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SPECTATOR TENSION IN LIMITED OVERS CRICKET MATCHES

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ABSTRACT

Depending on their construction, cricket performance measures can be used to measure various aspects of a match. In this study the focus is on the emotions experienced by the supporters of the two teams in limited overs matches. During a cricket match the supporters of the teams often experience high levels of tension depending on how their team performs and on the match situation. In this study measures are proposed to assess the supposed level of tension of the supporters of the team batting in the second innings of the match, and also of the supporters of the bowling team. Criteria are defined to assess the effect of boundaries scored or wickets falling on the tension or frustration experienced by the supporters of the two teams. These effects increase in size as the match progresses, except in the case of the bowling team where the effect of wickets falling remains almost the same. The measures are particularly interesting in the case of closely contested matches where the outcome remains in the balance up to the end.

***Keywords*:** Cricket; Sports analytics; Team sports; Match supporters.

INTRODUCTION

Limited overs matches draw large numbers of spectators who come to support their teams. The team batting first tries to set the largest possible target for their opponents. The team's score depends on many factors and during the course of its batting it gradually becomes clear what the condition of the pitch is and finally whether the target the team sets will be easy or difficult to attain. When the second team starts to bat, the scene is set for the spectators of both teams to assess performance of their team.

The tension experienced by a spectator depends mainly on two factors, namely the progress that the batting team makes towards the target score, and the fall of wickets. The required run rate of the team batting second is obviously another very useful criterion to judge the progress of the team towards the target score and victory. It was the cornerstone of methods defined by Lemmer to measure choking (Lemmer, 2015a) and strangling (Lemmer, 2015b) and also to define pressure indices (Shah & Shah, 2014; Bhattacharjee & Lemmer, 2016).

In the present study, the focus is on the supporters of the two teams. The emotions they experience are similar to the pressure on the players, but can be very different because they can do nothing to improve the position of the team they support. The players on the field can adapt to the situation and try to alleviate pressure, but the spectators are powerless. Therefore, their emotions may be quite different from those of the players.

Bhattacharjee and Lemmer (2016) proposed various performance measures to assess the pressure experienced by the teams batting and bowling in the second innings of a limited overs match, namely a One-Day International (ODI) or a Twenty20 match. In the present study, the

focus is on the supporters of the two teams. The measures defined here are similar to those of Bhattacharjee and Lemmer (2016), but are specifically designed to address the tension experienced by the supporters of the two teams. It is shown that the effect of a six becomes larger during the course of the innings. During the initial part of the innings, it is slightly larger for the supporters of the bowling team than for the batting team, but smaller in the latter part of the innings. The effect of a wicket falling also increases the tension as the match progresses, but is much more severe in the case of the supporters of the batting team rather than the bowling team.

The emotions experienced by the serious supporters of a team can be described in many ways. According to the Macmillan Dictionary (2009-2016), 'tension' can be described as "the nervous feeling that you have when you are reading or watching something very exciting or frightening". From Dictionary.com Unabridged (2016), there are descriptions like "mental or emotional strain; intense, suppressed suspense, anxiety, or excitement" and "a situation or condition of hostility, suspense, or uneasiness". Many other descriptions pertaining to the emotions of spectators can be found, for example in Thesaurus.com (2009).

Supporter tension is obviously a phenomenon in the field of psychology and there are methods to measure it. A vast body of literature, using physiological approaches, tried to quantify the tension experienced by the spectators in different sports. Mention can be made of Yuza *et al*. (1996), Berthier and Boulay (2003), Baumhäkel *et al*. (2007), Kloner *et al*. (2009) and Zimmerman *et al*. (2010), who used physiological indicators like blood pressure, heart rate, etc. and attempted to quantify the excitement level of spectators in the case of table tennis, baseball and football matches. No attempt will be made to use such measures in this study. Instead, the study attempts to design indices based on the performance statistics of the match that can help to indicate the possible levels of tension.

PURPOSE OF RESEARCH

The objective of this research is to show how live cricket data can be used to assess a psychological phenomenon, namely the emotions experienced by the supporters of the two teams in limited overs matches, specifically in the case of closely contested matches where the outcome remained in the balance up to the end. The method applied here is an innovative approach based on the performance statistics of the match, which are used to design indices that can be utilised to indicate the possible levels of tension. Criteria are defined to assess the effect of boundaries scored or wickets taken. The results show that these effects increase in size as the match progresses, except when the supporters of the bowling team observe wickets falling. The percentage changes in the indices indicating the tension of the supporters of the batting and bowling teams serve as criteria.

