Original paper

Structural models of coaching decision-making ability for individual offensive actions in basketball

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I. Introduction

A. Individual offensive actions and decision-making ability

Offensive strategies in basketball can be categorized into individual, group, and team strategies (Japan Basketball Association, 2002). Yoshii (1994) broadly divides the basic plays of these strategies into individual and combination plays. In order to successfully complete these plays while on both offense and defense, cooperation among players and team collectivity are essential (Inagaki, 1982; Japan Basketball Association, 2002). Accordingly, it is important for multiple players to play effectively while coordinating with each other. However, since many actions that determine the success of strategic plays are conducted one-on-one, regardless of the strategy employed, it is ultimately individual strategic actions that are put to the test (Inagaki, 1982; Stiehler et al., 1993).

Stiehler et al. (1993) stated that because individual strategies and skills influence each other, it is important for players to resolve situations by recognizing the state of the game and taking appropriate action based on their own strategies and skills. For example, as open space for a shooter can be thought of as the absolute minimum space needed to make a shooting motion, as long as that space is secured, a shot can be made, even if an opposing defender is standing right in front of the player (Japan Basketball Association, 2002). Wooden (1980) stated that knowing when not to shoot is just as important as knowing when to shoot. As such, players must make decisions appropriate to the relationship between the play and their own skills.

A general principle for the specific plays made by an offensive player is to observe game play and make decisions and act based on a motor performance program that matches the state of the game (Stiehler et al., 1988). Knight (1992) stated that it is important to coach players so that they become able to carefully watch, recognize, predict, and implement plays. Rose (2013) and Wissel (2002) showed that anticipating and recognizing the situation and making instantaneous decisions during individual offensive plays is important. Knight, Rose, and Wissel described the importance of the ability to make decisions in order to use one's physical strength and skills with appropriate timing in basketball, and numerous other researchers have reported the importance of this ability in other ball games (Chamberlain and Coelho, 1993; Nakagawa, 1982; Raab, 2003; Starkes and Lindley, 1994; Williams et al., 1992; Williams and Davids, 1998).

Freelance offense is an all-purpose and diverse offensive strategy and has been employed by many teams in recent years (Smith, 1992). In freelance offense, players have considerable freedom and independence; each player freely makes decisions and acts under the guidance of certain principles (Nagato and Uchiyama, 2005) and the choice of whether to pass, dribble, or shoot is tied directly to offensive results. The offensive strategy of ball handlers is to disrupt the defense and then break down the opposition in order to increase the chances of a shot (Inagaki, 1981). As this can be thought of as changes to the relationship with the opposition, even from a state of opposition during a

Key words: parallel third-order factor model, permutation model, specialization model, integration model

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play to the breakdown of opposition, decision-making concerning these states is necessary. From the above, decision-making during individual offensive situations can be categorized as follows: 1) decision-making determining the choice of offensive play by a player with the ball; 2) decision-making in response to changes in offensive action; and 3) decision-making during situations where the state of opposition is being maintained, including for players without the ball.

Yoshii (1994) stated that it is important to maneuver (e.g. shoot or dribble) depending on the basic relationship with the opposition. These various schools of thought provide coaching on decision-making in individual offensive situations. Although there are coaching books and other materials providing information on these methods (Lieberman, 2012; Newell, 1986l Ono, 2009), important points concerning how to move (Kodama, 2005), and the importance of decision-making (Kuraishi, 1995), there are few books or materials offering concrete suggestions for decision-making, and references to the sequence of coaching are absent.

B. A theoretical model of decision-making ability during individual offensive situations

As discussed above, there are various schools of thought concerning decision-making during individual offensive plays for matters such as the priority and selection of plays.

Phelps et al. (2011) listed passing as being both the most important and the first step during individual offensive actions, since not everyone can make a shot. Wooden (1980) prioritized passing when both dribbling and passing are possible, stating that passing is the most important of all fundamental offensive plays. Wissel (2002) placed priority on players with the ball on shooting from the outside, passing to an open player who is able to score more easily, driving to the basket and, if able to break through, shooting or passing, in that order. Morita and Shimatani (2013) stipulated that in coaching for freelance offense, plays should occur in the order of shooting, passing, and dribbling.

Yoshii (1994) stated that if there is a break in the opposition, the ideal offensive methods are to shoot immediately, dribble and then shoot, or pass to an open player who can take a shot. Wooden (1980) asserted that players should attempt to dribble in order to drive and produce new plays. Wooden also asserted that ball handlers must always seek opportunities to pass to teammates in good positions. This can be thought of as a structure dependent on the state of the opposition.

