Effects of Peppermint Scent Administration on Cognitive Video Game Performance

Kristin McCombs, Bryan Raudenbush, Andrea Bova, and Mark Sappington
Wheeling Jesuit University

Past research suggests the positive effects of both video game play and the benefits of peppermint scent administration. The present study assessed the combination of video game play and peppermint scent administration on physiology, mood, game performance, and task load. Participants completed a control condition with no scent administration to serve as a baseline, and were then assigned to either repeat the control condition or to complete an experimental condition in which peppermint scent was delivered via nasal cannula at 3 LPM. Participants played 3 Nintendo Wii Fit Plus games requiring cognitive and hand/eye reactions (Perfect 10, Snowball Fight, and Obstacle Course). Participants in the peppermint scent condition showed greater improvements, such as completing significantly more levels, more hits, more stars, and distance completed. Further, participants in the peppermint condition reported less mental demand, perceived effort, and anxiety. Control group participants had a significantly lower pulse change and diastolic blood pressure change, whereas, participants in the peppermint scent condition experienced no significant difference in pulse suggesting that the scent administration promoted greater physiological arousal, thus keeping them engaged in the testing process. Implications include the combination of video games and a physiologically arousing scent (specifically, peppermint) to further promote cognitive performance.

A struggle within the realm of video game research involves the games’ so-called “bad reputation.” As many video games involve violence, aggression, addiction, and gender bias (Selton-Green, 2005; Schrader & McCreery, 2007), many critics dismiss them as learning tools entirely, despite the widespread appeal and educational value they may possess. This “bad reputation” stems from the violence and illegality portrayed in games such as “Grand Theft Auto”™ and from the demeaning sexuality illustrated in games such as “Dead or Alive”™ (Gee, 2003). Other games, such as the violent African zombie game “Resident Evil 5”™, create controversy for their racial stereotyping. Because, in part, of the huge popularity of such games, other more socially or educationally appropriate games have been overshadowed.

Author info: Correspondence should be sent to: Dr. Bryan Raudenbush, Wheeling Jesuit University, Department of Psychology, 316 Washington Avenue, Wheeling, WV 26003. E-mail: raudenbc@wju.edu Phone: (304)243-2330
© NAJP
However, the Nintendo Wii™ game system is changing the way video games are considered; many of that system’s games involve an active and family-friendly approach to video game play.

Despite the occasionally questionable outlook on video games, research and real world findings note their benefits and applicability. The games themselves can provide goals for the player, positive reinforcement, and increasing challenge as he or she progresses through different levels (Gee, 2003). Games can support intrinsic motivation, since many require the player to be actively engaged through observing the environment, discover new aspects to a particular level or challenge, and solve problems (Dickey, 2005).

A subcategory of educational gaming is “edutainment.” Games in this category include Nintendo’s™ “Brain Age”™ and “Big Brain Academy”™ which aim to improve logic, memory, and mathematical skill, amongst other cognitive challenges, and Playstation 2’s™ Konami Kid Playground,™ which is a game that teaches numbers, letters, colors, and shapes to preschoolers. Such games are targeted towards a mass market, i.e. not aimed for classroom use exclusively, and are intended to teach the user a skill or content while he or she has fun progressing through the levels of the game.

Thus, it becomes important to describe a context when such learning is of importance. Educational implications of gaming are diverse. The current study hopes to quantify the cognitive benefits of video game use in a non-formal learning environment. Although it is still fairly new to the market, the majority of the use of the Nintendo Wii™ game system is for entertainment purposes and, more seriously but less frequently, for rehabilitation purposes (Peltier, 2007). However, new games are being developed that tie into the Nintendo™ brand’s broader goals of reaching a wide range of ages and engaging them in a wide variety of activities. While some research on the Wii’s rehabilitation abilities suggests that it can be effectively used to help rehabilitate stroke victims and cardiac patients as well as help physical therapy patients to improve their range of motion (Peltier, 2007), the Wii has not yet been used to study cognition.

Shin and Rosenbaum (2002) examined the ways in which cognitive and perceptual motor processes coordinate in a video arithmetic task. In their study, participants completed a video game task that involved arithmetic, aiming, or both. Results indicate that aiming occurred faster in the non-combined tasks. This suggests that a distraction of an additional task may hinder performance. Likewise, the current study hopes to examine how cognitive function can be enhanced through scent and gaming. Further, Barlett, Vowels, Shanteau, Crow, and Miller (2009) studied the impact of computer games on cognitive performance and
found that participants who did not play a game showed no cognitive change while participants that played either a violent or non-violent game showed an increase in cognitive performance. Lee and LaRose (2007) assessed various mechanisms of video game consumption behaviors. Results indicate that those who had low amounts of experience had less self-regulation and habit strength than regular players.

