

Differential Psychobiological Pathways Explaining Agile Reactions in World-class and Mediocre Cricket Players

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ABSTRACT: This study was done with the intention to compare the underlying psychobiological antecedents of whole-body reaction ability related to cricket-specific agile behaviour, in elite and development standard South-Asian cricketers. Twenty-three world-class cricket players of Bangladesh, selected for the ICC World Cup 2011, were compared with twenty-two recreational and eighteen trainee level cricketers of Malaysia, on the basis of their consistent high performance and on the basis of their performance on psychomotor and psychobiological parameters. Orienting reflex measures of skin conductance as well as of cardiovascular activity were done when 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 suggestive of possible relationships between the psychobiological processes explained by the HPA axis and the TCA pathways, in relation to the cognitive-motivational (behaviour-activation system) dimension of approaching behaviour in elite cricketers as the key factor of advantage compared to the developmental level counterparts.

Keywords: autonomic regulation, agility, cricket, peak performance

Introduction

High performance in sports could be considered as a resultant of successful interaction between several relevant psychological and psychobiological aspects resulting in peak reaction ability. The prominent issue here relates to persistence in peak reaction ability, which involves multiple interaction of cognitive and cortical activation. Reaction performance being a combination of a higher-order of cognitive and motor competence requires a unique coordination between the sensory and the involved motor processes (Saha *et al.*, 2001; Saha *et al.*, 2005a; Singer, 1988).

Cricket as a fast ball sport is characterised by ever-changing uncertainties, and hence unique as well as partially known situations must be evaluated simultaneously with agile yet appropriate and accurate execution of reaction performance. Absolutely unique or even slightly altered challenges matched with existing cognitive schema gets immediately processed with the introduction of optimum cortical arousal initiated by ascending reticular activating system (ARAS) which is mostly essential for cognitive processing. The descending tract of the RAS gets prepared for improved faster and coordinated reactions under higher levels of arousal (Franken, 1998). Optimum excitatory ARAS would facilitate in faster reactions, since it keeps up a sports performer readiness to react to any incoming stimulus. In consequence of being in the state of readiness, elite cricketers are not only able to process those stimuli spontaneously, but are able to process more information with further accuracy. Furthermore, this enables them to identify the important features in the environment more efficiently and to integrate that information with memories or schemata stored in the brain. Finally, because of the motor cortex being more activated, they get prepared to make an appropriate response both rapidly and accurately (Saha *et al.*, 2012a).

Bulk of researches done on cricket have reported that more skilful adult 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 (Abernethy and Russell, 1984; Müller *et al.*, 2006; Renshaw and Fairweather, 2000). Expert international habitually read and interpret complex situations quickly and take actions right away. Simpler agile actions being repeated

develop the ability to deal with complex situations as fast as possible (Saha *et al.*, 2005a). It will also give them advantage in initiating abrupt movement. 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. Previous researches by Abernethy and Russell (1984) and McLeod (1987), have explained about the neuropsychological pathways, which however inspired the future researchers (Land and McLeod, 2000; Penrose and Roach, 1995) to explore further into the intricate cognitive-emotional interactions, revealing the significance of accurate anticipation, used by the elite players to minimize the reaction time delays inherent in every aspect of sport activity (McRobert and Tayler, 2005; Renshaw and Fairweather, 2000). But these researches have numbers of limitation (Müller *et al.*, 2006); particularly most of those included competent players with minimal international exposure, who were compared with the novices.

Here we should focus onto the question of emotional overloading related negative expectancies, prevailing in the players. Thus the question of evaluation of the intricate psychological and psychobiological processes ensuring excellent cricket performance, must concentrate on evaluation of autonomic arousal modulation along with the measure of cortical activation (as indices of cognitive-emotional make-up). Apart from these the need for in-depth evaluation of movement related motor coordination (Heyman 1982; Tenenbaum *et al.*, 1992), should be taken into consideration.

In the present study, we are trying to point out our concern over the methodological issues related to the assessment and analyses of the optimal performance in cricket, along with the simultaneous assessment of other correlated and influencing psychobiological mediators. Simultaneous introduction of a few relevant psychobiological measures such as measures of cortical activation and electro-dermal activity as index of autonomic arousal modulation in experimental models to fit in correlation analyses would provide the researchers with relevant information related to accuracy in anticipation and movement coordination and agile reactions ensuring peak performance in elite-level cricket. To date, laboratory-based analytical researches incorporating objective and direct measures of performance that could be served as

predictors of excellent reaction and movement performance, 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 multicollinearity, and hence are not capable of predicting process-related shared aetiology behind performance excellence in cricket.