When determining the priority of plays for a player with the ball, Yoshii (1994) stated that deciding which play is appropriate should be based on the relationship with the opposition, and that the relationship with the opposing team can be categorized as “broken,” “somewhat broken,” or “virtually unbroken.” Based on the didactic principles of “moving from easy things to hard things” and “moving from easy things to complex things” (Dobler, 1985; Grosser and Neumaier, 1995) in sequences of motor learning, the following discussion lists conceivable structures for making decisions under Yoshii’s three states in order of increasing difficulty of decision-making.

Doi (1996) modeled coaching based on the principle of practicing each maneuver individually and ultimately moving towards synthesizing individual elements. This can be perceived as the “parallel third-order factor model,” and decision-making during each of the three states is independent of one another. Doi (1996) also offered the “permutation model,” in which coaching is improved based on the principle of moving from individual elements to synthesis with the entire structure being adopted from the start and gradually increasing the quality. In this model, each element can be thought of as lining up in series in a single sequence. In addition, as skills acquired through various settings influence new learning (Grosser and Neumaier, 1982), the “specialization model,” under which skills grow more complex and differentiated via progress and development, is also a conceivable model of decision-making. Sakai (1996) stated that once each play necessary for a particular individual strategy has been accomplished, the player should proceed to practicing the one-on-one strategies used in these plays. This can be thought of as the “integration model,” under which two or more maneuvers become one and remain associated with each other.

Because these theoretical structures of decision-making can be viewed as factors that regulate decision-

making in individual offensive situations, it is believed that investigating these structures could provide extremely productive knowledge not only in terms of individual strategies, but also in planning group and team strategies and training methods. Yaita and Aoyagi (2014b) developed the decision-making test battery reflecting actual game situations in basketball in which different and complicated values exist, and they reported it had sufficient validity and reliability. Also, using the same test, they classified the decision-making abilities of screen play into the one of screeners and the one of cutters and explained the relationships among the decision-making ability factors in chronological order (Yaita and Aoyagi, 2013). In addition, they also factored the decision-making abilities in fast break and extracted 6 factors such as "the ability during the transition in back court", "the ability when an opposing team is in an advantageous position", "the ability when attempting a shot", etc. These six factors were categorized and their structural relationships to each other were explained using the following three concepts: 1) positions in the court, 2) the balance between the number of offensive and defensive players, and 3) the decision-making process (Yaita and Aoyagi, 2014a).

Thus, although there are factorial studies about the decision-making ability in basketball, few studies were done about modeling complicated decision-making processes and investigating their cause-and-effect structures.

Accordingly, in this paper, decision-making ability tests were given targeting individual offensive situations in basketball, and an investigation of factor structures was conducted using covariance structure analysis to reveal the comprehensive factors regulating decision-making. Also, the discussions about coaching methods and the order of teaching decision-making are also conducted secondarily.

II. Method

A. Subjects

The subjects comprised a total of 158 students (87 men and 71 women) who were members of a basketball club at five universities, and eight coaches who had coached in the All Japan Intercollegiate Basketball Championship and possessed official Japan Basketball Association coaching qualifications (hereafter abbreviated as "qualified coaches"). Two of the coaches had also represented Japan in international tournaments. Table 1 details the teams, sex, and positions of the subjects. All coaches were members of universities affiliated with either the Kanto Collegiate Basketball Federation, the Kanto Women's Collegiate Basketball Association, or the Kyushu Collegiate Basketball Federation, which are under the umbrella of the All Japan University Basketball Federation.

After written and oral explanations of the purpose and other details of the study were explained to the subjects, only those who agreed in advance to participate and provided consent for personal information management were included in the analysis.

B. Decision-making test

1. Selected scenes

Scenes from two first-round games and four semifinal-round games of the 63rd All Japan Intercollegiate Basketball Championship were selected for use in the test. We defined the following three kinds of plays with no collective strategy as "individual offensive play": 1) the offensive plays of ball handlers, 2) the offensive

Table 1 Number of subjects by team, sex and position

Team	Men			Women			Total
	Guard	Forward	Center	Guard	Forward	Center	
A	14	9	4	3	10	2	42
B	14	9	1	8	5	3	40
C	5	5	0	6	9	7	32
D				4	8	6	18
E	12	11	3				26
Total	45	34	8	21	32	18	158

plays with which ball handlers try to break through the facing defenses, and 3) the offensive plays in the continuing defense-facing situation including players without balls. We chose them properly from actual games and made the video footage for the decision-making tests.

2. Implementation

Taking the need for play progression and multiple assessments into consideration, the test was conducted by displaying videos of the plays used by Yaita and Aoyagi (2014b) on a screen and shutting off the video just before the point where decision-making would be required. Subjects were then asked questions about the plays that should come next. Test items were chosen from the items of which validity and reliability had been already confirmed in our previous study (Yaita and Aoyagi, 2014b). Before the actual test, subjects were asked 14 practice questions for four scenes in order to help them feel comfortable taking a test using video images.

