ATINER CONFERENCE PAPER SERIES No: FIT2012-0274

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FIT2012-0274

Recovery Ratio from Autonomic Orienting Response as Predictor of High Performance in Cricket

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URL Conference Papers Series: www.atiner.gr/papers.htm

ISSN **2241-2891**
15/11/2012

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This paper should be cited as follows:

Saha, S., Saha, S., Chowdhury, D., Abedeen Fahim, N., Uddin, M. S. and Biplob, A.S. (2012) **"Recovery Ratio from Autonomic Orienting Response as Predictor of High Performance in Cricket"** Athens: ATINER'S Conference Paper Series, No: FIT2012-0274.

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Abstract

Twenty-three world-class cricket players of Bangladesh, selected for the ICC World Cup 2011, were compared with twenty-two amateur-competitive and eighteen developmental level cricketers of South-Asian contingent, on the basis

of their consistent high performance and on the basis of their performance on psychomotor and psychobiological parameters, volunteered in this study. Orienting reflex measures of skin conductance as well as cardiovascular activity were done while the cricketers were engaged in psychomotor performances. Whole body reaction ability and anticipation simulated with close-fielding performance in cricket were evaluated as measure of agility and anticipation, along with the evaluations of signal detection type of perceptual discrimination ability (as measure of cognitive competence). Structural equations were done to identify the path regression related to performance excellence, which were suggestive of incoherence between the predictors. Short-term intensive action-regulation training was introduced, which could in turn modify intrinsic psychobiological mechanism leading towards excellence in performance in the elite-level cricket players. Multiple linear and polynomial regression analyses along with the predictive structural analyses were done to identify relationships between the psychobiological processes explained by the HPA axis and the TCA pathways, in relation to the cognitive-affective and affective-motivational aspects of sports behaviour, revealed by the projective analyses of emotionality. These models were aptly able to explain the efficacy of the action-regulation intervention techniques, in inducing the cognitive and emotional flexibility required for performance excellence in elite-level cricket events.

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INTRODUCTION

Cricket is one sport which has been at the centre of intense nationalistic passions, and in recent past the centre of focus has changed a lot from the famous Ashes Series between England and Australia, which also encompasses the infamous 'bodyline' controversy during the 1932-33 Test Series between England and Australia, toward the South-Asian dominance in Cricket. Concluding International Cricket Council World-Cup Tournament 2011 has seen three of the South-Asian Countries as semifinalists with India, the ICC World Cup –Champion; Sri Lanka – the Runner –up and Pakistan. Recent outstanding performances by Bangladesh (Asian Games Champion and Asia Cup – Runner-up) contingent, with the advent of Mega-event Indian Premier League (IPL) Cricket tournament, the towering popularity of the sport in the sub-continent as well as in the South-Asian region has become somewhat fanatic in real sense, which has definitely over-shadowed the infamousness of 'bodyline' controversy.

This uncompromising growth in interest has put the cricketers into tougher expectancy related challenges, wherein the incentive value of each smaller achievement has been merchandised. Cricket practically being a fast ball sport, characterised by ever-changing uncertainties – vulnerability of the professional players has been multiplied up to the point of no-return. Here the role of psychology in cricket (as far as the demands of top coaches are concerned), required for the fine-tuning in mental conditioning has surpassed demands compared to that of other sport science back-ups (Gowan, 1979**;** see Bakker, Whiting & van der Brug, 1990)**.**

Cricket psychologists have reported professional batsmen are able to make better predictions of ball direction and delivery type from the pre-release movement patterns of both slow (spin) and fast (pace) bowlers; read and interpret complex situations quickly and take actions right away (e.g., Abernethy & Russell, 1984; Müller et al., 2006; Renshaw & Fairweather, 2000). Simpler agile actions being repeated develop the ability to deal with complex situations as fast as possible (Saha et al 2005a). Sharp and agile actions are generalised athletic abilities, whereas fast responses in a complex challenging situations specific to game of cricket; characterize game related decision-making (Land & McLeod, 2000; Penrose & Roach, 1995). Our previous researches inspired by Abernethy & Russell (1984) and McLeod (1987), have explained about the neuropsychological pathways (Saha et al, 2005a & 2012a) revealing the significance of accurate anticipation, used by the elite players to minimize the reaction time delays inherent in every aspect of cricket, but at the cost of emotional overloading (Saha et al. 2012a & b), while less focus has been given on estimation of emotional upheaval, and on the question of analyses of the psychological as well as concomitant psychobiological processes involved in cathartic channelling, have been largely ignored (Saha et al. 2012a & b).

