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Experimental Research in Table Tennis Spin

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Introduction

Spin and speed are two primary factors that play an important rôle in winning table tennis matches. They are often related to and restricted by each other. They help promote the development of world table tennis techniques. For example, in the 1960s Chinese players were known for their pen-hold fast attacking play and variation in the cutting spin; and in the 1970s the Europeans gained the upper hand with their looping techniques. In the 1980s techniques in spin and speed developed further, attracting even greater attention from players, coaches and researchers in both training and theoretic studies.

Chinese players are good at fast play. Yet sometimes they lose to their European counterparts because of their poor counter-looping techniques, thus it becomes very important and necessary to study spin techniques and their laws.

Now, people both inside and outside of China have gained much knowledge about spin balls through qualitative analyses. However, there is still a need for further quantitative studies for more discoveries. So far, nothing more has been done owing to the lack of testing means. In 1977 we learned from people concerned in Japan and West Germany that the rotational speed of the spin balls in table tennis can reach 100 to 150 revolutions per second (r/s), but according to a report run in a magazine in commemoration of the 50th anniversary of the West German Table Tennis Association, the rotational speed was only 50 r/s. At that time there was no special measuring equipment in those two countries, so it was difficult to prove the reliability of the data. In 1979, we asked to the Electronic Research Institute in Beijing to develop this kind of accurate r/s measuring instrument for us. It was completed in 1984 and approved by the Ministry of Electronics Industry and the State Physical Culture and Sports Commission.

After measuring the rotational speeds produced in looping, chopping and serving (see Table 1) of 24 players from the Chinese National Table Tennis Team and National Youth Team we figured the average and maximum rotational speeds brought by the above techniques so as to make preparations for further quantitative tests of the training effect, as well as for comparison of the same techniques between Chinese and foreign players. This will surely help improve the scientific training of the sport. In this paper we will also discuss the relationships between the intensity of spin and players' playing styles, training levels, the properties of their rackets, and their technical movements. This paper, in short, is the first of its kind in the world to announce the results of quantitative analyses of table tennis spin.

Methods

Our experiment was carried out in Beijing from March through May in 1987 and

Table 1

Testing Items of the Experiment

Games	Testing Items
loop	high loop, forward-driving loop, heavy chop, main services
fast attack	high lift (loop), forward-driving lift (loop), heavy chop, surprise attack, main services
cut	high loop, forward-driving loop, heavy chop, light cut, heavy cut, main services

Table 2

Experimental Result of the Two Chinese National Teams

	high loop				forward-driving loop			
	$\bar{X}$	M	S	n	$\bar{X}$	M	S	n
National Team	128.4	145.3	7.6	12	134.9	151.3	8.4	12
Youth Team	126.7	143.5	8.3	11	131.2	149.1	9.1	11
P	>0.50	>0.50	>0.20		>0.20	>0.50	>0.20	
	surprise attack				**heavy chop**			
	$\bar{X}$	M	S	n	$\bar{X}$	M	S	n
National Team	65.5	84.8	9.0	3	55.6	73.4	7.6	12
Youth Team	57.2	85:8	13.5	3	50.3	72.0	10.8	12
P	>0.50	>0.50	>0.10		>0.10	>0.50	<0.01	

$\bar{X}$: average rotational speeds(r/s) S: technical stability

M: maximum rotational speeds(r/s) n: number of players involved six fast-attacking pen-holders, four pen-hold loopers, 12 tennis grip loopers and two tennis grip cutting players. Half of them came from the national team, and the other half came from the national youth team. The average age was 22.8 for the national team players who had undergone 14 years of training amongst them, and 17.3 for the youth team players with 10 years of training.

Instruments used in the experiment were:

A. PD-1 Dynamic Spin-Surveying Metre*

Composition: detector and terminal

Features: dynamic measurement and real-time display

Specifications: range of measurement: 20-200 r/s

Uncertainty: ≤3%

Short-Time Stability: ≤2%

B. B-83 Table Tennis Robot

When the robot was used the rotational speeds were usually between 41 and 43 r/s for underspin balls and about 108 r/s for top-spin ones.

C. Special Tables and Table Tennis Balls

During the experiment, players practiced with a robot which produced 50 top-spin (only for cutting players) and underspin balls. The spin-surveying metre measured and kept the rotational speeds displayed by both the robot and the players.