3. Scoring

Following the methods of Nakagawa (1980), correct plays were those which four or more of the eight qualified coaches considered optimal.

C. Analysis

First, we conducted exploratory factor analysis about the marks of 23 test items, which were the totals of two or more binary sub-items (correct=1, incorrect=0) grouped by play features. The detail of play features was shown in Table 2. Second, we extracted the first-order factors using items of significant factor loading. Finally, covariance structure analysis was conducted with AMOS (Version 21.0, IBM Corporation) using the second-order factors as constructs. In this analysis, the second-order factors were compounded with two or more first-order factors considering their features.

Path diagrams were created referencing the theoretical models mentioned above and secondary factors were extracted. Statistical tests of the four hypothetical models were conducted using the χ^2 values and the goodness of fit index (GFI) of each model. If two or more models were statistically fitted, we compared Akaike Information Criterions (AICs), whereby the smaller AIC indicated the more suitable model.

III. Results

A. First-order exploratory factor analysis of decision-making in individual offensive situations

Table 2 shows the 23 items consisted of two or more binary sub-items grouped by play features and conditions. In order to conduct covariance structure analysis with AMOS, we carried out exploratory factor analysis about the marks of 23 items and extracted 9 factors with the eigenvalue of 1.0 or greater. They explained 58.5% of the total variance. Table 3 shows the factor contribution rate of the extracted 9 factors, and also the structure and pattern coefficients of the items with significant loadings relating to the factors. In this table, only items showing significant loadings with any of the factors were tabulated. Also, the correlation matrix of the extracted 9 factors was indicated in Table 4.

Factor 1 showed a significant factor loading for two items: “pass reception in the wing during zone defense” (simplified factor loading [=sfl]: 0.745; factor pattern [=fp]: 0.851) and “wing aiming to feed the post” (sfl: 0.542; fp: 0.510). These are situations in which a wing has the ball while in the low post position, and this factor was interpreted as “F1: Low post side wing decision-making.”

Factor 2 showed a significant factor loading for four items: “defense-free pass reception in the wing” (sfl: 0.600; fp: 0.568), “non-ball handler under loose defense” (sfl: 0.585; fp: 0.746), “pass reception via a post-screen play” (sfl: 0.536; fp: 0.503) and “pass reception at the top of the key after getting an offensive rebound” (sfl: 0.517; fp: 0.350). This factor was interpreted as “F2: Defense-free decision making.”

Factor 3 showed an only one significant factor loading with “Defense-free pass reception at the top of the key (sfl: 0.536; fp: 0.503).” As this factor indicated the situation that the offensive player tried to break through the facing opponents using dribbling at the top of the key, we interpreted this factor as “F3: The decision-making ability factors when the offense advantageously attacks at the top of the key.”

Factor 4 showed a significant factor loading for two items: “help defense for a drive from the top of the key”

Table 2 The 23 items consisted of two or more binary sub-items grouped by play features and conditions