Essentially, this means that regular gamers handle input from video games more efficiently than do novice gamers. Additionally, several studies suggest the benefit scents can have on performance and mood. Zoladz and Raudenbush (2005) examined the effects of scents on cognition and found a task-dependent relationship between scent and the enhancement of cognitive processing. Specifically, cinnamon scent improved participants’ scores on tasks related to attentional processes, virtual recognition memory, working memory, and visual-motor response speed. This research suggests that certain scents have the ability to increase cognitive performance. Similarly, Moss, Hewitt, Moss, and Wesnes (2008) examined scent-influenced cognitive performance and showed that peppermint scent enhanced memory whereas ylang-ylang both impaired it and lengthened processing speed.

Diego, Jones, Field, Hernandez-Reif, Schanberg, Kuhn, McAdam, Galamaga, and Galamaga (1998) studied the effects of lavender and rosemary scent administration on alertness, math computations, and mood. The lavender group showed increased alertness and performed the math computations faster and more accurately, while also indicating a more relaxed and less depressed mood. Those participants in the rosemary group showed increased cognition; however, only the speed of their math computations increased following scent administration, not their accuracy. Participants in this group reported that they felt more alert and relaxed as well as lower levels of anxiety.

Finally, Moss, Cook, Wesnes, and Duckett (2003) researched the olfactory impact of lavender and rosemary oils on memory tasks and attention. Lavender was found to impair both memory and attention. Rosemary showed a significant increase in performance for memory; however, rosemary negatively impacted the speed of memory. The lavender and control groups were significantly less alert than the rosemary group. Combined results of this study show that olfactory properties can produce objective effects on performance.

Thus, a foundation of previous research supports the current need for an examination of the effects of scent administration on cognition during video game play. Potential implications for positive findings from this research include using scent to enhance cognitive performance in other settings, such as a classroom, with the goal of raising test performance. The present study examines the effects of peppermint scent on video
game performance using the Nintendo Wii Fit Plus™ game system, specifically for three games related to cognition and judgment. It is hypothesized that peppermint scent administration will promote greater performance during game play than an unscented control condition.

METHOD

Participants
The participants consisted of 32 students who were enrolled in a university psychology class. Students received course credit for their participation if they needed it. Participants ranged in age from 17 to 22 years of age. Those who had not yet turned 18 had parent or guardian consent to participate in the study. All participants were Caucasian.

Gaming
The participants played three games on the Nintendo Wii™ Fit Plus game:

Perf 10: On the television screen, balls containing numbers are displayed. Participants must shift their weight to highlight the appropriate balls to add up to 20 while standing on the balance board. Both positive and negative numbers are displayed as difficulty increases through rounds of the game. All participants played on the expert difficulty level, which has 20 rounds.

Snowball Fight: During this game, the participant’s avatar is placed behind a shield, and the participant must shift weight on the Wii™ balance board to see other characters in the snowball fight to throw snowballs at them with the Wii™ remote. The players’ life levels are affected if they are hit with snowballs in quick succession. It is possible for the players’ avatar to be knocked unconscious in this game, which ends the 90 seconds allotted for the game.

Obstacle Course: In this game, participants run in place on the balance board. They must consider the timing of their steps as they are faced with obstacles, such as slippery ice, rolling logs, and swinging bombs, in the multi-level course. The game was played on the hard level.

Instruments
An Omron Automatic Blood Pressure Monitor (Model HEM 705CP) was used to measure participants’ blood pressure and pulse readings.

To assess mood, participants completed the Profile of Mood States (POMS; McNair, Lorr, & Droppleman, 1971). The POMS consists of a list of 65 adjectives concerning mood. Participants indicate the extent to which each adjective describes them at a particular moment using a 5-point scale. In addition to being able to assess each of the 65 adjectives, the POMS also contains summative subscales related to depression,
fatigue, tension, anxiety, and vigor. The POMS is a widely-used scale that has adequate reliability and validity (McNair, Lorr, & Droppleman, 1971).

Participants also completed the NASA Task Load Index (NASA-TLX; Hart & Staveland, 1998). The NASA-TLX is a multidimensional scale which measures both overall workload as well as specific components of workload in a given task along with three dimensions (mental, physical, and temporal demand) related to the demands imposed upon the participant by the task, and the three dimensions (effort, frustration, and performance) related to the interaction of the participant and the task. For this scale, participants are asked to make a mark on a 120cm line with ends marked low to high. If participants place their mark near the left side of the line, it is considered to be a low rating, whereas if the mark is near the right side of the line, it is considered to be a high rating. The left and right sides of the line are labeled as low or high, respectively. The scale has been shown to have adequate reliability and validity based on data from 3461 participants from two population databases (Hart & Staveland, 1988).

Finally, participants completed a general video game questionnaire asking game play preferences and the number of hours each week video games are played. Video game experience information was collected for use as possible covariates in data analysis.