Results and Discussion

1. National team and national youth team

Table 2 shows the experimental results for the above two teams. The average rotational speed (X) of the high loops for the national team was 128.4 r/s, and the maximum (M) was 145.3 r/s. In forward-driving loop, X was 134.9 r/s, and M was 151.3 r/s. These results were slightly better than those achieved by the national youth team. There was no noticeable difference between the two teams in either cut or surprise attack rotational speeds.

S in Table 2 is the standard deviation indicating technical stability. The smaller the S, the better the stability. Here the national team showed a better technical stability than the youth team, particularly in its performance of cutting ($p<0.01$). This means that the youth team players are not yet mature and need more solid training.

From Table 2 we know that the maximum rotational speed of the surprise attack was about 85 r/s. This shows that this technique is not just "hitting" the ball. Instead, one should hit the ball and create friction on it in order to make it fly in a good arc over the net.

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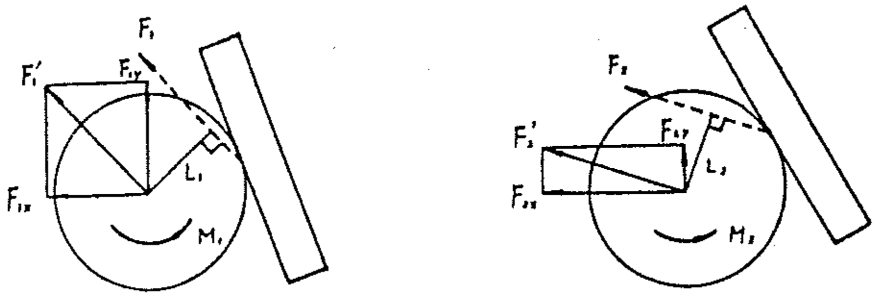
* It won a gold prize in the 14th International Development and New Techniques Fairs in Geneva in April 1986 and a silver prize in the 35th Brussels International Fairs in December 1986.



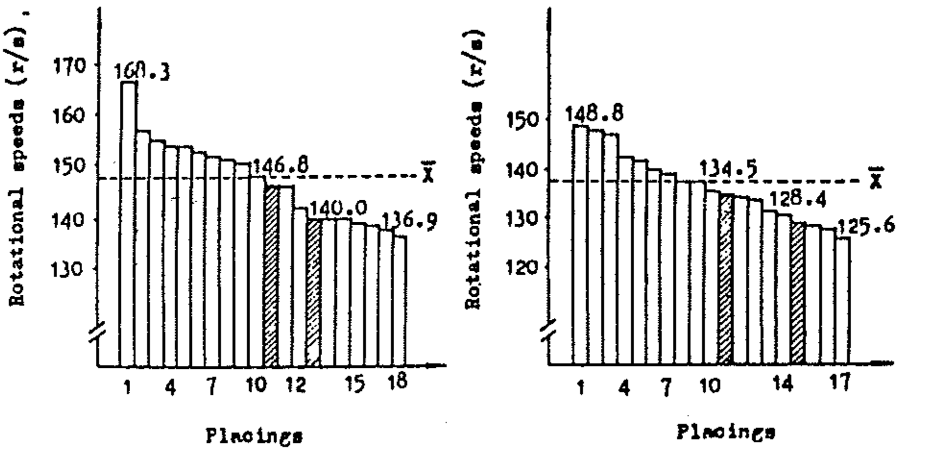
(a) (b)

Figure 1 Comparison of the force between high loop (a) and forward-driving loop (b)

Table 3

Rotational Speeds of Two Kinds of Loops

	$\bar{X}$	M	n
high loop	127.8	141.8	22
forward-driving loop	134.2	151.5	22
P	< 0.01	< 0.01	



Maximum value of high loop   Average value of forward-driving loop

Note: ▨ players with pip-out rubber
□ players with pip-in rubber

Figure 2 Looping performances by players with two different rubbers

2. High loop and forward-driving loop

Generally speaking, high loop produces greater spin but has slower speed than forward–driving loop does under similar conditions. As illustrated in Figure 1, when the racket touches the ball for a loop, the applied force F may be resolved into F' (force) and M (moment of force). Here M (=FL) makes the ball spin while F' (=F) is resolved into another two components, Fx and Fy, the former (Fx) making the ball go forward and the latter (Fy) go upward. In high loop, the force F1' is used mainly to produce friction in the ball and thinner cuts (L1>L2), which consequently result in a greater top–spin (M1), a high arc (F1y) and a low speed (F1x). Forward–driving loop is just the opposite having greater speed (F2x>F1x), lower arc (F2y<F1y) and less spin (M2<M1) because the racket is meant to hit the ball and create friction on it at the same time.