Items	No.	Play characteristics and situations of sub-items
1. Pass reception (loose) in the wing during zone defense	1	Watching the situation at the top of the key after getting an offensive rebound
	2	Pass reception from the top of the key by the right wing (defense is loose [zone])
	3	Pass reception from the top of the key by the right wing (defense is loose [zone])
2. Return pass reception/skip pass reception	1	End line thrown in pass to the right wing, pass reception via an outside screen play
	2	Reception of a return pass at the top right of the key (loose defense)
	3	Reception of a return pass at the top right of the key (loose defense)
	4	Skip pass reception at the left wing (no defense)
	5	Popping out and receiving a pass from the top of the key after a block
3. Cut-in pass reception	1	Dribbling to the goal after cutting in from the top left of the key and receiving a pass
	2	Dribbling to the goal after cutting in from the top left of the key and receiving a pass
4. Defense-free pass reception in the wing	1	Skip pass reception at the left wing (no defense)
	2	Feeding a pass to the low post at the right wing which becomes a return pass reception
	3	Pass reception from the post at the left wing (no defense)
	4	Pass reception from the post at the left wing (no defense)
5. Drive from the top of the key	1	Left side drive from the top left of the key (left defense is covered)
	2	Left side drive from the top left of the key (left defense is covered)
6. Defense-free pass reception at the top of the key	1	Pass reception at the top left of the key from the right (no defense post-offense rebunds)
	2	Pass reception at the top left of the key from the right (no defense post-OR)
	3	Moving into open space and receiving a pass after a dribble screen in the left wing
	4	Moving into open space and receiving a pass after a dribble screen in the left wing
7. Breaking down the opposition with a baseline drive from the wing	1	Breaking down the opposition with a baseline drive from the left wing and moving underneath the goal
	2	Breaking down the opposition with a baseline drive from the left wing and moving underneath the goal
8. Pass reception (free) in the wing during zone defense	1	Popping out and receiving a pass from the top of the key after a block
	2	Pass reception at the left wing (no defense [zone])
	3	Pass reception at the left wing (no defense [zone])
9. Baseline drive from the wing	1	Receiving a pass at the right wing and proceeding towards the goal via a baseline drive
	2	Receiving a pass at the right wing and proceeding towards the goal via a baseline drive
10. Fundamental awareness at the top of the key	1	Using a screen to receive a pass at the top of the key (loose defense)
	2	Using a screen to receive a pass at the top of the key (loose defense)
	3	Getting a rebound ball and moving out into open space via dribbling
	4	Passing from the top right of the key to the left and moving towards the left wing
	5	Watching a play in the left low post from the top right of the key and taking an open space
	6	Moving into open space and receiving a pass after a dribble screen in the left wing
11. Pass reception at the top of the key after an offensive rebound	1	Receiving a pass at the top of the key after getting an offensive rebound (no defense)
	2	Receiving a pass at the top of the key after getting an offensive rebound (no defense)
12. Wing aiming to feed the post	1	Receiving a pass from the left wing, holding the ball above the head, and aiming to pass to the low post
	2	Receiving a pass from the left wing, holding the ball above the head, and aiming to pass to the low post
13. Pass reception in the corner after a block	1	Receiving a pass in the corner using a low post block after a baseline cut
	2	Receiving a pass in the corner using a low post block after a baseline cut
14. Drive from the top of the key (maintenance of opposition)	1	Ride side drive from the top right of the key, unable to break down opposition, stopping dribbling at the right low post
	2	Ride side drive from the top right of the key, unable to break down opposition, stopping dribbling at the right low post
15. Pass reception (free) at the top of the key during zone defense	1	Reception of a return pass at the top of the key from the left wing (no defense [zone])
	2	Reception of a return pass at the top of the key from the left wing (no defense [zone])
16. Driving in after going inside out	1	Receiving a pass from the post at the top of the key and driving to the left
	2	Receiving a pass from the post at the top of the key and driving to the left
17. Defense-free pass reception from the top of the key at the wing	1	Receiving a pass deployed from the top right of the key at the left wing
	2	Receiving a pass deployed from the top right of the key at the left wing
18. Receiving a pass via a post-screen play	1	Using a block to get out into the left wing and receiving a pass (loose defense)
	2	Using a block to get out into the left wing and receiving a pass (loose defense)
	3	Blocking in the paint as a screener and watching a ball handler in the corner
	4	Moving into open space and receiving a pass after a dribble screen in the left wing
	5	Popping out from the high post and receiving a pass
19. Help defense for a drive from the top of the key	1	Right side drive from the top of the key (kicking out into the right corner)
	2	Right side drive from the top of the key (kicking out into the right corner)
20. A non-ball handler moving to become a receiver	1	Watching the ball from the help side
	2	Calling for a pass from the top after getting an offensive rebound
	3	Moving into open space (help side) after a goal cut
	4	A ball handler as a receiver while being double teamed
	5	A ball handler as a receiver while being double teamed
21. Ball retention in a four-on-four situation during fast offense	1	Receiving a fast pass in a four-on-four (loose defense) situation
	2	Receiving a fast pass in a four-on-four (loose defense) situation
	3	Entering the top right of the key from the back court by dribbling and offensively slashing dribbling back to the left
22. Skip pass receiver	1	Popping out and receiving a pass after being blocked at the high post
	2	Receiving a skip pass in the left corner (open space)
	3	Calling for a skip pass in the left wing from the right corner
23. Middle drive from the wing	4	Proceeding towards the goal via a middle drive from the right wing
	5	Proceeding towards the goal via a middle drive from the right wing

Table 3 The factor contribution rate of the extracted 9 factors and the structure and pattern coefficients having significant loadings with them

Structural concept	Factor contribution ratio	Observation variables	simplified factor loading	factor pattern
F1: Low post side wing decision-making	12.6%	8. Pass reception (free) in the wing during zone defense	0.745	0.851
		12. Wing aiming to feed the post	0.542	0.510
F2: Defense-free decision making	8.2%	4. Defense-free pass reception in the wing	0.600	0.568
		20. A non-ball handler moving to become a receiver	0.585	0.746
		18. Receiving a pass via a post-screen play	0.536	0.503
		11. Pass reception at the top of the key after an offensive rebound	0.517	0.350
F3: The decision-making ability factors when the offense advantageously attacks at the top of the key	6.6%	6. Defense-free pass reception in the top of the key	0.794	0.942
F4: Decision-making during drives from the top of the key	6.1%	19. Help defense for a drive from the top of the key	0.661	0.752
		5. Drive from the top of the key	0.514	0.453
F5: Pass reception decision-making while running	5.7%	3. Cut in pass reception	0.679	0.709
		21. Ball retention in a four-on-four during fast offense	0.671	0.664
F6: Decision-making during drives from the wing	5.1%	23. Middle drive from the wing	0.772	0.885
		7. Breaking down the opposition with a baseline drive from the wing	0.603	0.671
F7: Post-inside out pass reception decision-making	5.0%	14. Drive from the top of the key (maintenance of opposition)	0.750	0.855
		16. Driving in after going inside out	-0.337	-0.417
F8: Play decision-making concerning passes to open space	4.7%	22. Skip pass receiver	-0.706	-0.817
		9. Baseline drive from the wing	0.481	0.412
F9: Play decision-making after using a screen	4.4%	10. Fundamental awareness at the top of the key	0.700	0.789
		13. Pass reception in the corner after a block	-0.641	-0.687

