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Bilateral Motor Coordination as predictor of Inhibited Performance in Cricket

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Abstract

Accuracy in anticipation along with emotional resilience has always been emphasized as vital for peak sport performance and cricket being characterised as "game of uncertainty", impaired motor coordination has been postulated as possible inhibiting factor for persistent peak performance. Present study was done to identify the extent of direct and moderating contribution of asymmetry in bilateral motor and movement coordination on the cognitive-emotional competence required for performance excellence in cricket. Twenty National-selection group cricketers of Bangladesh and twenty National-development-squad cricketers of Malaysia were categorized into high and low performers (Gr. A and B - 10 high and low level cricketers from Bangladesh; and, their counterparts from Malaysia - Gr. A_{-1} and Gr. B_{-1}). They were assessed with autonomic measures (orienting activity) and with bilaterally recorded visual-motor coordination ability. Significant differences in skin conductance measures were obtained both in Gr. B and in Gr. B_{-1} players, which were not evident in high performers. Furthermore, Gr. B players were evident with inhibited visual motor co-ordination in left lateral side, but no such difference was observed in either of the high performer groups (i.e., Gr. A and Gr. A_{-1} players). Asymmetry in motor co-ordination was evident as predictor of low performance.

Keywords: Motor coordination, laterality, psychobiology, cricket.

Introduction

Fast-ball sports like cricket base-ball and soft ball are characterised by ever-changing uncertainties, and challenges are met with outstanding levels of individual fitness and well-planned coordinative strategies. In order to remain injury-free and yet extraordinarily vigorous, players need to consider the questions of balance and stability, while to pace up with the faster demanding nature of the game they need to remain flexible and ultra-paced. These complicated situations brought up the need for conceptualizing cricket especially in terms of Dynamical systems theory proposed by Williams and co-researchers[1]. As it is proposed, this theory has elaborately discussed on application of movement sciences as a promising structural concept related to modelling of sport performance. On the basis of this theoretical standpoint, human movement have been conceptualised as a grossly obscure and complicated system which depends on numerous sub-systems that enables patterns of the movements to appear through processes of nonspecific innate associations between physical, physiological and psychobiological systems[1,2]. The Expert internationally famous players have the ability to read and interpret complex situations quickly and to initiate decisive action. The faster the simple muscular reaction and movement time of the individual, the quickly will be responses to complex situations[3,4] (Saha et al., 2012a[3]; Saha et al., 2005[4]). Now the question is how they do that? The contradictory relationship between the stability as well as perspective of variability hypothesized in the dynamical systems theory explains why and how high performer skilled players are capable of maintaining consistency in their performance and yet remains flexible in motor output during performance.

Here it may appear a bit intrusive, as to why remaining persistent, and at the same time flexible in movements are crucially important for the high performing cricketers? Enormous research literatures focussing onto the science of cricket have reported that expert and experienced batsmen are comparatively more successful since they have better ability to predict supple changes in ball direction and delivery type from the pre-release movement patterns of both slower (spin) and faster (pace) deliveries[5,6]. Previous researchers[6,7] have also paid attention to the inherent ability of the elite players to minimize the reaction time delays, but large number of these researches have major limitations (Müller et al., 2006[5]), particularly most of those included competent players with minimal international exposure, who were compared with the novices. Since everything in cricket changes in split-second fractions, ability of the players in faster information processing matched with already developed cognitive schema gets immediately processed by ascending reticular activating system (ARAS) which is absolutely essential for processing cognitive schema[8]. The descending tract of RAS is known to take part in the motor functions. The descending tract of the RAS has been universally considered as partially responsible for faster reactions and better coordination in highly competitive stressful situations demanding higher levels of arousal[9]. Numerous studies pointed out the importance of ARAS only in controlling excellent reaction performance[9], while a lot others pointed out the need for consideration into movement related motor coordination[10, 11] and others considered role of involvement of cortical activation as cognitive component as more important factor for concern[4]. Further to add, majority of our previous research endeavours done from the same laboratory focussed mainly onto the psychomotor variables as etiological aspects related to performance outcomes only[2-4, 12-13]. Outcomes of these studies hinted up on the relevance of psychomotor aspects viz. movement coordination; perceptual motor skill related components of sport behaviour. The major issue of required optimal conditioning of psychomotor skills in athletes of South-Asian and Southeast Asian origin, aiming at amelioration of perceived helplessness and to eradicate the apprehension of losing in the athletes have largely been ignored. 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 psychobiological mediators. Simultaneous introduction of few relevant psychobiological measures such as measures of cortical activation and electrodermal 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 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 performance excellence in actual competitive set-ups, 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. Further to add, we intended to observe contribution of motor coordination, especially bilateral and cross-lateral symmetry in movement coordination in influencing and in ensuring performance excellence in cricket. With such a background, the present study was done: i. To evaluate whether cortical activation related to perceptual discrimination can predict high performance in cricket, ii. To observe contribution of anticipation in predicting excellence in performance, iii. To justify whether combined autonomic regulation (decomposed transformation of autonomic phasic and tonic skin conductance) can predict performance excellence in cricket, iv. To assess whether motor and symmetry in movement coordination can predict peak performance.

