Playing Nice: Charting the Effects of Oxytocin on Prosocial Behavior in Online Play

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ABSTRACT

This paper examines the role of oxytocin (OT), a hormone traditionally linked with social bonding and prosocial behaviors, in modulating emotional and social dynamics among video game players. Our study builds on this knowledge by creating a practical context wherein to test the assumptions discussed in positive social interaction and cognitive promotion in games. Utilizing the game *Minecraft*, we conducted an experimental study involving 30 physically healthy humans in Salt Lake City. The study yielded interesting findings about the social and emotional impacts of gaming, suggesting that multiplayer gaming environments facilitated significant (positive) changes in heart rate for players. Those changes were even more pronounced among players whose base mood was initially reported as negative. This study can serve as a reference for engaging players to socialize in games and can also pave the way for the design of immersive games and large social online environments.

Keywords

Oxytocin, prosocial, game design, emotion, emotional provision, psychology, player behavior

BACKGROUND

In the digital era, video games have transcended mere entertainment to become a platform for exploring complex human emotions and behaviors. One hormone, oxytocin (OT), commonly associated with social bonding and behavior, has sparked interest in its potential to shape interactions within virtual environments. In his landmark study on oxytocin, "*Cooperative video game play and generosity: Oxytocin production as a causal mechanism regarding prosocial behavior resulting from cooperative video game play,*" Matthew Grizzard claims that cooperative gameplay reduces generosity because cooperative gameplay induces ego depletion (2013). Put simply, the increased self-monitoring of one's behavior induced by interacting with another person and the sharing of

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resources increased ego depletion, resulting in lower generosity. This paper seeks to build on Grizzard's work to further explore the intersection of video game design, neuroscience, social formation, and group dynamics, evaluating how oxytocin's influence could extend beyond the screen to affect real-life social dynamics.

Previous research has often focused on dopamine's role in emotional regulation within gaming contexts, drawing connections to gaming addiction and reward-seeking behaviors. However, the multifaceted nature of hormonal influence suggests that a broader spectrum, including the likes of oxytocin, is likely at play. Oxytocin's role in modulating trust, empathy, and social interaction provides fertile ground for future game designs that integrate prosocial behavior and nuanced social interactions as part of their core mechanics. This in turn provides game designers the opportunity to foster increasingly profound and empathetic engagement within the virtual worlds they create.

A number of studies have sought to understand the connection between oxytocin and games, particularly around ideas of connection and aggression. Prevailing popular and scientific opinions often paint games in a negative light, suggesting that they have a harmful effect on users. This perspective is evident in several studies. Greitemeyer, for example, remarks, "Playing violent video games has been shown to increase aggression in players. This aggression can also spread to connected individuals in the Player's social network, even affecting those who do not play violent games themselves" (2018). Others have taken an even harsher view, going so far as to suggest that video games are destroying the younger generation. In "China Economic Information News," Wang Hantao remarks, "The impact of online games on minors is shocking" and "spiritual opium" has grown into an industry worth hundreds of billions" (2021). Yet others have looked to the role of competition within multiplayer games, suggesting that competition above violence itself might be the core cause of aggression and other anti-social behaviors. Dowsett and Jackson, for example, write, "[C]ompetition within video games may impact aggression more significantly than the violent content itself, suggesting that the competitive aspect of gaming could be a crucial factor in influencing aggressive behavior" (2019). Certainly, if we only consider these studies, we are left with quite a grim view of video games and their impact on social behaviors. However, the methods involved in these studies fail to give games a fair chance and completely discount the enormous positive potential that games offer. These naysaying studies, as a result, produce biased and sometimes inaccurate information about games' potential to promote sociality and connection.

