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Section IV – Behavioural Sciences in Sport

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The Effect of Virtual Training on Speed and Accuracy of Decision Making in Sport

by
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The concept of expertise is an appealing topic in numerous domains, including sport. Research suggests that the path leading to expertise in sport is significantly influenced by the development of specific components, such as knowledge, skill, and game-performance (Thomas and Thomas, 1994). A relatively new technique in the field of teaching and coaching is the use of video games as a mode of instruction (Swing and Anderson, 2008). The purpose of this study was to address the question of whether video games can improve declarative and procedural sport knowledge. Twenty-seven volunteers were recruited through flyers and word of mouth at a university in a Midwest community. Measurements included an American football knowledge (pre- and post) test, survey of experience, and six football practice sessions using a Microsoft X-box. The project was approved by the Institutional Review Board (IRB), Human Subjects Review Committee. Knowledge test scores increased significantly from pre- to post-test [t (26) =-4.997, p = 0.0001]; the improvements were moderate (effect size = 0.66). From practice one to practice six (time) the average speed of decisions improved significantly, but accuracy did not. Knowledge increased regardless of the experience level, but the largest improvements in decision accuracy took place at the lowest experience level. This research supports the idea that video games could be an effective tool to increase sport specific knowledge, particularly in novices.

Key words: *American Football, Decision-making, Procedural Knowledge, Xbox, Expertise.*

Introduction

The path leading to expertise in sport is influenced by the development of specific components of sport expertise, such as knowledge, motor skill, and game-performance (Thomas and Thomas, 1994). Knowing precedes doing; thus knowledge is critical to the development of sport expertise. There are many paths to knowledge; instruction, reading, study, and coaching. A challenge is finding an engaging and accurate source of knowledge. Video games are engaging, have the capacity to detect various levels of expertise (Buns and Thomas, 2011) and influence learning (Swing and Anderson, 2008). It remains unknown whether playing video games is a viable conduit for the prerequisite knowledge required for sport expertise.

The idea of expertise is an appealing topic in numerous domains, including sport. People's desire to be the best or to continue pursuing superior performance contributes to this interest. Defining "expert" traits in certain conditions has been the first step in expertise research and is often relative expertise, the best in a group. The definition of an expert can range from describing the best long jumper on a junior high track and field team to an Olympic champion in the decathlon.

A high level of game performance is one way to define expertise. The literature provides evidence that levels of game play and sport performance are influenced by knowledge. A study of children's basketball performance in

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relation to knowledge development indicated that the development of sport knowledge plays a significant role in skilled sport performance levels of children (French and Thomas, 1987). Decision making ability was the major determining factor in this study, showing that the change in a child's performance over the course of a season was due to an increase in their ability to make appropriate decisions during game play rather than an increase in motor skills. This suggests that cognitive skills in sport performance progress at a faster rate than motor skills. For example, the participant's execution component and scores for dribbling and shooting skills did not change over the season. Game play performance increased over the course of a season as did decision making, while skill did not. These findings suggest that the development of the sport knowledge base can influence actual game play without attainment of high levels of skill (French and Thomas, 1987).

Acquiring procedural knowledge can increase the correct response in game-play situations and can contribute to a higher level of success in game performance. These aspects of sport knowledge are obtained in the early years of participation (French et al., 1996), which explains why novice players often lack both declarative and procedural knowledge. The absence of declarative knowledge leads to the misunderstanding of rules or overall goals of games, while lack of procedural knowledge would lead to inability to make good decisions in game-play (Bunker and Thorpe, 1982). In sport, skill and procedural knowledge limit game performance. Knowing what to do (procedural knowledge) has been shown to precede the ability to perform motor or sport skill (McPherson and Thomas, 1989). Therefore, increasing procedural knowledge has the potential to improve game play performance. In the continuum of expertise, it may be more probable and effective to begin by building a sufficient knowledge base rather than beginning with the refinement of motor skills. The challenge is finding a way that this can be done, especially in view of the fact that coaches and teachers may possess limited procedural knowledge. Furthermore, coaches need knowledge and not motor skill; so increasing declarative and procedural knowledge has the potential to impact young athletes by providing better coaching.

