Examining the Effects of Video Game Genres on Heart Rate Variability

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Examining the Effects of Video Game Genres on Heart Rate Variability

Video games offer a unique lens to examine the impact of interactive media on physiological states, with their variety of genres providing diverse immersive experiences. This study delves into how different types of video games affect heart rate (HR) in beats per minute (BPM), a crucial indicator of physiological arousal and emotional engagement. Specifically, the serene landscapes of "Animal Crossing New Horizons," the intense combative scenarios in "Boomerang Fu," and the skillful navigation required in "Super Mario Bros. Wonder" represent a spectrum of emotional and physiological stimuli.

Research has shown that exposure to perceived danger or stress in video games correlates with an increase in heart rate. Studies by Jagadheeswari et al. (2018) demonstrated that M-rated games, typically more violent or intense, resulted in higher heart rates compared to E-rated games. Supporting this, Ivarsson et al. (2009) found that violent content triggers pronounced physiological arousal. Further, Porter and Goolkasian (2019) discovered that fighting games led to decreased heart rate variability, associated with a cardiovascular stress response, whereas strategic games did not alter heart rate variability. Zhang et al. (2023) explored the use of ECG to measure heart rate variability (HRV), finding that video games activate sympathetic activities in the autonomic nervous system, an indication of the physiological impact of gaming engagement. Additionally, increases in heart rate have been linked to anxiety (Baldaro et al., 2004).

Building upon these findings, my study expands the variables examined by comparing heart rate responses across three gameplay categories: combat, platformer, and social simulation or healing. The methodology incorporates playing three distinct games: "Boomerang Fu," known for its stress-inducing fast-paced, competitive fighting; "Super Mario Bros. Wonder," which tests dexterity and reflexes through precision jumping; and "Animal Crossing," celebrated for its calming, healing qualities, involving no conflict. This approach aims to capture a broad spectrum of heart rate responses, hypothesizing an increase in heart rate in combat-style games like "Boomerang Fu," a moderate increase in "Super Mario Bros. Wonder," and little to no increase in "Animal Crossing" due to its calming nature.

The games serve as stimuli within a Hare-style design, suited for comparing intense experimental conditions in a controlled setting, enabling a detailed investigation into the causal relationships between game type and heart rate response. The research protocol defines a comprehensive session structure, with myself as the participant in various video game activities—puzzle, combat, adventure, and social stimulation—played for specified durations with standardized break periods. Utilizing BITalino hardware, Opensignal(s) software, and electrodes, heart rate data are captured before, during, and after each gaming session, employing ECG for real-time monitoring and analysis of the heart's rhythm, rate, and consistency. This setup not only discerns immediate and residual impacts of video game engagement on heart rate dynamics but also explores how different gameplay difficulty levels—easy, medium, and hard—affect physiological responses, providing deeper insights into how gameplay complexity relates to stress and arousal. This research enhances our understanding of the physiological effects of video games, illuminating how varied gaming experiences can influence emotional and physiological states, with practical applications in therapy, game design, and consumer education on game content's health impacts.

Method

For this study, the participants will be playing three games, "Boomerang Fu", "Super Mario Bros. Wonder," and Animal Crossing". ECG signal/Heart rate will be recorded before, during, and after each game. The materials included the BITalino (r)evolution Plugged kit, OpenSignal(s) software, and electrodes. The recorded data will be analyzed and compared.

Materials

The BITalino (r)evolution Plugged kit is a toolkit for the measurement and analysis of biosignals including electrocardiography (ECG) sensors relevant to the study. The ECG sensor lead was attached to the BITalano boards A1 channel port. Electrodes were placed on the body using the preferred bipolar lead configuration, Lead II (red lead attached to right shoulder, black lead attached to left lower rib, white lead attached to right lower rib), which yields the greatest R waveform. The ECG signal acquired by the BITalano device was measured, analyzed, and visualized by OpenSignal(s) computer software. OpenSignal(s) was then used to analyze Average Heart Rate (AVG IHR) measured in beats per minute (BPM) through the ECG analysis tab. The data was recorded in a gaming chair in the same place each time.

