**Validity of a Reactive Agility Test for Australian Football**

Greg Henry, Brian Dawson, Brendan Lay, and Warren Young

**Purpose:** To study the validity of a video-based reactive agility test in Australian footballers. **Methods:** 15 higher performance, 15 lower performance, and 12 nonfootballers completed a light-based reactive agility test (LRAT), a video-based reactive agility test (VRAT), and a planned test (PLAN). **Results:** With skill groups pooled, agility time in PLAN (1346 ± 66 ms) was significantly faster ($P = .001$) than both reactive tests (VRAT = 1550 ± 102 ms; LRAT = 1572 ± 97 ms). In addition, decision time was significantly faster ($P = .001; d = 0.8$) in LRAT (278 ± 36 ms) than VRAT (311 ± 47 ms). The correlation in agility time between the two reactive tests ($r = .75$) was higher than between the planned and reactive tests ($r = .41–.68$). Higher performance players had faster agility and movement times on VRAT (agility, 130 ± 24 ms, $d = 1.27, P = .004$; movement, 69 ± 73 ms, $d = 0.88, P = .1$) and LRAT (agility, 95 ± 86 ms, $d = 0.99, P = .08$; movement, 79 ± 74 ms; $d = 0.9; P = .08)$ than the nonfootballers. In addition, higher (55 ± 39 ms, $d = 0.87, P = .05$) and lower (40 ± 57 ms, $d = 0.74, P = .18$) performance groups exhibited somewhat faster agility time than nonfootballers on PLAN. Furthermore, higher performance players were somewhat faster than lower performance for agility time on the VRAT (63 ± 85 ms, $d = 0.82, P = .16$) and decision time on the LRAT (20 ± 39 ms, $d = 0.66, P = .21$), but there was little difference in PLAN agility time between these groups (15 ± 150 ms, $d = 0.24, P = .8$). **Conclusions:** Differences in decision-making speed indicate that the sport-specific nature of the VRAT is not duplicated by a light-based stimulus. In addition, the VRAT is somewhat better able to discriminate different groups of Australian footballers than the LRAT. Collectively, this indicates that a video-based test is a more valid assessment tool for examining agility in Australian footballers.

**Keywords:** movement time, decision time, agility time, lateral foot movement

Agility is an important characteristic to develop for successful performance in many team sports, including Australian football, where over 50% of sprints involve a change of direction between 0 and 90°. Previously, agility was routinely examined using preplanned tasks, but recently it has been recognized that in most team sports directional changes are often initiated in response to some external

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Reactive Agility Test Validity

stimuli such as movements of an opponent or ball.\textsuperscript{4,5} Consequently, due to the absence of a cognitive aspect, and the closed nature of the tasks, many classical planned agility test protocols do not reflect the on-field agility demands of sports such as Australian football, and so have limited ecological validity.\textsuperscript{5} Accordingly, to accurately measure sport-specific agility it is advocated that a “not negotiable” aspect is the inclusion of a decision-making component.\textsuperscript{4}

As a result, several reactive agility tests have recently appeared in the literature, coupling simple light- or directional indicator-based stimuli with various movements.\textsuperscript{6–9} Though reactive in nature, the ecological validity of these protocols has also been questioned since the stimuli are dissimilar to those typically encountered on a sports field.\textsuperscript{5,10} For example, it has been reported that generic light-based tests fail to provide skilled performers the opportunity to exploit potential anticipatory skill superiority,\textsuperscript{5,10} achieved through the earlier acquisition of postural and other cues.\textsuperscript{11–13} Accordingly, generic stimuli may not be as effective in distinguishing athletes of differing abilities.\textsuperscript{10} Consequently, newer reactive agility test protocols have sought to enhance specificity by requiring participants to respond to stimuli such as a life-sized video image of a netball pass,\textsuperscript{4} a video of a rugby player changing direction and/or executing a pass,\textsuperscript{14} or a real person changing direction.\textsuperscript{10,15} These more realistic stimuli appear to offer enhanced ecological validity over earlier generic light versions. In addition, they have also successfully discriminated higher and lower performers in netball,\textsuperscript{4} Australian football,\textsuperscript{10} and rugby league,\textsuperscript{14,16} providing evidence of their construct validity.