Another issue for sport experts is the speed requirement in sport, where decisions must be accurate and rapid. In high strategy and fast-paced sports such as American football, basketball, and soccer, it is essential for players to make very rapid decisions about the nature of the action to be performed (Thomas and Thomas, 1994). The accuracy and speed of decisions made in these situations have been directly correlated to the availability of a sufficient networking system of nodes and links. The idea of a sufficient networking system is supported by similar findings involving research in youth basketball (French and Thomas, 1987) and tennis (McPherson and Thomas, 1989). These studies yielded significant differences in problem solutions between expertise levels. Logically, coaches making rapid and accurate decisions is also an important factor in success and the development of expert players.

A similar study conducted by French et al. (1996) found no differences between experts and novices in decision performance during baseball game. However, the lack of expert/novice differences in this study was attributed to the low frequency of complex decisions during game play and the continuous prompting of coaches and spectators. The majority of the literature illustrates differences between expert and novices when it comes to knowledge. Without the presence of this knowledge, expert levels of performance are not achieved. In the event of achieving expertise, a continuum of stages must be fulfilled. Attaining declarative and procedural knowledge ranks among the primary of these stages, with skill and game performance to follow.

While a sufficient knowledge base is very important, understanding the limitations keeping a student or athlete from this knowledge is equally important. One of the biggest limitations when it comes to expertise are instructional resources. Access to a knowledgeable coach during the learning process is essential to skill development. Research has shown that time spent with an instructor is crucial to an athlete's overall development (Deakin and Cobley, 2003). Given that a coach is normally responsible for a high percentage of an athlete's practice time, the coach's ability to devise an optimal learning environment becomes significant to an athlete's development (Horton and Baker, 2004).

Considerable evidence has been produced defining barriers to achieving expertise. The question of how athletes and coaches break these barriers in the pursuit of sport expertise remains. A relatively new technique becoming more evident in the field of teaching and coaching is the use of video games as a model of instruction.

Video games are of particular interest because they have been shown to be very effective teaching tools (Swing and Anderson, 2008) and have potential for skill improvement (Edwards et al., 2017). Success using video games has been recorded in such diverse domains as classroom education (Corbett et al., 2001), marine training (Prensky, 2001), and certain surgical procedures. In sport, studies conducted in American football (Londeree, 1967), baseball (Burroughs, 1984), ice hockey (Thiffault, 1974, 1980), and tennis (Haskins, 1965) have shown improvements to speed and accuracy of decision making through perceptual training. As stated before, decision making in sport is significantly affected by knowledge. Therefore, evidence suggests that the use of video simulation is an effective instrument in obtaining declarative and procedural knowledge in sports. American football performance was improved by perceptual training, suggesting that football knowledge might also be improved by training focused on knowledge.

All models of instruction have strengths and weaknesses, and video games are no exception. The vast majority of research on video games has focused on negative outcomes such as aggression, addiction, and depression (Granic et al., 2014). In recent years, however, the link between video game play and positive outcomes has increased. The literature highlights two strengths of video games that make them very effective teaching tools. The first of these two attributes is the ability video games have to capture and hold attention through an emphasis on perceptual cues (Swing and Anderson, 2008). A study designed to use video games to enhance the control of force in putting demonstrated the use of perceptual cues. Fery and Ponserre (2001) stated that a golf video game might not provide proprioceptive inferences for putting, but it could give sufficient visual cues to enhance force control in this skill. Video games help a person learn appropriate cues (major points in technique) for various situations that can be related to possible real-world situations. Therefore, a person is more inclined to use proper cues/response during a real-life situation resembling the situations learned from the video game.

Another advantage of a video game is that it offers clear objectives for the learner. This is important because these objectives/goals can be adapted to skills and knowledge of the player (Swing and Anderson, 2008). The games can also be adapted to each individual player's learning ability and pace of learning, which helps ensure that they learn the goals of the game. Video training provides realistic situations, and allows the individual player to react within its context. In a video game, the player may not respond appropriately or make the correct decision, but they receive immediate feedback. This feedback enables them to rethink their decision and ultimately lead to the correct response in a similar situation. The repetition and feedback of video games allow a player to learn correct decisions (accuracy) in the context of the game and use the learned information for future reference. Along with learned accuracy, the repetition of the situational decision making leads to making faster decisions. Video training may help the accuracy of decisions made by players, but the most likely effect is on how fast a player can make decisions (Starkes and Lindley, 1994).