Table 4 The correlation matrix of the 9 factors extracted from 23 items

Factors	1	2	3	4	5	6	7	8	9
1	1.000								
2	.297	1.000							
3	.192	.055	1.000						
4	.229	.148	.050	1.000					
5	.034	.051	.182	.021	1.000				
6	.253	.050	.368	.036	.132	1.000			
7	-.041	-.072	-.201	-.166	.000	.080	1.000		
8	-.207	-.040	.186	-.253	.015	.033	.059	1.000	
9	.007	-.206	.019	.157	.017	-.070	-.202	-.076	1.000

(sfl: 0.661; fp: 0.752) and “drive from the top of the key” (sfl: 0.514; fp: 0.453). These are situations in which a drive from the top of the key is attempted with the aim of breaking down the opposition, and this factor was interpreted as “F4: Decision-making during drives from the top of the key.”

Factor 5 showed a significant factor loading for two items: “cut in pass reception” (sfl: 0.679; fp: 0.709) and “ball retention in a four-on-four play during fast offense” (sfl: 0.671; fp: 0.664). These are situations in which a player receives a pass while on the move and becomes the ball handler, and this factor was interpreted as “F5: Pass reception decision-making while running.”

The remaining factors were interpreted as follows: Factor 6 as “F6: Decision-making during drives from the wing”; Factor 7 as “F7: Post-inside out pass reception decision-making”; Factor 8 as “F8: Play decision-making concerning passes to open space”; and Factor 9 as “F9: Play decision-making after using a screen.”

B. Consolidating second-order factors and statistical tests of the hypothetical models using covariance structural analysis

Although we extracted 9 factors from exploratory factor analysis, one factor was removed because it had only one significant loading. Therefore 8 factors were used as secondary-order factors to draw a path diagram.

Figure 1 displays the schematic diagram of those secondary-order factors drawn from the concept of the phase of individual offensive play. The extracted first-

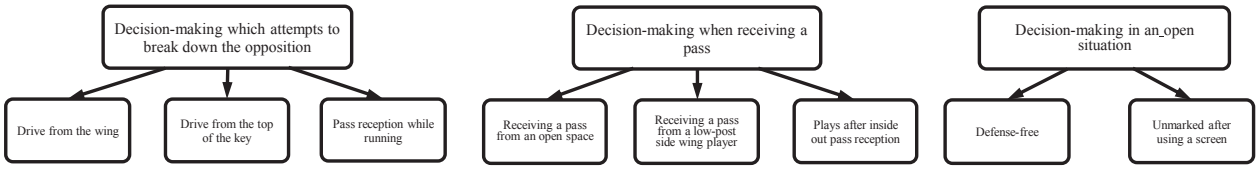

Fig. 1 Second-order factor structures of the eight factors extracted by exploratory factor analysis

order factors, "F1: Low post side wing decision-making", "F7: Post-inside out pass reception decision-making", and "F8: Play decision-making concerning passes to open space", all concern passing plays and were consolidated and interpreted as "D1: Passing play decision-making" in individual offensive situations.

"F2: Defense-free decision-making" and "F9: Play decision-making after using a screen" are offensive plays for players with the ball who have broken down the opposition. These were consolidated into "D2: Decision-making when the opposition has been broken down."

"F3: Decision-making during drives from the top of the key," "F5: Pass reception decision-making while running" and "F6: Decision-making during drives from the wing" concern plays conducted on the move and are attempts to break down the opposition by dribbling and passing. These factors were consolidated and interpreted as "D3: Decision-making which attempts to break down the opposition."

Figure 2 indicates the schematic diagram in which the relationships of the three secondary-order factors are applied to the following theoretical models: Parallel third-order factor model, Permutation model, Specialization model and Integration model. Table 5 shows the chi-square value, the degree of freedom, GFI and AIC in each model.