However, while intuitively appealing to assume that the response to more complex sport-specific stimuli would be different from similar light-based stimuli, and that the sport-specific stimuli would also be more effective in discriminating agility in players of differing skill levels, this has not been specifically investigated. Therefore, this current study sought to establish the validity of a new video-based reactive agility protocol requiring participants to “chase” a life-sized video projection of another player. Initially, validity was investigated by comparing agility performance between the video-based protocol, a similar light-based procedure, and planned agility task. In addition, this study aimed to determine whether a video reactive agility test is better able to discriminate performance differences between three groups of participants differentiated by their level of involvement in Australian football, verifying the enhanced construct validity of the video protocol.

**Methods**

**Participants**

Male participants (\(n = 42\)) were assigned to one of three groups according to their level of involvement in Australian football. Higher performance (HP) players (\(n = 15\), mean ± SD age, height and mass of 17.6 ± 0.6 y, 182 ± 6 cm, and 78.6 ± 7.5 kg respectively) were members of a top-echelon Western Australian Football League under-19 team. The lower performance (LP) group (\(n = 15\), age, height, and mass of 18.2 ± 0.1 y, 179 ± 4 cm, and 71.6 ± 5.0 kg respectively) played for lower grade amateur teams and the nonfootballers (NF) (\(n = 12\), age, height, and mass of 19.3 ± 1.7 y, 180.4 ± 8.2 cm, and 73.9 ± 14.0 kg respectively) were trained in various low-agility sports, such as distance running, paddling, and surf lifesaving, and
had no competitive Australian football experience in the previous 3 y. This study had the approval of the Human Ethics Committee of the University of Western Australia (UWA) and participants were provided information regarding the risks and subsequently gave informed consent.

**Procedures**

All testing was conducted indoors on a carpeted sprung wooden floor. During an initial visit to the laboratory, linear speed and reactive agility using a light-based reactive test (LRAT) protocol were assessed. During a second visit, 48 h later, a video-based reactive agility test (VRAT) and an analogous planned agility (PLAN) test were completed. Agility trials employed a single 45° change of direction, a pattern common in Australian Football. Data was collected using a 25 Hz video camera (Sony DCR-VX2100E) positioned 2 m behind the start gate interfaced with infrared timing gates (School of Sports Science Exercise and Health, UWA) and a computer loaded with customized “Agility” software (SSEH, UWA). During the VRAT (Figure 1) the “Agility” computer was networked to another with the custom “VidPlay” software controlling the stimulus video, which was in turn connected to a roof-mounted video projector (Epson EMP-1715) displaying a life-sized image of another player. The layout for the LRAT was identical to the VRAT except three LED light clusters mounted on a board provided the stimulus instead of the screen and projector. A group of players \((n = 12)\) completed the VRAT a second time, 1 wk after the first, to examine test-retest reliability, which for agility time had a coefficient of variation (CV) of 1.4% and an intraclass correlation coefficient (ICC) of 0.81. Furthermore, in a subset of trials \((n = 36, 20\%)\) decision time was reassessed by the principal researcher 1 wk after the initial analysis to determine the intrarater reliability, which was 5.2% (CV) and 0.99 (ICC).