Here we would like to focus onto the issue of psychobiological analysis protocol, with special attention to evaluation of extent of emotional venting in

the cricketers. Recent research findings from autonomic nervous system (ANS) and cerebral asymmetry studies are showing consistent differences among general emotions (Davidson, 1992; Levenson, 1992). As Levenson (1992) pointed out, distinctive ANS reactions involving negative emotions appear to be more robust than those involving positive emotions. ANS activities have been reliably attempted through EEG evaluation of hemispheric substrates of emotion; frontalis EMG; heart-rate variability etc (Davidson, 1992). Attempt of Hale & Collins (1994), actually successfully linked the magnitude and latency of the startle probe response (which provides significant indication of emotional valence), accompanied by self-report and behavioural indices, in a study of aggression levels in sports performers.

In our present study we would like to investigate into the startle-like responses by employing habituation paradigm skin conductance orienting activity (Dawson et al. 2000), but unlike the usual skin conductance component cluster, decomposition of phasic skin conductance activity into orienting recovery response will be attempted. Further to add, unlike it was suggested by Fowles (1986) and Edelberg (1993); we would like go ahead with evaluation of optimal autonomic recovery, and not half-recovery, which could be contaminated by residual arousal (Saha et al. 2012a). As per the suggestions of Hale and Collins (1994), attempts will be made for subjective evaluation substantiated with the afore-mentioned psychobiological evaluations, but unlike the use of self-reports (which could be contaminated by subject-relevant biases) projective evaluation of emotionality will be attempted which would enable us to probe into the inner core of emotionality of the cricketers.

Thus in the present study we are trying to point out to our concern over the methodological issues related to the assessment and analyses of the optimal performances in cricket, along with the simultaneous assessment of other correlated and influencing psychological and psychobiological mediators of consistent peak performance. To date, laboratory-based analytical researches incorporating objective and direct measures of performance that could be served as predictors of actual performance excellence, is scarce, and available researches are either not dealt with direct and objective measures, or done with variables which are detected as having source of multicolinearity, and hence are not capable of predicting process-related shared aetiology behind performance excellence in cricket.

With such a background, the present study was done-

1. To evaluate whether cortical activation related to perceptual discrimination can predict peak performance in cricket;
2. To justify whether there exist any corroborative influence of emotionality and autonomic arousal components in predicting peak performance in cricket;
3. To observe whether autonomic orienting recovery can predict performance excellence in cricket.

Materials and Method

Participants

Twenty-three world-class cricket players (Group C, Mean age – 21.8 and SD = 2.18) of Bangladesh selected for the ICC World Cup 2011, who were consistently high performing cricket players were primarily selected in the National squad of Bangladesh. These players were compared with twenty-two amateur-competitive development level cricket players (Group A, Mean age – 22.3 and SD = 1.8) of the University of Chittagong, Bangladesh and eighteen high performing cricketers of Malaysian contingent (Group B, Mean age – 19.9 and SD = 2.68), on the basis of their consistent high performance and on the basis of their performance on psychomotor and psychobiological parameters.

Materials and measures

1. Critical Flicker Fusion Apparatus (Lafayette Instrument Corporation, USA 2000) was used to assess the descending flicker threshold of the cricketers as index of cortical activation related to perceptual discrimination.
2. Skin Conductance Apparatus (Autogenic Corporation, USA 2000) was used to assess the extent of tonic and phasic autonomic regulation, orienting skin conductance recovery response as index of optimal emotional regulation in the cricketers.
3. Whole-Body Reaction and Movement Timer Apparatus (Lafayette Instrument Corporation, USA 2001) was used to assess both the visual and auditory whole -body reaction and movement time of the cricketers.
4. Bassin Anticipation Timer (Lafayette Instrument Corporation, USA 2000) was used to assess the anticipatory reaction time of the cricketers.
5. Photoelectric Rotary Pursuit Apparatus (Lafayette Instrument Corporation, USA 2000)

was used to evaluate the extent of bilateral symmetry in movement coordination observed in the cricketers.