The parallel third-order factor model shows the influence of the three factors on decision-making in parallel during individual offensive situations. The

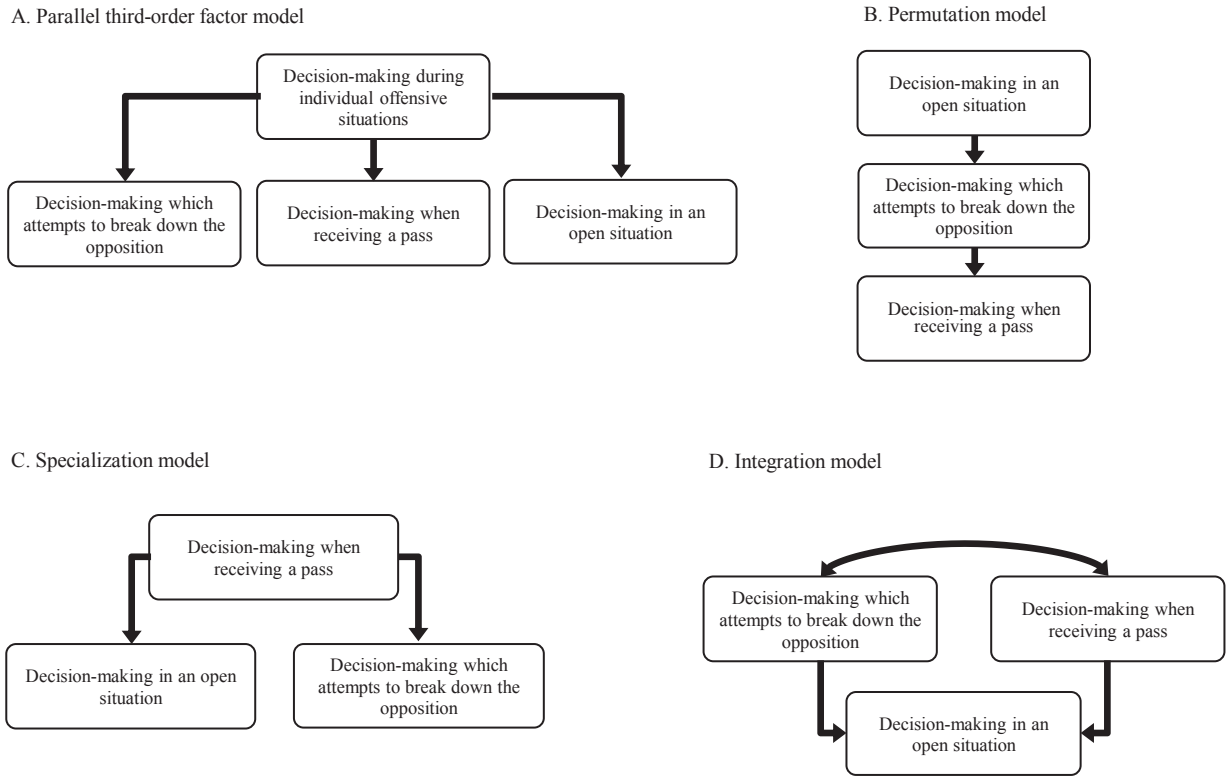

Fig. 2 Theoretical structural models showing second-order factor relationships

Table 5 The χ^2, GFI and AIC values for the four hypothetical structural models

Model	χ^2	df	GFI	AIC
Parallel third-order factor	150.96	142	0.909	208.96
Permutation	151.51	135	0.907	223.51
Specialization	151.51	135	0.907	223.51
Integration	137.37	131	0.916	217.37

AIC: Akaike Information Criterion; df: degrees of freedom; GFI: goodness of fit index.

indexes of fitness of this model were $\chi^2_{[df=142]} = 150.96$, GFI = 0.909 and AIC = 208.96. The indexes of fitness of the permutation model, which shows the sequential influence of the three factors in line in a single sequence, were $\chi^2_{[df=135]} = 151.51$, GFI = 0.907 and AIC = 223.51. The indexes of fitness of the specialization model, which shows the influence of the three factors in order of increasing complexity and specialization via progress and development, were $\chi^2_{[df=135]} = 151.51$, GFI = 0.907 and AIC = 223.51. The indices of fitness of the integration model, which shows the influence of one of the three factors developed from the unification of two of the factors, were $\chi^2_{[df=131]} = 137.37$, GFI = 0.916 and AIC = 217.37. As shown in Table 5, GFI was 0.9 or higher for all four models showing that the fit of the data was good. In addition, the AIC of the parallel third-order factor model, the permutation model, the specialization model and the integration model were 208.96, 223.51, 223.51 and 217.37, respectively, with the parallel third-order factor model showing the highest applicability.