With such a background, the present study was carried out with the following objectives:

1. To evaluate whether cortical activation related to perceptual discrimination can predict high performance in cricket;
2. To observe the level of visual anticipation time performances in predicting combined reaction ability;
3. To justify whether combined autonomic regulation (squared transformation of summated autonomic basal phasic and tonic skin conductance along with the autonomic adaptation level) can predict performance excellence in cricket;
4. To assess whether motor coordination alone can predict peak performance.

Materials and Methods

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 recreational cricket players (Group A, Mean age = 22.3 and SD = 1.8) of the University of Chittagong, Bangladesh and eighteen trainee level high performing cricketers of Universiti Kebangsaan Malaysia (UKM) contingent (Group B, Mean age = 19.9 and SD = 2.68), on the basis of their consistent high performance (being Champion of all of the Major University cricket tournaments) and on the basis of their performance on psychomotor (simple-muscular reaction ability) and psychobiological (basal tonic skin conductance ability) parameters (which were considered as the inclusion criteria). Apart from the elite cricketers

representing from the National squad of Bangladesh, players of the remaining two other teams were non-professional squads, and since they didn't compete in any other tournaments prior to the UKM Invitational tournament, no question of comparison in between them with regard to the issue of hierarchical standing could be raised herewith.

Materials and measures

1. Critical Flicker Fusion Apparatus (Lafayette Instrument Corporation, USA 2000) was used to assess the descending flicker threshold of the participants as index of cortical activation related to perceptual discrimination.
2. Skin Conductance Apparatus (Autogenic Corporation, USA 2000) was used to assess the extent of autonomic regulation as index of emotionality in the participants.
3. Photocell Whole-Body Reaction and Movement Timer Apparatus (Lafayette Instrument Corporation, USA 2001) were used to assess both the visual and auditory whole -body reaction time of the participants.
4. Bassin Anticipation Timer (Lafayette Instrument Corporation, USA 2000) was used to assess the anticipatory reaction time of the participants.

Procedures

All of the cricketers have been assessed by the researchers with regard to some of the parameters, and hence we had the previous records of reaction (simple-muscular reaction ability) and visual anticipation time performances, movement coordination(symmetry in coordination) and the psychobiological (basal tonic skin conductance ability) measures, which were available in the data bank with the researchers of the present study, and for all of the analyses of the present study (autonomic regulation using skin conductance activities-Sc and orienting amplitude; orienting recovery time and other habitual paradigm autonomic 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 and for the simulated reaction performances (particularly related to the whole -body reaction time- WRT),

assessments were done in the BCB MirpurSher-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 to display agile responses to some visual signal cues presented randomly, by diving laterally either to the left or right to strike a touch pad. Consistency in the agile-most reactions was considered as the data for the WRT performances. Players of Group A and B were assessed 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, when cricketers of both of the teams were participating in Invitational One-Day International Cricket tournament, in July 2011. All of these assessments were done following standard procedures (methodology detailed in the Saha *et al.*, 2005a& b; 2012a, b & c).

From the outcomes of parameters assessed, variables (*viz.*, agility, motor coordination and movement coordination) were derived. The difference between the scores obtained in initiation of the reaction performance, were subtracted from the scores of whole-body agile movements and thus the scores for agility. Observed sharpness or delay in the lateral movements were extrapolated as measures motor coordination (related to reaction time performance) and movement coordination (related to lateral symmetry in agile movement timing performance, explained in the earlier section). Measures of anticipation, cortical activation, spontaneous fluctuation, ANS arousal are universally accepted and widely employed assessment protocols done by employing Bassin Anticipation Timer; Critical Flicker Fusion Apparatus and Skin Conductance Apparatus respectively.

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

Results

Measures of behavioural manifestations as well as 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 observed significance of difference between them on the variables measured.

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

Groups	Agility (in m. Seconds)		Anticipation (in m. Seconds)		Cortical activation (hz./second)		Spontaneous fluctuation (numbers)		Ans arousal Log micro mhos		Motor coordination (in percentage)		Movement coordination (in percentage)	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
A	.36	.08	E .25	.06	34.2	8.13	11	3.2	1.53	.27	32%	8.2%	41%	19.2%
B	.30	.17	L .19	.07	38.9	11.1	14	7.1	1.21	1.38	45%	16.3%	38%	13.6%
C	.27	.07	L .06	.02	44.9	6.12	03	1.1	8.29	1.54	74%	16%	69%	12.3%
KW- values	25.78**		16.39**		22.26**		17.29**		11.34**		29.54**		32.13**	

* $P < 0.01$

Overall impressions have suggested that the performances of the elite cricketers (hereafter Group C performers) have placed them way ahead of their counterparts (from both Groups A and B). These findings clarify the superiority of the elite players (who have represented the World cup Cricket tournament 2011) 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 among them, in almost all of the variables measured, while their counterparts have failed to maintain that extent of consistency on majority of the variables assessed.