Because sport knowledge (declarative and procedural) affects game performance (French and Thomas, 1987; McPherson et al., 1993), further research is needed to determine how procedural and declarative knowledge can be obtained. It is a challenging task to determine how procedural and declarative knowledge can be obtained, what athletes (students) and coaches (teachers) need to do, and what is important to them and what is not. However, it is helpful to know these points in order to develop a level of proficiency in game performance. The purpose of this study was to address the question of whether video games can improve declarative and procedural sport knowledge. If so, is the increase in knowledge relative to initial football experience? What effect does video game practice have on speed and accuracy of decisions in game-play scenarios?

Methods

Participants

For this study novice coaches (someone interested in American football, but has never coached) ranging in age from 18-30 were recruited. Participants were recruited from college classes using both flyers and word-of-mouth. The participants recruited had varying backgrounds and different levels of experience (amount of American football played) in both real football and video games. French and Thomas (1987) noted significant changes in basketball knowledge; however they did not report the standard deviations or effect sizes. Similarly, Bartholow and Anderson (2002) found significant effects due to video game play, but did not report standard deviations. Bushman and Anderson (2001) conducted a meta-analysis with significant effects from video game play, but the average effect sizes reported were small (-0.17 to -0.22), while the number of participants was large (695-4400). Twenty-five participants with an effect size of 0.7 or larger have a power of .7 or higher. There was no extrinsic reward offered for participation in this study, while a time commitment of approximately seven hours (six separate meetings) was required in the protocol. All 27 participants that started the study finished it in its entirety (no dropouts). Informed consent was obtained from all participants and the project was approved by the Iowa State University Institutional Review Board (IRB).

Measures

American Football Knowledge Test. A 50-item multiple choice test was constructed and used to assess football knowledge. The items assessed both the participant's declarative and procedural knowledge in areas such as rules, player positions, terminology, strategy, proper technique, and situational decision making ability. The test included 25 items that represented procedural knowledge, even though knowledge tests are viewed as assessing declarative knowledge.

The first draft of the test was developed using a table of specifications based on two sources of football knowledge from the American Football Coaches Association (AFCA) and National Collegiate Athletic Association (NCAA). To further test content validity, the test was reviewed by two experienced American football coaches and revised based on their comments. The test was administered to five volunteers with varying football experience. Those volunteers took the test on two occasions and the test-retest reliability was calculated. Test-retest reliability (KR-20) was accepted at .7 and above for the small sample in the pilot study.

The knowledge test included 50 multiple choice items covering declarative and procedural knowledge of American football. There was a wide range of performance (M = 41 correct, SD = 5.3, minimum = 22, maximum = 48). The KR-20 of .80 showed the test has moderately high internal consistency. Thus, the test was declared reliable. The frequency distribution included a trend of increasing scores from pre- to-post intervention. The pre-test scores had only five test scores in the highest two interval ranges (44-45 and 46-48) and four tests of 33 or below, whereas the post-test scores had 13 test scores (nearly half) that fell in these two intervals with no tests below 34. The overall trend included an improvement of test scores from pre to post intervention with an average number of items correct being 39.41 in the pre-test and 42.78 in the post-test. The item analysis showed eight items from the test having a low item quality (point biserial < .10). Of these eight items, three were too easy (answered correctly by nearly 100% of participants), while the other five items had low item quality due to poorly structured questions and a higher level of difficulty (questions: 8, 24, 27, 35, 50).

Survey of Experience. This survey determined both American football and video game experience. It included questions regarding past experience: participation history, current participation, level played, coaching experience, interest in football, video game experience and other information regarding football and video game familiarity.

Electronic System Selection. The platform known as the X-Box 360 was used to display the virtual information to each participant. The X-box 360 allowed for a better visual representation of the cues and situations experienced in the virtual simulation compared to other video alternatives (e.g., Wii). The X-box focused more on decision making and declarative knowledge within the context of the game rather than manipulative movements of controls and hand-eye coordination. This made the X-box more appropriate for this study.

