International Journal of Law, Education, Social and Sports Studies (IJLESS)
A Peer Reviewed (Refereed) International Research Journal
Homepage:www.ijless.kypublications.com
Vol. 2. Supplementary issue 3.2015 (October)

Category: Information Technology in Sports

I S S N : 2 3 9 4 - 9 7 2 4

ADVANCES IN THE APPLICATION OF INFORMATION TECHNOLOGY TO SPORT PERFORMANCE

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ABSTRACT

This paper overviews the diverse information technologies that are used to provide athletes with relevant feed- back. Examples taken from various sports are used to illustrate selected applications of technology-based feedback. Several feedback systems are discussed, including vision, audition and proprioception. Each technology described here is based on the assumption that feedback would eventually enhance skill acquisition and sport performance and, as such, its usefulness to athletes and coaches in training is critically evaluated.

Keywords: feedback, information technology, skill acquisition, sport, training.

Introduction:

It is well documented that when feedback is provided in an appropriate manner, motor skill acquisition improves significantly (see Schmidt and Lee, 1999, for a review). Consequently, feedback is a major factor in the improvement of sport skill performance. Recently, advances in information technology have made it possible to augment and improve the feedback athletes receive during training and competition. Moreover, modern technology has had such a profound impact on sport that many athletes and coaches now consider information derived from technological advances to be invaluable. This might be related to the concept of feedback that originated in mechanical control theory.

In accordance with such engineering models, close loop systems were designed to keep homeostasis or equilibrium around a reference value, which, in turn, would allow the work of a main actuator (Shannon and Weaver, 1949). Deviations from the steady-state

Reference were coded as error, which would then drive the system to compensate or correct. That is, in movement science, feedback information about movement was generally expected to allow systematic corrections in the performance. However, feedback will be relevant to the human learner if, and only if, the individual knows the performance goal and perceives the need to carry out corrections relative to some expected out- come. Under such assumptions, a coach should strive to

Provide an environment that is conducive to optimum learning by augmenting the feedback that athletes receive. Feedback should thus enable athletes to modify their movements and produce optimum performance.

In this paper, we provide several sport examples of how performance feedback can be augmented by the use of modern technology. The examples are discussed and further used to bridge the theory of motor skill acquisition and the practice of coaching. Our main goal is to describe and evaluate technological advances applied to sports that could be potentially useful, provided they are based on an appropriate exploitation of the sensory and cognitive feedback resources available to the performer. However, it should be realized that this paper is not intended to be a comprehensive review of all the factors that the learning of motor skills.

Video information in training:

In normal conditions during training, athletes are active in correcting errors. However, on some occasions, coaches use alternative aids to provide extrinsic (external) visual feedback, for example videotaped replays of the performance. In this context, video technology has significantly influenced training methods.

Although video technology originated in the 1950s, its use in coaching is an innovation less than two decades old. Its attractions for use in training are its relatively low cost, accessibility and portability. It is affordable for most workers and, perhaps, already the most popular technology used in sport. However, using this medium requires performers to adopt a passive attitude. Individuals watching their performances cannot always control the feedback information received during a video presentation. This feedback is delayed until the task is complete and, therefore, cannot always be associated with the internal sensory information at the time of motor execution. Moreover, the information available may often exceed the athlete's processing ability; thus, additional guidance may be required, particularly with inexperienced or young athletes. In such cases, the coach's role is to guide and help in associating the visual feedback generated by the presentation of the video movie with the expected results.

Video-based motion analysis systems, although significantly more expensive, are also used to facilitate feedback about performance kinematics. Lately, these systems (e.g. APAS, Ariel Inc., http://www.arielnet. com; Silicon Coach, Silicon COACH Ltd, http://www. siliconcoach.com) have become more accessible, often being available over the Internet. They are adaptable to any common technology most PC platforms, video camera systems and frame grabbing technologies are supported and affordable for the coach. A combination of common digital technologies allows video recording in conditions, for example during a golf match. Images can be downloaded from any digital video camera via Fire wire to hand-held computers (e.g. HP Jornada Series). They can then be transmitted in a compressed image format to a remote server through GPS (Global Position System satellite service) or directly by a cellular phone to the same server (see hand-held APAS, Ariel Inc.). The video data can be distributed and analyzed by researchers in any of the available server locations providing the service around the world. Very basic kinematic proles and tabulated results such as shot release speed, angle, height and phase durations through the put can be returned to the performer or coach in the in minutes. These can be accompanied by similar data from world ranked experts for comparison, retrieved from a library of in the sport.

Video is also recognized as an appropriate medium for obtaining qualitative information about the performance. Video, in combination with TV technology (http://www.orad.co.il), is suitable enhancement of feedback using replays, real-time three-dimensional simulations or superposition of vector graphics. It can be further used for individual notational analysis and game statistics in remote locations. Less abstract and important information can be obtained from video playback technology; for example, for on-site immediate comparison between one's performance and that of other athletes. One interesting technology used for this process is based on a superposition of video sequences appropriately transformed and graphically enhanced (scaled, translated and rotated for comparison). Such a superposition of two footages (one from an expert and another from a less-experienced individual) is presented simultaneously. This allows the recognition of essential

Difference performances (http://www.dart®sh.com/technologies/technologies_simulcam.html) and, in this way, visual qualitative and meaningful feedback is provided to the performer. The underlying assumption of such a motor learning strategy is based on imitation. Humans and other primates imitate movements from birth (e.g. facial or hand; Meltzoþand Moore, 1977) and continue throughout life bypassing the need to extract abstract kinetic or kinematic information to learn a motor skill. Based on the human and animal models, the potential of learning by demonstration is recognized and implemented in robot motor learning (see Schaal, 1999).Other video analysis systems, such as the coach-friendly' Silicon Coach and Quintic emphasize this type of comparative feedback and imitation. However, a note of caution about this type of learning activity has been raised by Bartlett (1999): one person's optimal performance is unlikely to be the same as that of another.

