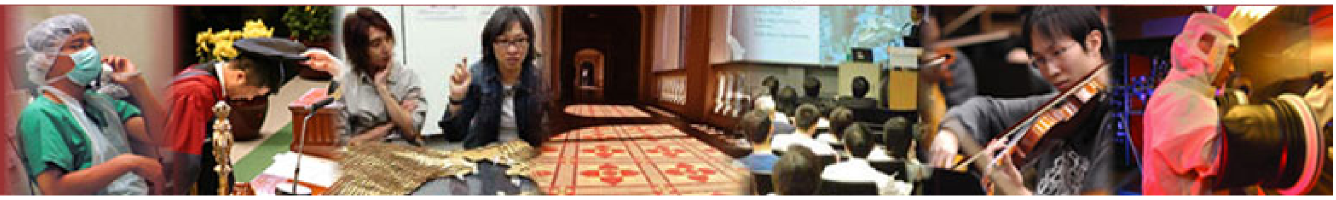

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INCREASING DIFFICULTY BUT NOT DECREASING PERFORMANCE – MAINTAINED INTERCEPTION WITH INCREMENTS IN VISUAL BLUR

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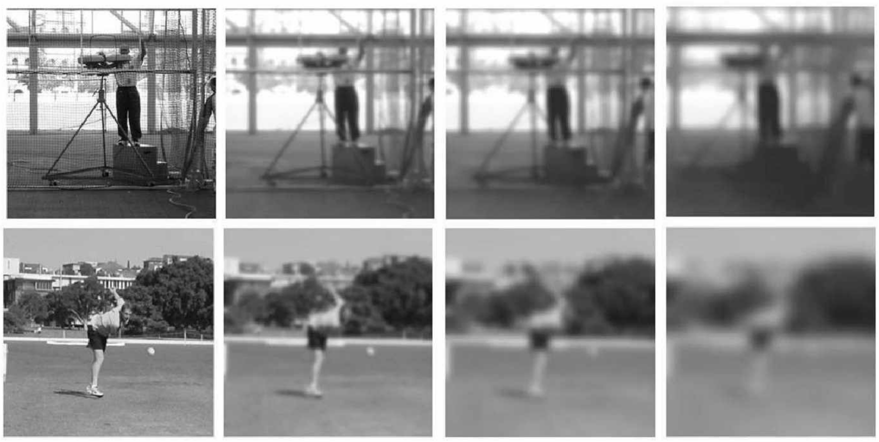
Introduction
In an earlier study on the relationship between visual blur and interceptive skill (Mann, Ho, De Souza, Watson, & Taylor, 2007) it was observed that interceptive performance can be maintained despite the introduction of significant refractive visual blur. Mann et al. found that contact lenses simulating legally-blind levels of short-sightedness were required (6/60 or 20/200 acuity) before any subjectively assessed decrease in skilled performance could be measured when intercepting balls pitched by a projection machine in the sport of cricket. Several of the participants reported a preference for taking part with low levels of visual blur as a means of focussing concentration and visual attention, raising the possibility that rather than decreasing performance, training with blurred vision may provide an opportunity to enhance skill acquisition. The aim of this study was to extend the protocol of Mann et al. by concurrently obtaining a more objective assessment of interceptive ability, plus participant ratings of task difficulty and performance whilst facing balls pitched i). by a projection machine ii). in-situ by bowlers across two different ball speeds.

Methods
Eleven skilled male cricket batters gave informed consent according to institutional guidelines prior to taking part in the study. Their task was to intercept projected balls across four different visual conditions. Contact lenses were fitted to participants' eyes to produce counterbalanced plano, +1.00, +2.00 and +3.00 visual conditions representing increasing levels of blur (Figure 1).

i).

ii).



Plano	+1.00	+2.00	+3.00
(6/6)	(6/15)	(6/40)	(6/60)

Figure 1. Simulated image of i). projection machine, and ii). in-situ bowler under four visual conditions of increasing levels of blur. Fraction in brackets indicates visual acuity resultant of such a condition.

