ACADEMIC World Academic Union

ISSN 1750-9823 (print)
International Journal of Sports Science and Engineering
Vol. 06 (2012) No. 03, pp. 159-164

The Team-Mate Identification (TM-ID) Test: A Portable Apparatus for Collecting Decision Latencies for Players in Team Invasion Sports

Kylie A Steel[1], John Eisenhuth[2]

[1]College of Health and Science, University of Western Sydney
[2]Faculty of Health Sciences, University of Sydney

(*Received February 2, 2012, accepted May 9, 2012*)

Abstract. In team sports, effective execution of a pass depends on correctly and quickly identifying the intended receiver as a team-mate. The ability to make such identifications has been tested by showing players short video-clips of moving players. However, an apparatus is needed to enable researchers to collect latency data for these decisions at a standard that provides suitable accuracy for scientific research. For the Team-Mate Identification (TM-ID) test, both identification times and response selections made by team players after viewing brief video-clips of moving athletes must be collected on response keys, for subsequent signal detection analysis. To do this, a timer is initiated when a light sensor fixed to the corner of a monitor screen detected a white square that had been edited into the video-clips. The observing player presses down on a home key, with six selection keys arranged in a semi-circular pattern. Decision time to release the home key and the selection key pressed ware then recorded. Using this apparatus participants view a series of randomly sequenced video-clips of the relevant locomotor skill, e.g., swimming or running performed by team-mates and unknowns. The apparatus designed and built for the TM-ID test is a compact and portable device, designed in this instance to work with a PC laptop system that provides a portable testing apparatus that could be taken to the athlete.

Keywords: Latency-apparatus, reaction time, water-polo, team-mate, identification

1. Introduction

In sport decision-making tests (Abernethy, 1996: Farrow, Young, & Bruce, 2005), the perceived value and ecological validity of dynamic rather than static perceptual material has resulted in more frequent use of video film of athletes. In these tests, a commonly-collected performance measure is time taken to respond to a particular perceptual event, or Reaction Time (RT). Currently, there is no readily-available method and apparatus for obtaining RT data from observers of sport video footage. The aim of the current project was to develop an apparatus that would permit the collection of RTs from players watching video footage on a computer monitor.

Specifically, the need to collect latency data arose from our work on team-mate identification (Steel, Adams, & Canning, 2009; 2008; 2007; 2006). The findings with the team-mate identification (TM-ID) test were that, in both touch football and water-polo, observers could classify a moving player seen for less than one second as their team-mate or not, at rates better than chance. However, the test methodology employed in these studies was not time-stressed, so the decisions were not like those that characterise most sports situations. Therefore, for greater ecological validity, the test should be time-stressed and reaction time data collected.

An important consideration in apparatus design for collection of RT in the TM-ID test was that the apparatus also records level of confidence in the TM-ID decision, using the previously-employed 6-point rating scale (Steel, Adams, & Canning, 2009; 2008; 2007; 2006). The value of having the player who is observing a video-clip select a number on a scale from 1 = ‘high certainty not a team-mate’ up to 6 = ‘high certainty team-mate’ is that this rating scale information permits the use of non-parametric Signal Detection Theory. In Signal Detection Theory terms, the person observed on the video-clip can only be either a team-mate (i.e., a ‘signal’ event) or not a team-mate (i.e., a ‘noise’ event). Analysis with ROC curves (Swets & Dawes, 2000) is conducted to obtain a measure of each player’s discrimination ability. A further consideration is that many latency devices do not provide the millisecond accuracy required for scientific research (Li, Liang, Kleiner, & Lu, 2010) particularly if the response keys are part of a traditional keyboard. These systems lead to inaccurate time recordings due to software delaying response information. Therefore to overcome these limitations an external apparatus that can simultaneously collect an observer's RT and decision rating selection was designed and tested using the TM-ID test protocol.

2. RL-Timer Latency Apparatus

2.1. Design Overview

Reaction time (RT), Movement Time (MT) and response choice data were collected using a purpose-built latency box connected to the laptop computer on which edited video footage was shown (Figure 1). The stimulus footage contained a white 2 cm x 2 cm square in the bottom left hand corner of each video-clip that could be detected by a light sensor attached to the bottom left corner of the computer screen. The square would act as a trigger for the timing components connected to the laptop and latency apparatus. The latency apparatus panel consisted of a home key and six response choice keys arranged in a semicircular pattern. This design enables separation of identification time from choice (Welford, 1980) such that the time to release the home key, or reaction time (RT), thus represents the identification time for whether a stimulus viewed was a team-mate, unconfounded by whether the selected response choice key is on the observer's preferred side or not. This aspect is important as movements to the preferred side are made significantly faster than to the non-preferred side. Use of this set of selection keys, ordered from greatest to least certainty that the athlete being observed was a team-mate, enables the application of the non-parametric signal detection analysis described by McNicol (2005) that produces an Area Under a ROC curve (AUC) as a discrimination index. This information is then stored using purpose-written software; RL-Timer V1.0 (Sydney University, East St, Lidcombe, NSW, 1825).

