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A Study on the Compilation of a Behavioral Scale for Timeout Decision of Taiwan's Table-tennis Players

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Abstract:Purpose: This research aims to explore the rules and regulations concerning the timeouts in table tennis matches, and to develop reliable and valid scale of reasons for calling timeouts. Method: Based on previous research, a questionnaire about timeout decisions is designed. With the help of item analysis and exploratory factor analysis, the discrimination of the scales, as well as the factors listed in the scales, are examined. A total of 369 questionnaires are distributed, and 352 are completed and returned. The valid response rate is 97.78%. Result: A good fit of the modality is indicated by structural equation modeling (SEM).(χ2 =176.88, df =86, χ2/df=2.05, GFI=0.94, SRMR=0.042, RMSEA=0.054, NNFI=0.95, CFI=0.96, PNFI= 0.76, PGFI= 0.67, CN=222.45) Conclusion: The scale of timeout decision is consistent with the empirical statistics, and it can be further applied to other relevant research.

Key words: table tennis, the rules of table tennis, timeout decision

1. INTRODUCTION

1. 1 Background and motivation

Since the rules of table tennis were changed radically in 2000, each player or pair has been entitled to claim a timeout in an individual match. These alterations in rules and regulations have certainly brought new challenges to the table tennis circles, and have made significant impact on the training in skill, tactic, and psychology.

As Leet and Rushall (1984) point out, during competitive matches, it is usually difficult for coaches to make decisions, and inappropriate decisions often affect the result of a match. Coaches have to make decisions in a very short time during every game. Therefore, this research attempts to study the timeout decisions made by players and their coaches, and it can be used as a reference for coaches, players, and relevant administrative organizations to understand the importance of calling a timeout. Indeed, the timeout regulations are beneficial to the progress of games, making it more competitive and exciting. If coaches and players take good advantage of their rights to call a timeout, they will have a chance to adjust their tactics, strategy, as well as psychology, and they may therefore turn the game around. However, an unreasonable timeout decision may have an opposite effect on the game. That is, when to ask for a break would influence the result, and the importance of timeout cannot be neglected. When is the right time to call a timeout? Under what circumstance is a timeout considered reasonable? Do coaches and players have the same idea of calling a timeout? The outcome of athletic games can be easily influenced by players' capabilities, including skills, the adjustment of strategies, physical and psychological preparation, all of which are essential for athletes' performance in matches. If players are not in their best condition before a match begins, which leads to errors in performance, the scores would be affected significantly. This is particularly true in table tennis matches, where players stand in a short distance, react to a fast-moving ball, and compete fiercely with their opponents. With the advancement in technology nowadays, coaches and players expect to perform perfectly in matches by making good use of the outcome of scientific research to prevent any possible factor from influencing their performance.

Table tennis is a complex sport that involves fierce competition and interaction between players. Small balls move back and forth speedily between players, and players have to judge the direction in which balls move and rotate, then stand at the right position, and make a good return. This process requires players' accurate judgment and quick reaction. In addition to step-by-step training, players need to participate in matches to examine the effect of training. By doing so, they are able to modify their training and enhance their advantages. This is an important issue in scientific training, which is emphasized nowadays. Gilovich believes that table tennis is a sport suitable for the research on decision-making. Making a decision (in other words, making up one's mind) refers to the process in which, based on available yet uncertain information, decision-makers choose the best option from the others. As Shao (1996), Liu (2002), and others point out, the ability to make a decision is the ability to take objective conditions into consideration, and decide on strategies, skills, action, targets, and possible solutions. They also claim that coaches' ability consists

of encyclopedic knowledge, wisdom, abundant experience, calmness, strategy, strong willpower, inspiration, and the ability to cope with emergency. Before matches start, coaches can choose the most satisfying decision to follow so that the result of matches will be better. During games, especially key ones and finals, however, coaches have to make a right, irreversible decision to increase the possibility to win. According to Wu, Meng, and Zhang (1999), to be a good decision-maker requires: 1. knowledge, including the theories of specific training and of related disciplines; 2. ability, including intelligence, teaching ability, and creativity; 3. the ability to deal with emergency. Any timeout decision influences players' skills, strategies, and psychology, and this is strongly related to the outcome of matches. As a consequence, coaches' decisions, either about training or the immediate advice in games, have direct influence on the effect of training and the result of matches. The famous tennis player Connors once said, when athletes' physical condition and skills are at peak, the final result is almost decided by their mental state on the court. (Wenberg 1988) The physical condition and skill of a player can be easily observed, but the mental state of a player cannot because it is a subtle inner factor. (Liao 1993) Therefore, in a match where two players that seem equally good compete with each other, knowing well their mental condition is very important.