During the initial test session, participants completed a standardized warm-up before undertaking five straight 11-m sprints, with a split time recorded at 4 m. The mean of each participant’s 4 m splits was used to individually manipulate aspects of the reactive tests such as stimulus presentation point (SP), delay and abort times. Following the straight sprints there was a 5 min passive recovery period, followed by an agility specific warm-up and 5 min of stretching, during which the LRAT procedure was explained and demonstrated. Next, five submaximal LRAT familiarization trials were completed, with SP varied by ±48 ms and comprising two turns each to the left and right and one with no turn. This was followed by another 5 min recovery period, after which the 12 experimental trials commenced which were randomly ordered before completion and comprised four turns each to the left and right, two “dummy” turns (one per side) and two with no turn. The “dummy” trials appeared the same as the experimental trials except SP was altered (±20–28 ms) which, in conjunction with the no turn option, increased spatial and temporal uncertainty. The data from dummy and no-turn trials was discarded, leaving eight experimental trials (four left and four right) for analysis.

In the reactive trials, the stimulus was presented at a predetermined time (equal to each individual’s mean 4 m straight sprint split) following the initiation of the sprint that, during the LRAT, occurred when the appropriate LED illuminated or, during the VRAT, when the person in the video initiated the change of direction. Specifically, in the VRAT, stimulus presentation was defined as the first definitive
Participants were instructed to sprint forward as fast as possible, respond quickly and accurately to the stimulus and sprint through the exit gate. In addition, to help ensure a high-speed approach run and control the physical location of the SP, the reactive protocols incorporated a unique abort feature, whereby failing to reach the 3 m abort gate before the abort time elapsing (also mean 4 m straight sprint split time) resulted in the trial aborting, occluding the stimulus. Accordingly, having the abort and SP times equal ensured the SP point was limited to the 3–4 m zone, thereby ensuring consistency for each participant across each test session.

Participants returned to the laboratory 48 h later and again completed the standard agility warm-up where the VRAT was explained and demonstrated during the final 5 min period. Then, five submaximal familiarization trials were completed.
followed by another 5 min rest period, after which the 12 experimental VRAT trials were completed (in a different random order to the LRAT) again resulting in eight experimental trials following the discarding of the no turn and dummy trials. During the VRAT a life-sized projection of an opposition player running away from the test participant was used, this person was filmed alone, without a ball and ran straight before performing a cut maneuver (except on the no-turn trials), thereby simulating an attempted chase and tackle. The video clips were individually manipulated to make the SP equal to each participant’s mean 4 m straight sprint time assessed previously. Specifically, the duration of the experimental clips was 780 ms, and were paused for an extra period (delay time) so the sum (780 ms + delay time) equaled each individual’s SP time. To calculate delay time the constant 780 ms of each clip was subtracted from each participant’s mean 4 m split time; for example, for a 4 m split of 840 ms the delay would be 60 ms (840 ms – 780 ms).

Finally, 5 min after completing the VRAT, participants completed eight (four per side) planned agility runs around a marker placed 50 cm short of, and 25 cm offset to the left or right of the 7 m mark replicating the pattern used for the reactive agility conditions (but without any external stimulus).

The video record was edited using commercial video editing software (Pinnacle Studio V9, Avid, Burlington, Massachusetts) to remove superfluous content. The requisite clips were then analyzed using siliconCOACH PRO V6 (Dunedin, New Zealand) software, allowing times to be recorded (±20 ms). Data yielded from both the recorded video and timing gates provided the following measures, all reported in milliseconds.

1. **3 m time (3 m)** — from start gate to the abort gate at the 3 m mark.
2. **Decision Time (DT)** — elapsed time (±20 ms) from stimulus presentation point until the initiation of the physical response by the test participant, defined as the first definitive lateral movement of the foot which initiates the change of direction.
3. **Total Time (TT)** — from start until passing through one of the exit gates.
4. **Agility Time (AT)** — TT minus 3 m.
5. **Movement Time (MT)** — The time from response initiation until triggering an exit gate.

**Statistical Analyses**

Trials where participants made incorrect decisions were discarded and the mean of the remaining trials used for analysis. A mixed-model ANOVA (group × test) established whether there were group or test effects, and Tukey HSD and paired t tests were used for post hoc analyses, with a P value of <0.05 denoting significance where appropriate. In addition, to further interpret any differences between means, effect sizes (Cohen’s d) were calculated and interpreted based on the criteria of Hopkins where 0 = trivial, 0.2 = small, 0.6 = moderate, 1.2 = large, 2.0 = very large, and >4.0 nearly perfect.