METHODOLOGY

Bhattacharjee and Lemmer (2016), defined performance measures as assessing the pressure on the batting and bowling team in the second innings of limited overs matches. For the batting team, the pressure index was defined as

$$PI_3 = \left(\frac{CRRR}{IRRR}\right) \text{ x } \frac{1}{2}\left[\exp\left(RU/100\right) + \exp(\Sigma w_i/11)\right] \quad (1)$$

where *CRRR* denotes the current required run rate=6.*Rr/Br* with *Rr* the number of runs still required and *Br* the number of balls remaining, *IRRR* the initial required run rate, *RU* the percentage of resources used according to the Duckworth/Lewis (1998) system, $\sum w_i$ the sum of the weights of the wickets that had fallen at the specific stage of the innings, with $\{w_i\}$ the wicket weights of Lemmer (2005). In the case of the bowling team, the pressure index was defined as

$$BI = (1/CI) \text{ x } [(11 - \sum w_i)/11 + \exp(RU/100)]/2 \quad (2)$$

where

$$CI = CRRR/IRRR. \quad (3)$$

Full details of both (1) and (2) are given in Bhattacharjee and Lemmer (2016). For the present study, the progress of the batting team can be followed by using *CI*. Furthermore, *CRRR* and *IRRR* can be calculated per over or per ball, depending on the situation. If the value of *CI* tends to zero, the team is on its way to victory, provided that wickets do not fall too fast. Thus, the tension that the team's supporters experience is determined by the value of *CI* and by the extent to which the loss of wickets grows. When $\sum w_i$ increases it is an indication that the team's wicket strength is decreasing. Taking into account that the sum of all the wicket weights is equal to 11, the factor $AF=11/(11 - \sum w_i)$ can be used to indicate to what extent wickets that had fallen contribute to the tension. But the value of *AF* can vary between 1 and a maximum of 18.966 if batsmen numbers 10 and 11 are the last two at the crease. It is more realistic to use $(AF)^{½}$, which has a maximum value of 4.355. The *tension index* is defined as the measure indicating the tension experienced by the supporters of the batting team.

$$A = CI.(AF)^{½} = CI.[11/(11- \sum w_i)]^{½} \quad (4)$$

For the supporters of the bowling team, the situation is obviously different. If the value of *CI* decreases, the value of 1/*CI* increases, giving an indication of increasing tension experienced by the supporters of the bowling team. As wickets fall, this tension is diminished according to the way wickets fall. Now $SW=\sum w_i/11$ reflects how far the wicket strength has deteriorated. As in Bhattacharjee and Lemmer (2016), exp(*SW*) can be used to measure the effect of wickets falling and thus exp(-*SW*) to measure the increase in tension due to wickets falling. The maximum value is exp(*SW*)=2.579 if batsmen numbers 10 and 11 are the last two at the crease. The tension index for the supporters of the bowling team can be defined as

$$C = (1/CI).\exp(-SW) = 1/[CI.\exp(SW)]. \quad (5)$$

In the construction of the measures *A* and *C*, it was reasoned that the fall of a wicket had a larger impact on the feelings of the batting team than the bowling team supporters. When a wicket falls, the new batsman has to adapt to the batting conditions and the pressure on the other batsman increases. This creates more tension on the supporters of the batting team compared to the release in tension experienced by the supporters of the bowling team, who only count the number of wickets that are down. Therefore, $(AF)^{½}$ (with a maximum possible value of 4.355) was used in *A* and the more moderate measure exp(*SW*) (with maximum possible value of 2.579) in *C*. It is important to note that the indices *A* and *C* are not on the same scale and that their values are not directly comparable.

RESULTS

The use of the two indices is illustrated by using the results of the second Twenty20 match of Pakistan vs. Sri Lanka, played on 1 August 2015 in Colombo (Cricinfo, 2015).

Table 1. **BALL-BY-BALL VALUES OF TENSION INDICES OF SUPPORTERS OF TEAMS IN SECOND TWENTY20 MATCH BETWEEN PAKISTAN AND SRI LANKA: PAKISTAN BATTING SECOND**

Note: *Bn*=Ball number; *R*=Number of runs scored per ball; *Wd*=Number of the wicket that went down; *Rr*=Number of runs required for victory; *Br*=Number of balls remaining. Thus, *CRRR* = *Rr*/*Br*.