Video Game Selection. Madden 2008© was the game used for this study because it ranked among the best of recent video games (at the time of the study) representing real-life situations, rules, regulations, and strategies. The game allowed for two important opportunities. First, at the end of practice sessions, game results (statistics) were provided. They were then recorded and used to represent each practice performance. These results were used to assure the participant's engagement in each practice session. Second, various levels of difficulty were possible in Madden 2008©. As participants improved in video game-play, the level of difficulty in the game/competition increased accordingly to assure each participant the opportunity to improve. Participants were evaluated on both the results of each individual practice (game statistics) and the difficulty in the level of play achieved.

Design and Procedures

Participants came to the lab for all testing. There were two testing sessions (one pre- and one post-intervention) and three weeks of practice (intervention). During the pre-test session, participants read and signed informed consent, completed the football/video game experience survey, took the knowledge test for the first time, and scheduled six practice sessions for the intervention. The informed consent included a request that participants would not play any American football video games outside the study until their participation in the study was complete. The remainder of the pre-test session was used for the participants to become familiar with the game, controllers, and procedure. This was done through the use of Madden 2008© mini-games. Each participant took part in four mini-games. These mini-games enabled the participants to become familiar with the characteristics of the controller along with the visual representation of Madden 2008© on the television screen. These mini-games helped reduce the effects of a video game learning curve when the intervention began. A pilot was used prior to the study design to help control for effects of a video game learning curve. The pilot work provided feedback on the mini-games that were the most beneficial for familiarizing participants with the gaming system and visual representation. The pilot showed four mini-games to be the most beneficial in reducing the learning curve associated with most video games. The same four mini-games were used for each participant during the pre-test session.

The post-test session took place during the last or sixth practice session of the intervention. The knowledge test (administered for the second time) was taken immediately following the completion of the last practice session. Once the post-test was completed, the participants were given a post-test survey regarding how much exposure to American football and football video game play was done outside the experiment. The survey included questions such as: "Have you attended a football game since the beginning of this study? Have you read about or studied football since you started this study? Have you watched football on TV? Have you played Madden 2008© during this study other than the intervention? Are you interested in coaching football? How confident are you in your ability to coach football at this time?" This helped to better understand the true effect of the intervention. This procedure was the same for all participants.

There were six practice sessions over a three-week period that lasted approximately one hour each. These sessions were consistent for each participant and involved the same or similar situations for each session. The game was loaded and ready to play upon the participant's arrival starting with the coin flip. The game consisted of a home team (controlled by the participant) and an away team (computer controlled). The New England Patriots football team was used as both the home and away team during each practice session. This was done for consistency between participants and practice sessions. The game settings were consistent for each session of the intervention. They were set to best simulate a real-life football game under "normal" conditions (sunny, no wind, no precipitation, etc). The quarters were set to 5 minutes instead of a real football quarter of 12 (high school) minutes due to time constraints. At the end of each quarter, statistics were recorded. At the end of each practice session, each participant was asked to refrain from reading, studying, playing, or watching football until finished with the study.

Each individual experience during the 20 min simulation of a football game was unique.

The scenarios and situations experienced during these simulation games cannot be controlled. Each game played had a wide variety of scenarios and interactions within the context of the game of football. Each participant played approximately 20-25 downs (individual plays or scenarios) during each five minute quarter, which yielded approximately 80-100 total plays for the entire 20-min game. The simulation experienced by one participant differed from that of the other participants, but the second portion of each practice session involved a protocol of consistent scenarios across all participants.

Each practice session had a set of six consistent scenarios. These scenarios were carried out at the end of each practice session following the 20-min simulation. In these six scenarios, the participant was responsible for offensive decision making whereas everything else was controlled and constant (defense, score, time remaining, down/distance, etc). The context for these scenarios was presented visually to the participants using flash cards which were constructed to mirror the look of a football scoreboard. They included all the necessary information needed for a coach to make an informed decision based on a football scenario. Using the knowledge provided by the situational scenarios (flash cards), the participant then was required to choose what they thought to be the most appropriate decision in the given situation. Upon the presentation of each flashcard, a 25- s timer (representing a high school play clock) was started simultaneously. Once the situational scenario had been provided, the participant had 25 s to make their decision for the situation. Each decision (offensive selection) related to the given scenario was recorded along with the amount of time it took to make the decision. This data were used to test accuracy (play selection) and speed of decisions (decision time).