IV. Discussion

A. Conceptual factor structures of individual offensive situation decision-making

Decision-making during individual offensive situations was categorized as: 1) a player with the ball determining the choice of offensive play; 2) decision-making in response to an offensive action; and 3) decision-making when the state of opposition is being maintained, including for non-ball handlers. When looking at the factor structures in this paper from individual offensive situations, “F1: Low post side wing decision-making”, “F7: Post-inside out pass reception decision-making”, and “F8: Play decision-making concerning passes to open space”, can be characterized as “passing play decision-making”, and represent decision-making in situations where the state of opposition is being maintained, including for non-ball handlers. In these situations, the purpose of plays and the positional relationships between players are diverse; they are the plays that occur the most frequently in a game. Decisions in these situations can be considered some of the most important when attempting to set the offense.

In addition, “F2: Defense-free decision-making” and “F9: Play decision-making after using a screen” were characterized as “decision-making when the opposition has been broken down” in individual offensive situations, and represent decision-making for offensive plays by players with the ball. In these situations, offensive actions, especially decision-making when attempting to shoot, are important decision-making items when attempting to break down the opposition to attempt a shot, the ultimate purpose of offense (Inagaki, 1981).

Further, when perceived in relation to concepts concerning individual offensive situations, “F4: Decision-making during drives from the top of the key”, “F5: Pass reception decision-making while running”, and “F6: Decision-making during drives from the wing” were characterized as “decision-making which attempts to break down the opposition”, and represent decision-making in response to an offensive action. These situations demand that a player maintains an awareness of the stance and position of the opposing defender when taking offensive actions; they must also respond to the movements of other coordinating defenders. Various responses such as understanding moment-to-moment changes in game situations and predicting player movements are demanded of players, and these responses are important decision-making items.

From the above, it is likely valid that the eight factors concerning decision-making in individual offensive situations can be consolidated into the following three factors: 1) "passing play decision-making"; 2) "decision-making when the opposition has been broken down"; and 3) "decision-making which attempts to break down the opposition."

B. Testing the factor structures of the hypothetical models for individual offensive situation decision-making

The parallel third-order factor model, which had the lowest AIC value under covariance structure analysis, showed the parallel influence of the three factors of "passing play decision-making", "decision-making when the opposition has been broken down", and "decision-making which attempts to break down the opposition". When on the offense, if there is a break in the relationship with the opposition, the best offensive methods are to shoot immediately, dribble and then shoot, or pass to an open player (Yoshii, 1994). When aiming to break down the opposition or create a new play, attempting to dribble is an effective offensive method (Wooden, 1980). In addition, as Wooden (1980) stated, ball handlers must always seek opportunities to pass to teammates in good positions. Accordingly, as each situation under a state of opposition requires decision-making, independently influential parallel third-order factor structures can be thought of as the models with the highest degree of applicability.

Although the permutation model did not have the lowest AIC, this model showed that "decision-making when the opposition has been broken down" develops into "decision-making which attempts to break down the opposition" and then "passing play decision making." Since this can be seen as the relationship with the opposing team being "broken", "somewhat broken", and "virtually unbroken" (Yoshii, 1994), the basis for play decision-making, this would mean that coaching should proceed in sequence of increasing difficulty of decision-making. Yoshii (1994) stated that shot decision-making is relatively easy as it concerns offensive and defensive situations during that specific moment, while passing is an important skill supporting team play and also requires extremely high-level decision-making in comparison with shooting and dribbling (Japan Basketball Association, 2002). These can be thought of as coming under the didactic principle of "moving from easy things to complex things" in training sequences of motor learning (Dobler, 1985; Grosser and Neumaier, 1995). It is possible that the permutation model did not have the highest applicability because the subjects for this research were university students, who were inexperienced in decision-making concerning shooting. This stresses the importance of making appropriate decisions concerning one's own shots by knowing when and when not to shoot (Wooden, 1980).

The specialization model showed that "passing play decision-making" develops into "decision-making when the opposition has been broken down", and then into "decision-making which attempts to break down the opposition." Phelps et al. (2011) and Wooden (1980) stated that passing should be prioritized over shooting and dribbling since it is the most important of all individual offensive plays; therefore, passing skills can be perceived as the most fundamental in individual offensive situations. Passing, however, is an important skill supporting team play and also requires extremely high-level decision-making in comparison with shooting and dribbling (Japan Basketball Association, 2002). While passing is the most fundamental skill, passing play decision-making is extremely difficult and may be the reason why the specialization model was not the model with the best applicability.