Participants were required to intercept balls in an aggressive manner according to contextual game information facing 24 trials in each visual condition from i). a ball projection machine ('Medium pace' ball speed 100-115 km/hr), and ii). three in-situ cricket bowlers (ball speed; Bowler A 'Fast pace' 120-130 km/hr, Bowlers B & C 'Medium pace' 100-115 km/hr). Both the projection machine and in-situ bowlers followed a script of five different ball trajectories counterbalanced across trials. Interceptive performance was scored for each trial by a composite measure of quality of bat-ball contact, aggressiveness of bat-ball contact, and likelihood of dismissal, with an average taken across trials to provide a score for each condition. Participants self-rated the task difficulty and their interceptive performance for each condition on continuous Likert-style rating scales.

A 2 (Projection type; projection machine, in-situ bowler) x 4 (Visual condition; plano, +1.00, +2.00, +3.00) ANOVA was used to examine for changes in performance for those trials of comparable 'medium pace' speed. To compare performance across ball speeds a 2 (Ball speed; medium pace, fast pace) x 4 (Visual condition; plano, +1.00, +2.00, +3.00) ANOVA was used for all trials in the in-situ bowler condition. Separate 2 (Projection type; projection machine, in-situ bowler) x 4 (Visual condition; plano, +1.00, +2.00, +3.00) ANOVAs were used to examine for changes in self-ratings of task difficulty and performance.

Results

Across comparable ball speeds, projection type did not influence performance across visual conditions, with similar response patterns occurring for the ball projection and in-situ bowler conditions (Figure 2). A main effect for visual condition occurred with a significant decrement in performance occurring at the +3.00 condition ($F(3,30) = 20.122$, $p < .001$, $\eta_p^2 = .49$) for both the ball projection ($p < .001$) and in-situ bowler conditions ($p < .001$). When comparing the two ball speeds presented for the in-situ bowler condition, a significant interaction occurred between ball speed and visual condition ($F(3,30) = 9.08$, $p < .01$, $\eta_p^2 = .40$; Figure 3), with performance decreasing in the +2.00 condition for fast pace ($p < .05$) and the +3.00 condition for the medium pace trials ($p < .001$).

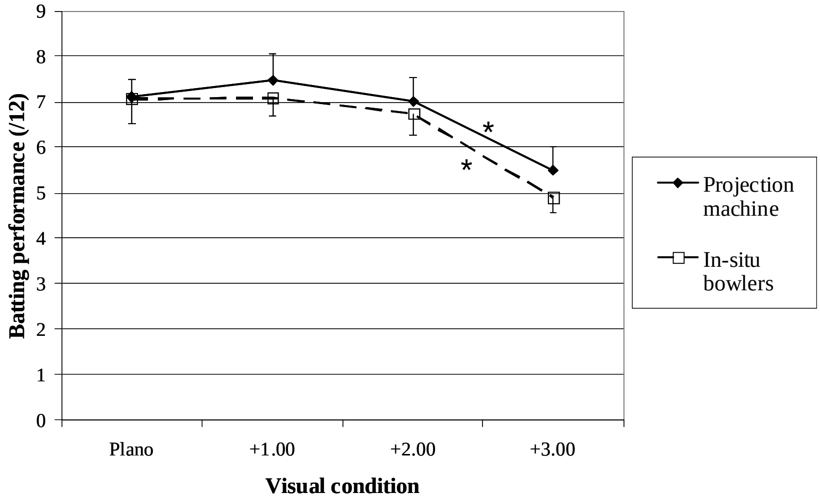


Figure 2. Batting performance across visual conditions when facing the projection machine and in-situ bowlers. Error bars indicate SE. * p < .001.

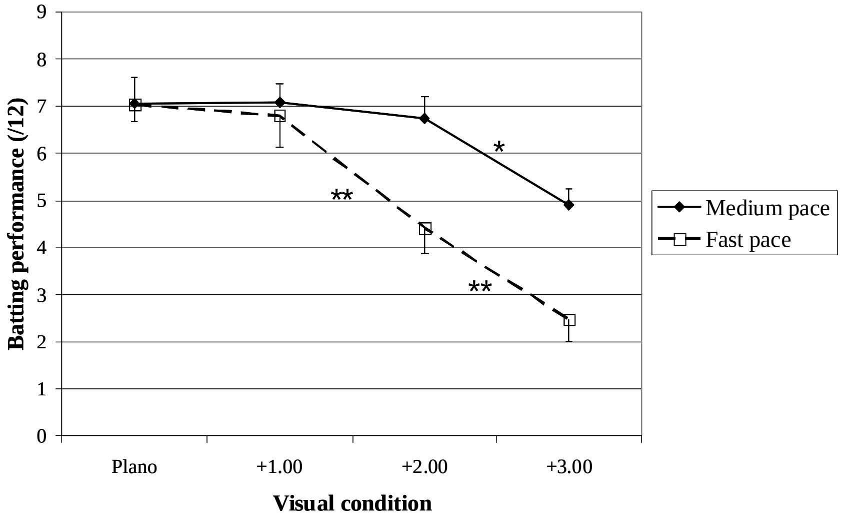


Figure 3. Batting performance across visual conditions when facing medium pace and fast pace in-situ bowlers. Error bars indicate SE. * p < .05, ** p < .001.