Yet others have attempted to paint gaming as the enemy of sociality. For instance, in his landmark study "Metaanalysis of the relationship between violent video game play and physical aggression over time," Jay Hull, a social psychologist at Dartmouth College, summarizes a number of key studies to "support the general claim that violent video game play is associated with increases in physical aggression over time (2018)." However, the methods and arguments used to come to this stance are so riddled with inconsistencies and shortcomings that the conclusions can hardly be trusted. The work is further suspect in the fact that it draws false comparisons between digital and real-world behaviors, undermining the fundamental claim that video games somehow perpetuate anti-social or violent behavior. As Moyer puts it, they solely measure "the frequency of aggressive thoughts or language rather than physically aggressive behaviors like hitting or pushing, which have more real-world relevance" (2019).

If what Moyer says is true, people's actual behavior is more telling and relevant than their perceived thoughts or intentions. People are, after all, social animals, and their existence sits at the intersection of thought and action. For this reason, we are interested in whether the influence of society and the environment can impact the interactions typically associated with oxytocin. Some of these experiences include things like feeling stressed, embarrassed, or scared during social interactions.

In order to understand the power of OT to influence human behavior, it is necessary to understand h ow it operates in non-digital social settings. In The Social Salience Hypothesis of Oxytocin (Shamay-Tsoory et al) seems to indicate that OT adjusts the prominence of social cues by controlling dopamine's importance coding and the redirection of attention signals. In their words, "OT attenuates neuroendocrine stress reactivity and decreases amygdala activation in response to threatening stimuli. OT may modulate social behavior in a manner that is not related to stress reduction. OT may trigger orienting responses to threat rather than safe signals and increase anxiety" rather than decreasing it (2016). This means OT may reduce anxiety by reducing threat-oriented responses, a concept which the Social Salience Hypothesis uses to more broadly explain how OT works in the brain. Shamay-Tsoory et al say that OT enhances the salience of social cues by boosting dopamine's coding signal. This clearly demonstrates that a decrease in tonic dopamine release may lead to compensatory adjustments in the brain. Specifically, the amygdala and the nucleus accumbens, which react to both negative and positive stimuli, are affected (Taylor 2020). Various studies demonstrate that oxytocin directly influences dopamine release in these areas during maternal behaviors like pup grooming in female rats (Shahrokh 2010). We know that the brains of mice and humans are highly similar, so it was a natural transition to begin thinking about how effective it would be to simulate these prosocial interactions at the human level.

The exploration of oxytocin's role in social cognition and behavior is a burgeoning field within neuroscience and psychology. As mentioned before, a number of authors have written about how oxytocin can affect human social interaction, including empathy, trust, and the processing of social cues. Oxytocin plays a critical role in modulating dopamine release, which can influence a variety of behaviors; abnormalities in this process may affect individual responses to various stimuli. This opens the door to the possibility of creating intentional game experiences that use added social cues and context to promote prosocial behavior in Player. This is exactly the framework we seek to explore in the gap between this research and the Social Salience Hypothesis of Oxytocin.

The Social Salience Hypothesis of Oxytocin was developed by Shamay-Tsoory, Simone G. et al. in 2009 and generally proposes that dopamine pathways could be harnessed in video game contexts to promote social interactions between players. This model is explored at length in the work of Barraza and Zak, where they state, "Recent studies in humans have revealed that OT promotes prosocial behaviors, including trust, reciprocity, and generosity measured using monetary transfers to strangers." In Shamay-Tsoory, Simone G. et al., participants were shown another participant who was struggling and then were given the option of how much money to send to that other person. Afterwards, the OT levels of the recipient of the money were measured and compared to the levels of participants receiving a transfer from the system rather than from another participant. Barraza and Zak remark that "interaction between the oxytocinergic and dopaminergic systems has been reported in several studies examining the association of OT with activity within dopaminergic regions" (2009). This connection illustrates that the happiness brought by OT can be longer-lasting and more stable than that brought by dopamine. The results were similarly staggering: "OT levels measured in plasma were 41% higher in subjects after a monetary transfer denoting trust was received compared to those who received a randomly chosen transfer of the same average amount." In other words, people who received a transfer from someone else in specific registered a higher OT reading than someone who received a transfer arbitrarily from the system. While this is interesting, it fails to provide a concrete pathway whereby this mechanism could be utilized to further promote prosocial behavior in games: it suggests a causation scenario but without providing a framework within which to actually work toward reducing people's stress levels or promoting positive interactions between players in a digital system. Regardless, Barraza and Zak's findings around the OT pathway are fertile ground for game designers to build social engagement and empathy among players, a topic which we hope to further explore in this study. They explain:

