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ARTICLE

The Influence of Restricted Visual Feedback on Dribbling Performance in Youth Soccer Players

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The aim of the current study was to examine the influence of restricted visual feedback using stroboscopic eyewear on the dribbling performance of youth soccer players. Three dribble test conditions were used in a within-subjects design to measure the effect of restricted visual feedback on soccer dribbling performance in 189 youth soccer players (age: 10–18 y) classified as fast, average or slow dribblers. The results showed that limiting visual feedback increased dribble test times across all abilities. Furthermore, the largest performance decrement between stroboscopic and full vision conditions was in fast dribblers, showing that fast dribblers were most affected by reduced visual information. This may be due to a greater dependency on visual feedback at increased speeds, which may limit the ability to maintain continuous control of the ball. These findings may have important implications for the development of soccer dribbling ability.

Keywords: development, feedback, occlusion, stroboscopic vision, football

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Sensory systems augment the performance of motor skills by providing auditory, visual, proprioceptive and tactile information to the performer. The most prominent source of sensory information required during complex, sport specific skills is visual feedback (Abernethy, Farrow, Gorman, & Mann, 2012; Williams, Davids, & Williams, 1999). Indeed, occlusion studies—which limit visual afferent information during motor tasks—have shown poorer performance in complex skills such as ball catching (Tijtgat, Bennett, Savelsbergh, De Clercq, & Lenoir, 2010) and tennis ground strokes (Ward, Williams, & Bennett, 2002) when visual feedback is removed or obscured. While these studies have provided valuable information about the role of restricted visual feedback on motor skill performance in controlled environments, less is understood about its role in complex, fast-paced motor tasks which are more specific to many sports. Accordingly, many previous studies have been limited in their ecological validity to sport (Van der Kamp, Rivas, & Van Doorn, 2008), as most have been conducted in well controlled laboratory settings with image/video-based temporal (Farrow, Abernethy, & Jackson, 2005) or spatial (Muller, Abernethy, & Farrow, 2006) occlusion using physical screens (Panchuk & Vickers, 2009) or visual occlusion goggles (Abernethy, Gill, Parks, & Packer, 2001).

The role of visual feedback during continuous skills is to facilitate a ‘closed feedback loop’ (Magill & Anderson, 2010)—where feedback is used to identify and correct deviations from the desired outcome. For example, during a task such as soccer dribbling, the position of the ball must be continuously tracked relative to environmental obstacles. In these fast-paced movements, it may be difficult for players to maintain an interaction with the moving ball to anticipate its future position during visual occlusion. Furthermore, if the speed of movement is increased, which is the case for highly skilled dribblers, the spatio-temporal characteristics of the motion of the occluded ball may be more difficult to predict, as the distance between the ball’s initial position and the final anticipated position is increased (Bennett, Baures, Hecht, & Benguigui, 2010). Bennett and colleagues (2010) observed this phenomenon during a visual-tracking task, with subjects underestimating time to contact when tracking a fast moving object. However, the prediction of object motion under restricted visual feedback has not yet been investigated in asport specific task with a nonlinear trajectory, such as soccer dribbling.

The ability to perform highly specific, fast-paced sport movements may also depend on the amount of visual feedback that is available during practice. Early research by Proteau and colleagues (1992) investigated the specificity of practice hypothesis suggesting that learners are highly dependent on the sources of feedback present during the initial stages of motor learning. For example, when visual feedback was removed after 2000 trials of an aiming task, movement accuracy was reduced (Proteau & Marteniuk, 1993). Similarly, Tremblay and Proteau (1998) demonstrated that power lifters who practiced a squat using a mirror were not able to produce the same movement in the absence of visual feedback. However, as these studies investigated the specificity of practice in highly controlled research settings they possess limited external validity. Therefore, it is important to consider this hypothesis with reference to highly specific, fast-paced sport movements within their normal performance environment.

The aim of the current study is to examine the influence of restricted visual feedback on the dribbling performance of youth soccer players. According to the specificity of practice hypothesis, it is expected that dribbling ability will be poorer when visual information is restricted. Further, it is hypothesized that when visual feedback is limited, participants with faster dribbling times will display the greatest decrement in performance as they will have less time to anticipate the future position of the ball.