These scenarios offered consistency between participants that ensured each was experiencing at least six of the same scenarios during each practice session. There was a set of six unique scenarios designated for each practice session. The scenarios were similar in their context, but not identical. The six scenarios were standard and constant for each participant in each session meaning that each participant was exposed to the same set of six scenarios during the same practice session. These scenarios were used to help understand participant knowledge of football and if this knowledge was increasing throughout the intervention.

The standard scenarios used during the practice sessions were directly correlated to 24 questions on the cognitive test, ensuring that each participant experienced at least six consistent scenarios during each session and was a means of measurement of knowledge gained within the intervention.

Certain benchmarks were set in order to determine the difficulty in the level of play at which each participant competed. All participants began at the game's second level (Pro). Total offensive output was the benchmark used to determine the advancement in the level of difficulty. The difficulty level increased by one level each time a participant reached 400 yards of total offense. When this benchmark was met, then the level of difficulty was increased by one level before the start of the next practice session. Difficulty of play continued to increase one level each time the benchmark was reached to assure each participant was challenged during practice and allowed the chance to improve.

Statistical Analysis

The study design was a simple pre-post design with an intervention of six video game play sessions. The analysis for the main question was a dependent t-test on the total knowledge test score pre and post. In order to assess the benefits of practice, a repeated measures MANOVA was completed with practice sessions (stats) as the repeated measure, and total yards and correct decisions within the time (scenarios) as dependent variables.

Results

The dependent variables used in the data analysis were knowledge score, total yards, level of video play, win/loss ratio, accuracy of decisions, and speed of decisions. There were other variables among the data collected, but the previously listed variables were the variables that yielded data in a more normal distribution allowing for a better interpretation of the results and meeting the assumptions for parametric statistical analysis. In the analysis of the data, the game stats were corrected for the level of difficulty. There were three levels of difficulty in the intervention. In order to associate a higher value or improvement with the higher the level of difficulty, the game stats (total yards) were multiplied by the level of difficulty (pro = 1, all-pro = 2, all-Madden = 3) attributing higher values to the participants who improved to the higher levels of difficulty. Three analyses were completed on the same data; therefore Bonferroni was used to correct the alpha (.05/3 = 0.0167).

A dependent t-test was used to evaluate whether or not declarative and procedural knowledge changed from the pre to the post-knowledge test. Knowledge test scores increased significantly from the pre- to the post-test [t (26) =-4.997, p = 0.0001] and the improvements were moderate (effect size = 0.66). Descriptive data for the pre and post knowledge test scores are presented in Table 1.

To determine if video games improve the accuracy and speed of decisions in game scenarios, the participants were divided into two groups, a low (n = 11) and a high (n = 16) knowledge group. The two groups were formed based on the post-knowledge test scores. The overall mean (85.6) was used as the cut-off point. The minimum and maximum scores indicate that there was no overlap between the newly formed groups at the post-test for knowledge; confidence intervals support differences between the groups at the pre- and the post-test for knowledge (Table1).

A group by time (2 x 6) MANOVA produced significant within subjects effects for speed [F (5, 125) =29.99, p = .0001], total yards [F (5,125) = 9.99, p = .0001] and level of video play [F (5, 125) = 14.06, p = .0001], but not for accuracy of decisions or win-loss record. No within subject interactions were significant. None of the between subjects effects (knowledge group) were significant. Win-loss was the only dependent variable approaching significance at p = .08. Descriptive data for this MANOVA are presented in Table 2.

To examine the influence of previous American football experience, three experience groups were formed based on previous football experience: low (n = 8), moderate (n = 12) and high (n = 7). The MANOVA repeated measures for experience by time (3 x 2) produced three significant time (pre-post) main effects for knowledge [F(1,24) = 24.83, p = .0001], speed [F(1,24) = 47.06, p = .0001], and total yards [F(1,24) = 8.2, p = .008 and one interaction for accuracy [F(2,24) = 6.5, p = .006]. No between subjects effects were significant, with accuracy of the only one variable approaching significance (p = .056). Descriptive data for this MANOVA are presented in Table 3.

