# Response Time and Puzzle Solving Skills in Gamers vs. Non-gamers

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## INTRODUCTION

Participating in recreational video gaming has been a popular activity for many children that may even transcend into their adult years. It is estimated that four out of five U.S. households contain a gaming device. Around 42% of U.S. purchasers engage in video game participation at least three hours or more a week, with the average gamer being around 35 years old [1]. Participating in consistent video gaming throughout a life time may have a potentially positive effect on the physical construct of the brain. Specifically, the changes are seen with an increased gray matter in the entorhinal cortex, part of the temporal lobe associated with the formation of spatial memories, memory formation, as well as memory consolidation[2].

Video gaming requires fast response times, adaptive learning and attention to detail by continuously engaging cognitive and physical reactions provided via visual stimuli. A gamer is defined as an individual who participates in video gaming nine hours or more a week. Engaging in video games regularly may positively affect individuals' reaction times and problem solving skills[3]. Studies show that an individual's ability to solve the Tower of Hanoi is an accurate measurement of problem solving skills and validates a measure of spacial memory[4]. Notably, response time may be demonstrated to be inherently increased by video games participation, however research notes that attempting short training sessions of even 20 hours will not significantly improve response times in non-gaming individuals[5]. The previous literature suggests that individuals who engage in gaming may have improved capability to track objects, switch between tasks, and respond to multiple stimuli and provide rapid execution of response skills[6].

## PURPOSE

The purpose of this study is to compare response times and puzzle solving skills between gamers, semi-gamers, and non-gamers.

## METHODS

**IRB Approval.** The study was approved by the Institutional Review Board (Human Subjects) at Texas A&M University-Kingsville.

**Subjects.** All subjects agreed to participate by signing the informed consent. Due to previous literature, gamers were labeled as those who gamed more than nine hours a week, semi-gamers were those who gamed one to eight hours a week, and those who did not report gaming at all were labeled as non-gamers. Sixty eight participants were selected in total, categorized as gamers ($N$= 24), semi-gamers ($N$=18), and non-gamers ($N$=26), and were selected from the student population of Texas A&M University-Kingsville.

**Experimental Design.** Participants were asked to fill out surveys that would categorize them as gamers, semi-gamers or non-gamers, as well as demographic data. All participants underwent the same experimental design. First, they were asked to complete a series of ten trials on the MOART board (Figure 1) designed to measure response time. Participants placed both their hands on the board aligning each finger with a button (except thumbs). Once a light went off above a corresponding button they were instructed to press that button. PsymLab software recorded the response time of the participants in milliseconds. The trials were performed instantaneously after one another and without break.

The second experiment involved participants completing three trials on the Tower of Hanoi (Figure 2). The objective was to move the block pyramid pieces from peg 1 to peg 3 while following only two rules: only move one block at a time, and do not place a larger block on top of a smaller one. Trials on the Tower of Hanoi ended when the participant either solved it or made a mistake by not following one of the two rules. Participants were only allowed to attempt three trials

**Measurements.** During each experimental trial on the MOART board their reaction times and movement times were recorded in milliseconds. The three trials on the Tower of Hanoi were measured in minutes and seconds until completion.

**Figure 1: MOART Board Response Timer**

## METHODS, cont.

**Statistical Analysis.** A one-way ANOVA ($\alpha$= 0.05) was utilized to compare the aggregated mean scores of the response times of the MOART board, and was also used to compare the Tower of Hanoi puzzle. If needed, appropriate *post-hoc* tests were used for specific differences across the three groups' mean scores. The experimentwise error rate ($\alpha$=0.05) was maintained throughout all *post-hoc* tests for specific differences.

**Figure 2:Tower of Hanoi puzzle**

## RESULTS

**Table 1: Subject Demographics**

| Variable | Mean | SD | Range |
|---|---|---|---|
| Age (yr) | 22.6 | 2.6 | 18-32 |
| GPA | 3.26 | 0.51 | 2.0-4.0 |
| Gaming hours per week | 8.11 | 12.8 | 0.00-70.0 |

**Table 2: MOART Board Aggregated Trial Results (in milliseconds)**

| Group | Mean | SD | Range |
|---|---|---|---|
| Gamer | 129.3* | 19.8 | 6.0-401.0 |
| Semi-Gamer | 252.11 | 35.5 | 21.0-600.0 |
| Non-Gamer | 309.7* | 287.3 | 6.0-1476.0 |

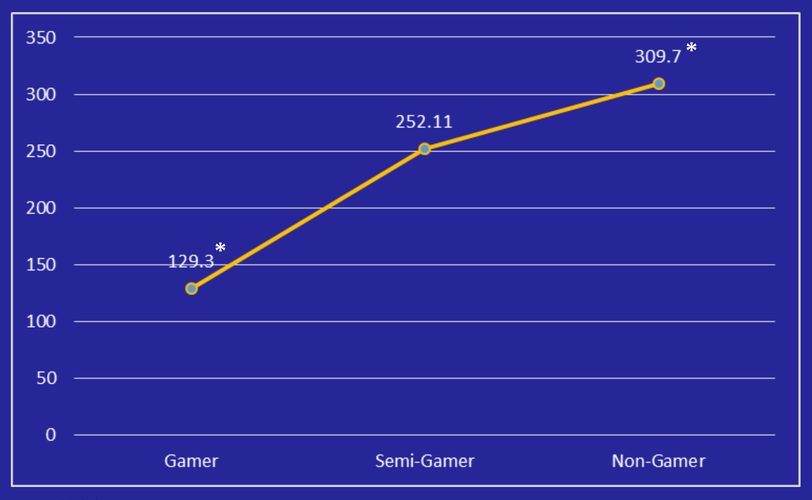
Statistical significance was only discovered between the aggregated means of Gamers and Non-Gamers (*$p$=0.007). See Figure 3.