In an important match, the decisions made by either coaches or players will affect the final result. Because of the alteration of rules, the difference in scores between athletes decreases, and more uncertainties arise. These phenomena are particularly important to coaches, who look at games closely and give advice to players. Liu (1995) believes that the result of a game can often decided within a very short time, so coaches cannot hesitate to make decisions. Their decisions need to be authoritative, and any argument about the decisions is not allowed. Because coaches are responsible for not only the effect of training but also the result of every match, their observation and analysis in a game must be sensitive and accurate.

The existence of the timeout regulations is of great importance.

Coaches and players need to put more emphases on the combination, as well as the flexible application, of skill and strategy. They also have to learn to improve their sense of observation so that they can make full use of one-minute timeout periods. As Barrow (1977) claims, an outstanding coach should act like an experienced psychologist, who is able to understand players' psychological state immediately, regulate their emotion, and adjust their condition during games to ensure their best performance, as well as the smooth progress of games. The leadership of coaches is meant to help athletes achieve their goals in a short time. How coaches and players take good advantage of the only timeout is certainly worthy of discussion.

1.2 The purpose of this research

In the past, table tennis coaches can only instruct the players between each interval of matches. Instructions of any kind at any other time are considered illegal and are prohibited by the rules. Violation of the rules, as a result, may lead to coaches expelled out of the game. During the breaks between games, coaches can only give advice concerning the next game, but this can not change the result of the previous game at all. Now players, or pairs, are entitled to call one timeout during each match, and this alteration in rules may be a crucial factor that defines the result of a competitive match. That is, a timely timeout can significantly affect the result of a match, retain advantageous situations, and adjust the mental state of players. To the contrary, an improper timeout can be counterproductive. Consequently, it is of great importance when coaches and players decide to call their only timeout. Even though many coaches and players have suggested the importance, as well as the influence, of timeout decisions in games, no empirical research is available. Previous research on timeouts is all about other sports, with none of them aiming at the timeout decision in table tennis matches. Thus, this research attempts to compile a scale of the reasons for timeouts, hoping to look at timeout decisions, as well as the attitude of players and coaches, in a scientific way.

Based on the above research backgrounds and motives, this research attempts to:

(1) Compiling a scale of good reliability, convergent validity, and discriminant validity.

(2) Serving as reference to relevant organizations of table tennis.

2. METHOD

The purpose of this research is to compile a scale of the reasons for timeouts. To begin with, literature review and analysis are conducted. Then, a pilot questionnaire on the reasons for timeouts was designed. The questionnaires were distributed to do a pilot. After item analysis and exploratory factor analysis of the returned pilot questionnaires, the revised scale printed as questionnaires were officially distributed to all subjects.

2.1 Scale compilation

On the basis of the theoretical scheme set up by Lin(2003), Duck and Corlett(1992), Wu, Meng, and Zhang(1999), Gilovich(1984), Liu and Huo(2002), along with other relevant literature and research, the scale "*Behavioral Scale of Reasons for Calling a Timeout"* was compiled. It contains 15 questions, which reflect faithfully the reasons for calling timeouts in genuine matches. After some suggestions provided by three experienced national coaches were taken into consideration, the questions were slightly adjusted. At

last, the pilot questionnaire on players' reasons for timeouts was completed. The questionnaire is divided into two sections: basic information of respondents and the scales of reasons for calling timeouts. The Likert 5-point rating scale is utilized, ranging from "always," "often," "sometimes," "seldom," and "never," each of which is given 5, 4, 3, 2, and 1 point in sequence.

There are 24 questions in the questionnaire, the aspects of them including attack, defense, strategy, and emotion.

2.2 Steps

(1) Stage 1

The pilot questionnaire was distributed to the table tennis teams from 12 universities nationwide. There are 200 subjects, among which 134 players are male and 64 are female. In this stage, by means of item analysis and exploratory factor analysis (EFA), the discrimination of the scale of the reasons for calling timeouts is examined.

(2) Stage 2

In this stage, the subjects are players taking part in the 2007 Selective Trial of Table Tennis National Representatives. After the contact with all teams, as well as the agreement from coaches and players, questionnaires were distributed to each member of all teams by the researcher in person. 378 questionnaires were distributed, with 369 of them returned and 9 invalid. The valid response rate is 95.24% (256 males and 104 females). The average age of male respondents is 19.82±3.28, and that of female respondents is 17.69±2.8.