Further, the smallest worthwhile change (SWC) was used in conjunction with raw differences in means and 90% confidence intervals (CI) to determine the practical importance of the differences. For agility time the SWC was determined
to be 15 ms, based on a similar length RAT using a comparable population and for decision and movement times the SWC was 16 and 17 ms respectively, based on similar measures from another RAT. A spreadsheet was used to compare the differences in the mean ± CI against the SWC to determine the likelihood that any difference is large enough to have an important practical benefit, expressed as the probability (percentage) that the mean difference ± CI is beneficial/trivial/detrimental. The resulting practical inference was expressed using the descriptors: <1%, almost certainly not; 1–5%, very unlikely; 5–25%, unlikely; 25–75%, possibly; 75–95%, likely; 95–99% very likely; and >99%, almost certainly. For example, 80/15/5 equates to “likely” (beneficial), “very unlikely” (trivial), and “almost certainly not” (harmful), and therefore the change in this example would be interpreted as “likely beneficial.”

Finally, Pearson correlations (r) were used to determine the relationships between the dependent variables and interpreted based on the criteria of Hopkins, whereby 0 = trivial, 0.1 = small, 0.3 = moderate, 0.5 = large, 0.7 = very large, 0.9 = nearly perfect, 1 = perfect.

### Results

For pooled participant data, in both the reactive test modes total times (VRAT = 2308 ± 152 ms; LRAT = 2330 ± 127 ms) and agility times (VRAT = 1550 ± 102 ms; LRAT = 1572 ± 97 ms) were significantly (P < .001) slower than the planned protocol (Total = 2102 ± 103 ms; Agility = 1346 ± 66ms), accompanied by very strong effect sizes (1.6–2.7) and a 100% likelihood that these times were different when compared with the smallest worthwhile change (Table 1). In addition, decision time was significantly faster in the light-based test (LRAT) than the video-based test (VRAT) (33 ± 13 ms; P < .001; d = 0.8; SWC = 98/2/0%) but no significant differences were observed in agility and movement times between the reactive modes. In addition, very large correlations (>0.7) were found in total time between the three modes while moderate (Plan–LRAT 0.4), large (Plan–VRAT 0.68), and very large (VRAT-LRAT 0.75) correlations were observed for agility time (Table 2).

There was a significant group effect for total time and post hoc analysis revealed that the nonfootballers (NF) were significantly (P ≤ .001–0.002) slower than both lower performance (LP) and higher performance (HP) groups on all tests, with large associated effect sizes (1.58–1.91) and 100% probability that these were practically important differences (Table 3). In addition, HP had faster agility (d = 1.27; P = .004; SWC = 100/0/0%) and movement times (d = 0.88; P = .1; SWC 88/9/3%; likely) on the VRAT than NF. Further, the higher performance players had faster agility (d = 0.99; P = .08; SWC = 94/3/3%; likely) and movement times (d = 0.9; P = .08; SWC = 92/6/2%; likely) than NF in the LRAT.

Finally, HP had a faster agility time than LP on the VRAT (d = 0.82; P = .16; 88/6/6%) and a faster decision time than LP on the LRAT (d = 0.66; P = .21; 60/34/6%) with moderate effect sizes indicated.
Table 1  Mean ± SD total, agility, decision, and movement times (in milliseconds) in planned (PLAN), light-based (LRAT), and video-based (VRAT) reactive agility tests