The integration model showed that "passing play decision-making" and "decision-making which attempts to break down the opposition" tie into each other and develop into "decision-making when the opposition has been broken down" after each individual skill has been acquired. In this model, decision-making in situations where the state of opposition changes in response to an offensive action and decision-making concerning the state of opposition is being maintained tie into each other and develop into "decision-making concerning situations in which the opposition has been broken down". These are directly connected to attempting to shoot. Inagaki (1987) stated that one should persistently attempt to break down the opposing player and score while properly handling the ball. In other words, one should bring the ball closer to the net by passing and

dribbling and tie this to shooting. Game skills are not tied to strategic training at the start of basic training, but are rather absolutely tied into resolving strategic issues (Dobler, 1995; Stiehler et al., 1993, p. 51); therefore, it is conceivable that dribbling and passing as a means of making better shots can be taught through training (Japan Basketball Association, 2002). Although the integration model displayed a certain level of applicability, and regardless of the fact that technical explanations concerning shooting are provided in many coaching books (Hasegawa, 2007; Hidaka, 2011; Ono, 2009), shooting skills are extremely difficult (Inagaki, 1978) and not everyone can make shots (Phelps et al., 2011). This may be one of the reasons why the integration model was not the most applicable.

C. Coaching sequences using covariance structure analysis for individual offensive situation decision-making

Individual offensive situations can be categorized into situations in which the player with the ball selects an offensive play, situations requiring a response to changes in offensive action, and situations where the state of opposition is being maintained, including for non-ball handlers. As such, technical training for various situations should be provided for each type of situation.

However, decision-making has been found to consist of three independent types: “passing play decision-making”; “decision-making when the opposition has been broken down”; and “decision-making which attempts to break down the opposition”. In their survey of decision-making ability by competitive level in various basketball plays, Yaita and Aoyagi (2012a) reported that although driving and passing plays show a relationship between competitive level and decision-making ability, shooting does not. This may be the result of coaching which does not take the relationship between decision-making when the opposition has been broken down and competitive ability into account.

The parallel third-order factor model, which had the highest applicability to the model data in this paper, suggested the importance of independent decision-making standards in each of the situations that players with the ball encounter during offensive plays. Situations requiring a response to changes in offensive actions and those in which the opposition is being maintained, including for non-ball handlers, were also highlighted. As such, this model recognized the need for coaching in all of these situations in order to improve play and strategic understanding, as well as decision-making ability.

V. Conclusion

This paper tested comprehensive factors regulating decision-making in individual offensive situations in basketball via exploratory factor analysis after a decision-making test. Further, this paper created and tested four hypothetical structural models of decision-making acquisition sequences using covariance structure analysis of the extracted decision-making factors.

Individual offensive situations can be categorized as follows: situations in which the player with the ball selects an offensive play; situations requiring a response to changes in offensive action; and situations in which the state of opposition is being maintained, including for non-ball handlers. In this paper, factor structures were consolidated into the three factors of “passing play decision-making”, “decision-making when the opposition has been broken down”, and “decision-making which attempts to break down the opposition”.

In addition, conceivable theoretical structural models based on these factors were as follows: the parallel third-order factor model, in which the three situations are independent of one another; the permutation model, in which each situation is lined up in a single series; the specialization model, in which complexity and differentiation are increased with the stage of learning; and the integration model, in which two or more factors tie into each other and develop into one factor. After applying the extracted factors to each model and analyzing the results, the parallel third-order factor model was found to have the highest degree of applicability. In this model, the three factors of “passing play decision-making”, “decision-making when the opposition has been broken down”, and “decision-making which attempts to break down the opposition” are coached in parallel.

This study found that in order to provide players with better decision-making ability, basketball coaching for

individual offensive situations requires not only training in decision-making for the progression of plays during team situations on the court, but also training to acquire the skills necessary for each type of individual situation and an understanding of necessary skills.

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バスケットボールの個人的攻撃行動における状況判断能力のコーチング構造モデル

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和文抄録

本研究は，バスケットボールの個人的攻撃局面における状況判断について，状況判断能力テストの結果を探索的因子分析によって包括的な要因を検討し，さらに，抽出された状況判断能力因子の構造から共分散構造分析を用いて状況判断能力の習得の順次性について仮説的構造モデルを作成して検証した．

標本は，大学のバスケットボール部に所属する158名であり，全テスト67問をプレイの特徴から23項目にまとめそれらのテスト結果を観測変数としてAMOSによる共分散構造分析を行った．

個人的な攻撃の局面における状況判断能力の8つの因子は，個人的な攻撃の局面におけるそれぞれの特徴から3つの2次因子にまとめ，仮説的概念モデルとして「並列型3次因子モデル」，「順列型モデル」などの4つを表した．それらに抽出された因子を当てはめて分析したところ，「並列型3次因子モデル」が最も当てはまりの度合いが高かった．

「並列型3次因子モデル」は，2次因子にはそれぞれ独立した判断基準が存在する可能性が示唆されたものと考えられ，プレイや戦術の理解とともに状況判断力の向上のためには各状況における指導の必要性が認められた．

キーワード：並列型3次因子モデル，順列型モデル，分化型モデル，統合型モデル

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