The software LISREL is used for confirmatory factor analysis (CFA), which is meant to examine the general goodness of fit, reliability, and the discriminant validity of the scales.

The program of LISREL provides various Goodness-of-Fit Indices. This research takes the suggestions from Huang (2002, 2004), Qiu (2003), and Byrne (1989) as reference, which includes: (1) Chi-square($\chi 2$), which represents the Goodness-of-Fit between the hypothesized modality and empirical statistics. The smaller $\chi 2$ is, the better the Goodness-of-Fit is. (2) Generally speaking, a GFI (Goodness of Fit Index) exceeding 0.90 means good fit. (3) SRMR (Standardized Root Mean Square Residual) is the residual in average between the observed samplings and predicted matrix. A value of zero indicates perfect fit; a value less than 0.05 means good fit; a value between 0.05 and 0.10 is considered acceptable. (4) A ratio of $\chi 2$ to the degree of freedom ($\chi 2$/df), which is less than 1.0-3.0, indicates excellent fit. (5) AGFI (Adjusted Goodness-of-Fit Index) consists of the variance and covariance from the hypothesized modality. A value which is more than 0.09 is considered acceptable. (6) RMSEA (Root Mean Square Error of Approzimation) is a measurement of the difference between each degree of freedom. A value of RMSEA, which is less than 0.05, indicates good fit while a value below 0.08 is still considered reasonable. (7) NFI (Normed Fit Index) is the Goodness-of-Fit calculated on the basis of $\chi 2$, with a value ranging from zero to 1. (8) NNFI (Non-normed Fit Index) is the NFI after the degree of freedom is taken into consideration. A value of NNFI exceeding 0.90 means a good fit in the hypothesized modality. (9) CFI (Comparative Fit Index) is the outcome of calculation after the size of sampling is taken into consideration. A value of 1 means the modality is perfect while a value of zero has the opposite meaning.

3. RESULT

3.1 Pilot test of the Scales

This study adopted SPSS for Windows 12.0, a program for statistics, to do item analysis and exploratory factor analysis.

(1) Item analysis

In establishing the scale, this research adopted correlation analysis and internal consistent criteria to analyze scales items. Correlation analysis was administered through calculating product-moment coefficient between the individual item score and the total score. If they are significantly correlated ($p<.05$) and their product-moment correlation is higher than 0.30, the item is of good discrimination. Internal consistent criteria method is a way in which all the subjects' scores in the pilot test, which adopted a tentative item scale, are ranked from high to low. The top 27% are labeled as high scores, and the lowest 27% are labeled as low scores. Then, independent sample t-test was administered. If the CR value is higher than 3 and shows that they are significantly different ($P<.05$), it means it is able to be discriminate from one another. (Chiu, 2002)

Using the two methods mentioned, the result showed that the correlation coefficient of this *The Behavioral Scale of Reasons For Calling a Timeout* was between .310~.728; critical ratio locates among 6.385~18.382; and all the individual question items showed the ability to discriminate significantly from one another.

Each question in *The Behavioral Scale of Reasons For Calling a Timeout* includes: X1. I call for timeout because I am not prepared for the incoming serving pattern yet. X2. I call for timeout because the locations where my attacks and defenses ball hit in previous plays are bad. X3. I call for timeout because I want to change my tactic. X4. I call for timeout because I want to change my playing pattern. X5. I call for timeout because the opponent plays all too smoothly during previous plays. X6 I call for timeout for lifting up the player. X7. I call for timeout because the player is frustrated and lacks confidence. X8. I call for timeout because the clumsy resuming stance during balls flying to-and-fro in a row. X9. I call for timeout because the

rate of serving-error is too high in previous plays. X10. I call for timeout because the player did not play hard enough. X11. I call for timeout to adjust the strategy I adopted and let the player take a rest. X12. I call for timeout because I am affected by spectators and others outside the court. X13. I call for timeout because there is a problem in striking at balls returned from serving. X14. I call for timeout because there is a problem in striking at balls that are served from the opponent. X15. I call for timeout because there is a problem in a ball playing to-and-fro continuingly for a long period.