Table 1

Descriptive data for the knowledge test at pre- and post-intervention.

Test	n	Knowledge Group	M	SD	95% Confidence Interval Lower Boundary	Upper Boundary
Pre-Knowledge Test	11	Low	71.0	14.4	61	81
	16	High	84.0	6.1	81	88
	27	Overall	79.0	12.1	74	84
Post-Knowledge Test	11	Low	78.0	5.7	74	82
	16	High	91.0	3.4	89	93
	27	Overall	85.6	7.9	82	89

**Indicates Significance (p < .05)*

Table 2

Descriptive data for the MANOVA repeated measures with two groups (high and low knowledge) and time (six practice sessions) for dependent variables of speed and accuracy of decisions, level of play, win/loss, and total offensive yards.

Main Effect Group	Knowledge Group	M	SD	95% Confidence Interval Lower Boundary	95% Confidence Interval Upper Boundary
Accuracy	Low	81.8%	17.4	78.06	87.21
	High	85.8%	13.2	83.31	91.50
Speed of decisions	Low	14.46	3.30	11.13	13.43
	High	13.72	2.69	11.84	13.09
Win/loss	Low	0.63	0.52	.42	.83
	High	0.87	0.56	.69	1.01
Total offensive yards	Low	337	116.16	226	448
	High	341	85.4	242	440
Level of play	Low	1.26	0.75	1.05	1.48
	High	1.28	0.77	1.08	1.47

Table 3

MANOVA repeated measures experience group by pre-post for number correct of 42 on knowledge test, speed of decisions, total yards offense and win percent.

	Effect	Mean	SD	95% Confidence Interval Lower boundary	95% Confidence Interval Upper boundary
Time Main Effects					
Knowledge test*	Pre	33	1.16	31	35
	Post	37	0.73	35	38
Speed of decisions*	1	16.64	4.84	14.68	18.59
	6	10.67	1.89	9.92	11.42
Total offensive yards*	1	253	96.95	215.09	291.80
	6	447	452.05	308.20	587.20
Win-loss	1	.54	.10	.33	.75
	6	.56	.10	.35	.78