PROCEDURE

Previous records of reaction and anticipation performances, movement coordination and the psychophysiological measures were available in the data bank with the researchers (since majority of the players of groups B and C were continuously taken care of and supervised by the authors of the present study for a period of more than three years), and for all of the analyses of the present study (tonic and phasic autonomic regulation and orienting skin conductance – i.e., Sc recovery response measures related to emotional behaviour and perceptual discrimination related cortical activation- CFF) all

the participants of the World cup cricket team (Group –C) were assessed in the BCB Cricket Academy (orienting Sc responses were recorded at the resting heart-rate level). For the simulated reaction performances (particularly related to the WRT), assessments were done in the BCB Mirpur Sher-E-Bangla National Cricket Stadium, Mirpur, Dhaka, Bangladesh. WRT for the athletes were planned mostly simulating the relevant competitive situations, in which players were required display agile responses to some visual signal cues presented randomly, by diving laterally either to the left or right to strike a touch pad (which was attached to the auxiliary port of the Lafayette Reaction and Movement timer to evaluate whole-body reaction time). Consistency in the agile-most reactions were considered as the data for the WRT performances. Players of Group A and B were assessed with the afore-mentioned parameters following the similarly rigorous methodology (methodology detailed in the Saha et al 2005 & 2012) in the cricket pavilion of the Cricket Academy of UKM, Selangor, Kuala Lumpur, Malaysia and for the simulated reaction performances (particularly related to the WRT), assessments were done in the Cricket ground of UKM, Selangor, Kuala Lumpur, Malaysia, while cricketers of both of the teams were participating in Invitational One-Day International Cricket tournament, in the month of July, 2011. All of these assessments were done following standard procedures (methodology detailed in the Saha et al 2005a & 2012a). Here w would like to mention that, Silliconcoach Pro 7 video performance analyser was used to evaluate actual performance efficiency of the cricketers, during practice sessions, match-practice sessions, as well as during the actual competitive sessions, and the evidences of consistent efficiency in match performances were considered as relevant dependent variable.

On the basis of the scores obtained from the projective analyses of emotionality (employing RIB), emotional measures of Resilience and Constriction were derived. Tonic and phasic Sc (Sc) activity data were decomposed as – basal or tonic Sc; SF or NS-SCR (non-specific Sc response, which is also termed as spontaneous fluctuation or SF) and tonic consistency measures; and, phasic Sc, and stimulus-specific orienting response measures (viz. latency; amplitude and recovery time).

Data were treated with PASW 18.0 for identification of the normality index. Thereafter multiple linear regression analyses were done to identify how far the different psychophysiological variables (autonomic regulation and orienting reflex information obtained from skin conductance measures and measures of cortical activation); psychomotor (agility, anticipation and movement coordination) and psychological (emotional resilience and constriction phenomena) contribute in the shared aetiology of consistency in excellent performance in cricket.

RESULTS

Measures of subjective feelings of emotionality as well as of the psychobiological and psychomotor parameters are summarised in the table of descriptive statistics (Table-1). Means and standard deviations of the variables

measured amongst the participants of the three groups are tabulated along with the existent significance of difference between them on the variables measured.

Table 1 – Descriptive measure and significance of variance amongst the three groups