Materials and Method

Participants: Twenty National-selection group cricketers of Bangladesh and twenty National-development-squad cricketers of Malaysia were categorized into high and low performers (Gr. A and B - 10 high and low level cricketers from Bangladesh (Mean age = 23.4 yr.s; SD = 2.4); and, their counterparts from Malaysia - Gr. A_{-1} and Gr. B_{-1} (Mean age – 22.3 and SD = 1.8)). The high performing cricketers were consistently high performing cricket players who were primarily selected in the National squad of Bangladesh. The low performers were selected from a batch of development-squad players who were facing troubles concerning consistency in performance. These players were compared with ten National selection players of Malaysia (hereafter high performers of Gr. A_1 (Mean age – 22.3 and SD = 1.8) and ten amateur-competitive development level cricket players (Group B_1, Mean age – 19.9 and SD = 2.68).

Inclusion criteria values were set as: i. Faster or equal visual simple muscular reaction time (SRT) - .335 ms, ii. Faster or equal auditory SRT - .219 ms, iii. Faster or equal visual movement time (MT) - .448 ms, iv. Faster or equal auditory movement time (MT) - .331 ms, v. Faster or equal visual whole body reaction time (WRT) - .565 ms, vi. Faster or equal auditory whole body reaction time (WRT) - .434 ms.

Materials and measures: i. Photoelectric Rotary Pursuit Apparatus (Lafayette Instrument Corporation, USA 2000) was used to assess motor coordination; movement coordination, visuo-motor coordination of the participants as index of bilateral symmetry in coordination. ii. 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. iii. Skin Conductance Apparatus (Autogenic Corporation, USA 2000) was used to assess the extent of autonomic regulation as index of emotionality in the participants. iv. Photocell Whole-Body Reaction and Movement Timer Apparatus (Lafayette Instrument Corporation, USA 2001) was used to assess both the visual and auditory whole -body reaction time of the participants. v. Bassin Anticipation Timer (Lafayette Instrument Corporation, USA 2000) was used to assess the visual anticipation time of the participants.

Procedure: Previous records of reaction and anticipation performances, movement coordination and the psychobiological measures obtained from the participants of this present study were available in the data bank (those were collected intermittently from the participants of both of the contingents and countries within a period of September 2010 to August 2012) 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 Bangladesh were assessed in the BCB Cricket Academy and 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. Consistency in the agile-most reactions were considered as the data for the WRT performances. Players of Group A_1 and B_1 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, 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[3,12,14-16].

Data were treated with SPSS 20.0 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) contribute in the shared aetiology of consistency in excellent performance in cricket.

Results and Discussion

Reports on descriptive statistics and measure of mean differences were summarized in the table 1, which represented somewhat consistency in the data obtained from the participants of all of the groups (moderate and lower extents of standard deviation indices clarified that the data were considerably free from huge dispersions). Here we would like to clarify that, since we had very few participants in each of the separate groups, to minimize complications we introduced Kruskal-Wallis test as non-parametric statistics for analysis of mean difference.

Tables 2 to 7 represented summary of multiple regression analysis done separately from each of the different groups of players. To identify relative contributions of a set of independent predictors on performance of the cricketers in match situations, and in matches with particular reference to the question of consistency in performance, notational analyses procedures were followed. On the basis of reports on performance analyses, scores were given to each of the players on actual match performance, which was indexed as Actual Performance; and depending on the question of consistency in high performance, scores on Consistency in Performance was given.

Models *a, b, c* and *d* were conceived to identify relative strength of association between the predictor variables and the dependent measure of actual performance observed separately from the players of four different groups. Significant models emerged for the all of models, in which anticipation; movement time; visuo motor coordination; muscular reaction time and emotional index of skin conductance activity were observed to predict changes in actual performance scores obtained by the players.