In our experiment, however, the average and rotational speeds of the high loops displayed by most pen–holders and tennis grip players (91%) were obviously lower than those of the forward–driving loops ($p<0.01$, see Table 3). Why was this result so different from the common opinion? We think there are two main reasons:

A. Training. According to the principles of athletic training, any technique can be improved through repeated practice. From the experiment we can deduce that the players had less high–loop training, and this was proved by the factor that some players' high looping movements were not so coordinated as those in their forward–driving looping play.

B. Trend of Development. During 1960s and 1970s, players used high loop techniques as a key weapon along with some forward–driving loops. In the 1980s, especially after the 36th World Championships in 1981, players began to use forward–driving loops more often because the high loops were not so menacing and often brought them into a passive position. This showed the latest trend of development in world table tennis–spin and speed were more closely combined, which forced coaches and players to pay more attention to the quality of the forward–driving loops.

3. Pips–out rubber and pips–in rubber

Fast, aggressive games with pips–out rubber have contributed to the unfading glory of the Chinese team for more than two decades, but now there are fewer elite players with this style of game in any age group. One of the reasons for this is that some people believe the pips–out rubber is good for speed and neglect its spinning potentiality. In our experiment, though on the average players with pips–out rubber obviously did not produce as great a spin as those with pips–in rubber, a few of them still did better in the looping play. Take Chen Hongyu from the youth team for instance. With his maximum rotational speed of 146.8 r/s in high loops (see Figure 2) he placed 11th among 18 players with pips–in rubber. This showed that the loops produced by pips–out rubber could reach the performance level of those by pips–in rubber so long as the fast–attacking players paid close attention to training for the spinning techniques to improve their playing styles. This also conforms to the trend of the table tennis development.

Many people think that the tennis grip suits the looping game better than the pen-hold grip because it can produce greater spin. That's why the number of the Chinese pen–hold loopers is decreasing. Our experiment showed that pen–hold pips–in rubber produced about the same rotational speeds in looping and chopping as the tennis grip pips–in rubber did ($p<0.10$). It even had a slightly higher spin in services than the latter. This helped provide an experimental basis for further development of the pen–hold grip looping play.

4. Cut and loop

Chinese cutting players have won world titles on many occasions. In the 1980s, with the development of looping techniques, the cutting play began to go downhill. People have been trying to find a way out of it. Some believe it is possible for cuts to reach the rotational speed of the loops since the two have similar movements, except for the direction of exertion. During the experiment the maximum rotational speeds showed in cutting by two players, who were the best in their respective age groups, were 106.9 r/s and 120.7 r/s respectively, while their speeds in looping were 136.9 r/s and 137.9 r/s respectively. Although theoretical analyses shows that the rotational speed of cutting is never higher than that of looping, it is still possible to improve the former in one way or another. This result will probably encourage defensive players in developing their own styles. For example, they may use attacking and counterattacking techniques more often while improving the quality of cutting to contend with the loops.

Conclusions

1. Both the average and maximum rotational speeds produced by the national team were higher than those of the national youth team in high loops, forward–driving loops and heavy chops, though the difference was not so obvious. In technical stability, the national team was better again. Its chopping performance was particularly higher ($p<0.01$).

2. The rotational speed of the forward–driving loops displayed by most players from both teams was significantly higher ($p<0.01$) than that of the high loops. This new discovery was quite different from the old idea. However, what it has shown up in the latest trend of world table tennis development, is that, spin and speed are more closely combined.

3. Although pips–out rubber produced less spin than the pips–in rubber, the rotational speeds of the loops by some players with pips–out rubber could still reach the average level of those with pips–in rubber. This shows fast–attacking players still have much left to do in developing the looping spin. There was no obvious difference between the pen–hold grip and tennis grip pips–in rubber so far as the loops, chops and services were concerned.

4. The experiment indicated that the maximum rotational speed of the cuts produced by some cutting players was lower than that of their loops. This will help define the future development of the cutting games.