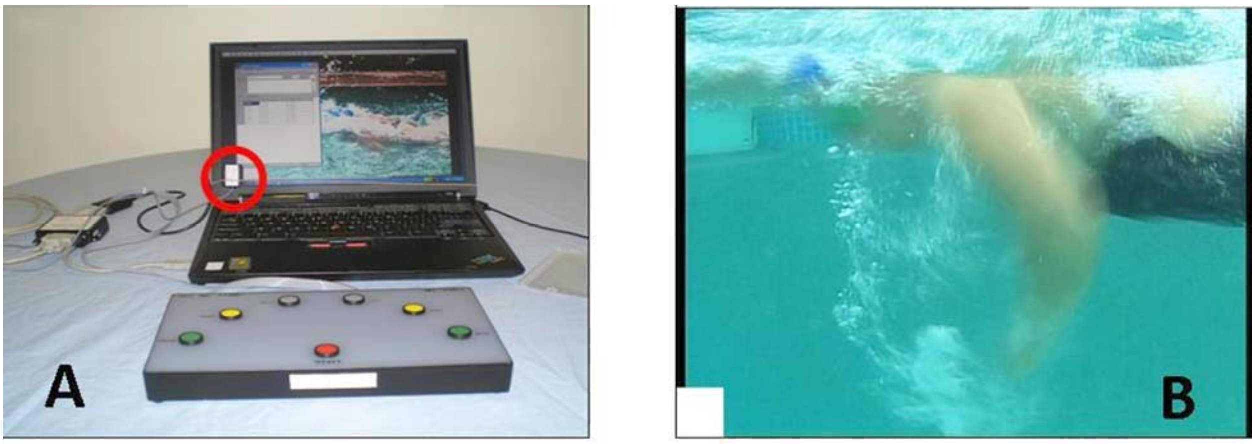

Figure. 1. Panel A: The laptop computer used to display the sequence of video clips and the panel of response keys used to collect the latency and selection data for decision-making. The timing sensor in the bottom left hand corner of the screen is circled in red. Panel B: A still example from a video sequence taken using an underwater camera showing the white square 2cm x 2cm that is edited into the bottom left-hand corner in each frame of all video-clips for a timing trigger.

2.2. Apparatus Components

2.2.1. DVD Video

The RL-Timer trigger (light sensor) requires a randomly sequenced series of video-clips of participants e.g., water-polo or football, performing a head down freestyle sprint past a digital video camera. Each video-clip includes a white 2cm x 2cm square edited into the bottom left hand corner of each frame. This square acts as a trigger that is detected by the RL-Timer light sensor.

2.2.2. Light Sensor (Trigger) Module

The light sensor module consists of a photosensitive diode that detects changes in light level. Also included are a trans-impedance amplifier that amplifies the output from the photosensitive diode and a comparator that compares the output from the trans-impedance amplifier and changes state when a user adjustable threshold level is exceeded. The output of the comparator serves as the trigger signal to the RL-

Timer Controller

2.2.3. RL-Timer Key Console

The RL-Timer Key (key) Console consists of seven keys. The home key is used as a reference position during a test. The response keys (six) are arranged in a semi-circular pattern around the home key. These keys are arranged in two groups: Not My Team (left) and My Team (right). Within each group there are three keys that represent the level of certainty that the response belongs to the selected group. The following nomenclature is used (Figure 2).

- NMTLC – Not My Team Low Certainty
- NMTMC – Not My Team Medium Certainty
- NMTHC – Not My Team High Certainty
- MTLC – My Team Low Certainty
- MTMC – My Team Medium Certainty
- MTHC – My Team High Certainty