Table-1

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
Gr. A	.27	.07	L .06	.02	44.9	6.12	03	1.1	8.29	1.54	74%	16%	69%	12.3%
Gr. A_1	.31	.09	L .08	.04	40.7	7.21	06	2.1	6.01	3.85	58%	23%	54%	19.7%
Gr. B	.36	.08	L .19	.07	34.2	8.13	11	3.2	1.53	.27	45%	16.3%	48%	13.6%
Gr. B_1	.39	.17	L .21	.06	29.6	6.17	12	2.4	1.71	.28	48%	19.3%	41%	16.8%
KW-values	25.78**		16.39**		22.26**		17.29**		11.34**		29.54**		32.13**	

Table–2
Summary of linear multiple regressions (when high level cricketers from Bangladesh were considered)

(Model *a*) Dep. Variable – Actual Performance	Unstandardized Coefficients		Standard Coefficients	t	Sig.
	B	Std. Error	Beta		
Intercept	10.888	1.492		7.298	.000
BAT (Visual anticipation)	-.131	.029	-0.334	-4.439	.000
MT (Movement Time)	-.080	.018	-0.375	-4.518	.000
RP (Visuo motor coordination)	.081	.010	0.608	7.825	.000
RT (Muscular reaction time)	-.096	.043	-0.185	-2.254	.028
Sc (basal skin conductance)	.265	.054	0.311	4.907	.000

[a](F (1, 09) = 22.500, p < 0.000)) Model R^2 = 40.2%.

In the table II (which was obtained from the high performing cricketers of Bangladesh) the model *a* however, was found to explain 40.2% of variance in changes in the extent of Actual Performance. Detailed analyses revealed that, high performance in actual competitive situations observed in the players were differentially predicted by various potential predictors, viz., sharp anticipation; faster reaction as well as movement timing; higher-order motor coordination and higher emotional stability indexed by autonomic skin conductance activity indices could explain as high as over 40% of extent of actual performance scores obtained by the high performer players of Bangladesh.

Similarly the model *b* (table III) which was conceived on high level cricketers from Malaysia, depicted that similar predictor variables could explain 34.1% of extent of Actual performance in them, in which faster reaction and movement performance; higher –order motor coordination, but delayed anticipation and relatively lower extent of emotional stability (indexed by skin conductance activity) emerged as potential predictors.

In tables 4 and 5, summary of linear multiple regressions predicting changes in the actual performance, which were conceived on the low performing players of Bangladesh as well as of Malaysia, are presented. Detailed analyses (model *c*) here revealed that, comparatively lower performance in actual competitive situations observed in the Bangladeshi players were differentially predicted by various potential predictors, viz., relatively delayed and inaccurate anticipation; relatively slower reaction as well as movement timing; lower-order motor coordination but higher- order emotional stability indexed by autonomic skin conductance activity indices could explain as high as over 48.2% of extent of actual performance scores obtained by the low performer players of Bangladesh (refer to the table – 4, model *c*).

Similarly significant model emerged for the model *d* (table 5) in which the low level cricketers from Malaysia were considered, and it could explain about 42.1% of changes in the extent of actual performance. Detailed analyses however implied that, observed low performance in actual competitive situations evident in the low performing players of Malaysia was differentially predicted by various potential predictors, viz., sharp anticipation but delayed reaction as well as movement timing; lower-order motor coordination and lower extent of emotional stability indexed by autonomic skin conductance activity indices could explain 42.1% of extent of actual performance scores obtained by these players of Malaysia.

In the table 6 (which was conceived on high level cricketers from both Bangladesh and Malaysia) the model *e* however, was found to explain as much as 76.9% of variance in changes in the extent of consistency in peak performance. Similarly in the model *f* which was conceived on low level cricketers from both Bangladesh and Malaysia reported that it could explain as much as 63.1% of variance in changes in the extent of consistency in peak performance.

Table–3
Summary of linear multiple regressions (when high level cricketers from Malaysia were considered)

Model *b:* Dep. Variable – Actual Performance	Unstandardized Coefficients		Standard Coefficients	t	Sig.
	B	Std. Error	Beta		
Intercept	10.258	1.417		6.225	.000
BAT (Visual anticipation)	1.370	.412	0.059	3.324	.001
MT (Movement Time)	-.098	.029	-0.364	-4.298	.000
RP (Visuo motor coordination)	.091	.010	0.639	8.255	.000
RT (Muscular reaction time)	-.098	.043	-0.235	-2.164	.027
Sc (basal skin conductance)	-.215	.057	-0.371	-3.521	.000

[b]$(F (2, 8) = 23.803, p < 0.000))$ Model $R^2 = 34.1\%$.