Groups / Parameters	AGILITY (in M. Seconds)	ANTICIPATION (in M. Seconds)	PERCEPTUAL DISCRIMINATION (in /second)	SYMMETRY in MOTOR COORDINATION	Tonic Sc level (log log logmicrosiemens)	Phasic Sc level (log logmicrosiemens)	Orienting Latency (sec.s)	Orienting Amplitude (log microsiemens)	Orienting Recovery (sec.s)	RESILIENCE (scores)	CONSTRICTION (scores)
	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)
Gr. A	.39 (.09)	E .29 (.07)	31.3 (8.13)	32% (7.1%)	7.97 (3.81)	5.77 (3.41)	2.13 (1.85)	.43 (.57)	11.65 (5.12)	11.4 (6.01)	11.8 (5.21)
Gr. B	.33 (.18)	L .23 (.08)	36.9 (11.1)	45% (9.4%)	5.84 (3.81)	3.75 (2.01)	4.19 (3.11)	.67 (.81)	9.91 (3.11)	12.9 (2.89)	9.6 (4.01)
Gr. C	.28 (.09)	L .04 (.02)	43.8 (6.12)	74% (13%)	8.52 (3.81)	9.22 (1.84)	3.01 (1.61)	.94 (.52)	6.13 (.82)	16.3 (3.47)	7.8 (2.45)
KW-values	21.73**	17.11**	21.79**	19.01**	22.39**	22.11**	20.09**	18.33**	25.78**	14.59**	19.16**

Overall impressions have suggested that the performances of the elite cricketers (hereafter Group C performers) have definitely placed them ahead of their counterparts (from both Groups A & B). These findings clarify the superiority of the elite players (who have represented the World cup Cricket tournament 2011, won the Gold in Asian Games twenty20 Cricket event 2010 and also are current runner-up in the Asia Cup Cricket tournament 2012) not only in the game of cricket but also in the laboratory-based and performance-based analyses of cricket-specific behavioural, psychobiological and psychomotor measures, over their developmental (Group A) and intermediate level (Group B) counterparts.

Further to add, elite players have been observed to display marked level of consistency between themselves, in almost all of the variables measured, while their counterparts have failed to maintain that extent of consistency on majority of the variables assessed.

The results of multiple linear regressions were presented from Tables 2 to 4. Table- 2 explained that, in case of the players of the development group (i.e., Group A) independent variables such as resilience ($p = .001$), along with measures of orienting recovery ($p = .001$) and perceptual discrimination ($p = .014$) can predict 12.7% of variance in changes in the levels consistency in peak performance in cricket (refer to model ***a***).

Table – 2 -Model ***a*** - Summary of multiple linear regression analysis explaining predictors of consistent peak performance observed in the cricketers of the Group A (Development Group team Chittagong, Bangladesh).

Model *a*	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
Intercept	**1.810**	**.142**		**12.703**	**.000**					
Resilience	**.118**	**.034**	**.252**	**3.494**	**.001**	**.283**	**.251**	**.241**	**.913**	**1.095**
Orienting Recovery	**-.056**	**.017**	**-.263**	**-3.360**	**.001**	**-.249**	**-.242**	**-.231**	**.777**	**1.286**
Perceptual Discrimination	**.055**	**.022**	**.190**	**-2.469**	**.014**	**022**	**-.181**	**.170**	**.802**	**1.247**

a. Dependent Variable: Consistent peak performance
(F (3, 18) = 9.905, P <0.000)) Model Adj.R^2 = 12.7%.

Similarly the multiple linear regression equations (Table – 3, model ***b***) depicted that measures of constriction (p = .000); perceptual discrimination (p = .001) along with measures of orienting recovery (p = .001) explained 23.5% of variance changes in the possibility of high performance in cricket by the players of the Malaysian contingent.

Table – 3 -Model ***b*** - Summary of multiple linear regression analysis explaining predictors of Consistent peak performance observed in the cricketers of the Group B (the Malaysian contingent team).

Model *b*	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
Intercept	1.843	.204		9.042	.000					
Constriction	-.086	.015	-.412	-5.894	.000	-.357	-.401	-.380	.853	1.172
Perceptual Discrimination	.112	.032	.253	3.512	.001	.176	.253	.226	.802	1.246
Orienting Recovery	-.072	.027	-.183	-2.647	.009	-.306	-.193	-.171	.872	1.146

a. Dependent Variable: Consistent peak performance

(F (2, 15) = 19.820, P <0.000)) Model Adj.R^2 = 23.5%.

Table – 4 however summarizes that, in case of the elite level players (the World Cup contingent of Bangladesh), similar variables (almost same as those represented in the model ***b***, for Group B cricketers together can predict peak performance at the elite levels. The regression equation in

Table – 4 -Model ***c*** - Summary of multiple linear regression analysis explaining predictors of Consistent peak performance observed in the cricketers of Group C (The World Cup team of Bangladesh).