Bn	*R*	*CRRR*	Wd	$\sum w_i$	*CI*	*Rr*	*Br*	*A*	*%A*	*C*	*%C*
1	1	1.445		0	1.003	172	119	1.002		0.998	
2	0	1.458		0	1.011	172	118	1.011	0.900	0.989	-0.892
3	0	1.47		0	1.020	172	117	1.020	0.823	0.981	-0.816
4	4	1.448		0	1.005	168	116	1.004	-1.497	0.996	1.519
5	2	1.443		0	1.001	166	115	1.001	-0.345	0.999	0.347
6	0	1.456		0	1.010	166	114	1.010	0.901	0.990	-0.893
7	0	1.469		0	1.019	166	113	1.019	0.893	0.981	-0.885
8	0	1.482		0	1.028	166	112	1.028	0.885	0.973	-0.877
9	0	1.495		0	1.037	166	111	1.037	0.877	0.964	-0.870
10	2	1.491		0	1.034	164	110	1.034	-0.268	0.967	0.268
11	1	1.495		0	1.037	163	109	1.037	0.268	0.964	-0.268
12	1	1.500		0	1.040	162	108	1.040	0.334	0.961	-0.333
13	0	1.514		0	1.050	162	107	1.050	0.933	0.952	-0.925
14	0	1.528	2	1.35	1.060	162	106	1.132	7.753	0.835	-12.360
15	4	1.505		1.35	1.044	158	105	1.115	-1.505	0.847	1.528
16	1	1.510		1.35	1.047	157	104	1.118	0.332	0.844	-0.331
17	0	1.524	1	2.65	1.057	157	103	1.213	8.500	0.743	-11.963
18	1	1.529		2.65	1.061	156	102	1.217	0.328	0.741	-0.327
19	0	1.545		2.65	1.071	156	101	1.230	1.046	0.733	-1.036
20	0	1.560		2.65	1.082	156	100	1.242	0.971	0.726	-0.962
21	0	1.576		2.65	1.093	156	99	1.255	1.026	0.719	-1.015
22	0	1.592		2.65	1.104	156	98	1.267	1.015	0.712	-1.005
23	1	1.598		2.65	1.108	155	97	1.272	0.377	0.709	-0.375
24	1	1.604		2.65	1.113	154	96	1.277	0.375	0.706	-0.374
25	2	1.600		2.65	1.110	152	95	1.274	-0.249	0.708	0.250
26	1	1.606		2.65	1.114	151	94	1.279	0.375	0.706	-0.374
27	2	1.602		2.65	1.111	149	93	1.275	-0.249	0.707	0.250
28	1	1.609		2.65	1.116	148	92	1.281	0.437	0.704	-0.435
29	6	1.560		2.65	1.082	142	91	1.242	-3.045	0.726	3.141
30	1	1.567		2.65	1.087	141	90	1.248	0.449	0.723	-0.447