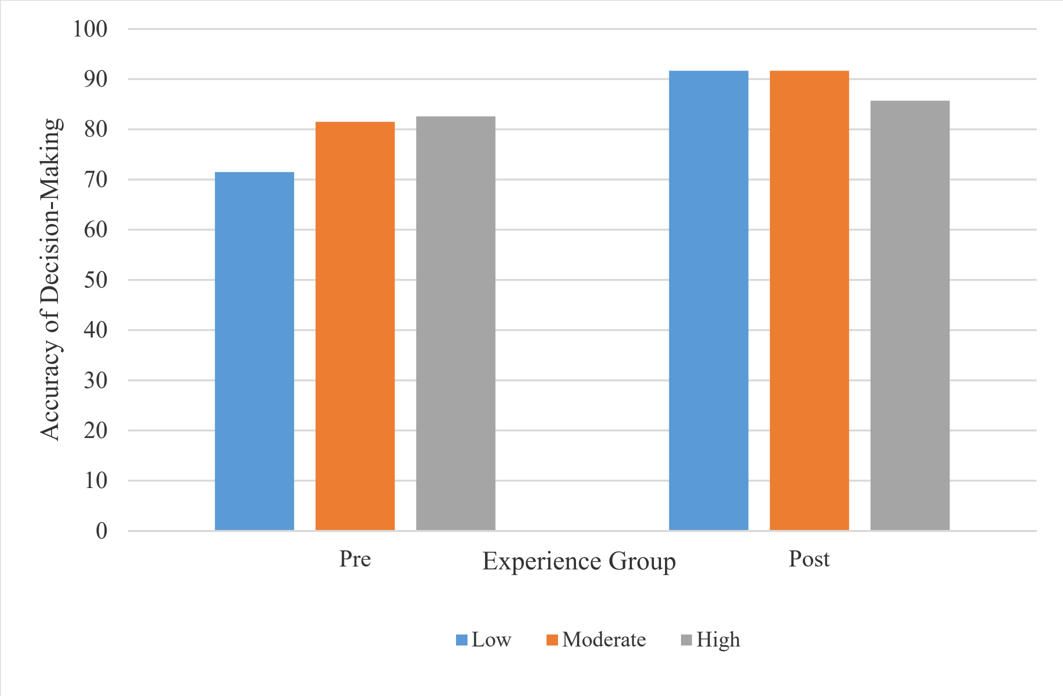

Figure 1

Descriptive analysis of average accuracy of decision-making by a football experience group from pre to post.

Six real-life game scenarios were presented to the participants at the end of each practice session. In each practice session there were five scenarios that had one correct answer, along with one scenario that was considered a gray scenario (one answer is considered correct, but others were possible, yet poorer choices). The average correct response percentage for the gray scenarios was 72%, whereas the average for the rest of the scenarios was 88%. The easiest scenarios were when passing was the best choice (96% correct), and the most difficult was punting (78% correct). Considering incorrect responses, the most frequently used when the choice was poor or incorrect was passing (60%). Punting was never selected as a poor choice and a deep (DP) kick, field goal (FG) and onside (OS) kick were selected 10% or less of the time as poor or incorrect choices.

Discussion

The discussion focuses on three findings: the increase of declarative and procedural sport knowledge related to video representation, the effect of video game practice on speed and accuracy of decisions in game scenarios, and the increase of knowledge relative to initial American football experience.

This research supports the idea that video games are an effective tool to increase knowledge. Participants' knowledge increased with exposure to the video game. Knowledge, based on a written knowledge test, increased significantly in this study. The moderate effect size (0.66) showed that the intervention had a significant and meaningful influence on the outcome of the knowledge scores. This is particularly important because the time for the intervention was short (six one-hour sessions) and the intervention was simple (play video games). Previous literature has shown that video games were effective teaching tools (Swing and Anderson, 2008), but little research has been done on video game's effect on the increase of knowledge in sport. The results demonstrate meaningful differences in the knowledge test scores from pre- to-post intervention, which supports the idea that video games can be used to increase knowledge as a foundation for expertise. This is particularly interesting because the participants were focused on learning the central knowledge associated with video game play, but improved on incidental knowledge as measured by the knowledge test.

One of the single greatest challenges facing teachers and coaches is increasing knowledge for themselves and their students or athletes (Siedentop et al., 2004). Expert or high caliber athletes and coaches excel within their sport, in part, due to their significant stores of procedural and declarative knowledge (Chamberlain and Coelho, 1993). The attainment of this knowledge enables novices to progress toward expertise in their sport. However, it has been a challenge to find an efficient resource that helps make this increase in knowledge both cost and time efficient. Consistent with the theory and research in sport expertise, the participants in this study increased knowledge as a result of video game play and those with more experience at the start of the study had more knowledge and performed better than less experienced participants in video game play.

A second measure of knowledge that is particularly important in sport expertise is procedural knowledge. In this case, scenarios were used to determine the speed and accuracy of decisions. In sport, speed in decision making has been identified as a critical feature in success. The ability to make rapid, accurate decisions in sport is a characteristic that sets experts apart from novices. In sports such as American football (fast paced/high strategy), the speed of decisions regarding the action to be performed is associated with the level of success (Thomas and Thomas, 1994). The speed at which these decisions are made is directly related to the knowledge base. In order to be fast and accurate in the decision making process, the appropriate knowledge must be available (French and Thomas, 1987; McPherson and Thomas 1989).