<table>
<thead>
<tr>
<th></th>
<th>VRAT</th>
<th>LRAT</th>
<th>PLAN</th>
<th>VRAT vs LRAT: Diff in mean ± 90% CI; d; P value; SWC%</th>
<th>LRAT vs PLAN: Diff in mean ± 90% CI; d; P value; SWC%</th>
<th>PLAN vs VRAT: Diff in mean ± 90% CI; d; P value; SWC%</th>
</tr>
</thead>
<tbody>
<tr>
<td>DT</td>
<td>311 ± 47</td>
<td>278 ± 36*</td>
<td>—</td>
<td>33 ± 13; 0.8; &lt;0.001; 98/2/0</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>MT</td>
<td>1094 ± 81</td>
<td>1090 ± 93</td>
<td>—</td>
<td>4 ± 19; 0.04; 0.723; 13/84/3</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>AT</td>
<td>1550 ± 102</td>
<td>1572 ± 97</td>
<td>1346 ± 66**</td>
<td>21 ± 19; 0.2; 0.07; 70/30/0</td>
<td>226 ± 88; 2.7; &lt;0.001; 100/0/0</td>
<td>204 ± 79; 2.4; &lt;0.001; 100/0/0</td>
</tr>
<tr>
<td>TT</td>
<td>2308 ± 152</td>
<td>2330 ± 127</td>
<td>2102 ± 103**</td>
<td>22 ± 23; 0.2; 0.12; 70/30/0</td>
<td>228 ± 89; 2.0; &lt;0.001; 100/0/0</td>
<td>206 ± 80; 1.6; &lt;0.001; 100/0/0</td>
</tr>
</tbody>
</table>

*LRAT significantly faster than VRAT, P < .001.
**Planned significantly faster than both VRAT and LRAT, P < .001.
Discussion

Initially, this study examined agility performance between a planned and two reactive agility tests, and observed no differences in total time (TT) and agility time (AT) between the reactive tests ($d = 0.2; P = .07–0.12$) but also that both reactive tests were significantly slower ($P < .001; d = 1.6–2.7$) than the planned test (Table 1). In addition, very large correlations in TT (0.73–0.82) were observed between the reactive and planned scenarios, but the correlations were smaller for AT (0.41–0.68) (Table 2). Further, it should be noted that the correlations between linear speed, measured via the initial 4m linear sprint test, and all agility tests were also much stronger for TT (0.71–0.81) than AT (0.32–0.43) indicating that agility as measured by total time and tests for linear speed are measuring similar qualities. Put another way, it appears that linear speed “contaminates” the agility measure when it includes a straight sprint approach segment and also appears to overinflate the relationship between the reactive tests. Consequently, AT appears a more valid agility measure and as such will be the primary performance measure discussed here.

Notwithstanding that direct comparisons between planned and reactive tests may be problematic due to variations in the technique used to change direction (curve-linear versus a distinctive cut)$^{10}$ the differences in AT between the planned and reactive modes, with common variances of less than 50%, supports previous research showing reactive agility and planned change of direction speed are unique skills.$^{4,10}$ Therefore, although several studies are required to prove validity,$^{21}$ these findings add to the growing body of evidence validating the broad reactive agility test paradigm over preplanned test.$^{4,9,10,14–16}$

The LRAT and VRAT both assess reactive agility, confirmed by the similar agility times and very large correlations (0.75), yet a common variance of 56%, while supporting a certain degree of commonality, also indicates that some differences remain. Table 1 shows that the only significant difference was in DT where the LRAT was significantly faster ($P < .001; d = 0.8$) than VRAT. Therefore, a simple light-based stimulus allows participants to make significantly faster decisions, likely due to the reduced cognitive demand in that protocol, ie, either the light is “on” or “off,” although in this instance participants were not able to translate this into a faster overall performance even though movement time was the same for each

Table 2  Pearson correlation coefficients for planned (PLAN) agility, light-based (LRAT), and video-based (VRAT) reactive agility test variables ($n = 42$) (TT= Total time, AT= Agility time)