Continued

Bn	***R***	***CRRR***	**Wd**	$\sum w_i$	***CI***	***Rr***	***Br***	***A***	***%A***	***C***	***%C***
31	1	1.573		2.65	1.091	140	89	1.252	0.383	0.720	-0.381
32	0	1.591		2.65	1.104	140	88	1.267	1.144	0.712	-1.131
33	0	1.609	3	4.05	1.116	140	87	1.404	10.850	0.620	-12.936
34	1	1.616		4.05	1.121	139	86	1.410	0.435	0.617	-0.433
35	0	1.635		4.05	1.134	139	85	1.427	1.176	0.610	-1.162
36	0	1.655		4.05	1.148	139	84	1.444	1.223	0.603	-1.208
37	1	1.663		4.05	1.153	138	83	1.451	0.483	0.600	-0.481
38	3	1.646		4.05	1.142	135	82	1.436	-1.022	0.606	1.033
39	0	1.667		4.05	1.156	135	81	1.455	1.276	0.598	-1.260
40	1	1.675		4.05	1.162	134	80	1.462	0.480	0.596	-0.478
41	1	1.684	5	5.43	1.168	133	79	1.641	12.303	0.523	-12.262
42	0	1.705		5.43	1.183	133	78	1.662	1.247	0.516	-1.232
43	0	1.727		5.43	1.198	133	77	1.683	1.290	0.510	-1.274
44	0	1.750	4	6.88	1.214	133	76	1.983	17.822	0.441	-13.502
45	1	1.760		6.88	1.221	132	75	1.995	0.571	0.438	-0.568
46	1	1.770		6.88	1.228	131	74	2.006	0.568	0.436	-0.565
47	1	1.781		6.88	1.235	130	73	2.019	0.621	0.433	-0.618
48	1	1.792		6.88	1.243	129	72	2.031	0.618	0.430	-0.614
49	1	1.803		6.88	1.251	128	71	2.043	0.614	0.428	-0.610
50	1	1.814		6.88	1.258	127	70	2.056	0.610	0.425	-0.606
51	0	1.841		6.88	1.277	127	69	2.087	1.488	0.419	-1.467
52	1	1.853		6.88	1.285	126	68	2.100	0.652	0.416	-0.648
53	0	1.881		6.88	1.304	126	67	2.132	1.511	0.410	-1.489
54	1	1.894		6.88	1.314	125	66	2.147	0.691	0.407	-0.686
55	1	1.908		6.88	1.323	124	65	2.162	0.739	0.404	-0.734
56	1	1.922		6.88	1.333	123	64	2.178	0.734	0.401	-0.728
57	4	1.889		6.88	1.310	119	63	2.141	-1.717	0.408	1.747
58	6	1.823		6.88	1.264	113	62	2.066	-3.494	0.423	3.620
59	1	1.836		6.88	1.274	112	61	2.081	0.713	0.420	-0.708
60	0	1.867		6.88	1.295	112	60	2.116	1.688	0.413	-1.660
61	2	1.864		6.88	1.293	110	59	2.113	-0.161	0.414	0.161
62	6	1.793		6.88	1.244	104	58	2.032	-3.809	0.430	3.960
63	1	1.807		6.88	1.253	103	57	2.048	0.781	0.427	-0.775
64	1	1.821		6.88	1.263	102	56	2.064	0.775	0.424	-0.769

Continued

Bn	***R***	***CRRR***	**Wd**	$\sum w_i$	***CI***	***Rr***	***Br***	***A***	***%A***	***C***	***%C***
65	1	1.836		6.88	1.274	101	55	2.081	0.824	0.420	-0.817
66	1	1.852		6.88	1.285	100	54	2.099	0.871	0.416	-0.864
67	1	1.868		6.88	1.296	99	53	2.117	0.864	0.413	-0.857
68	6	1.788		6.88	1.241	93	52	2.026	-4.283	0.431	4.474
69	1	1.804		6.88	1.251	92	51	2.045	0.895	0.428	-0.887
70	1	1.820		6.88	1.262	91	50	2.063	0.887	0.424	-0.879
71	6	1.735		6.88	1.203	85	49	1.966	-4.670	0.445	4.899
72	0	1.771		6.88	1.228	85	48	2.007	2.075	0.436	-2.033
73	1	1.787		6.88	1.240	84	47	2.025	0.903	0.432	-0.895
74	2	1.783		6.88	1.236	82	46	2.021	-0.224	0.433	0.224
75	2	1.778		6.88	1.233	80	45	2.015	-0.280	0.434	0.281
76	1	1.795		6.88	1.245	79	44	2.034	0.956	0.430	-0.947
77	0	1.837		6.88	1.274	79	43	2.082	2.340	0.420	-2.286
78	1	1.857		6.88	1.288	78	42	2.105	1.089	0.415	-1.077
79	4	1.805		6.88	1.252	74	41	2.046	-2.800	0.427	2.881
80	1	1.825		6.88	1.266	73	40	2.068	1.108	0.423	-1.096
81	1	1.846	6	8.06	1.281	72	39	2.477	19.741	0.375	-11.194
82	1	1.868		8.06	1.296	71	38	2.506	1.192	0.371	-1.178
83	1	1.892		8.06	1.312	70	37	2.538	1.285	0.366	-1.268
84	4	1.833		8.06	1.272	66	36	2.459	-3.118	0.378	3.219
85	0	1.886	7	9.04	1.308	66	35	3.099	26.016	0.336	-11.094
86	2	1.882		9.04	1.306	64	34	3.093	-0.212	0.337	0.213
87	1	1.909		9.04	1.324	63	33	3.137	1.435	0.332	-1.414
88	0	1.969		9.04	1.366	63	32	3.235	3.143	0.322	-3.047
89	1	2.000		9.04	1.387	62	31	3.286	1.574	0.317	-1.550
90	2	2.000		9.04	1.387	60	30	3.286	0.000	0.317	0.000
91	4	1.931		9.04	1.339	56	29	3.173	-3.450	0.328	3.573
92	0	2.000		9.04	1.387	56	28	3.286	3.573	0.317	-3.450
93	0	2.074		9.04	1.439	56	27	3.408	3.700	0.306	-3.568
94	1	2.115		9.04	1.467	55	26	3.475	1.977	0.300	-1.939
95	1	2.160		9.04	1.498	54	25	3.549	2.128	0.293	-2.083
96	1	2.208		9.04	1.532	53	24	3.628	2.222	0.287	-2.174
97	1	2.261		9.04	1.568	52	23	3.715	2.400	0.280	-2.344
98	6	2.091		9.04	1.450	46	22	3.436	-7.519	0.303	8.130