Table 2: Summary of multiple linear regressions analysis explaining predictors of consistent peak performance observed in the cricketers of the Group A (Development Group team Chittagong, Bangladesh).

Dep. Variable-Consistent Peak Performances	Unstandardized Coefficients		Standard Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	0.652	0.245		2.689	0.036
Agility	-0.174	0.083	-0.252	-2.103	0.048
Anticipation	-0.130	0.055	-0.182	-2.367	0.043
Spontaneous fluctuation	0.435	0.074	0.693	5.867	0.000

(F (3.21) = 29.493, P<0.000)) Model Adj. R² = 78.1%.

The results of multiple linear regressions presented in **Table 2** to **Table 4**. **Table 2** explained that, for players of the development group (i.e., Group A) independent variables such as agility (p = 0.048), along with measures of anticipation (p =0.043) and autonomic measure of spontaneous fluctuation (p = 0.000) can predict 78.1% of variance in changes in the levels of consistency in peak performance in cricket (refer to model *a*).

Similarly the multiple linear regression equations (**Table 3**, model *b*) showed that the measures of motor coordination (p = 0.000); accuracy in anticipation (p = 0.000); extent of cortical activation (p = 0.000); autonomic measure of spontaneous fluctuation (p = 0.000); level of tonic autonomic arousal (p = 0.000) and level of movement coordination (p = 0.000) explained as high as 99.7% 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 performances observed in the cricketers of the Group B (The Malaysian contingent team).

Dep. Variable-Consistent Peak Performances	Unstandardized Coefficients		Standard Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	12.966	0.260		67.053	0.000
Motor Coordination	1.332	0.020	2.210	52.445	0.000
Anticipation	2.918	0.056	1.793	-19.049	0.000
Cortical activation	-0.172	0.009	-0.339	-42.648	0.000
Spontaneous fluctuation	-2.073	0.048	-0.791	-69.361	0.000
Autonomic arousal	-1.543	0.022	-2.253	-63.294	0.000
Movement coordination	-2.039	0.032	-3.341	49.938	0.000

(F (3,15) = 1051.480, P<0.000)) Model Adj.R² =99.7%.

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

Dep. Variable-Consistent Peak Performances	Unstandardized Coefficients		Standard Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	4.200	0.460		9.135	0.000
Spontaneous fluctuation	-0.229	0.064	-0.732	-3.602	0.002
Cortical activation	0.815	0.183	3.323	4.447	0.000
Anticipation	-0.948	0.213	-4.326	-4.446	0.000
Agility	-0.383	0.087	-1.835	-4.397	0.000
Movement coordination	-0.069	0.033	-0.579	-2.109	0.051
Motor coordination	0.302	0.082	2.253	3.685	0.002

(F(3,20) = 5.042, P<0.004)) Model Adj.R² = 52.4%.

Table 4 however summarises that, for elite level players (The World Cup contingent of Bangladesh), similar variables (almost same as those represented in the model **b**, for Group B cricketers) can predict peak performance at the elite levels. The model **c** however emerged as a significant model, in which autonomic measure of spontaneous fluctuation (p =0.002); extent of cortical activation (p = 0.000); accuracy in anticipation (p = 0.000); extent of agility (p = 0.000); level of movement coordination (p = 0.051) and measures of motor coordination (p = 0.002)

explained 52.4% of variance changes in peak level cricket performance at the highest level of International cricket (World Cup One-Day International Cricket, 2011).

Discussion

The present study examined the interrelationships between psychobiological and psychomotor variables in predicting the performance excellence in cricket. Outcomes of this research would highlight on a few significant aspects related to performance excellence in cricket. Since high performance in cricket is fast reaction dependent, level of agility has been given the highest priority, which however has been observed as one of the significant predictors of consistent peak performance.

