Tetris as Research Paradigm: An Approach to Studying Complex Cognitive Skills

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Tetris™ is the video game most used as a research paradigm by the Cognitive Science community (Mayer, in press). Collectively, the members of this symposium have and are using Tetris to study several phenomena that we each believe is just slightly out of reach but in sight of contemporary cognitive theory.

- Focusing on the *cognitive consequences* of Tetris play, Mayer and Adams will examine claims for general transfer from Tetris to executive functions, reasoning, and memory skills.
- Turning Tetris into an instructional paradigm, Skinner and Johnson explore intriguing data suggesting that the synchronization of instructor and student EEGs is correlated with successful student learning.
- Struck by the extreme expertise exemplified by the best Tetris players (e.g., watch this video – deathscout8, 2014) Lindstedt turns to AI-based models to explore the parameter space of features and feature weights that allow us to classify a human move as good or bad.
- Realizing the Yogi Berra maxim that, "You can see a lot by just looking", Gray examines the use of eyes in Tetris and relates the findings to the Cognitive Science issue of Epistemic Action (Kirsh & Maglio, 1994).
- Finally, skeptical as always, VanLehn (our Discussant) will begin the discussion by questioning the transfer of results from Tetris to other task domains.

Organized by Perez and Gray. Address all correspondence to Wayne Gray <grayw@rpi.edu>.

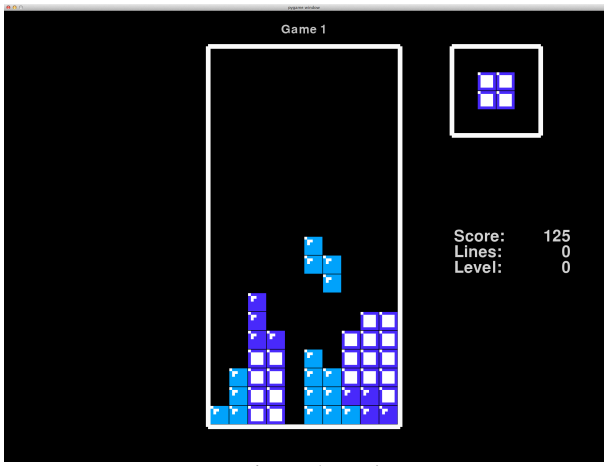

Figure 1. Tetris™

Symposium Presentations

The symposium will feature an introduction by Perez, followed by four talks, a short discussion, and then by a 20 min QandA among panel members and the audience.

Cognitive Consequences of Playing Tetris: A Research Review – Richard E. Mayer and Deanne Adams

Mayer and Adams will review research on the cognitive consequences of playing Tetris (Mayer, in press). One of the major methodologies in game research is the cognitive consequences approach (Mayer, 2011) which compares changes in the cognitive skills of a group that plays an off-the-shelf computer game for an extended period of time (game group) versus a group that does not play the game (comparison group).

On the positive side, playing Tetris has been shown to have a substantial effect on 2D mental rotation of Tetris-like shapes (d = 0.82 based on 6 comparisons) and a moderate

effect on 2D mental rotation of non-Tetris shapes (d = 0.38 based on 5 comparisons). On the negative side, playing Tetris has a negligible effect on 3D mental rotation skills (d = 0.20 based on 3 comparisons), other spatial cognition skills (d = 0.04 based on 14 comparisons), and perceptual attention skills (d = 0.15 based on 5 comparisons). The sparse available evidence does not show substantial effects of Tetris playing on executive function skills, reasoning skills, or memory skills.

Overall, research on the cognitive consequences of Tetris playing is most consistent with the specific-transfer-of-general-skills theory in which game playing is most likely to improve cognitive tasks that require the same cognitive processing (Sims & Mayer, 2002).

Neural Synchronies for Performance Improvements – Anna Skinner and Robin Johnson

fMRI measures of brain activity have been shown to be spatially and temporally coupled between speakers and listeners (Stephens, Silbert, & Hasson, 2010). This neural coupling correlates with increases in measures of story understanding. Recently, EEG-derived measures of task engagement (Stevens, Galloway, Wang, & Berka, 2012) were shown to shift among measures of submarine teams across task segments and internal and external task changes. Inspired by this work, we report EEG data between tutor and tutee in a Tetris study showing that increased synchrony of our EEG measures is correlated with higher tutee game performance.

What can Machine Learning Models tell us about Human Play in Tetris? – John Lindstedt

Strategy discovery and implementation is critical to the acquisition of human expertise. However, in dynamic tasks such as Tetris, identifying when a particular strategy is used can be difficult. Any decision made during Tetris gameplay may lead to a multitude of possible outcomes and signify any of a number of strategies. In search of a better way to quantify strategy deployment, we turn to work on artificial Tetris players (Thiery & Scherrer, 2009). These players are simple controllers that combine quantitative task features linearly to make gameplay decisions. Using the *cross-entropy reinforcement learning* method, we train controllers to maximize different performance outcomes thereby creating a "hard instantiation" of different strategies (e.g., high-scores versus longevity). Using these controllers to identify the occurrence of various strategies in human performance data, we hope to tease out qualitative differences in strategies and quantitative shifts of the application of different strategies across expertise levels.

The Eyes Have It – Wayne Gray

One of the mysteries of game-play research is that few researchers ever look to see what their players are doing! Yes, this does sound like I must have this wrong but I do not. With rare exceptions, study after study uses game scores or time played as their DVs and attempts to correlate, say, pre- and post-play scores with pre-and post-changes in performance on a cognitive task battery. Indeed, even studies that do look at in-game behavior seldom look at looking (e.g., Kirsh & Maglio, 1994; Destefano, Lindstedt, & Gray, 2011). In this short presentation the mystery of how the eyes are used in Tetris and why knowing this would be of interest to cognitive science shall be revealed.

Discussant: Robert Atkinson

Does studying Tetris lead to improvements education? More pointedly, "If you study Tetris skill for 10 years, can you find a way to teach it so that students achieve mastery, say, twice as fast? And will those methods also improve non-Tetris skill acquisition?"

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