Continued

Bn	***R***	***CRRR***	**Wd**	$\sum w_i$	***CI***	***Rr***	***Br***	***A***	***%A***	***C***	***%C***
99	1	2.143		9.04	1.486	45	21	3.521	2.487	0.296	-2.427
100	3	2.100		9.04	1.457	42	20	3.451	-2.007	0.302	2.048
101	6	1.895		9.04	1.314	36	19	3.114	-9.762	0.334	10.818
102	4	1.778		9.04	1.233	32	18	2.922	-6.174	0.356	6.580
103	1	1.824		9.04	1.265	31	17	2.997	2.587	0.347	-2.522
104	0	1.938		9.04	1.344	31	16	3.185	6.250	0.327	-5.882
105	6	1.667		9.04	1.156	25	15	2.739	-13.983	0.380	16.257
106	4	1.500		9.04	1.040	21	14	2.465	-10.018	0.423	11.133
107	0	1.615		9.04	1.120	21	13	2.654	7.667	0.392	-7.121
108	1	1.667		9.04	1.156	20	12	2.739	3.220	0.380	-3.119
109	6	1.273		9.04	0.883	14	11	2.092	-23.635	0.498	30.951
110	2	1.200		9.04	0.832	12	10	1.972	-5.734	0.528	6.083
111	4	0.889		9.04	0.617	8	9	1.461	-25.917	0.713	34.983
112	0	1.000	9	9.63	0.694	8	8	1.965	34.545	0.601	-15.743
113	1	1.000		9.63	0.694	7	7	1.965	0.000	0.601	0.000
114	1	1.000	10	10.00	0.694	6	6	2.324	18.235	0.580	-3.483
115	1	1.000		10.00	0.694	5	5	2.324	0.000	0.580	0.000
116	6	0		10.00	0.000	0	4	0.000		∞	

Note that the data used in this study was not obtained through random sampling but by utilising officially published cricket statistics. Only closely contested matches were considered. Sri Lanka batted first and scored 172 runs for the loss of 7 wickets. The target for Pakistan was therefore 173. They narrowly reached the target for the loss of 9 wickets, with only 4 balls to spare. The initial required run rate (*IRRR*) for Pakistan was 8.65 per over, or 1.442 per ball, which was quite high. The ball-by-ball values of the tension indices *A* and *C* are given in Table 1.

The contents of the table aid the reader in following the calculations. The value of CI indicates how well the batting team keeps up with the required run rate. A value of one indicates even performances between bat and ball as far as the scoring of runs is concerned. By combining CI with factors reflecting the effect of wickets falling, we arrive at the values of the performance measures A in (4) and C in (5).

In order to assess the effect of a wicket falling or runs scored from each ball, the most informative indicator is the percentage increase in the value of *A*, indicated by *%A* (or in *C*, indicated by *%C*). Thereby the present situation is taken into account and also the result produced by the next ball. Note that the value of *CI* generally increased from the first to the 56th ball, remained more or less the same until the 75th ball, then increased until the 97th ball and finally decreased to the end. After ball 28, the required run rate (per ball) was 1.609. From ball 29, a six was hit, so *CI* decreased from 1.116 to 1.082 because 6>1.609.

The value of *A* also decreased (from 1.281 to 1.242) between these two balls. The percentage increase in *A* due to this six, denoted by *%A*, was -3.045 (thus a decrease of 3.045%). The effect of sixes becomes larger as the match progresses, showing that the value of a six had increasingly larger effects on supporters' tension towards the end of the innings (Table 2). Early sixes are fine to observe by the supporters of the batting team, but scoring sixes may become crucial towards the end of the innings. The effect of wickets falling is obviously much larger than the effect of sixes being scored. Their effects also increase as the match progresses. As wicket number 4 fell from ball 44 the percentage increase in *A* was 17.822, as wicket number 7 fell from ball 85 the percentage increase in *A* was 26.016 and as wicket 9 fell from ball 112 it was 34.545.