<table>
<thead>
<tr>
<th></th>
<th>VRAT TT</th>
<th>VRAT AT</th>
<th>LRAT TT</th>
<th>LRAT AT</th>
<th>PLAN TT</th>
<th>PLAN AT</th>
</tr>
</thead>
<tbody>
<tr>
<td>VRAT TT</td>
<td>1</td>
<td>.58**</td>
<td>.82***</td>
<td>.60**</td>
<td>.78***</td>
<td>.44*</td>
</tr>
<tr>
<td>VRAT AT</td>
<td>—</td>
<td>1</td>
<td>.66**</td>
<td>.75***</td>
<td>.45*</td>
<td>.68**</td>
</tr>
<tr>
<td>LRAT TT</td>
<td>—</td>
<td>—</td>
<td>1</td>
<td>.65**</td>
<td>.73***</td>
<td>.43*</td>
</tr>
<tr>
<td>LRAT AT</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1</td>
<td>.32*</td>
<td>.41*</td>
</tr>
<tr>
<td>PLAN TT</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1</td>
<td>.56**</td>
</tr>
</tbody>
</table>

* $r = .3–.5$, moderate; ** $r = .5–.7$, large; *** $r = .7–.9$, very large.
Table 3  Mean ± SD total, agility, decision, and movement times (in milliseconds) in higher (HP) and lower (LP) performance footballers and nonfootballers (NF) for a planned agility (PLAN), light-based (LRAT), and video-based (VRAT) reactive agility tests

<table>
<thead>
<tr>
<th></th>
<th>HP</th>
<th>LP</th>
<th>NF</th>
<th>HP vs LP Difference in mean ± 90%CI; d; P value; SWC</th>
<th>HP vs NF Difference in mean ± 90%CI; d; P value; SWC</th>
<th>LP vs NF Difference in mean ± 90%CI; d; P value; SWC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>HP vs LP</td>
<td>HP vs NF</td>
<td>LP vs NF</td>
</tr>
<tr>
<td>DT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VRAT</td>
<td>309 ± 38</td>
<td>303 ± 44</td>
<td>325 ± 60</td>
<td>6 ± 210; 0.14; 0.94; 45/15/40</td>
<td>16 ± 90; 0.33; 0.65; 50/30/20</td>
<td>22 ± 69; 0.43; 0.45; 60/29/12</td>
</tr>
<tr>
<td>LRAT</td>
<td>267 ± 30</td>
<td>287 ± 38</td>
<td>279 ± 36</td>
<td>20 ± 39; 0.66; 0.21; 60/34/6</td>
<td>12 ± 50; 0.43; 0.53; 44/45/11</td>
<td>8 ± 110; 0.19; 0.85; 43/28/29</td>
</tr>
<tr>
<td>MT</td>
<td></td>
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</tr>
<tr>
<td>VRAT</td>
<td>1065 ± 70</td>
<td>1095 ± 80</td>
<td>1134 ± 88</td>
<td>30 ± 87; 0.40; 0.56; 60/22/18</td>
<td>69 ± 73; 0.88; 0.1; 88/9/3</td>
<td>39 ± 85; 0.47; 0.44; 67/20/13</td>
</tr>
<tr>
<td>LRAT</td>
<td>1059 ± 80</td>
<td>1087 ± 94</td>
<td>1138 ± 95</td>
<td>28 ± 93; 0.34; 0.62; 58/21/21</td>
<td>79 ± 74; 0.9; 0.08; 92/6/2</td>
<td>51 ± 99; 0.49; 0.39; 72/15/13</td>
</tr>
<tr>
<td>AT</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>VRAT</td>
<td>1493 ± 76</td>
<td>1556 ± 77</td>
<td>1623 ± 124†</td>
<td>63 ± 85; 0.82; 0.16; 88/6/6</td>
<td>130 ± 24; 1.27; 0.004; 100/0/0</td>
<td>67 ± 97; 0.65; 0.182; 87/6/7</td>
</tr>
<tr>
<td>LRAT</td>
<td>1533 ± 56</td>
<td>1570 ± 114</td>
<td>1628 ± 94</td>
<td>37 ± 140; 0.42; 0.5; 66/15/19</td>
<td>95 ± 86; 0.99; 0.08; 94/3/3</td>
<td>58 ± 210; 0.38; 0.5; 69/10/21</td>
</tr>
<tr>
<td>PLAN</td>
<td>1326 ± 69</td>
<td>1341 ± 52</td>
<td>1381 ± 73</td>
<td>15 ± 150; 0.24; 0.8; 50/19/31</td>
<td>55 ± 39; 0.87; 0.05; 95/3/2</td>
<td>40 ± 57; 0.74; 0.18; 84/11/5</td>
</tr>
<tr>
<td>TT</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VRAT</td>
<td>2224 ± 136</td>
<td>2281 ± 85</td>
<td>2466 ± 141*</td>
<td>57 ± 170; 0.50; 0.43; 72/11/17</td>
<td>242 ± 7; 1.73; 0.002; 100/0/0</td>
<td>185 ± 24; 1.58; &lt;0.001; 100/0/0</td>
</tr>
<tr>
<td>LRAT</td>
<td>2270 ± 81</td>
<td>2286 ± 85</td>
<td>2480 ± 120**</td>
<td>16 ± 190; 0.25; 0.83; 50/17/33</td>
<td>210 ± 6.1; 1.91; &lt;0.001; 100/0/0</td>
<td>194 ± 5.7; 1.68; &lt;0.001; 100/0/0</td>
</tr>
<tr>
<td>PLAN</td>
<td>2076 ± 65</td>
<td>2055 ± 81</td>
<td>2211 ± 104**</td>
<td>21 ± 180; 0.29; 0.77; 53/16/31</td>
<td>135 ± 3.9; 1.74; &lt;0.001; 100/0/0</td>
<td>156 ± 4.6; 1.85; &lt;0.001; 100/0/0</td>
</tr>
</tbody>
</table>

