The Use of Game-Based Training to Provide a Match-Specific Environment for Cricket Players

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Statement of Originality

The thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. I give consent to the final version of my thesis being made available worldwide when deposited in the University’s Digital Repository, subject to the provisions of the Copyright Act 1968.

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Acknowledgement of Collaboration

I hereby certify that the work embodied in this thesis has been done in collaboration with other researchers, or carried out in other institutions. I have included as part of the thesis a statement clearly outlining the extent of the collaboration, with whom and under what auspices.

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We, Ben Dascombe and Rob Duffield attest that the research completed within this thesis by the candidate William Vickery, was completed in collaboration with the following organisations:

- University of Technology, Sydney
- Australian Institute of Sport, Canberra
- Cricket Australia, Albion

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Supervisor: Ben Dascombe (PhD)  Date Signed

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Supervisor: Rob Duffield (PhD)  Date Signed
Acknowledgement of Authorship

I hereby certify that the work embodied in this thesis contains published papers of which I am a joint author. I have included as part of the thesis a written statement, endorsed by my supervisors, attesting to my contribution to the joint publications.

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We, Ben Dascombe and Rob Duffield attest that Research Higher Degree candidate William Vickery was a contributor to the conception, design, writing and revision of the previously mentioned publications.

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Abstract

Cricket coaches have historically relied on isolated training practices such as net-based sessions and centre-wicket (CW) simulations to develop match-specific skills. However, such training modes may lack skill-specific application or be of insufficient intensity compared to a match. Recently, a small-sided games (SSG) approach has been designed for cricket (termed Battlezone [BZ]); to concurrently develop the conditioning profile and technical abilities of players. This thesis examined the physiological, physical and technical demands of cricket players during various cricket training formats and match-play. The application of game-based training within the sport of cricket, particularly BZ, may provide a unique training environment for improving a player's conditioning and skill profile which can be transferred into match-play.

In recent times, the physical demands of athletes have been quantified using individual global positioning system (GPS) devices. In order to complete the current research, the accuracy of the GPS devices used to quantify physical demands were examined. Two male participants (age: 25.5 ± 0.7 yr; height: 1.75 ± 0.01 m; body mass: 74.0 ± 5.7 kg) completed ten repetitions of drills replicating movements of cricket activities (as well as tennis and field-based sports), whilst wearing two 5, 10 (MinimaxX) and 15 (GPSports) Hz GPS devices. The GPS devices were compared to a 22-camera VICON system. No significant differences were reported ($p > 0.05$) between the GPS devices and VICON system for the majority of distance and speed measures. The results also showed no improvements in accuracy with increases in the sampling rate.
of the GPS devices when compared to VICON ($p > 0.05$). The co-efficient of variation (CV) for the 5 and 15 Hz devices for distance and speed measures ranged between 3-33%, with increasing variability evident in higher speed zones. When examining the reliability of the devices, a low level of inter-unit reliability ($r = -0.35–0.39$) was reported for the majority of measures. Based on these results, the GPS devices demonstrated a low to moderate level of inter-unit reliability for distance and speed measures during high-speed straight line running, multi-direction movement patterns and unstructured movements.