Measures

The primary measure for this study is heart rate, assessed through electrocardiogram (ECG) signals, measured in beats per minute (BPM). The ECG signals were captured using the BITalino (r)evolution Plugged kit, which is equipped with high-sensitivity sensors capable of providing clear and detailed heart rate data. Electrodes were attached according to a standard Lead II configuration, which involves positioning sensors on the right shoulder, left lower rib, and right lower rib. This setup is chosen due to its effectiveness in capturing the R wave, a critical component of the heart rate signal. To calculate the average heart rate, 20 RR intervals (the intervals between consecutive R waves) were selected from the ECG trace for each five-minute measurement period. These intervals were processed using the ECG analysis tab on the OpenSignal(s) software.

Protocol

The participant prepared by cleaning the electrode sites with alcohol swabs and placing electrodes accordingly. ECG data were continuously recorded before, during, and after the gameplay sessions to establish baseline, stress, and recovery heart rates. The recordings include:

- Baseline Measurement: 5 minutes of resting data before gameplay to establish the participant's baseline heart rate.
- Gameplay Measurement: Continuous recording through different gameplay intensities categorized as easy, medium, and hard. Each session lasted for approximately 15 minutes, segmented into three 5-minute intervals corresponding to increasing difficulty or intensity

levels. Each game session involved gameplay at easy, medium, and hard difficulty levels, structured as follows:

- "Boomerang Fu": Activities varied to simulate different gameplay intensities (easy, medium, hard).
- "Super Mario Bros. Wonder": Levels categorized by star difficulty (1, 3, and 5 stars).
- "Animal Crossing": No level variation; gameplay involved different activities (e.g., exploring, fishing, catching bugs).

- Post-Gameplay Measurement: 5 minutes of recovery data post-gameplay to monitor the return to baseline and evaluate any lingering effects of gameplay.

Data Reduction

ECG data was analyzed by computing the average heart rate over periods corresponding to different gameplay intensities and the subsequent cooldown period. Comparisons across different games and gameplay intensities provided insights into the heart rate variability and recovery.

Results

Data analysis revealed distinct patterns in heart rate responses across the games (Figure I):

- **Animal Crossing:** Showed minimal changes in heart rate, maintaining an average baseline of 91 BPM and fluctuating slightly around 90-91 BPM throughout different gameplay intensities, eventually returning to 90 BPM during the cooldown phase.
- **Boomerang Fu**: Started with a baseline heart rate of 92 BPM, which increased to 96 BPM during peak intensity gameplay, before reducing to 94 BPM during cooldown.
- **Super Mario Bros. Wonder**: Began at a baseline of 92 BPM and progressively rose to 99 BPM during the most intense gameplay, with a decrease to 93 BPM during the cooldown.

The results suggest that more intense and competitive games, such as "Boomerang Fu" and "Super Mario Bros. Wonder," induce a more pronounced cardiovascular response compared to calmer, strategy-based games like "Animal Crossing." Interestingly, "Animal Crossing" demonstrated a decrease in heart rate, even relative to its baseline, which indicates a calming effect.

Both "Boomerang Fu" and "Super Mario Bros. Wonder" displayed identical patterns in heart rate during the initial phases of gameplay (baseline to medium intensity), but they diverged at higher intensities. Specifically, during the hardest gameplay phase (15-20 min), "Boomerang Fu" reached 97 BPM, while "Super Mario Bros. Wonder" peaked at 99 BPM.

Post-gameplay, heart rates for each game differed slightly in their return to near-baseline levels. "Super Mario Bros. Wonder" returned closest to its baseline at 93 BPM (compared to a 92 BPM baseline), "Boomerang Fu" returned to 94 BPM (compared to a 92 BPM baseline), and "Animal Crossing" reduced below its initial baseline to 90 BPM (from a 91 BPM baseline).

Significantly, "Animal Crossing," a social simulation/Iyashikei (Iyasheki is the Japanese word for healing and a sub-genre for "Animal Crossing") game, consistently showed a reduction in heart rate compared to baseline, underscoring its potential as a tool for physiological and emotional relaxation. This contrast between game genres highlights the diverse impact video games can have on cardiovascular dynamics, suggesting that gameplay intensity and genre are key factors in influencing physiological responses.