(2) Exploratory factor analysis

The exploratory factor analysis of this research adopted Principal axis factoring, Promax rotations, and oblique rotations to test the validity and factorial structure of the scales. There are four indices in *The Behavioral Scale of Reasons For Calling a Timeout*. Factor one, named as "strategy," includes three items that are mainly about factors of strategy and playing patterns played by players and players who adjust their tactics and playing patterns through calling for timeout. Factor two, named as "emotion," includes six items that mainly focus on players' mental state, and how they adjust their emotions and face such factors through calling for timeout. Factor three, named as "attack," includes two items that mainly focus on the factors which lead players to launch an attack, and how players adjust their tempo to do this by calling for timeout. Factor four, named as "defense," includes four items that are mainly about factors of players' defense and contingent striking pattern during a match, and how players adjust it through calling for timeout. Among those items, item 2 and 3 are deleted because they are greatly overlapped and contribute to a factor loading which is too low. The factor loading of four indices in *The Behavioral Scale of Reasons For Calling a Timeout* are located among .51 ~.75, .46~.71,.53~.75, and .44~71; characteristic values are 9.65, 2.01, 1.23, and .99 respectively; descriptive variances are 18.26, 17.56%, 12.29%, and 9.68% respectively; cumulative descriptive variances are 18.26%, 35.82%, 48.12%, and 57.8% respectively; total descriptive variance is 57.8%.

(3) Mean, standard deviation, kurtosis, and skew tests of the sample

This research used SPSS 12.0 statistics program to test each item's mean, standard deviation, kurtosis, and skew coefficient. The result showed that the means in the scales are between 2.74~3.40, standard deviations are between .94~1.12, kurtosis are between -.48~.14, skews are between -.89~.13. Consequently, the result can be seen as approximate normal distribution and thus is suitable to use Maximum likelihood for estimating parameters. Each item's correlation matrix, mean, standard deviation, kurtosis, and skew of *Free Time Management Scale* are shown in Table 1.

Table 1 Correlation matrix, mean, standard deviation, kurtosis, and skew of observed Variables

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15
X1	1.00														
X2	.43*	1.00													
X3	.43*	.44*	1.00												
X4	.35*	.43*	.72*	1.00											
X5	.31*	.36*	.54*	.44*	1.00										
X6	.40*	.39*	.32*	.43*	.25*	1.00									
X7	.33*	.39*	.35*	.36*	.37*	.46*	1.00								
X8	.39*	.50*	.32*	.42*	.18*	.44*	.51*	1.00							
X9	.35*	.35*	.26*	.38*	.21*	.31*	.31*	.51*	1.00						
X10	.38*	.46*	.31*	.23*	.20	398	-431	.47*	.44*	1.00					
X11	.39*	.41*	.42*	.39*	.26*	.42*	.41*	.49*	.41*	.48*	1.00				
X12	.36*	.40*	.30*	.40*	.24*	.28*	.45*	.46*	.43*	.44*	.47*	1.00			
X13	.40*	.53*	.42*	.50*	.29*	.43*	.45*	.53*	.39*	.50*	.43*	.60*	1.00		
X14	.34*	.53*	.41*	.35*	.35*	.40*	.46*	.47*	.43*	.43*	.44*	.57*	.76*	1.00	
X15	.37*	.49*	.38*	.44*	.28*	.39*	.45*	.55*	.39*	.47*	.44*	510	.68*	.71*	1.00
Mean	3.00	2.91	3.40	3.30	3.43	2.96	2.91	2.74	2.83	2.79	3.01	2.80	2.96	2.99	2.95
SD	1.04	.98	.94	.96	1.06	1.08	1.06	.99	1.10	1.08	1.07	1.12	1.08	1.05	1.03
Skew	.02	-.11	-.40	-.22	-.48	-.07	-.12	.06	.14	.03	-.04	-.05	-.08	-.22	-.17
Kurtosis	-.53	-.75	.13	-.42	-.32	-.77	-.75	-.78	-.64	-.76	-.66	-.89	-.66	-.49	-.59

3.2 Compilation of the officially distributed scale

Based on the results of the exploratory factor analysis, along with the statistical technology of confirmatory factor analysis, theoretical modality of this research is examined. This is used in examining the construct reliability of individual observed variables and potential variables, convergent validity and the discriminant validity.

After the examination of whether the observed samples are in normal distribution, the confirmatory factor analysis of the scale is conducted. With the result of the 15 questions listed on the revised scale and the help of LISREL 8.52, the Goodness-of-Fit of the modality is estimated.

