games excluding player D, all the figures were under 0.700 seconds. The most frequent figure is less than 0.599 in B - C, 0.650 - 0.699 seconds in C - A, and 0.600 - 0.649 seconds in B - A.

The waiting time ranged from 0.47 to 1.73 seconds with the mean time being 0.71 to 0.84 seconds. This mean time looks similar to the whole body reaction time for Japan table tennis players scored by use of a tool produced by T.K.K. Co., Ltd of Japan. This measurement has been popular as that of the exercise physiological scores using the light stimulus. The subject is requested to move onto one of the four plates located 25 cm apart from the center plate, forward, backward, rightward and leftward directions. Therefore, the whole body multiple reaction-time is the time which elapsed from a light to the end of the movement into indicated position. The time usually ranged from 0.6 to

0.8 seconds. Therefore, it would be estimated that a table tennis player returns the ball against his opponent within a critical time-limit for men's physiological reaction when he strives hard to advance the attack.

Table 7 shows the percent of heart rate level to the whole heart rate; mean heart rate; and the percentage of mean heart rate during the game to their own maximum heart rate(% HR max). The average of maximum heart rate during the matches was 91 ± 4 %. The mean heart rate during the matches ranged from 137 to 176 bpm, and the average of the four player was 157.5 ± 12.01 bpm. % HR max ranged from 71 to 86 %, and the average was 80 ± 5 %.

As is quite evident in this table, there exist large differences in heart rate and its levels between these players. About player A, his heart rate indices are always higher than those of the others during the game, and rose to 196 bpm, or 96 percent of his own maximum heart rate. Player B, who was a winner at that time, also showed relatively higher heart rate level when he played against D, but it necessitated him about 44 minutes to finish that game: this time consumption was the largest in those six matches. On balance, however, his heart rate level was low during his game compared with other players' levels. Player C always played close-to-table like Chinese attackers. His heart rate increased during his match against both player A and D. Finally, concerning player D (a chopper), he played his game with the lowest heart rate of the attackers, although he played his game in the widest tactical sphere. This result shows that the tactical sphere is not necessarily a physical load upon players.

Summary

1. One fast attacker with Chinese-style penhold grip was positioned close-to-table and one Japanese-style penhold grip fast attacker, who was the Men's singles champion of 35th World Table Tennis Championships in 1979, remained in the narrowest tactical sphere among these four players. And another attacker, who was the singles winner of All Japan Table Tennis Championships at that time, was a bit farther off the table. And his tactical sphere was wider than those of the other two attackers.

2. One shakehand grip chopper was still farther off the table, perhaps, in order to gain time for more advantageous movements. So, he played his game in the widest tactical sphere, about three times as large as a player B's.

3. The total rally time occupied merely half of the game. The mean heart rate during the game ranged from 71 to 86 percent of maximum heart rate which occurred during the rally period. So the rally period was the main cause of increased heart rate.

4. In the matches among the three attackers, 80 % of a rally for getting one point takes less than 4 seconds and the number of strokes was less than 5, so the waiting time for a player was less than 0.7 seconds. It was confirmed that the time available for table tennis ball shift was just near the physiological limit in which a man can react.

5. The physiological load on these players in reference to the heart rate level during the matches was 71 - 86 % HR max and it is supposed that the figure would be higher during the rally. It was tentatively concluded that the top players' rallies would be anaerobic exercise because of its explosive and powerful hitting in a very short time. Therefore it follows that a table tennis player, especially a fast attacker, performs anaerobic exercise with intermittent breaks during a game.

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