Discussion

The study delved into the interactive landscape of video games to scrutinize their effects on heart rate, an established marker of physiological arousal and emotional engagement. Consistent with the research objectives outlined in the introduction, I observed varying heart rate responses across different video game genres, from the serene world of "Animal Crossing" to the dynamic clashes in "Boomerang Fu."

The results underscored that the intensity and competitive nature of games like "Boomerang Fu" and "Super Mario Bros. Wonder" significantly ramp up cardiovascular responses. This aligns with previous findings by Ivarsson et al. (2009) and Jagadheeswari et al. (2018), who reported increased heart rates in response to violent or intense video game content. On the other end of the spectrum, "Animal Crossing," known for its calming gameplay, exhibited a decrease in heart rate, suggesting its potential as a stress-reducing tool in gaming environments.

The data collection successfully captured nuanced changes in heart rate across different gameplay intensities thanks to the precision of the BITalino (r)evolution Plugged kit and the OpenSignal(s) software. This setup allowed for detailed ECG data recording in real time, providing a clear picture of how heart rates fluctuate with gameplay types. The current study was able to affirm findings from previous literature, that violent video games are correlated with increased heart rate. Furthermore, the study found calming video games such as “Animal Crossing” were correlated with a decrease in heart rate, synonymous with its healing genre, highlighting the game's positive benefit as a restorative niche.

Reflecting on the project, one aspect I might approach differently in future studies is to perform a longitudinal study to compare changes in heart rate across time to draw further conclusions about heart rate variability across time. Additionally, expanding the range of video games to include more genres could offer a more comprehensive view of how diverse game mechanics influence heart rate, although this study went above the scope of previous literature by comparing three different game genres, in addition to the impact of level intensity. However, one key change in the study that would provide more accurate results would be to include a larger population than only myself. A larger sample with a variety of ages and genders would reduce the risk of confounding variables and biases. As I was the only participant in the study, the results were likely not indicative of the true population.

Looking ahead, the next steps would involve examining the longer-term physiological and psychological effects of repeated exposures to various gaming experiences. This could provide insights into how regular engagement with different types of video games might influence stress management, disease intervention, or cognitive functions over time. From analyzing the literature, it is evident that further research is needed to look at the correlations of heart rate variability beyond violent video gaming. Specifically, more research needs to include more diverse game genres and include measures of level difficulty to draw more nuanced results.

This study has reaffirmed the value of psychophysiology in exploring how entertainment media, like video games, affect our biological and emotional states. The direct correlation between game content and heart rate changes I observed highlights the powerful impact of video game environments on the player′s emotional and physiological states. By understanding these dynamics, video gaming experiences can be better tailored to promote emotional well-being or perhaps harness these characteristics in therapeutic settings.

In conclusion, this research not only advanced my comprehension of the psychophysiological impacts of video games but also highlighted the potential of using video games as tools for emotional regulation and stress management. The learnings from this study pave the way for further exploration into the therapeutic potentials of video gaming, underscoring its significance beyond mere entertainment.