Methods

Participants

189 youth soccer players aged between 10–18 years were recruited from two Belgian high level football teams. Participants were divided into three groups of fast (n = 64, age = 13.5 ± 2.4 y), average (n = 63, age = 13.7 ± 2.3 y) and slow (n = 62, age = 13.9 ± 2.5 y) dribblers. Before the commencement of this study, written consent was obtained from all participants and their parent(s) or guardian(s). The Ghent University Hospital ethics committee approved all experimental procedures.

Materials and Procedure

Soccer dribbling ability was assessed using the Ghent University Dribbling Test (dribble test) according to the procedures described by Vandendriessche et al. (2012). Following familiarization with the dribbling course (run through course without the ball), participants performed three assessment trials of the dribble test under different visual feedback conditions in a randomized order. During all trials, participants performed the dribble test on a course trajectory outlined on a purposefully designed mat (Figure 1). At all times, players who were not able to keep control of the ball (ball crossing a border of 2 m away from the course trajectory) received a warning and were allowed to start over. Two observers measured the time (0.01 s) from start to finish with a handheld stopwatch and the average time of both times was recorded. The Ghent University Dribbling Test has been found reliable in a sample of 40 adolescent soccer players (ICC =0.81) by Vandendriessche et al. (2012).

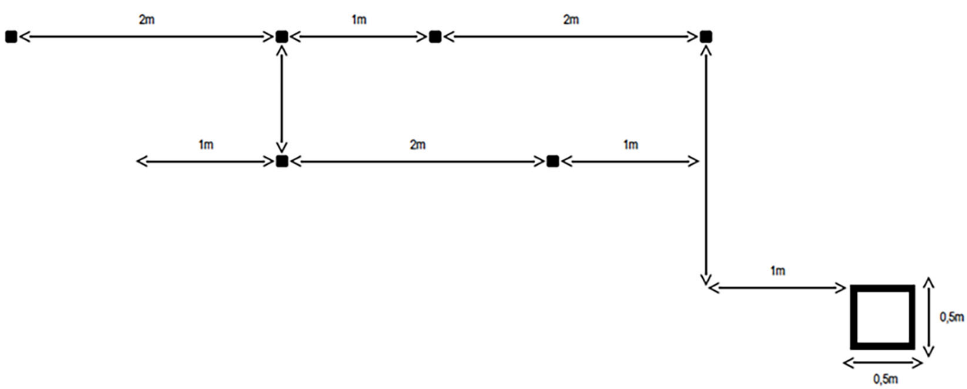

Figure 1 — Course trajectory of the Ghent University Dribbling Test

To limit visual feedback during the appropriate trials, the Nike Vapor Strobe stroboscopic glasses (Nike Inc., Beaverton, Oregon, USA) were used (Appelbaum, Cain, Schroeder, Darling, & Mitroff, 2012). To investigate the influence of visual feedback on performance, the dribble test was performed across three conditions: full vision (Control); stroboscopic level 3 (Strobe3, stroboscopic frequency of 4 Hz, clear vision for 0.1s, opaque vision for 0.150 s); and stroboscopic level 7 (Strobe 7, stroboscopic frequency of 1.33 Hz, clear vision for 0.1s, opaque vision for 0.650 s).'The participants performed each trial of the dribble test in a randomized order and were instructed to provide maximal effort on each attempt.

Data Analysis

Before analysis, age-standardized dribble test score (z-scores) for control trials were compared with a dataset of Belgian dribble test performances ($n = 7867$) to accurately classify players as fast (≤ percentile 33), average (> percentile 33; < percentile 66) or slow (≥ percentile 66) dribblers. A Repeated Measures Analysis of Variance (RM-ANOVA) was used to analyze differences between dribbling groups (Fast × Average × Slow), with each condition (Control × Strobe3 × Strobe7) used as within-subject variables. In addition, Control dribble test time was subtracted from Strobe3 and Strobe7 dribble test times to calculate Delta (Δ) change for each condition. To analyze differences in performance decrements (ΔStrobe3 × ΔStrobe7) across dribbling groups in each condition, a repeated-measures ANOVA was used. In both repeated measures analyses, Bonferroni corrections were applied when interpreting post hoc analyses and partial eta squared effect sizes (ES) were used to analyze the magnitude of effects. Effect sizes were interpreted as 0.01–0.06, small; 0.06–0.14, moderate; and >0.14, large (Cohen, 1992). The criterion alpha level for significance was set at $p \leq .05$.