***Table 2*. EFFECTS OF WICKETS FALLING AND OF SIXES SCORED**

Ball	**W down**	***%A***	***%C***		**B with six**	***%A***	***%C***
14	2	7.753	-12.360				
17	1	8.500	-11.963				
					29	-3.045	3.141
33	3	10.850	-12.936				
44	4	17.822	-13.502				
					58	-3.494	3.620
					62	-3.809	3.960
					68	-4.283	4.474
					71	-4.670	4.899
85	7	26.016	-11.094				
					98	-7.519	8.130
					101	-9.762	10.818
					105	-13.983	16.257
					109	-23.635	30.951
112	9	34.545	-15.743				

W=Wicket B=Ball

For the supporters of the bowling team the effect on their tension index, *C*, of a 'six' (or 'four') also increases dramatically as the match progresses, but the effect of wickets falling does not follow a similar pattern, as can be seen in the last column of Table 1. Through the factor *SW* it depends on which wicket had fallen, but towards the end the match situation features strongly (cf. ball 112). The tension diminished as wickets fell and the required run rate increased until the 97th ball, where after the tension suddenly increased.

CI reflects the progress of the batting team, showing that the team was generally under increasing pressure until the 97th ball, after which the scoring rate improved until the match was won. *CI* is part of *A* and *C* alike. Besides the trend of *CI* contained in both, the tension indices *A* and *C* are affected differently by the falling of wickets. A comparison between the percentage increases in *A* and *C* reveals the following: boundaries influence *C* more than *A*, which is due to the fact that if the number of runs scored per ball (or over) exceeds the required run rate, the percentage increase in *C* is larger than the percentage decrease in *A*. The effect of

wickets falling is interesting. If a wicket falls during the initial stages of the innings, the percentage increase in *A* is smaller than the percentage decrease in *C*, but during the later stages of the match the effect of wickets falling influences *A* more than *C*. This is intuitively very logical, because towards the end of its innings the team cannot afford to lose wickets.

By comparing the number of runs scored from a specific ball to the required run rate, or whether a wicket has fallen for each ball bowled, it is clear that *A* and *C* reflect the match situation as seen by the supporters of the two teams very realistically. This is clear from the results of the present study and from many other cases examined (cf. the practical applications section). It is important to mention that the indices *A* and *C* are not on the same scale and that their values are therefore not directly comparable. However, the percentage changes in *A* and *C* are much more informative than their absolute values.

In the construction of the indices *A* and *C*, the intention was to define measures that can reflect the tension experienced by the serious supporters of the two teams. It soon became clear that the indices should rather be interpreted in a wider sense, namely as measures reflecting the emotions, for example, the tension or the frustration experienced by the supporters. In cases where the progress of the batting team is either very good or very bad, there is very little tension for the supporters of the winning team, whereas the index of the supporters of the losing team can rather be interpreted as their level of frustration. When they realise that their team will definitely not win the match, their tension is replaced by frustration, or even anger. The more interesting cases are found when the outcome remains in the balance.

PRACTICAL APPLICATIONS

The tension indices have been studied in a variety of matches. The matches considered have been selected specifically from those where the result was dramatically uncertain towards the end. Consider the first Twenty20 match between South Africa and England on 19 February 2016. England scored 134 runs for 8 wickets and South Africa had to score 135 runs. In their 19th over South Africa lost two wickets and had to score 15 runs in the final over, with only three wickets in hand. They managed this dramatically with scores of 1, 4, 6, 0, 2 and 2 from the final ball. The details of their innings are provided in Table 3.

From the second up to the nineteenth over, South Africa batted too slowly and gradually fell back according to the required run rate *CRRR*. The value of *CI* increased to a value of 2.489 after the first ball of the twentieth over. The value of the index *A* also increased along with *CI* and was augmented by additional increments when wickets fell.

The highest value of *A* was 5.896, when the first ball of the final over produced only one run. South Africa then needed 14 runs from 5 balls, an almost impossible task. By scoring a four from the second ball their index *A* decreased by 10.71% (and *C* increased by 12%) and a six from the next ball had a dramatic effect. *A* decreased by 46.67% and *C* increased by a much higher 87.5%. Suddenly they only needed four runs from three balls, which they narrowly achieved by scoring 0, 2 and 2 from the last three balls.