Model *c*	Unstandardized Coefficients		Standardized Coefficients			Correlations			Collinearity Statistics	
	B	Std. Error	Beta	t	Sig.	Zero-order	Partial	Part	Tolerance	VIF
Intercept	1.608	.179		8.960	.000					
Orienting Recovery	-.119	.030	-.271	-3.991	.000	-.192	-.269	-.233	.744	1.344
Resilience	.089	.015	.437	6.106	.000	.291	.393	.357	.666	1.501
Perceptual Discrimination	.143	.023	.336	6.523	.000	.373	.133	.112	.680	1.472

c. Dependent Variable: Consistent peak performance
(F (2, 20) = 31.491, P <0.000)) Model Adj.R^2 = 76.5%.

the model ***c*** however emerged as a significant model, in which autonomic measure of orienting recovery response (p = .000); extent of emotional resilience (p = .000) and perceptual discrimination evaluated by the cortical activation (p = .000) together explained 76.5% of variance changes in consistent peak level cricket performance at the highest level of International cricket (viz., Asia Cup 2012 & World Cup One-Day International Cricket, 2011).

DISCUSSION

Findings from the Table -1 revealed that, the GR. C cricketers (i.e., elite cricketers) apart from their excellence in cricket skills, owing to their higher-order perceptual discrimination ability and better symmetry in bilateral movement coordination accompanied by accuracy in anticipation and agile reactions, were observed as definitely far ahead of their counterparts. Present study, irrespective of the level of expertise in cricket, intended to examine the interrelationships between psychobiological and psychomotor variables in

predicting performance excellence in cricket. Outcomes of this research would highlight on a few significant aspects, apart from the already well-documented parameters, such as – anticipation (Müller et al., 2006; Weissensteiner et al. 2008); reaction ability and coordination (Abernethy and Russell, 1984; Saha et al. 2012a & b) related to performance excellence in cricket.

Here we would like to get into a little more details of outcomes of multiple regression analyses. **Model *a*** (in Table 2) explained that, there existed positive relationships between the emotional resilience and the question of peak performance consistency, which explained that, the reason behind observed quite inconsistent performance level, could be attributed to the lack in emotional resilience, which was evidentially substantiated by lower-order perceptual discrimination ability, and fairly delayed orienting recovery response indices (Saha et al. 2005a & 2012a). Behavioural measures (as revealed through psychobiological and psychomotor evaluations) in case of cricketers of Malaysian contingent have however explained 23.5% of variance changes in high level cricket performance (**Model *b*** in Table – 3). Detailed reports however revealed that there existed positive associations between perceptual discrimination ability with inconsistent as well as deteriorated performance outcomes, while independent variances of emotional constriction and orienting recovery time had negative relationships with performance outcomes. These findings have further implications, as lack in perceptual discrimination ability; high extent of emotional constrictions as well as delayed orienting recovery together contributed to the inhibited performance outcomes. Table -4 represented the summary of **model *c*** which revealed when orienting recovery was regressed, 76.5% of variance in changes in the extent of consistency in peak performance could be explained. The model however also clarified the fact that in elite players, higher levels of emotional resilience as well as higher order perceptual discrimination ability had favourably contributed in consistent peak performance.

Models ***a, b & c*** were conceived to explore into the diverse nature of hypothesized relationship between perceptual discrimination ability (absolutely essential quality of maturing cricketers); subjective evaluation of cognitive-emotional make-up of the players, and their inherent ability in autonomic regulation over startle-like emotionality, in predicting consistency in extremely resolute competitive behavior. Inhibitive impact of significantly inadequate emotional resilience independent of and excluding the effect of the all other predictor variables, clarified the inability of development level of cricketers in regulating immense emotional and concomitant autonomic overloading, which was found significant enough to display devastating performance. Higher tolerance index observed in colinearity statistics (Table – 2) suggested that – very high extent of (91.3%) variance in resilience was not predicted by other psychobiological (orienting recovery) independent measure of emotionality. For the group A cricketers emotionally it became further critical, since they also lacked in perceptual discrimination ability and the delayed autonomic recovery perhaps made them vulnerable to choke even in relatively non-threatening situations. In case of group B cricketers (refer to model ***b*** in Table

3), observed higher level of emotional constriction (85.3% tolerance index) coupled with similar nature of inhibitive factors such as perceptual shortcomings and delayed autonomic recovery, led themselves to performance hindrances.