Results

Table 1 displays the descriptive statistics (mean ± *SD*), F-values, *p*-values and effect sizes) for fast, average and slow dribblers across each condition.

A RM-ANOVA revealed a moderate group x dribble test condition interaction effect for dribbling time (F = 6.142; $p < .001$; ES = 0.06). Fast dribblers displayed consistently faster dribbling times in the Control, Strobe3 and Strobe7 conditions. However, these differences became increasingly smaller with limited visual feedback (Figure 2). Further univariate analysis revealed a large main effect of group (F = 48.649; $p < .001$; ES = 0.34) and dribble test condition (F = 75.909; $p < .001$; ES = 0.45). The fast dribbling group had the fastest dribbling times over all conditions. Additionally, the slowest dribbling times overall were reported in the Strobe7 condition.

A second RM-ANOVA did not reveal a significant Group × Dribble Test Condition interaction effect. However, a small main effect of dribble test condition (F = 6.433; $p = .012$; ES = 0.03) and moderate main effect of group (F = 11.342; $p < .001$; ES = 0.11) was apparent. Multiple comparisons revealed that DStrobe7 dribbling times were slower than DStrobe3 dribbling times ($p < .05$). In addition, further analysis revealed fast and average dribblers had significantly greater DStrobe3 and DStrobe7 times compared with slow dribblers (1.58 ± 0.16 s; 1.15 ± 0.15 s; 0.55 ± 0.15 s for fast, average and slow dribblers respectively). All dribble test times for fast, average and slow dribblers across all conditions are displayed in Figure 3.

Table 1 Dribbling Times for Slow, Average, and Fast Dribblers Under Different Conditions of Visual Feedback

							Condition			Group			Interaction		
Dribbling speed	Control	95% CI	Strobe3 (s)	95% CI	Strobe7 (s)	95% CI	*F*-value	ES	Power	*F*-value	ES	Power	*F*-value	ES	Power
fast ($n = 62$)	17.93 ± 1.08	[17.63, 18.24]	19.21 ± 1.35	[18.80, 19.61]	19.81 ± 1.94	[19.33, 20.29]									
average ($n = 63$)	19.37 ± 1.06	[19.07, 19.67]	20.36 ± 1.67	[19.95, 20.76]	20.68 ± 1.84	[20.21, 21.16]	68.577**	0.27	1.00	48.649**	0.34	1.00	6.142**	0.06	0.99
slow ($n = 64$)	20.98 ± 1.43	[20.68, 21.27]	21.54 ± 1.79	[21.14, 21.94]	21.51 ± 1.93	[21.04, 21.98]									
	DStrobe3 (s)		DStrobe7 (s)												
fast ($n = 62$)	1.27 ± 1.04	[0.93, 1.62]	1.88 ± 1.66	[1.49, 2.26]											
average ($n = 63$)	0.98 ± 1.53	[0.64, 1.33]	1.31 ± 1.56	[0.93, 1.70]			68.577**	0.27	0.71	48.649**	0.34	0.99	6.262**	0.06	0.49
slow ($n = 64$)	0.56 ± 1.52	[0.22, 0.91]	0.53 ± 1.39	[0.15, 0.91]											

Note. Data are means ± *SD*; * = $p < .05$; ** = $p < .001$. ΔStrobe3 = Strobe3 time (s)—Control time (s); ΔStrobe7 = Strobe7 time (s)—Control time (s);. Condition = Dribble test condition; Group = Dribbling group; Interaction = Dribble test condition * Dribbling group. ES = Partial eta squared Effect Size. 0.01–0.06 = small effect, 0.06–0.14 = moderate effect, >0.014 = large effect.