Procedure
Participation required two visits, with each visit lasting approximately 40 minutes. During the first visit, participants were taken to a separate testing room to play the Wii™. Participants rested for 5 minutes before baseline physiological measures were taken. All participants completed a control session first, to serve as a baseline. During this session, participants wore a nasal cannula delivering oxygen at 3LMP. The participant was instructed to play 3 games on the Wii Fit Plus game for the Nintendo Wii game system: Perfect 10, Snowball Fight, and Obstacle Course. Upon completion of the Wii session, participants completed the POMS (McNair, Lorr, & Droppleman, 1971) and NASA-TLX (Hart & Staveland, 1998) were administered along with the gaming questionnaire.

For the second visit, participants were randomly assigned to one of two conditions: a control condition that was exactly like their first visit, or an experimental condition during which peppermint scented oxygen was delivered through the cannula at 3 LPM. The experimental session was otherwise similar to the control session. The division of the second visit into two groups was done to have comparison groups.
RESULTS

Data were analyzed using paired sample t-tests using the control and peppermint scent conditions as two separate groups. See Table 1 for means, standard deviations, and statistical outcomes.

For those in the peppermint condition, a statistically significant difference was found as the number of levels completed increased for the second visit for Perfect 10. Statistical significance was also found in the number of hits during Snowball Fight, as well as the number of stars participant’s earned, which indicate a higher level of success. The third game, Obstacle Course, showed significant differences in the number of levels completed and distance completed on the course, again with the peppermint group showing an increase for both.

Analysis of the NASA-TLX showed participants in the peppermint condition indicated more mental demand, more perceived effort, and more anxiety. This suggests peppermint kept them more engaged in the gaming process.

TABLE 1  Means, SDs, and Statistical Analyses for the Control and Peppermint Conditions among the Assessment Measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Control</th>
<th>Peppermint</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>Perfect 10 levels completed</td>
<td>18.0 (5.4)</td>
<td>21.5 (5.0)</td>
</tr>
<tr>
<td>Snowball hits</td>
<td>11.5 (7.8)</td>
<td>19.2 (10.3)</td>
</tr>
<tr>
<td>Snowball stars</td>
<td>1.1 (0.15)</td>
<td>1.8 (0.8)</td>
</tr>
<tr>
<td>Obstacle levels</td>
<td>1.2 (1.1)</td>
<td>1.1 (1.1)</td>
</tr>
<tr>
<td>Obstacle distance</td>
<td>180.3 (144)</td>
<td>144.7 (163)</td>
</tr>
<tr>
<td>Mental demand</td>
<td>58.0 (30.2)</td>
<td>49.9 (27.2)</td>
</tr>
<tr>
<td>Effort</td>
<td>55.2 (32.8)</td>
<td>55.6 (27.8)</td>
</tr>
<tr>
<td>Anxiety</td>
<td>8.1 (4.0)</td>
<td>8.5 (6.2)</td>
</tr>
<tr>
<td>Systolic BP</td>
<td>-2.9 (13.6)</td>
<td>0.3 (17.4)</td>
</tr>
<tr>
<td>Diastolic BP</td>
<td>-1.4 (6.6)</td>
<td>5.8 (11.8)</td>
</tr>
<tr>
<td>Pulse</td>
<td>4.5 (8.1)</td>
<td>3.2 (5.0)</td>
</tr>
</tbody>
</table>
In terms of physiological data, participants in the control group had a significantly lower pre/post pulse change and a trend for a lower pre/post diastolic blood pressure change at the end of their session; whereas, participants in the peppermint scent condition experienced no significant difference in pulse from pre to post, suggesting that the scent administration promoted greater physiological arousal, thus keeping them engaged in the testing process. No statistical significance was found for any of the subscales of the POMS.

**DISCUSSION**

As previous research suggests, peppermint scent administration can be an effective adjunct to learning and attention. The results of the current study support the benefits of peppermint scent administration in several ways, such as performance and perceived task load. In terms of performance, participants' improvement in the experimental condition (peppermint scent administration) was significantly higher than participants' improvement in the control condition (no scent administration). Participants in the peppermint scent administration condition rated their perceived mental demand lower than the mental demand perceived by participants in the control group. Also, effort ratings for those in the peppermint scent administration condition improved over time. Zoladz and Raudenbush (2005) reported that peppermint scent administration enhanced performance on tasks related to attention, memory, and response speed and Raudenbush, Grayhem, Sears, and Wilson (2009) found that scent improved alertness, mood, and workload during simulated driving tasks. With individuals feeling less fatigued on tasks when peppermint scent is administered, it may be advantageous to present the scent when facing a grueling task. Further, when individuals are exposed to a pleasant scent, cognitive functioning improves in terms of speed, accuracy, and memory (Wilmes, Harrington, Kohler-Evans, & Sumpter, 2008).

As the study by Barker, Grayhem, Koon, Perkins, Whalen, and Raudenbush (2003) suggested, peppermint scent can improve performance on tasks related to speed and accuracy. While the Barker et al. (2003) study focused on clerical skills and the present study assessed video game play performance, future research could apply these findings to an ecologically valid classroom learning experience.

**REFERENCES**