The mentioned percentage changes indicate the sensitivity of the indices *A* and *C* towards the end of a match. The index *C* showed a gradual decrease in the tension of the bowling team's supporters as *CI* increased and wickets fell, except at the very end, where the match was over before they could realise what was going on.

***Table 3*. TENSION INDICES OF SUPPORTERS OF TEAMS IN FIRST TWENTY20 MATCH BETWEEN SOUTH AFRICA AND ENGLAND, FEBRUARY 2016: SOUTH AFRICA BATTING SECOND**

O	*R*	*CRRR*	*Rr*	*Br*	*Wd*	$\sum w_i$	*CI*	*A*	*%A*	*C*	*%C*
1	11	6.52	124	114		0	0.966	0.966		1.035	
2	3	6.72	121	108		0	0.996	0.996	3.067	1.004	-2.976
3	8	6.64	113	102		0	0.984	0.984	-1.190	1.017	1.205
4	9	6.50	104	96		0	0.963	0.963	-2.108	1.038	2.154
5	4	6.66	100	90	2	1.35	0.987	1.053	9.394	0.896	-13.674
6	0	7.14	100	84	1	2.65	1.058	1.214	15.251	0.743	-17.120
7	8	7.07	92	78		2.65	1.047	1.202	-0.980	0.750	0.990
8	7	7.08	85	72		2.65	1.049	1.204	0.141	0.749	-0.141
9	7	7.09	78	66		2.65	1.050	1.206	0.141	0.748	-0.141
10	4	7.40	74	60		2.65	1.096	1.258	4.372	0.717	-4.189
11	4	7.77	70	54		2.65	1.151	1.321	5.000	0.683	-4.762
12	9	7.62	61	48		2.65	1.129	1.296	-1.931	0.696	1.969
13	5	8.00	56	42	4	4.10	1.185	1.496	15.492	0.581	-16.513
14	4	8.66	52	36		4.10	1.283	1.620	8.250	0.537	-7.621
15	8	8.80	44	30		4.10	1.304	1.646	1.617	0.528	-1.591
16	7	9.25	37	24	3	5.50	1.370	1.938	17.734	0.443	-16.234
17	5	10.66	32	18		5.50	1.579	2.233	15.243	0.384	-13.227
18	11	10.50	21	12	5	6.88	1.556	2.542	13.806	0.344	-10.446
19	6	15.00	15	6	6, 7	9.04	2.222	5.264	107.120	0.198	-42.480
19.1	1	16.80	14	5		9.04	2.489	5.896	12.000	0.177	-10.714
19.2	4	15.00	10	4		9.04	2.222	5.264	-10.714	0.198	12.000
19.3	6	8.00	4	3		9.04	1.185	2.808	-46.667	0.371	87.500
19.4	0	12.00	4	2		9.04	1.778	4.212	50.000	0.247	-33.333
19.5	2	12.00	2	1		9.04	1.778	4.212	0.000	0.247	0.000
20	2		0	0				0.000		∞	

O= Over number *R*=Number of runs scored

In the fourth ODI between South Africa and England played at the Wanderers on 12 February 2016, England scored 262 all out. South Africa batted second and won the match narrowly by one wicket (Table 4) where, in order to save space, detail is given only from the 33rd over.

South Africa kept the required run rate reasonably under control, but lost wickets regularly until the 42nd over, with the result that the value of *A* crept up. In the 45th over 14 runs were scored and from there on the value of *A* decreased fast. The value of *C* was well under control until the 45th over, after which it increased fast. By comparing the runs required with the balls

remaining, it is clear why the four in over 45.3 had a much larger effect than the four from the previous ball. Similarly, the six in over 46.3 had a much larger effect than the six in over 45.1. These observations are in line with supporter experience.

Table 4. **TENSION INDICES OF SUPPORTERS OF TEAMS IN FOURTH ODI BETWEEN SOUTH AFRICA AND ENGLAND, FEBRUARY 2016: SOUTH AFRICA BATTING SECOND**