Table–4
Summary of linear multiple regressions (when low level cricketers from Bangladesh were considered)

Model *c*: Dep. Variable – Actual Performance	Unstandardized Coefficients		Standard Coefficients	t	Sig.
	B	Std. Error	Beta		
Intercept	10.888	1.436		8.273	.000
BAT (Visual anticipation)	-.191	.429	-0.365	-4.519	.000
MT (Movement Time)	-.980	.218	-0.485	-4.458	.000
RP (Visuo motor coordination)	.481	.070	0.708	7.825	.000
RT (Muscular reaction time)	-.396	.043	-0.565	-2.254	.028
Sc (basal skin conductance)	-.615	.088	-0.281	-3.717	.000

[c]$(F (1, 8) = 24.600, p < 0.000))$ Model $R^2 = 48.2\%$.

Table–5
Summary of linear multiple regressions (when low level cricketers from Malaysia were considered)

Model d: Dep. Variable – Actual Performance	Unstandardized Coefficients		Standard Coefficients	t	Sig.
	B	Std. Error	Beta		
Intercept	10.258	1.717		6.336	.000
BAT (Visual anticipation)	1.520	.812	0.115	3.694	.002
MT (Movement Time)	-.398	.089	-0.634	-4.258	.000
RP (Visuo motor coordination)	.291	.070	0.869	8.277	.000
RT (Muscular reaction time)	-.498	.093	-0.235	-2.964	.037
Sc (basal skin conductance)	.405	.157	0.371	2.580	.048

[d](F (2, 7) = 28.693, $p < 0.000$)) Model $R^2 = 42.1\%$.

Table–6
Summary of linear multiple regressions (when high level cricketers from both Bangladesh and Malaysia were considered)

Model e: Dep. Variable – Consistent Peak Performance	Unstandardized Coefficients		Standard Coefficients	t	Sig.
	B	Std. Error	Beta		
Intercept	10.596	1.753		6.045	.000
RP (Visuo motor coordination)	.331	.082	0.869	4.037	.000
Symmetry in coordination	1.360	.414	0.107	3.284	.002
Sc (basal skin conductance)	.200	.063	3.803	3.172	.003
MT (Movement Time)	-.143	.046	-6.397	-3.102	.004
Cortical Activation	1.170	.469	0.153	2.495	.046
RT (Muscular reaction time)	-2.861	.877	-6.841	-3.262	.002

[e](F (3, 17) = 26.573, $p < 0.000$)) Model $R^2 = 76.9\%$.

Table-7
Summary of linear multiple regressions (when low level cricketers from both Bangladesh and Malaysia were considered)

Model *f*: Dep. Variable – Consistent Peak Performance	Unstandardized Coefficients		Standard Coefficients	t	Sig.
	B	Std. Error	Beta		
Intercept	-7,295	1,682		-4.338	.000
Symmetry in coordination	1.254	.377	.512	3.324	.004
MT (Movement Time)	.539	.195	.414	2.757	.013
RP (Visuo motor coordination)	-.658	.153	-.317	-4.301	.000
Sc (basal skin conductance)	.009	.010	.335	.953	.353
RT (Muscular reaction time)	.067	.026	.447	2.533	.020

[f](F (2, 17) = 21.013, $p < 0.000$)) Model $R^2 = 63.1\%$.

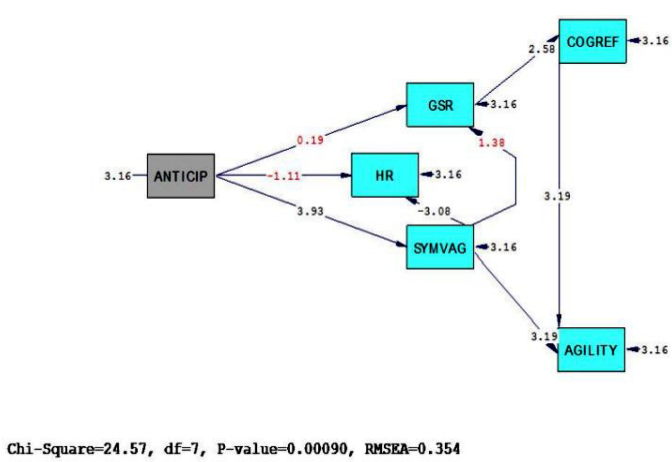

Figure-1

If we pay attention to the detailed analyses, it could reveal that consistency in peak performance observed in the high performer players of both of countries and low performers as well were differentially predicted by various potential predictors. Model ***e*** however clarified that consistent peak performance observed in the high performers, was aptly contributed by their higher-order visual-motor coordination; high extents of bilaterally symmetric coordination in movements; higher emotional stability indexed by autonomic skin conductance activity indices; faster movements as well as reaction timing and higher extent of cortical competence. Contrary to this finding, reports of model ***f*** revealed an altogether different picture since, they were observed to have higher-order visual-motor coordination and faster movements as well as reaction timing, but those were not supported by emotional stability and more importantly altogether asymmetric coordination in movements might have created major inhibiting impacts onto consistency in peak performance.

