The use of Video Game Technology for Investigating Perceptual and Cognitive Awareness in Sports

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ABSTRACT
This paper describes a framework for investigating and manipulating the attentional components of video game play in order to affect learning transfer across different task environments. Several groups of video game players (VGP) and non video game players – both hockey and non-hockey groups (NVGPH, NVGP) will be tested at baseline on several aspects of visual processing skill. The NVGP and NVGPH groups will then train for one week in an action video game playing environment. They will then be re-tested for attentional efficiency. The hockey group will also be tested before and after training on a pattern and cue recognition sport video test. We intend to show that, not only does video game play alter basic components of visual attentional resources, but that it can also enhance perceptual learning transfer across unrelated task domains.

Keywords
Attention, cognition, ice hockey, perceptual learning, sports, video games, visual processing

BACKGROUND
Emerging evidence concerning the nature of expertise in sport shows that, regardless of innate talent, genetic limitations, and hereditary predispositions, elite skill levels cannot be attained without many years of focused, dedicated, and deliberate practice[5,11,12]. Through this 'immersive' environment players acquire the appropriate perceptual, cognitive, and social skills needed to optimize anticipation and decision-making within their sport. Similarly, current research indicates that video game play is also a highly immersive endeavor, whereby players develop advanced perceptual, cognitive, and social skills that they are, for the most part, unaware of [7]. It is this similarity that we seek to exploit through the utilization of sports video game play as a

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framework to understand the mechanisms underlying decision-making in sport.

Our research is concerned with the development of expertise. We seek to understand the characteristics of expert awareness and decision-making in sport. The current standard laboratory research paradigm in sport psychology favors independent trials where the beginning of the trial is defined by the occurrence of the presented stimulus, a process outside the control of the subject[4]. Mechanisms such as cueing strategies, pattern recognition, and visual search strategies are all investigated in isolation of each other. In contrast, within the ecological landscape of an athlete's playing environment, expert performance is ever-changing and continuous, characterized by a perception-action continuum and the need to analyze emergent situations in order to elicit responsive action instantaneously[3].

We take a novel approach to investigating and explaining the nature of expertise in that, while we agree that expertise encompasses specific skills at each of the perceptual, cognitive, and social levels, and that it is important to understand the underlying mechanisms involved in expert performance, we contend that researchers must also consider the interplay between these mechanisms, and the ecological context in which they are performed, in order to fully understand the nature of expertise. While much of our own research involves investigation in the field, we propose here a novel ecological approach to the study of sports expertise that makes use of the immersive nature and realism of high-fidelity video games, in an attempt to affect the transfer of perceptual learning between the video game environment and the actual sports environment.

It is now recognized that experts in sport are differentiated from novices by their superior decision-making abilities[14]. Decision-making is a by-product of perceptual, cognitive and social skill, and the elements that have been shown to contribute most to high levels of perceptual, cognitive and social skill in sport include;

- the ability to process contextual information using effective advance postural cue utilization;
- superior recall and recognition of sport-specific patterns of play;
- more appropriate and efficient visual search strategies; and
- the ability to anticipate future events through the efficient assignment of appropriate situational probabilities[13,14].

From this characterization it is clear that there are various different knowledge elements important to the formation of expertise. The stance taken by most current literature suggests that there are distinct frameworks that govern such different cognitive knowledge types, and that these elements are treated independently. Our research seeks to extend this approach by investigating the ongoing interaction between all of these knowledge types (i.e. cue utilization, pattern recognition, visual search, assignment of situational probabilities), and the instantaneous, and quick-shifting pattern of action between them. Our overarching research hypothesis contends that expertise is characterized by the ability to shift, or translate, between various knowledge representations, or strategies, and to hold these different knowledge types in memory simultaneously during decision-making. Our long-term research goal is to advance the formation of expertise by providing learning mechanisms designed to enhance this ability to shift between, and learn, different knowledge attributes. Specifically, the goal is to create a conceptual

framework that will help designers make better-informed design decisions through a more thorough understanding of the constituents of, and interplay between, different knowledge types.