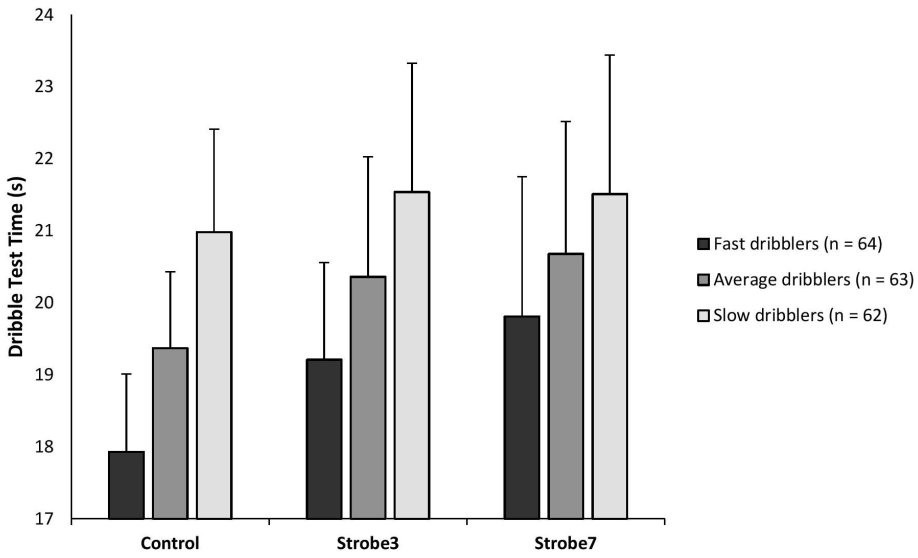

Figure 2 — Differences between dribble test conditions in fast, average and slow dribblers.

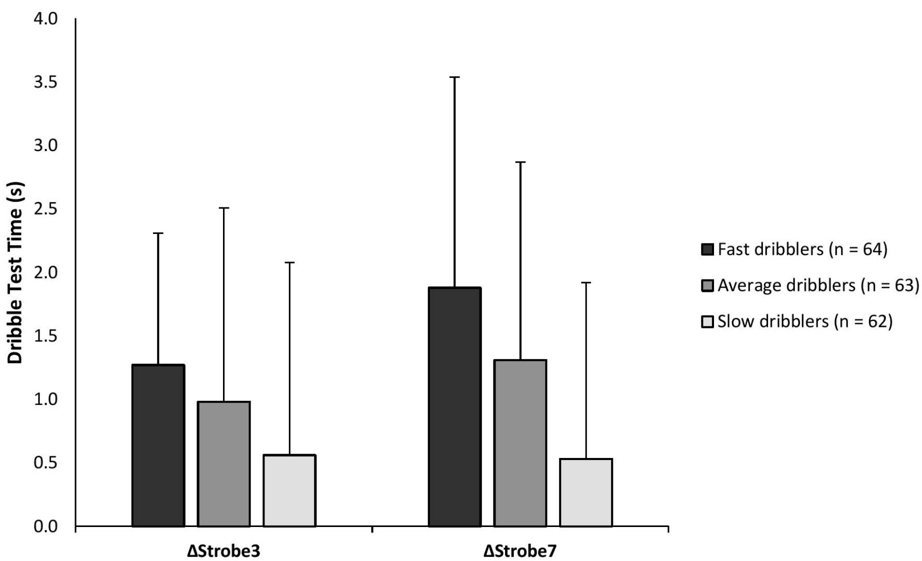

Figure 3 — Differences between ΔStrobe3 and ΔStrobe7 in fast, average and slow dribblers.

Discussion

The purpose of the current study was to examine the influence of restricted visual feedback on the dribbling performance of highly trained youth soccer players. In support of the main hypothesis, the results showed that dribbling performance was significantly impaired with decreasing visual feedback. In addition, the decrements in dribble test performance with limited visual feedback were greater for fast dribblers when compared with slow dribblers.