Note. NF significantly slower than both LP and HP, *P < .05; **P < .001; †NF significantly slower than HP, P < .05.
group. This apparent disparity was due to the cumulative effect of small differences in the approach aspects of the tests such as approach time and position within the stimulus zone, resulting in the participants being in a similar spatial location at the initiation of the change of direction. In contrast, during the video-based task participants require more time to decode a multitude of postural and position cues before instigating a definitive response. Hence, since the primary difference between the reactive tests is the decision-making component, these results substantiate the view that perceptual elements required from complex sports-specific stimuli, such as another person changing direction, are somewhat unique and may not be effectively duplicated using a generic light-based stimulus.\textsuperscript{4,5,9} Consequently, the video-based protocol appears to be a more valid assessment tool than a light-based procedure for examining agility.

Previously, reactive agility testing has confirmed that higher skilled players have a superior ability to extract and utilize advanced cues from opponents more quickly than lesser skilled peers.\textsuperscript{4,10,14–16} Further, it is purported that generic stimuli will not provide the opportunity to exploit this perceptual advantage and as such would be less sensitive to any apparent skill group differences.\textsuperscript{4,5,13,22,23} This notion is supported by the results in Table 3 showing that the HP group had a significantly faster AT than NF on the VRAT (HP faster by 130 ± 24 ms; \(d = 1.27; P = .004\)), and a somewhat faster AT on the LRAT (HP faster by 95 ± 86 ms; \(d = 0.99; P = .08\)) and PLAN tests (HP faster by 55 ± 39 ms; \(d = 0.87; P = .05\)). In addition, although the LP group were also faster than NF on all tests the differences were nonsignificant with only moderate effect sizes on the VRAT (LP faster by 67 ± 97; \(d = 0.65\)) and PLAN tests (LP faster by 40 ± 57 ms; \(d = 0.74\)). These results differ somewhat from those of Wilkinson, Leedale-Brown and Winter\textsuperscript{24} who found no difference between squash and nonsquash players on a planned agility test but significant between group differences on a squash-specific reactive agility test. However, in their study the “non-playing” cohort were active Soccer players (thus agility trained) whereas in this current study, while active in various sports, the NF participants were not involved in agility (team) sports, and so unlikely to perform as well in agility tasks. Further, in this current study it is notable that the differences between HP/LP and NF tended to increase, in line with task complexity and skill level (ie, smallest in the PLAN and greatest on the VRAT and HP more than LP), lending some support to the theory that the video-based test would be more sensitive to any skill-group differences and further supporting the construct validity of the video-based protocol.