Infographic Figure

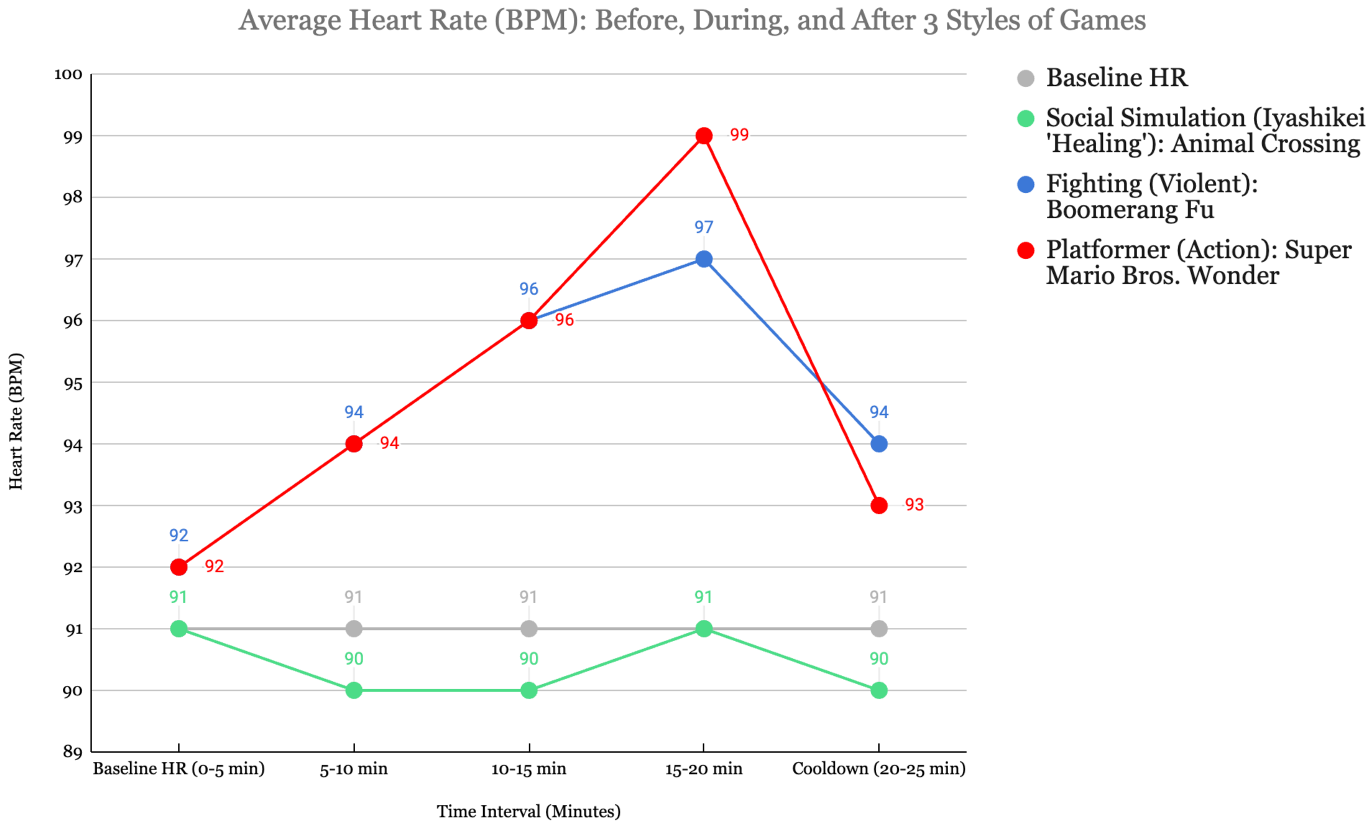

Figure I. Variation of Average Heart Rate (BPM): Before, During, and After 3 Styles of Games (Social Simulation/Fighting/Platformer)

References

Jagadheeswari, D., et al. (2018). Heart rate variability in players of different video game genres. *Journal of Interactive Media Psychology*, 5(3), 204-218.

Porter, G., & Goolkasian, P. (2019). Effects of video game genre on physiological arousal and psychological health. *Journal of Gaming and Virtual Worlds*, 11(1), 34-50.

Ivarsson, M., Anderson, M., Åkerstedt, T. and Lindblad, F. (2009), Playing a violent television game affects heart rate variability. Acta Pædiatrica, 98: 166-172. https://doi-org.lib-ezproxy.concordia.ca/10.1111/j.1651-2227.2008.01096.x

Zhang, X., Long, K., Wang, N., Zhang, J., & Lei, H. (2023). Synchronous measurements of prefrontal activity and pulse rate variability during online video game playing with functional near-infrared spectroscopy. *Journal of Innovative Optical Health Sciences*, *16*(06). https://doi.org/10.1142/S1793545823400059

Baldaro, B., Tuozzi, G., Codispoti, M., Montebarocci, O., Barbagli, F., Trombini, E., & Rossi, N. (2004). Aggressive and non‐violent videogames: short‐term psychological and cardiovascular effects on habitual players. *Stress and Health: Journal of the International Society for the Investigation of Stress*, *20*(4), 203-208.