By applying the results demonstrated in the previous study, Study 2 compared the physiological, physical and technical demands of elite cricket players during traditional cricket training (TCT) sessions (net sessions and fielding drills) ($n = 26$), CW simulations ($n = 5$) and One-Day (OD) matches ($n = 5$). During all training and match-play, heart rate (HR), movement patterns and rating of perceived exertion (RPE) were recorded from 42 cricket players (age: $23 \pm 4$ yr, height: $1.86 \pm 0.07$ m, body mass: $85.8 \pm 8.5$ kg). Quantification of technical skill involvements was performed via post hoc video analysis. Medium-fast bowlers demonstrated similar physiological (mean HR [HR$_{\text{mean}}$]: $148 \pm 16$ b·min$^{-1}$; $148 \pm 9$ b·min$^{-1}$) and physical (mean speed: $82 \pm 13$ m·min$^{-1}$; $77 \pm 28$ m·min$^{-1}$) responses during the TCT and OD matches, respectively. By comparison, CW simulations were characterised by a decreased physiological (HR$_{\text{mean}}$: $129 \pm 17$ b·min$^{-1}$) and physical (mean speed: $64 \pm 13$ m·min$^{-1}$) intensity. Batsmen were placed under greater physiological and physical demands from OD matches when compared to either TCT or CW training format. Further, a higher HR$_{\text{mean}}$ (TCT: $137 \pm 14$ b·min$^{-1}$; CW simulations: $148 \pm 12$ b·min$^{-1}$; OD match: $152 \pm 13$
b\text{min}^{-1})\text{ and mean speed (TCT: }25 \pm 6 \text{ m}\text{min}^{-1};\text{ CW simulations: }38 \pm 5 \text{ b}\text{min}^{-1};\text{ OD matches: }54 \pm 45 \text{ m}\text{min}^{-1})\text{ were associated with CW simulation training compared to TCT. Irrespective of playing position, technical demand was greatest during TCT compared to matches or CW simulations. Collectively, this evidence suggests that neither training modality consistently provided players with a training stimulus that replicated a match. Importantly, the use of CW simulations may be limited in the transfer of match-specific skills and tactical strategies due to the lower physical and physiological intensities when compared to match-play.

Given the findings of Study 2, Study 3 examined the movement demands and physiological responses of BZ, and determined its inter-session reproducibility. Unlike CW simulations whereby players trained using the entire space of a cricket field, BZ enclosed players within the inner circle of a typical cricket field using netting. Thirteen male, amateur cricket players (age: 22.8 \pm 3.5 yr, height: 1.78 \pm 0.06 m, body mass: 78.6 \pm 7.1 kg) completed two separate BZ sessions during which HR, movement patterns, blood lactate concentration ([BLa⁻]) and RPE were recorded. During a BZ session, batsmen reported the greatest physical demand (mean speed: 63 \pm 9 \text{ m}\text{min}^{-1}), followed by medium-fast bowlers (60 \pm 10 \text{ m}\text{min}^{-1}). Regardless of playing position, the majority of time (79-90\%) was spent between 51-85\% of maximum heart rate (HR_{max}) and [BLa⁻] between 1.1-2.0 \text{ mmol-L}^{-1}. Ratings of perceived exertion ranged between 4.2-6.0. The movement demands and physiological responses of players, did not differ between sessions (p > 0.05), irrespective of playing position. Mean speed (CV: 7-9\%; Intra-class correlation [ICC]: 0.56-1.00) and peak %HR_{max} achieved
(CV: 6-8%; ICC: -0.80-0.73) demonstrated acceptable reliability across each playing position. Thus, the use of BZ as a training method may be suitable for replicating match demands. Furthermore, the results also suggest that the training stimulus provided through BZ is consistent.

Study 4 compared the physiological, physical and technical demands of cricket players between BZ, TCT and OD matches. Eleven amateur, male cricket players (age: 22.2 ± 3.3 yr, height: 1.82 ± 0.06 m, body mass: 80.4 ± 9.8 kg) completed four BZ and four TCT sessions whilst measures of HR, [BLa], RPE and movement patterns of players were collected. The involvements of technical skill of each player were quantified by post hoc video analysis. Following this, similar measures were collected from 42 amateur, male cricket players (23.5 ± 4.7 yr, 1.81 ± 0.07 m, 81.4 ± 11.4 kg) during ten OD matches. Batsmen performed with the greatest HR_{mean} (164 ± 12 b·min⁻¹) during BZ, likely due to the greater relative distance covered at a high-intensity (HI) (21 ± 7 m·min⁻¹). The greatest technical demand (number of [#] balls faced: 6 ± 1 balls·min⁻¹, # balls hit: 4 ± 1 balls·min⁻¹, % good contact shots: 82 ± 7%) for batsmen was observed during TCT. Similarly within other playing positions, a greater HR_{mean} was reported during BZ in comparison to TCT and OD matches regardless of playing position. Therefore, across each of the different playing positions the physiological, physical and technical demands of BZ and TCT replicate or exceed the relative demands of a OD match in amateur players.