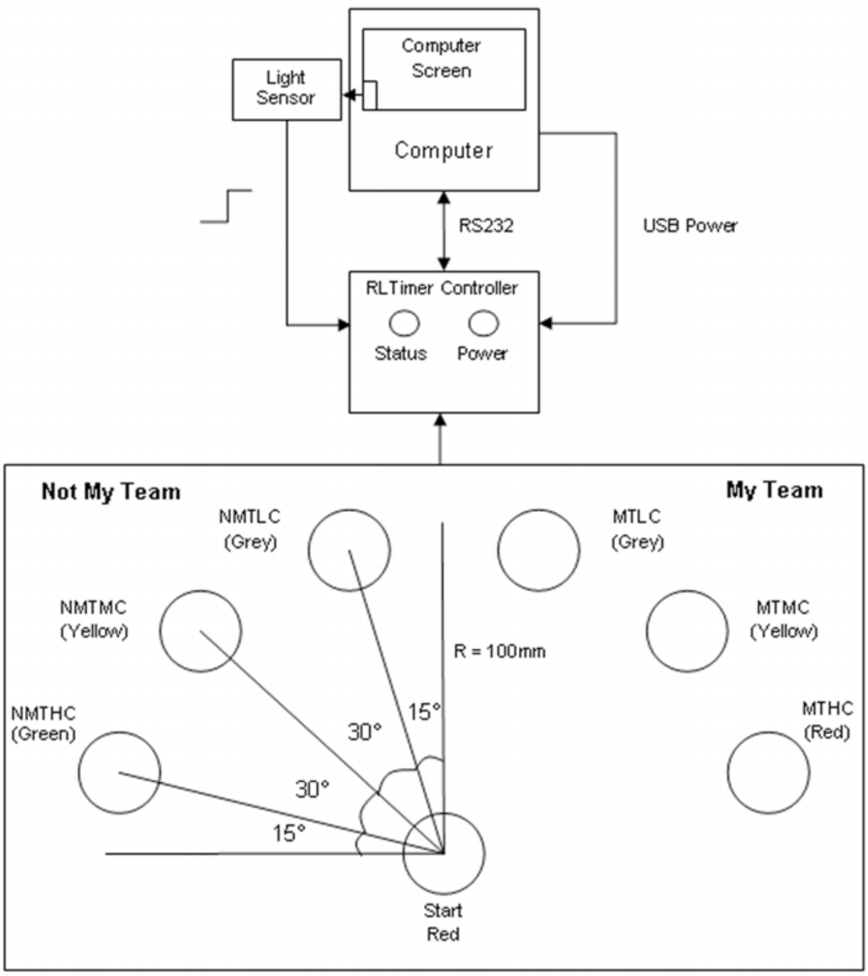

Figure. 2. Schematic of the design of the RL-Timer latency device.

2.2.4. RL-Timer Controller

The RL-Timer Controller is a microcontroller-based device that monitors the trigger and key inputs. It also controls a timer that measures the time taken from detection of the trigger input to the release of the home key to give the latency time. The timer also measures the time taken for the user to activate a response key to give the reaction time and the level of certainty of the response. On completion of the measurement the RL-Timer Controller module sends the results to a PC running RL-Timer V1.0 software. Two LEDs are used to indicate to the operator that power is on and which state the system is in. The Status LED indicates the RL-Timer Controller state by flashing at different rates. The flash rates and their meaning are listed below.

- 2Hz 10% duty cycle -> Waiting for PC to connect
- 2Hz 70% duty cycle -> Transmitting to PC
- 1Hz 10% duty cycle -> Standby, waiting for user to activate and hold the home key.
- 1Hz 50% duty cycle -> Home key activated, trigger armed. Waiting for light sensor to indicate start of video.
- 1Hz 83% duty cycle -> Trigger received, timer running.
- 4Hz 10% duty cycle -> Test error, home key released too soon.
- 4Hz 50% duty cycle -> Time Out error, user too slow to respond.

2.2.5. Power

The RL-Timer Controller draws its power from the 5VDC supply available on any USB port with a **USB "A" to DC plug power cable** supplied to enable connection.

2.2.6. Interconnection

Some newer PC systems do not support an RS232 serial bus. However, most modern systems support USB. For these systems a USB **to RS232 serial adaptor** must be used with a **serial modem cable** in order to connect the RL-Timer Controller to a PC. If the PC system does support RS232 it is only necessary to use serial modem cable.

2.3. Software Design

2.3.1. RL-Timer V1.0 Windows Application

RL-Timer software is a simple software tool that runs in a Windows PC environment and receives incoming data from the RL-Timer Controller along an RS232 connection and displays it on a screen. The displayed data includes the test number, user response, latency time and reaction time. The application allows the user details to be entered along with the measurement data and for the entire record to be saved as a text file to a storage device. The text file can be imported into Microsoft Excel as comma delimited text with custom cell formatting mm:ss.000. On start up the software automatically searches the PC's COM ports for RL-Timer Controller and reports to the user whether RL-Timer Controller is detected and if so what COM port it is connected to. The RS232 connection can also be checked by clicking COM Port->Connect on the main menu.