Participant self ratings of task difficulty demonstrated no main effect across projection conditions (Figure 4i), and no interaction between projection and visual conditions. A main effect occurred for visual condition ($F(3,30) = 24.21$, $p < .001$, $n_p^2 = .71$), exhibiting a linear relationship between visual blur and task difficulty. Significant increases in difficulty were found for the +1.00 to +2.00 ($p < .01$), and +2.00 to +3.00 comparisons ($p < .01$). Self ratings of task performance again demonstrated no main effect across projection condition or interaction between projection and visual condition (Figure 4ii). A main effect occurred for visual condition ($F(3,30) = 15.71$, $p < .001$, $n_p^2 = .61$) due primarily to a significant decrease in rated performance from the +2.00 to +3.00 visual condition ($p < .001$).

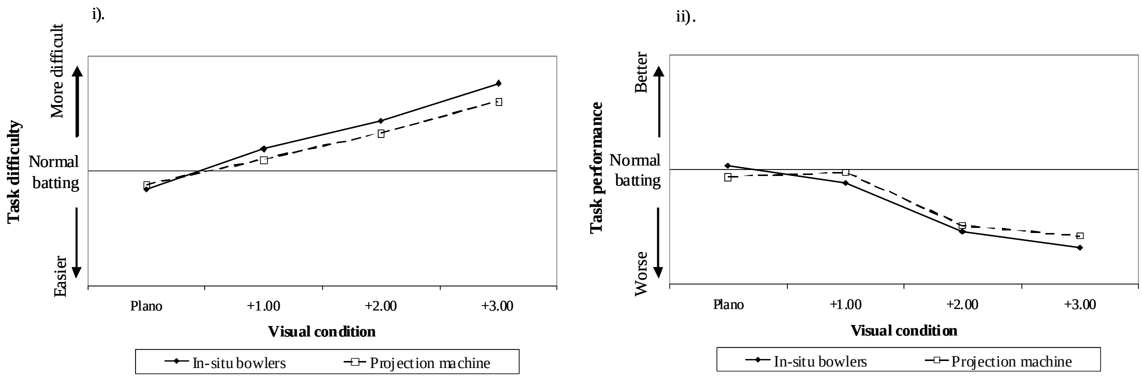


Figure 4. Self-ratings of i). task difficulty, and ii). task performance for both projection conditions across all four visual conditions.

Discussion

This study has both replicated and extended previous findings on the effects of visual blur on sporting performance. Interceptive performance when facing a projection machine was maintained until visual blur reached levels simulating legal blindness (+3.00), replicating the findings of Mann et al and supporting those found in more static aiming tasks such as golf (Bulson, Ciuffreda, & Hung, 2008) and basketball (Applegate & Applegate, 1992). A similar response was found for interceptive performance when facing in-situ bowlers despite the addition of advance kinematic information known to be an important component of expertise (Abernethy & Russell, 1987; Shim, Carlton, Chow, & Chae, 2005). This finding may be a reflection of the slower ball speeds (100-115 km/hr) presented in such trials. When facing an in-situ bowler of increased speed (120-130 km/hr), a decrement in performance was apparent with a lower level of visual blur, most likely reflecting the reliance on earlier ball-flight or kinematic information not immediately apparent when experiencing higher levels of visual blur.
The linear relationship between visual blur and self-rated task difficulty was not mirrored by decrements in performance, with both self and observer ratings of performance maintained until at least the +2.00 visual condition. As the progressive introduction of low levels of blurring increases subjective assessment of task difficulty without impairing performance, it may offer potential as a novel but safe training tool to increase training load. In addition, visual blur may prove in the future to aid in modifying attentional behaviour, guiding awareness towards the ball and encouraging an external focus of attention thought to be beneficial for skilled performers (Beilock, Carr, MacMahon, & Starkes, 2002).

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