These findings however have pointed out the need to nurture the promising cricketers with the simulated trainings to strengthen their ability to positively transfer the tough competitions related task-specific skills learned and conditioned in practice situations adequately enough to the actual competitive situations. These simulated trainings would culminate in better ability of the cricketers to adapt to the suddenness of competitive situations, leading to consistent peak performance. Elite cricketers on the other hand are rigorously seasoned with devastating demands stemming from abrupt, as well as never-ending cues of unexpectedness inherent in world-class competitions, and hence they rather tend to remain ever-prepared, and this cognitive-perceptual flexibility enhanced with optimal resilience result in consistent peak performance (Saha and Saha 2006; 2005a & b; 2009; 2012a, b & c). Here we would like to explore into the observed centred or in-zone nature of emotional make-up. Cricket involving all-the-way gruesome perceptually and cognitively overloading task, what kind of internal make-up aid the elite cricketers in remaining persistently in-zone?

Table - 4 however revealed that, in case of elite cricketers, faster autonomic recovery, high extent of cortically determined perceptual discrimination ability and favourable extent of emotional resilience have facilitated in observable consistent peak performance. Higher tolerance index observed in colinearity statistics (refer to Model ***c*** in Table – 4) suggested that – very high extent of (74.4%) variance in autonomic recovery was not predicted by other independent measure of emotionality (resilience), and perceptual discrimination. Thus optimally faster recovery from orienting (response-specific yet suddenly occurring) autonomic activation, which is finely tuned by cholinergic sympathetic activation, kept the elite cricketers emotionally conditioned enough to handle any intense situation as perceived and dealt with as not critical, rather favourable for optimal performance (Saha et al., 2012 a, b & c). Decomposition of phasic skin conductance activity into orienting activity in predicting performance excellence in sports is not fairly common practice, but consideration of orienting recovery independently of other usual skin conductance component constellation, as predictor of peak performance contradicts established experimental Sc related practice (Dawson et al. 2000). Here we feel it worthy to be mentioned that, present paradigm considered the phasic Sc component of orienting recovery, and not ER-SCR half recovery, as it was proposed by Fowles (1986) and Edelberg (1993), and uniformity in the orienting recovery ratio have been considered as representative data for autonomic response that could have predictive influence on maintenance in peak cricket performance (Saha et al. 2005a; 2012a, b & c). Apart from all these, the elite cricketers have also been observed to have unique level of motor coordination and their cognitive competence, as have been judged by cortical activation related to perceptual discrimination task have revealed their

excellence in cricket-specific skills (Müller et al., 2006; Weissensteiner et al. 2008; Saha et al 2012 b and c).

Finally summary of present discussion would like to hint upon the need of accuracy in selection of task-relevant stimuli; inner feelings of resilience and optimal relieve from transient and suddenly evoking stimulation to remain prepared for novelties characterized by relatively threatening unexpectedness – as few key features of elite cricketers. Arousal no matter to what extent, if coupled with negative expectancies can create severe detrimental effects even at the average level of performance in cricket, characterized by delayed signal detection leading to time-constraint for optimal performance leading to multiple hindrances.

CONCLUSION

Findings of the present study may be summarised as the followings:

- Perceptual discrimination has been observed as associated with orienting recovery in predicting peak performance in the elite players.
- Emotional measures, such as resilience and constriction have been observed as associated with orienting recovery in predicting performance outcomes differentially amongst the elite and other category cricketers.
- Faster autonomic orienting recovery has been observed as associated with peak performance in elite cricketers.

ACKNOWLEDGEMENT

The research was done by virtue of a Memorandum of Agreement between Universiti Sains Malaysia and Bangladesh Cricket Board (which was operative for the International Cricket Council World One-Day International tournament 2011, since July 2010 till May 2011), and in Malaysia the project was partially carried out in the cricket ground of UKM. Researchers of the present study are hereby indebted to all of these afore-mentioned institutions for their collaborative assistance.

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