One further drawback with all video analysis systems is the time taken to record manually and accurately the coordinates of the joints of the body and other points important in the analysis (see, for example, Ay and Kubo, 1999). This precludes immediate feedback of anything other than the video images themselves and restricts fast feedback to simple kinematic and temporal data as noted above. More detailed kinematic analysis takes time. Automatic tracking systems (e.g. Expert Vision Analysis [EVA], Motion Analysis Corp., http://www. motionanalysis.com; Vicon, Oxford Metrics, http:// www.vicon.com; CODA, Charnwood Dynamics, http://charndyn.com) use several different technologies to track and record movements, some in real time. The systems that use passive markers and pulsed light arrays with simultaneous sampling from multiple cameras (e.g.EVA, Vicon) are particularly attractive for rapid feed- back in non-competitive sport settings. Hubbard and Always (1989) reported the early use of the EVA system to measure release conditions in the javelin throw quickly enough for the thrower to `improve performance' in the next throw. This system in corporate an optimization of javelin light for that thrower with the same release speed, and then fed back information on optimal release angle, angle of attack and pitch rate compared with values for the actual throw. As with

Much technologically driven information on the pro-vision of immediate feedback, no attention was paid to whether the immediate feedback of such information could improve performance. In this case, we expect, from over a decade's experience, that athletes need information on how to change their techniques to act changes in release angles and that this information is best provided with non-immediacy. Automatic tracking systems have not yet been widely used in athlete feedback, probably because of their high cost, their use frequently being limited to indoors and not providing a video image, although this can be done with separate and synchronized video cameras. However, because of the increasing frame rates of these systems (the latest Motion Analysis Eagle digital cameras capture at 500 Hz), real-time display not only of stick but also of joint kinematics and even of solid body models through packages such as SIMM (Software for Interactive Musculoskeletal Modeling) suggest wider applications in indoor training.

Training in three-dimensional virtual environments:

Visual feedback inherently carries information about the perceived relationship between the individual and the environment. Self-motion relative to the suroundings initiates perception of the moving environment as a precursor to action (Gibson, 1979; Michaels and Carello, 1981). To exploit the link between perception and action, computer applications create virtual environments by using different visual effects. This relationship is implicitin simulation trainers that are accompanied by three dimensional displays. Stereovision is a common technique used to create such a three-dimensional effect, based on the principle that each eye receives a slightly different view of the same visual object. Fusion of the two views and further interpretation of the three-dimensional image occurs at higher brain centers. Red-green or red-blue (passive), or polarized (active) glasses synchronized with a monitor (see http://www.3d-video.de), are among the earliest techniques to show different images to the two eyes. They have been used in semi-real environments or in completely immersed virtual-reality settings (see http://www.sgi.com/virtual_reality/, Immerse Reality). A more recent technology uses glasses that provide a complete TV display that is slightly different for each eye (see http://www.i-glasses.com). A simpler and more popular way to provide a three-dimensional experience is by showing superimposed objects, appropriately scaled and put in perspective, by creating movement and shading effects in the planar display. This is the case in TV-video games such as Nintendo and Sony Play Station.

In a simulated three-dimensional virtual environment, the coach may regulate important factors that influence perception, such as speed, orientation and directional changes, simply by operating a joystick or a keyboard. Thus, skill may result as a by-product of training in controlled simulated three dimensional virtual environments. Some technologies today have been developed for training in conditions that simulate the real surroundings. These technologies are setting a standard for indoor coaching in, for example, bicycle riding (CompuTrainer, RaceMate Inc.), golf (Part-T- Golf Ô, Part-T-Golf Marketing Company), windsurng (Force4 WindSurf Simulator, Force4 Enterprises Inc.) and other sports. Kelly and Hubbard (2000) reported the design and construction of a bobsled simulator for driver training. The system comprised a bobsled cockpit, motion control system and graphics workstation. The shape of the track being simulated was derived from construction specifications. The driver's view of the simulated track was presented to him on a monitor mounted in the cockpit, synchronized to roll angle and steering force feedback through the motion control system. Interestingly, this development was intended not only to help train the US bobsled team, but also to provide a `tourist attraction' to increase interest in the sport. Whether it succeeded in either intention was not reported. A recent concept is that of remote coaching via the Internet. People carry out a computerized exercise pro- gram while a third party supervises the routines and controls the mechanism. For example, a `servo valve' may be controlled in a remote mode to adjust speed, resistance and other parameters during a bench press or a knee extension on an isokinetic machine (see Ariel Dynamics Ltd, http://www.arielnet.com). The feedback is provided by the computer as a graphic display of selected movement parameters plus statistics such as peak and mean results of the performances during the workout. Similarly, on-line coaching can be done for running on a treadmill, cycling or training on a stepper (see NetAthlonÔ or UltraCOACH VRÒ software, IFT Ltd, http://www.®tcentric.com). The per- former can train in a virtual environment showing scenery of preference that is displayed on a screen while jogging on a treadmill. Wearing appropriate glasses.

These are all the advancements that are being used by various developed countries like USA and Canada which is helping them to reach great extents in sports and games .By implementing these sort of techniques even we can reach even heights in the future.