(1) Testing the Goodness-of-Fit of the whole modality

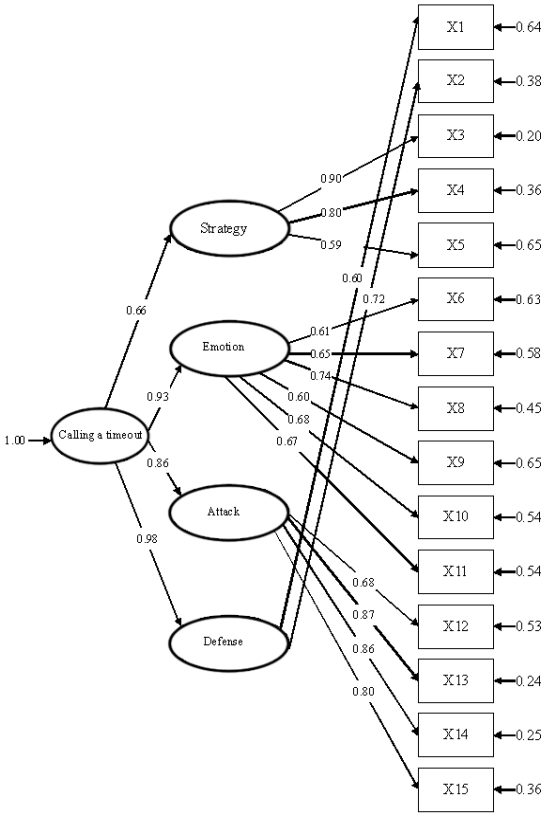

Fig. 1 Hand in the way obliquly in factor of two steps one of form of the amount of Behavioral Scale for Timeout Decision of table tennis

After the confirmatory factor analysis, along with the review of every Goodness of Fit Index, the hypothesized modality of this research is acceptable because it has passed various required standards. As a result, this modality accords with the empirical statistics, as shown in Table 2.

Table 2 Result of confirmative factor analysis to the whole scale

Measure Mode	χ^2/df	GFI	SRMR	AGFI	RMSEA	NFI	NNFI	CFI
Result of current study	**2.06**	**0.94**	**0.042**	**0.91**	**0.054**	**0.93**	**0.95**	**0.96**
Suggested values	**1.0-3.0**	**>0.90**	**<0.05**	**>0.90**	**<0.08**	**>0.90**	**>0.90**	**>0.90**

(2) The construct reliability of measured variable and potential variable

According to Huang (2002, 2004), the reliability of measured variables has to exceed 0.20, and to examine the reliability of potential variable, construct reliability is adopted. The value of it needs to be more than 0.60. Through the evaluation of reliability, the reliability of individual observed variables and potential variables can be examined. All of the estimated parameters from The Behavioral Scale of Reasons for Calling a Timeout have met the required standard, with the value of t exceeding 1.96. No obvious errors are found, either. The reliability of individual variables is between 0.35 and 0.81, and that of potential variables lies between 0.61 and 0.88. As a consequence, The Behavioral Scale of Reasons for Calling a Timeout is of good construct reliability, as shown in Table 3.

Table 3 Individual variables and the reliability of latent variables

Latent Variable	Measured Variable	R^2	Construct Reliability
Timeout Behavior			0.82
Defense	C1	0.36	0.61
	C2	0.52	
Strategy	C3	0.81	0.81
	C4	0.64	
	C5	0.35	
Psychological Emotion	C6	0.37	0.82
	C7	0.42	
	C8	055	
	C9	0.36	
	C10	0.46	
	C11	0.45	
Attack	C12	0.46	0.88
	C13	0.76	
	C14	0.74	
	C15	0.64	

(3) The experiment of convergent validity

On the validity of individual variables, this research aims at investigating the standardized loading of variables on their reflected factors. From Table 4, "The parameter estimation of four-factor hypothesized measurement models about table tennis timeout behavioral scale" indicates that all the standardized coefficients have significant results. On convergent validity, according to Huang (2004) and Anderson & Gerbing (1991), it can effectively be a factor indicator to its belonging category if the t-value is more than 1.96, which makes a significant difference. Meanwhile, it also shows the positive convergent validity.