INVESTIGATIVE FRAMEWORK

Here we will present a framework for investigating the precursors to perceptual learning in hockey. We are using an immersive video game environment to attempt to transfer increases in perceptual learning to the actual sports environment. While the field of perceptual learning provides many examples of training-induced performance enhancements, these increases in performance are generally specific to the tasks being trained, and do not transfer well to new environments[1,2,6,8,10]. We seek to show that playing video games can affect changes to several components of visual processing, including both attentional resources and pre-attentive processing, and that these changes can also be transferred to sport-specific playing environments.

The study is specifically interested in;

(a) Understanding and measuring the visual processes that are utilized in video game play.
(b) How these processes are affected by training.
(c) The ability to transfer these training affects in perceptual learning to novel environments.
(d) Understanding the visual search strategies of experts and non-experts
(e) The suitability of a high-fidelity video game environment as a platform to examine the real ecological environment of sport.

Several standard attentional study protocols will be utilized to measure attentional resources, enumeration performance, attention over space (periphery), attention over time (attentional blink), and performance before and after training. Eye-tracking will also be utilized in order to determine search patterns of experts versus non-experts.

The three groups involved include;

(a) Expert video game players who do not play ice hockey (VGP)
(b) Expert hockey players who do not play video games (NVGPH)
(c) Non-video game players who also do not play hockey (NVGP)

Pre-tests will be conducted on all groups in order to obtain baseline scores on several attentional tests. Additionally, the hockey group (NVGPH) will be examined using a real video protocol, where subjects will be required to choose responses to video clip sequences of game action and will be scored on speed and accuracy.

Both non-video game playing groups (NVGP, NVGPH) will then train for one week on an action video game. At the end of this period a re-test of attentional resources will be carried out on these groups. The hockey group (NVGPH) will also be tested again using the same video clip protocol as before.

We expect to see improvements in scores on the attentional resource tests, as a result of the one week video game training period, but more importantly we are interested to see if perceptual learning of this type can transfer to the unrelated task environment of hockey itself.

REFERENCES

1. Ahissar, M., Laiwand, R., Kozminsky, G. & Hochstein, S. (1998). Learning pop-out detection: building representations for conflicting target-distractor relationship.Vision Res. 38, 3095–3107.
2. Ahissar, M. & Hochstein, S. (2000). The spread of attention and learning in feature search: effects of target distribution and task difficulty. Vision Res. 40, 1349–1364.
3. Ericsson, K. A., & Charness, N. (1994). Expert performance: Its structure and acquisition. American Psychologist, 49, 725-747.
4. Ericsson, K. A., & Smith, J. (1991). Prospects and limits of the empirical study of expertise: An introduction. In K. A. Ericsson & J. Smith (Eds.), Toward a general theory of expertise (pp. 1-38). Cambridge, UK: Cambridge University Press.
5. Ericsson, K. A., Krampe, R. T., & Tesch-Romer, C. (1993). The role of deliberate practice in the acquisition of expert performance. Psychological Review, 100, 363-406.
6. Fahle, M. & Edelman, S. (1993). Long-term learning in vernier acuity: effects of stimulus orientation, range, and of feedback. Vision Res. 33, 397–412.
7. Gee, J. P. (2003) What video games have to teach us about learning and literacy. New York: Palgrave Macmillan Press.
8. Poggio, T., Fahle, M. & Edelman, S. (1992). Fast perceptual learning in visual hyperacuity. Science 256, 1018–1021.
9. Sagi, D. & Tanne, D. (1994). Perceptual learning: learning to see. Curr. Opin. Neurobiol. 4, 195–199.
10. Sirenteanu, R. & Regina, R. (2000). Perceptual learning in visual search generalizes over task locations and eyes. Vision Res. 40, 2925–2949.
11. Starkes, J. L. (2000). The road to expertise: Is practice the only determinant? International Journal of Sport Psychology, 31, 431-451.
12. Starkes, J. L., Helsen, W., & Jack, R. (2001). Expert performance in sport and dance. In R. N. Singer, H. A. Hausenblas, & C. M. Janelle (Eds.), Handbook of sport psychology (2nd ed.) (pp. 174-201). New York: Wiley.
13. Tenenbaum, G. (ed.) (1999). The development of expertise in sport: Nature and nurture. International Journal of Sport Psychology, 30, 113-304.
14. Williams, A.M., Davids, K. & Williams, J.G. (1999). Visual Perception and Action in Sport. London: E & FN Spon.