Findings of the present study could be explained in terms of the following graphic representation (own previous research – Saha et al.[2]) which examined the interrelationships between psychobiological and psychomotor variables in predicting performance excellence in cricket. Outcomes of this research would highlight on 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.

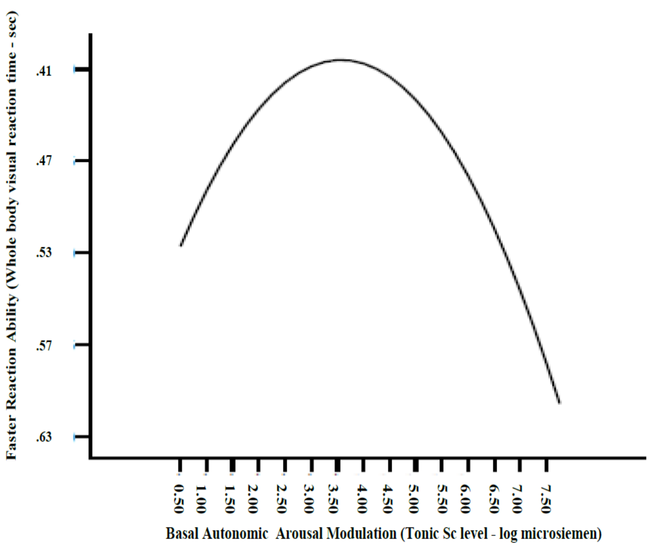

Figure-2
Relationship between whole body visual reaction time and autonomic arousal modulation capacity observed in the elite cricketers of Bangladesh national Team

Our previous researches[3] also evidentially clarified that, even amongst the high-performer cricketers of Bangladesh (who represented in the ICC World Cup Tournament 2011), those who were better capable of arousal modulation, were also susceptible to have faster WRT (whole-body reaction performance), in fact with the quadratic relationship, an altogether different characteristic feature was noted (Graphic representation was adapted from our previous work cited in Saha et al.[3]). Players with very low-level of basal autonomic regulation, probably because of their lower level of self-control [17], lower self-esteem[18] and due to their observed lack in their conflict management resources and ability[19] could display moderate level of WRT performance, and those with higher than the minimal level of arousal modulation, could perform WRT much better than their low-autonomic ability counterparts, while the fastest WRT performance scores were obtained by those who obtained lower than moderate level of group score in autonomic arousal modulation.

Observed negative relationship between the WRT and the quadratic–order autonomic arousal modulation capacity implied that improvement in arousal modulation was inversely related to reduction in WRT. This finding of negative impact though create an impression that the players, those who were better capable of arousal modulation, were also susceptible to have faster WRT, in fact with the quadratic relationship, an altogether different characteristic feature was noted. Players with very low-level of basal autonomic regulation could display moderate level of WRT performance, and those with higher than the minimal level of arousal modulation, could perform WRT much better than their low-autonomic ability counterparts, while the fastest WRT performance scores were obtained by those who obtained lower than moderate level of group score in autonomic arousal modulation[3].

Conclusion

Findings of the present study may be summarised as the followings: i. Perceptual discrimination related cortical activation has been observed as special competence of the high performing cricketers of both Bangladesh and Malaysia, which was observed to facilitate in peak performance only in the elite players. Actually this competence was observed as facilitating mainly in maintaining consistency in peak performance. ii. Accuracy in anticipation has been grossly observed to have indirect relationship with success in actual performance. Elite players of Bangladesh were only observed to have benefits of having accuracy in anticipation, and moreover they were observed to have faster anticipation compared to others. iii. Higher autonomic tonic arousal (electrodermal activity) has been observed as associated with actual performance and has also contributed in maintaining consistency in peak performance in Cricketers of Bangladesh only (irrespective of whether high or low performers. iv. Movement and motor coordination have been identified as the most significant predictor of peak performance in elite players of Bangladesh and Malaysia as well as for the low –performers of both of these countries. Furthermore, bilateral symmetry in movement coordination was observed to have vital contribution behind success in performance for the high performers of both of the contingents, while asymmetric coordination was found as significant confounding factor for observed inhibitive performance in the low-performers of both of contingents.

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