Table 4 The parameter estimation of four-factor hypothesized measurement models about table tennis time-out behavioral scale

Parameter	Non-standardized parameter	Standard error	t value	Standardized parameter
δ1	0.62	0.02	----	0.60
δ2	0.71	0.07	10.27	0.72
δ3	0.84	0.01	----	0.81
δ4	0.77	0.05	15.36	0.64
δ5	0.62	0.06	11.25	0.35
δ6	0.66	0.02	----	0.37
δ7	0.68	0.07	9.99	0.42
δ8	0.73	0.07	11.05	0.55

δ9	0.66	0.07	9.39	0.36
δ10	0.73	0.07	10.34	0.46
δ11	0.72	0.07	10.33	0.45
δ12	0.76	0.01	----	0.46
δ13	0.94	0.06	14.66	0.76
δ14	0.90	0.06	14.58	0.74
δ15	0.82	0.06	13.63	0.64

Note.: Unlisted Standard error and t value are reference pointers; * $p < .05$

(4) The experiment of discriminant validity

The researcher applies the second order model to reveal the timeout measurement model of table tennis players in the end, so there is only one highest element. That is to say, there is no discriminant validity which is required to be tested.

4. DISCUSSION

4.1 Discussion

The implementation of the timeout clause has brought a dramatic change to tennis match. Each player or pair is entitled with one opportunity to claim a timeout period during an individual match. When players are well-matched in strength, a timeout period could incur dramatic changes and uncertainty to the result of a match. Making a timeout decision not only displays a coach's ability to give a quick response and guidance to the player, but also adds excitement and tenseness to the match. The result of the match is unpredictable when the match is every close in particular. At the same time, calling a timeout also suggests the importance of decision making by the player and the coach during the match. In a competitive game, players and coaches have to seize the uncertainty, and then come out with a proper policy. The decision of when to call a timeout during the match may make a difference. Moreover, if it happens in the tie-break period, it may affect the result of the whole match. Therefore, making good and reasonable use of timeouts is very important in a match.

First, this research reviewed related literature about table tennis timeout behavioral scales. After reviewing and arranging the literature, the researcher foud that there are very few timeout behavioral scales, and that previous research is mainly about the timeout decision in basketball and volleyball games. Due to the essential difference between sports, the rules of different sports are also very different. The research tried to focus on the appearance of the timeout rule and regulations in table tennis. The researcher proposed a list of various aspects, defense, strategy , emotion, and attack. The researcher further distinguished the differences between the timeout in table tennis and in other sports. Moreover, this research is different from previous research of timeout scale, which only used item analysis, exploratory factor analysis and the reliability test of alpha coefficient by Cronbach (Wu, 2004; Lin, 2003; Huang, 2001, Huang, 2004 & Duck & Corlett, 1992). This research adopted item analysis in pilot test and exploratory factor analysis. After deleting two items, the researcher underwent the second stage of examination and verification. With the advancement in statistical technology, Structural Equation Modeling (SEM) can facilitate researchers to strongly testify these scales theoretically via confirmatory factor analysis. This also becomes a new method of making scales, too. (Jöreskog & Sörbom,1993 and Huang, 2004). That is, after the researcher has finished item analysis and exploratory factor analysis, the researcher adopted SEM to conduct confirmatory factor analysis and construct reliability, convergent validity, and the test of discriminant validity. This examines the scales more carefully.

As a result, it could be found that the table tennis timeout behavioral scale in this research had more flexible measurement tools, including strategy, emotion, defense, and attack. The scale was of good internal consistence and construct validity. Meanwhile, through confirmatory factor analysis, it was proven that the modality had a good fit.

4.2 Conclusion

During the initial stage, the scale in this research was compiled with the help of existing scales of other sports. Previous timeout scales and timeout theories were mainly about basketball and volleyball games, in which coaches have more than two opportunities for calling timeouts or substituting players. This leads to the emphasis on the efficiency of calling a timeout for player substitution. However, owing to the differences in essence among sports and different times for calling timeouts, the rules of table tennis have been amended in the recent years. In the past, players only had a short break for guidance during each game, and the efficiency of guidance in the next game was the main concern. The new timeout rule allows the guidance for the game in progress and the next game, so it depends on the situation at that moment to make decisions. To sum up, the new game rule indicates the importance of using timeout period in the match, with strategy, emotion, defense and attack as the main concern. Table tennis timeout behavioral scale is considered as a measurement tool that accords with empirical statistics. Researchers in the future could make use of the compiled scale in this research to conduct further studies.

4.3 Suggestion

The achievement of the table tennis timeout behavioral scale not only facilitates table tennis players to seize good timeout time management, but also reminds coaches and players of the importance and uses of the right time to call a timeout during the match. Coaches and players should think highly of their timeout decisions and reflect themselves to make full use of timeouts. This is the ultimate goal of the scale in this research. In the future, more other variables could be taken into consideration in further research, such as

the professional quality of coaches and players, which could help them to figure out more appropriate timing for making timeout decisions.

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