Finally, Study 5 examined the influence of modifying the constraints associated with the BZ training environment. Eleven male, cricket players (22.2 ± 3.6 yr;
performed four modified scenarios of BZ which included a reduction in field size, the removal of a fielder, a combination of these two modifications and the inclusion of new playing rules. As with previous studies, each player’s HR, [BLa], RPE and movement patterns were measured during each BZ scenario. Between the different scenarios, the greatest HR response and [BLa] resulted from the changes in playing rules, which resulted from the increased movement demands (mean speed, HI activity) of this scenario ($p < 0.05$), most notably for batsmen ($HR_{\text{mean}}: 158 \pm 17 \, \text{b.min}^{-1}$, mean speed: $67 \pm 7 \, \text{m.min}^{-1}$) and wicketkeepers ($HR_{\text{mean}}: 145 \pm 9 \, \text{b.min}^{-1}$, mean speed: $37 \pm 10 \, \text{m.min}^{-1}$). By comparison, manipulating the size of the BZ playing field or the number of fielders present did not appear to significantly influence ($p > 0.05$) the physical demands or physiological responses of players. As such, the manipulation of BZ constraints can help to provide a range of match-specific training environments.

Collectively, these findings demonstrate the advantages of using BZ as a cricket training format as opposed to game-based CW simulations. Overall, the physiological, physical and technical demands of BZ appear similar to or exceed that of a OD match as well as the more traditional forms of cricket training. This demonstrates that BZ can provide a sufficient match-appropriate training load (TL). Importantly, BZ demonstrated an acceptable level of reliability between training sessions, suggesting that a consistent TL can be applied. Furthermore, manipulating BZ constraints can vary the training response to provide variation to help develop different aspects of a cricket player’s game, such as technical skill or conditioning status.
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List of Abbreviations and Nomenclature

\( p \)  \quad \text{Alpha}

ANOVA  \quad \text{Analysis of variance}

AU  \quad \text{Arbitrary unit}

balls min\(^{-1}\)  \quad \text{Balls per minute}

BATEX  \quad \text{Batting exercise}

b min\(^{-1}\)  \quad \text{Beats per minute}

[BLa\( \text{\textsuperscript{-}} \)]  \quad \text{Blood lactate concentration}

BZ  \quad \text{Battlezone}

cm  \quad \text{Centimetre}

COD  \quad \text{Changes of direction}

CR-10  \quad \text{Category ratio 10 scale}

r  \quad \text{Coefficient of correlation}

CV  \quad \text{Coefficient of variation}

CW  \quad \text{Centre-wicket}

\degree  \quad \text{Degree}

\degree \text{C}  \quad \text{Degrees Celsius}

d  \quad \text{Cohen's effect size}

FBTS  \quad \text{Field-based team sports}

GPS  \quad \text{Global positioning system}

>  \quad \text{Greater than}

HDOP  \quad \text{Horizontal dilution of position}

HR  \quad \text{Heart rate}

HR\(_{\text{max}}\)  \quad \text{Maximum heart rate}

\%HR\(_{\text{max}}\)  \quad \text{Mean heart rate as a percentage of maximum heart rate}

HR\(_{\text{mean}}\)  \quad \text{Mean heart rate}

HI  \quad \text{High-intensity}

Hz  \quad \text{Hertz}

ICC  \quad \text{Intra-class correlation}
kg Kilogram/s
km Kilometre/s
km·h\(^{-1}\) Kilometres per hour
< Less than
L·min\(^{-1}\) Litres per minute
LI Low-intensity
m Metre/s
m·h\(^{-1}\) Metres per hour
m·min\(^{-1}\) Metres per minute
m·s\(^{-1}\) Meters per second
µL Microlitre
ml·kg\(^{-1}\)·min\(^{-1}\) Millilitres per kilogram per minute
mmol·L\(^{-1}\) Millimole per litre
min Minute
n Number
# Number of
OD One-Day
% Percent
·h\(^{-1}\) Per hour
RPE Rating of perceived exertion
s Second/s
SD Standard deviation of the mean
SSG Small-sided games
TCT Traditional cricket training
TL Training Load
T20 Twenty20
TE% Typical error as a percentage of the mean
\(\dot{V}O_2\) Oxygen consumption
\(\dot{V}O_{2\text{max}}\) Maximal aerobic capacity
yd Yard
yr Year/s
List of Publications Arising from this Thesis

Peer Reviewed Articles


**Conference Proceedings**