In agreement with previous research (Tijtgat et al., 2010; Ward et al., 2002), the current study showed a restriction of visual feedback to reduce motor skill performance. Indeed, dribble test times slowed across all groups under both stroboscopic conditions, with slowest times recorded under the condition with the least amount of visual feedback available (Control < Strobe3 < Strobe7). It is likely that a dependence on visual information during soccer dribbling has slowed dribble performance under stroboscopic conditions in this study. These findings are supported by the specificity of practice hypothesis, which suggests that learners are highly dependent on the sources of feedback present during the initial stages of motor learning (Proteau et al., 1992). Previous research investigating the specificity of practice hypothesis—with skills such as ball catching (Whiting, Savelsbergh, & Pijpers, 1995), an arm positioning task (Ivens & Marteniuk, 1997) and a manual aim task (Proteau & Marteniuk, 1993)—have demonstrated that participants with higher levels of expertise display greater decrements in performance when afferent feedback conditions were dissimilar to the environment in which they perform or learned the skill. However, it is difficult to practically apply these findings to sport specific movements due to differences in both task complexity and movement speed. The findings of the current study therefore extend the specificity of practice hypothesis to sport specific tasks that require continuous movement control at high speeds, highlighting the role of visual information in the early stages of learning. Accordingly, it is important for coaches to consider the extent of sensory feedback available in early learning environments, and how these may influence the development of motor skills such as dribbling ability.

While the current study revealed that all dribbling groups had poorer dribble test performance under stroboscopic conditions, fast dribblers were shown to suffer greater performance decrements when visual feedback was limited. Initially, it might be expected that expert dribblers would be less affected by vision restriction, since it is well known that experts within sports have better anticipatory skills than nonexperts (Savelsbergh, Williams, Van der Kamp, & Ward, 2002). However, it is important to recognize that the change of the ball position between intermittent visual feedback is increased with the speed of movement, making occluded motion prediction more difficult. Consequently, the fast movement speeds of more proficient dribblers may reduce their opportunity to adjust to changes in ball position with restricted visual feedback. These findings are supported by Bennett and colleagues (2010), who reported the velocity of movement to significantly influence the ability of participants to accurately estimate the position of a moving object during a visual-tracking task. This previous investigation showed that when the velocity of the object was increased, time to contact was underestimated, but when velocity was reduced, time to contact was overestimated—highlighting the importance of movement velocity for the control of fast-paced sport specific movements. Although this study was executed while tracking or fixating during a linear trajectory task, the results may also be applicable to ball trajectory in the current study. Moreover, as a high degree of continuous control is required to accurately navigate the ball throughout the dribble test, the negative effects of visual restriction could be accentuated in this study. However, future research should include an analysis of gaze behavior to further support this.

The present study has some limitations that must be considered when interpreting the observed findings. First, the stroboscopic eyewear used in this study has limited customisability, with strobe frequencies predetermined by the manufacturer, which limited the researchers in this study to manipulate the availability of visual feedback freely. Second, it may be difficult to compare the present findings with those from traditional occlusion studies as the stroboscopic eyewear used never completely occludes vision. Therefore, visual feedback—although severely reduced—was available at all times during the Strobe3 and Strobe7 conditions. Finally, although fast dribblers had greater performance decrements than slow and average dribblers under conditions of limited visual feedback, fast dribblers were faster with restricted feedback than slow dribblers with full visual feedback. This finding shows that restricting visual feedback has limited effects on the performance of fast dribblers. Despite this, the current study showed the ability to apply fundamental concepts of motor learning to a highly sport-specific skill in a large and representative population of youth soccer players.

In conclusion, the current study used stroboscopic vision to limit the visual feedback of youth soccer players during a dribbling task. The main finding of this study was that when visual feedback was restricted, dribbling times declined across all abilities. This finding provides support for the specificity of practice hypothesis, which states that learners are highly dependent on the sources of feedback present during the initial stages of learning. Furthermore, limited visual feedback resulted in greater declines in dribbling performance for fast dribblers when compared with slow dribblers. This finding may have important implications for the development of soccer dribbling ability, as it seems that faster dribblers are more reliant on visual feedback to accurately control the ball due to a faster speed of movement. Practice under conditions of intermittent visual feedback may therefore be a useful tool to reduce a reliance on visual afferent information during complex motor skills. A reduced reliance on visual feedback may increase a player's ability to pick up cues from different sources of visual information (teammates, ball, opposition), as continuous vision of the ball is unlikely while dribbling during soccer match play. Future research should attempt to study gaze behavior during periods of visual occlusion to better understand the effect of limiting visual feedback in fast-paced, sport specific tasks such as soccer dribbling.

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