Similarly, although there was little difference in AT and small effect sizes between HP and LP on both the PLAN (\(d, 0.24\)) and LRAT (\(d, 0.42\)) tests, there were larger, albeit nonsignificant, differences on the VRAT (\(d, 0.82\)). As was the case between the playing and nonplaying cohorts this indicates a trend toward an increasing divergence in the ability of the different playing groups to deal with the increasing cognitive demand from the PLAN to the LRAT to the VRAT. Although not as clear as previous studies, which found significant differences in reactive agility between different playing groups,\textsuperscript{4,10,14–16} the current results indicate that the VRAT appears to be more useful than light-based and planned tests in discriminating between football and nonfootball athletes and between different groups of younger Australian football players, thereby supporting the construct validity of this protocol.
Previously, differences in reactive agility performance between players from different skill levels have been attributed to heightened perceptual and anticipatory ability in the higher skilled group, a view supported by data showing superior players exhibited faster decision times using various sport-specific stimuli. However, in this study no significant differences were observed in DT between the participant groups on any test mode and the increase in DT from the LRAT to the VRAT was actually greater in HP (42 ms; \(d = 1.23; P < .001\)) than LP (16 ms; \(d = 0.4; P = .13\)). This contrasts both with earlier research and with the theory that better players have enhanced anticipatory skill. In fact, in this instance, the larger differences in AT between NF and HP were primarily due to differences in movement time (\(d = 0.88–0.9; P = .08–.1\)) rather than decision time (\(d = 0.33–0.43\)). Notwithstanding that in part this is related to the fact that MT makes up a much larger proportion of AT than DT, it also indicates that the physical rather than cognitive aspect of agility was chiefly responsible for the improved performance. Potentially, their relatively young age (17–18 y in the playing groups) means the HP players may not have fully developed their cognitive expertise advantage, which may take up to 10 years of dedicated training to mature. Therefore, they may still be reliant on enhanced motor skill, as evidenced by the faster MT, rather than decision-making speed, which may change with experience.

**Conclusion**

The high correlation between linear speed and agility when the common linear approach segment is included in the agility test indicates that the overall result is unduly influenced by linear speed, therefore the agility time variable may be a more specific measure of agility than total time. The reactive and planned tests measure distinctly different characteristics, supporting previous findings that reactive protocols are a more valid method for determining sport-specific agility ability. In addition, although light and video-based reactive tests measure similar qualities, it appears that the cognitive and perceptual challenge is somewhat different and the sport-specific nature of the video test is not replicated with a generic stimulus. Finally, the construct validity of the video-based test is further supported by the fact that it is better able to discriminate football players from nonplayers and between different playing groups of younger Australian footballers. Therefore, video-based reactive agility tests should be utilized in preference to more generic light-based stimuli for examining sports-specific agility in Australian footballers.

**Practical Applications**

Reactive tests should be preferred over planned agility tests when examining sport-specific agility ability and similarly, video-based protocols should be used in preference to tests using generic stimuli. This notion can extend to the training environment where sport specific scenarios should be used in preference to preplanned tasks. Finally, a test protocol that allows differentiation of the subcomponents of agility will provide coaches with a greater understanding of the agility profile of individuals and teams, allowing a more targeted training approach to address weaknesses and maximize strengths.
References