This study yielded results both supporting and opposing previously viewed literature regarding the effect of video game practice on speed and accuracy of decisions. The within subject effects showed a significant decrease in the time required to make decisions during game scenarios (M = 13.98 s to 10.67 s); however, the accuracy of these decisions did not yield a significant improvement (M = 85.8% to 90.12%). The between subjects (knowledge groups) results were reversed, yielding a significant improvement in the accuracy of the decisions with no difference in speed. Thus, from practice one to practice six (time) the average speed of decisions improved significantly, but accuracy did not. However, when comparing high and low knowledge groups (based on the pre-knowledge test score), the accuracy of decisions was significantly higher for the high knowledge group, whereas the speed had no significant difference. All participants improved their speed of decision making, but the difference in accuracy was related to the knowledge level of the participants. This can be explained by finding of French et al. (1996) that showed that acquisition of knowledge could help increase the correct response in game-play situations leading to higher success levels. However, this aspect of sport knowledge was obtained in early years of participation, explaining why novices often lacked the declarative and procedural knowledge necessary for making correct decisions. The results from this study show a consistent improvement of speed across participants, but the greatest accuracy was held by those with the higher level of knowledge. These findings support the idea that knowledge improves both speed and accuracy of decisions, but these improvements may be expressed differently at various knowledge levels.

Declarative knowledge (e.g., rules, definitions) is the lowest level and first knowledge mastered, followed by procedural knowledge. Both types of knowledge in sports have been related to experience (French et al., 1996). Generally more experience has been associated with more knowledge and expertise, which is supported in this study. The time main effects showed an improvement in knowledge, speed of decisions, and total yards (game-stats) which suggest that the intervention was effective. For the purposes of this study, increasing time was increasing experience, showing that on average all participants improved in these categories from practice one to practice six. The group main effects (between subjects) had no significant differences showing that the improvements were consistent across all levels of experience. All participants increased knowledge regardless of their initial experience.

When group by time interactions were calculated, accuracy produced the only significant interaction. The interaction showed that accuracy of scenario decisions was affected by the level of experience in American football. The greatest change in accuracy took place at the low level of football experience (up to 1 year of high school American football). The moderate level of experience showed little change, while high experience actually decreased in the accuracy of decisions (Figure 1). A plateau effect of learning was evident where the greatest improvement in accuracy took place at the lowest level of football experience, with little improvement at the moderate level (2-4 years high school football) experience and an actual decrease at the highest level (college football). The moderate and high experienced groups had high levels of accuracy at the start of the study (90% and 95%, respectively), therefore leaving little room for improvement. The results show that knowledge increased regardless of the experience level, but the level of experience did have an effect on the amount of improvement in the decision making accuracy during the intervention. The largest improvements in decision accuracy took place at the lowest experience level, suggesting that learners with the lowest amount of experience may benefit the most from the intervention.

Limitations

This study design did not include a control group, leaving questions in the overall effects of the intervention on the pre- to-post knowledge tests. The recruitment for this study was not random due to the need for novice coaches of a certain age. Each participant was asked not to participate in football video games during the intervention, but there was no way to have complete control of these variables. The intervention took only offensive game statistics and offensive scenarios into consideration as the video game is biased to offense. There were uncontrolled variables that could influence the outcome of the simulation such as defensive play and special teams. A study design and analysis taking into consideration offensive, defensive, and special team variables could produce a better representation regarding overall American football knowledge. These modifications lead to making video games a more effective tool in both assessing and generating a broader knowledge base.

Future Recommendations

Video games have been shown to be useful tools in increasing both knowledge and skill, but rarely have they been used in the realm of sport. Past studies have shown video games to increase knowledge and create effective training methods in areas unrelated to sport (Corbett et Al., 2001; Prensky, 2001), and even their use in sport to increase skill improvement (Barnett et al., 2012) and speed and accuracy in decision making (Burroughs). This study shows different patterns in video games effects on knowledge and performance. The experience and repetition of these contextual situations increase the knowledge of both correct and incorrect responses, which leads the player to understand what decisions are best for certain situations. Virtual sport experiences appear to offer tremendous learning opportunity. Video games have the potential to be a cost/time effective method of decreasing the gap between novices and experts, and future research can help construct an efficient method of increasing sport knowledge and expertise. However, there are unanswered questions about the use of video games to enhance sport performance and coaching potential.

While the current study suggests video game play can improve knowledge and "side-line" decision making, skills critical to coaches, it remains unknown whether such knowledge would be effectively applied during actual game play. Thus, video training works for coaches in the lab, but it is unknown whether it will work for athletes. Future research should also examine additional opportunities for learning beyond the changes identified in the current study and whether or not there is a plateau effect to this learning.

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