O	*R*	*CRRR*	*Rr*	*Br*	*Wd*	$\sum w_i$	*CI*	*A*	*%A*	*C*	*%C*
35.0	7	5.60	84	90		6.88	1.065	1.740	-1.408	0.503	1.429
36.0	5	5.64	79	84		6.88	1.072	1.752	0.714	0.499	-0.709
37.0	7	5.53	72	78		6.88	1.051	1.718	-1.950	0.509	1.989
38.0	3	5.75	69	72	6	8.06	1.093	2.114	23.089	0.440	-13.609
39.0	5	5.81	64	66		8.06	1.105	2.137	1.043	0.435	-1.033
40.0	5	5.90	59	60		8.06	1.122	2.170	1.549	0.428	-1.525
41.0	3	6.22	56	54	7	9.04	1.183	2.801	29.117	0.372	-13.230
42.0	6	6.25	50	48	9	9.63	1.188	3.367	20.187	0.351	-5.677
43.0	5	6.42	45	42		9.63	1.221	3.458	2.720	0.341	-2.648
44.0	8	6.16	37	36		9.63	1.171	3.318	-4.050	0.356	4.221
45.0	14	4.60	23	30		9.63	0.875	2.478	-25.325	0.476	33.913
45.1	6	3.52	17	29		9.63	0.669	1.895	-23.538	0.623	30.784
45.2	4	2.79	13	28		9.63	0.530	1.501	-20.798	0.787	26.260
45.3	4	2.00	9	27		9.63	0.380	1.077	-28.205	1.096	39.286
45.4	1	1.85	8	26		9.63	0.351	0.995	-7.692	1.187	8.333
45.5	0	1.92	8	25		9.63	0.365	1.034	4.000	1.142	-3.846
46.0	0	2.00	8	24		9.63	0.380	1.077	4.167	1.096	-4.000
46.1	0	2.09	8	23		9.63	0.397	1.124	4.348	1.050	-4.167
46.2	0	2.18	8	22		9.63	0.415	1.175	4.545	1.005	-4.348
46.3	6	0.57	2	21		9.63	0.109	0.308	-73.810	3.835	281.818
46.4	0	0.60	2	20		9.63	0.114	0.323	5.000	3.653	-4.762
46.5	1	0.32	1	19		9.63	0.060	0.170	-47.368	6.940	90.000
47.0	0	0.33	1	18		9.63	0.063	0.180	5.556	6.575	-5.263
47.1	0	0.35	1	17	8	10.42	0.067	0.292	62.731	5.779	-12.101
47.2	4	0.00	0	16		10.42	0.000	0.000		∞	

DISCUSSION

The indices A and C are calculated from the performance statistics of the match. By assuming that they reflect the tension experienced by the supporters of the teams, the conclusions arrived at are in accordance with one's own experience, after observing numerous matches which ended dramatically close. Factors like noise levels in the pavilions and the way spectators react

to happenings on the field, further strengthen the conclusions that although A and C are not psychological measures they seem to lead to very realistic conclusions about spectator tension. Psychologists interested in cricket are invited to examine how closely their measures would lead to the same conclusions and whether they agree that our measures do in fact indicate the levels of tension of the spectators fairly well.

The approach of using performance measures to assess spectator tension can also be used in some other sports like tennis, badminton, baseball, etc. Taking tennis as an example, the progress of a match can be followed by recording the results on a ball by ball basis. It remains for tennis experts to construct suitable performance measures reflecting the emotions of the supporters of the players.

The indices *A* and *C* are not on the same scale, but it is believed that the trend in each could give a good indication of the direction of the tension experienced by the team supporters. The most interesting aspects of this study lie in observing the abrupt changes in the indices when boundaries are scored or wickets are falling, as reflected in *%A* and *%C*, confirming that these criteria reflect the most important aspects of this study. A close look at the percentage increases *%A* and *%C*, during the final part of the innings, clearly shows the effect of boundaries being scored or wickets falling. These agree well with one's own experience of the emotions, especially during the last part of a match. When runs are scored and a wicket falls in the same over, the joint effect of both determines the percentage change. For a study of the effect of each of these separately, it is necessary to look at ball-by-ball cases where either runs are scored or a wicket falls.

CONCLUSION

The results of this study give useful information regarding supporter emotions due to runs scored and wickets taken during the different phases of matches. These can also help captains and players alike in planning their playing strategies during the different phases of a match.

Another important issue of this study is perhaps to identify the cricketers who have increased the tension on the supporters of the opposing team as and when they perform. Such cricketers are a matter of concern for their opponents and for the supporters of the opposing team. These players remain in focus on the field and attract large numbers of supporters. Such popular cricketers are of interest to advertising agencies, as the products promoted by them should appeal to their fans. By computing players' average values of *%A* (or *%C*) on a ball-by-ball basis for a series of matches, the most exciting players of a team can be identified. This might well prove to be an interesting finding for marketers, as they can now identify players for marketing their products.

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