**Table 3: Tower of Hanoi First and Final Trials (in minutes)**

| Variable | Mean | SD | Range |
|---|---|---|---|
| Trial 1 (Gamer) | 29.0 | 6.8 | 12.2-43.0 |
| Trial 1 (Semi-gamer) | 32.9 | 10.3 | 16.8-49.0 |
| Trial 1 (Non-Gamer) | 26.2 | 12.6 | 18.2-36.7 |
| Trial Final (Gamer) | 12.8* | 8.8 | 3.48-30.0 |
| Trial Final (Semi-Gamer) | 21.0 | 4.2 | 10.5-37.7 |
| Trial Final (Non-gamer) | 28.1* | 8.1 | 6.35-61.0 |

No statistical significance was found in trial 1 across all participant categories. In the final trial, the third trial, statistical significance was found comparing Gamers to Non-Gamers (*$p$=0.016). Trends of improvement were noted in both Gamer and Semi-Gamer participant categories. See Figure 4.

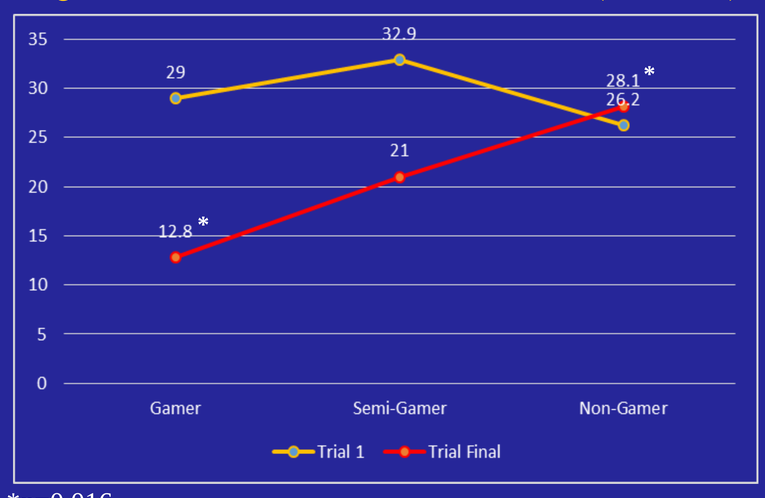
**Figure 3: MOART Board Aggregated Trial Results (in milliseconds)**




*$p$=0.007

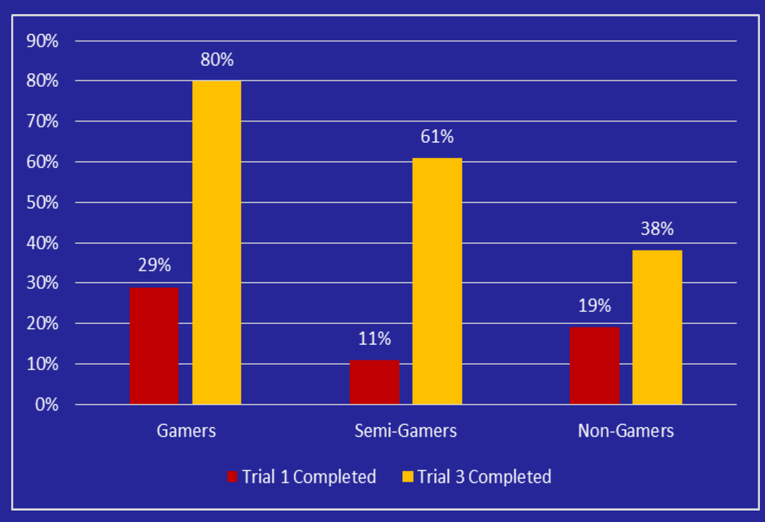
## RESULTS, cont.

**Figure 4: Tower of Hanoi First and Final Trials (in minutes)**




*$p$=0.016

**Figure 5: Tower of Hanoi Puzzle Trial 1 and Trial 3 Completion by Group**




## CONCLUSIONS

The results of the study convey no statistical significance when initially comparing the groups for puzzle completion and completion time in response time. However, aggregation of the response time data reveal a significant difference between the Gamer and Non-Gamer participants ($p$=0.007). The notable increased difference were in the speed of responses in the later trials on the MOART board.

The results of the Tower of Hanoi puzzle showed no significant difference in completion of the first trial. The third and final trial noted difference among all three groups, demonstrating a decrease in the mean scores, time in minutes to completion, in the categories of Gamer and Semi-Gamer, but an increase in mean completion time of Non-Gamers (see Figure 4). Statistical significance was only found in the difference of Gamer and Non-Gamer categories (p=0.016). Additionally, adaptation is seen not only in the decreasing mean time for the Tower of Hanoi completion, but also in the amount of participants in total completion per category. Potentially leading to note that while participants may have failed, those in gaming categories potentially revised mental schemas and special memory for improvement. Additional research is needed to confirm the effect of games on cognitive and memory capabilities.

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