Outcomes of the **Table 2** explained 78.1% of variance changes in peak performance, which has implied that for developmental level players of Bangladesh, both agility and accuracy in anticipation have been indirectly associated to the peak performance, revealing the fact that, out of the cricketers of Group A, those having relatively less accuracy in anticipation and relatively less agile reactions, have been observed to remain consistent in high performance. These findings however have pointed out the need to consider the ability of cricketers to positively transfer the practice situation agility and anticipation performance efficiencies to those required during actual competitive match situations. Observed direct relationship between the autonomic measures of spontaneous fluctuation and the peak performance have however implied that a better ability of the cricketers to adapt to the suddenness of competitive situations has facilitated in their peak performance.

Behavioural measures (as revealed through psychobiological and psychomotor evaluations) for cricketers of Malaysian contingent have however explained 99.7% of variance changes in high level cricket performance (**Table 3**). Measures of motor coordination; accuracy in anticipation; extent of cortical activation; autonomic measure of spontaneous fluctuation; level of tonic autonomic arousal and level of movement coordination altogether have been observed to explain the consistency in peak performance. Alike the performers of Group B, cricketers from

Malaysian Contingent have been observed to have an indirect relationship between measures of anticipation and the dependent measure of peak performance. Apart from that, other variables like cortical activation; spontaneous fluctuation; level of tonic autonomic arousal also have been observed to have indirect relationship with the measure of performance as well. Measures of coordination (both motor and movement coordination) however have been observed to have contributed directly onto the extent of peak performance.

Findings by far have suggested that higher level of coordination performances though have been found to facilitate in maintenance of peak performance, relatively inferior level of anticipation and relative lack in control over cortical as well as autonomic measures of arousal however have raised the question how far these variables can reliably predict alteration in performance behaviour. At this instant we have further concentrated on scrutinising the descriptive data, which have pointed out to the question of observed huge inconsistency amongst the data on majority of the variables. A clear distinction in the nature of data has been observed, which has depicted that, a considerable number of cricketers in both of the groups (groups A and B) have performed poorly on psychomotor as well as psychobiological parameters evaluated, and a few of the performers outperformed their group mates on the afore-mentioned variables, but their overall cricket performance were not efficient enough. Furthermore, a few others (who have performed very nicely in match-situations) have failed to produce their performance excellence on that variables assessed in the laboratory as well in the performance related evaluations. This might have happened to them because of the suddenness of the evaluations and due to the performance-relevant test anxiety. Our previous researches on intermediate and developmental groups of athletes from Indian sub-continent and from South-Asian origin have revealed similar types of irregularities in the data (Saha *et al.*, 2006; 2008; 2009 and 2012a).

Table 4 however revealed that, for elite cricketers measures of motor coordination and extent of cortical activation have facilitated in peak performance, but other measures such as, accuracy in anticipation; autonomic measure of spontaneous fluctuation; level of tonic autonomic arousal and level of movement coordination have relatively inhibitive impact on the issue of consistency in peak performance. **Table 1** has clarified that, on all of the variables assessed, elite players have

performed extremely well, and their level of consistency in performance have also been remarkable. Hence, out of the excellent scores, a few of those who have outperformed all others in really challenging competitive situations, but have lagged little bit behind their group-mates made the difference in the overall group performance on majority of the behavioural and psychobiological measures. Apart from all these, the elite cricketers have 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, the measures of observed accuracy in anticipation amongst the three groups have revealed that the intermediate level performers (group B – Malaysian contingent cricketers) have displayed fairly delayed and inaccurate level of anticipation, whereas the development squad from Bangladesh (group A cricketers) have displayed inaccurate as well as early anticipation (which have been fairly inappropriate, since those are supposed to have mismatching and incoherent anticipations), while only the elite players maintained consistent and accurate anticipation (with slightest possible delay in anticipation) (Land and McLeod, 2000; McRobert and Tayler, 2005 and Saha *et al.*, 2012a).

Conclusion

Findings of the present study may be summarised as follows:

- Cortical activation has been observed to facilitate in peak performance in the elite players.
- Accuracy in anticipation has been observed to have indirect relationship with peak performance. Elite players have been observed as having the lowest level of delay in anticipation, while others have remained inconsistent in maintaining accuracy.
- Higher autonomic tonic arousal (electrodermal activity) has been observed as associated with peak performance in Cricketers of Malaysian contingent. Occurrence of changes in phasic skin conductance activity, referred as spontaneous fluctuation has been observed to influence peak performance amongst cricketers of all of the groups.

- Movement and motor coordination have been identified as the most significant predictor of peak performance in elite and intermediate level, i.e., Malaysian contingent cricketers, whereas it has no contributory impact in the development group players.

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