2.3.2. Operating RL-Timer:

- Check that RL-Timer Controller is in standby mode by observing that the status LED is flashing at 1Hz 10% duty cycle.
- The user must press and hold down the home key just prior to any trigger being received. When the home key is activated the trigger is armed and ready to fire. The status LED flashes at 1Hz 50% duty cycle.
- When a trigger is received the timer on board the RL-Timer Controller starts. The status LED flashes at 1Hz 83% duty cycle indicating that a time measurement is under way.
- During this time the user observes and processes the video-clip being displayed and when a decision has been made releases the home key in order to activate a response key. The time that the start key was deactivated is recorded and saved.
- When a response key is activated the timer stops and records the time the response key was activated.
- The measured times are automatically transmitted to the PC where RL-Timer software displays them on the PC screen.
- RL-Timer Controller automatically returns to the standby mode and the status LED flashes at 1Hz 10% duty cycle.

2.3.3. Measurement errors

Timeout error:

- The user is given 5 seconds to respond to each test clip presented. If the user fails to respond to the stimulus within 5 seconds the following results are sent to the PC.
- If the user fails to deactivate the home key within 5 seconds the latency time and the response time are both recorded as 99:99.000 and no response key identity is recorded.
- If the home key is deactivated but the response key is not activated the latency time is recorded as normal, the response time is recorded as 99:99.000 and no key identity is recorded.

Test error:

- After a trigger is detected RL-Timer Controller checks to see if the home key is activated. If the start key is not activated at this time an error occurs and the following result is sent to the PC. No response key ID is recorded and both the latency time and the response time are recorded as 00:00.000.
- Note that only a very small window of opportunity exists for this condition to occur and in normal operation is very unlikely to occur.

3. Analysis and Results when using the TM-ID Test the RL-Timer

When using the TM-ID Test and RL-Timer software and device, the Signal Detection approach is used to analyse identification data. Team-mates are considered signals and non-team-mates noise. Analysis can then be conducted using the software packages such as SPSS for Windows (Version 14; SPSS, Inc., 233 S. Wacker Drive, Chicago, IL 60606) which have Receiver Operator Characteristic (ROC) sub-routines. The status of the team-mate or non-team-mate is entered as the state variable and the observer's certainty rating that the stimulus (runner or swimmer) was a team-mate or not was entered as the continuous variable. The ROC routine then generates an Area Under the Curve (AUC) value for each observer, with 0.5 representing chance level, and 1.0 representing perfect discrimination performance. Treating the AUC for each player as their TM-ID score, an ANOVA can then be conducted on these scores to examine the various effects of conditions, including comparisons between choice confidence, reaction time and movement time.

4. Discussion and Conclusions

The apparatus designed to test the time stressed aspects of the TM-ID test resulted in an effective portable system that can be replicated by appropriately trained electrical technicians in sport and exercise settings, e.g., sport institutes, academies and colleges and universities. The system collects latency and response selection data which is used to show that players in team sports can recognise their team-mates from video footage captured from various camera view points (Steel, Adams, Canning, & Eisenhuth, 2010) at levels significantly better than chance. This type of testing system is important as the variables that remain trainable within athletes become increasingly more plausible in the motor skill domain as physiological limits and loads are reached. That is, current training is heavily biased toward physiological concepts (Norton, Burton, & Upton, 2005) rather than more holistic approaches that also include sound motor learning theory and applications. Thus usable tests and decision-making concepts and strategies should be employed.

This paper has reported that latency data can be collected with a purpose-built apparatus that utilised a home key and semicircular key panel to collect reaction time and response choice data. Examination of RT data collected using this device (Steel et al., 2010) has shown that the participants were able to make their decisions with reaction times that are useful in fast-ball sports, i.e., < 500 ms (McMorris, 2004).

When using the device participants are instructed to move from the home key to the appropriate selection key in the one movement, as soon as they had decided whether they were watching a team-mate or not, and how confidant they were about their decision. If participants react to the appearance of the video-clip on the monitor screen by immediately lifting their hand from the home key, then decided whether they were watching a team-mate or not before moving to one of the selection keys, all RT values would have been uniform. This has not been the case (Steel et al., 2010) when using this device. The data collected on this device shows a standard of time sensitivity that provides data that can be used to compare against other studies in RT (Pierrel & Murray, 1963).

In conclusion an apparatus involving a sensor attached to a monitor screen that can start a timer when a sport video-clip appears can be used to test athletes for their ability to identify team-mates in the TM-ID test.

A separate decision key and set of selection keys on a response panel enable collection of both latency and signal-detection decision accuracy measures. The apparatus design presented here has potential for application with all invasion team sport players and in any gait recognition based task. A further application for this device and testing protocol could take place in armed forces settings, e.g., the military though is a matter for future research.

5. Acknowledgment

The research reported in this article was supported by a grant awarded by the Australian College of Physical Education, Olympic Park, Australia.

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