> [the research provides] the first direct evidence for this claim, and we have demonstrated both a statistically and quantitatively significant increase in OT after an emotional stimulus. Even more compelling, [the result] discovered a positive parametric relationship between the experience of empathy and the change in OT (2009).

As far as we know, increasing OT can reduce people's heart rate. Barraza and Zak's 2009 study examines the relationship between empathy towards strangers and oxytocin release and the subsequent impact on generosity. Their findings suggest that witnessing or imagining another person's plight triggers the release of oxytocin, a hormone associated with social bonding, which in turn increases generosity. This is something we see play out strongly in Hideo Kojima's landmark game, *Death Stranding.* In the book "Longing, Ruin, and Connection in Hideo Kojima's Death Stranding," Amy M. Green writes:

> [The player experience of *Death Stranding*] overlay[s] one person's experience of the game with the experiences of other players. These echoes of other players remind the Player embodying Sam in a current game that even when the terrain looks foreboding, there will always be a way through (2021).

This phenomenon has not only been noticed by professionals, but articles in gaming media have also mentioned the use of OT in *Death Stranding*. In the blog "Death Stranding Explained: What Smart Drugs Actually Are", Kyle Gratton explains that an in-game drug that increases oxytocin "promotes social behaviors not only narratively [..] but also contributes greatly to the subtext regarding the importance of community throughout the entirety of *Death Stranding*'s story." This goes to support the idea that oxytocin can be a powerful stimulus for prosocial behaviors, as first introduced by Barraza and Zak. OT plays a crucial role in facilitating prosocial behavior in humans, particularly in response to empathetic engagement. Still, there is a dearth of empirical evidence supporting the investigation of oxytocin's role in regulating social behaviors within video games.

Building upon the premise that oxytocin could be a key player in enhancing social interaction in video game environments, we aim to empirically test its impact across multiplayer interactions and solitary gaming tasks. The contrasting dynamics of multiplayer settings, which may elicit distinct oxytocin responses compared to solitary engagements, could reveal insights into how oxytocin mediates group social interplay and individual behavior in isolation. We have developed a rigorous experimental methodology to understand these phenomena in depth. In the following sections, we will detail the experimental design, execution, and approach to quantifying the impact of oxytocin on the players' social cognition and decision-making behaviors in these varied contexts.

Several scholars have sought to provide models that would allow us to quantify the impact of OT on video game players. In "Promoting Social Relationships Using a Couch Cooperative Video Game: An Empirical Experiment with Unacquainted Players", for example, Bateman and Boon propose that "The natural manifestation of player-to-player interaction in a video game context poses a unique opportunity to study the effects of co-playing on social relationship formation." Bateman and Boon found there to be strong favorable responses of players towards communal experiences shared in the same physical space. They write that when the Player plays a game—especially when recreating and socializing—they have a strong development of social processes. In other words, "[t]he superimposition of entertaining gameplay and friendly visual vibes also hides the obligatory player-to-player interaction, making it easier for players to initiate social bonding.". This comment almost makes it seem like the graphics and vibe make it easier for players to socialize, because it lowers their guard and draws attention away from the fact that they are socially bonding, an activity that can be diminished by culture, anxiety, competition, etc. Bateman and Boon, in fact, carried out their own experiments to explore these ideas for coaching players in video games, showing how OT can be strongly tied to prosocial behaviors.

As Bateman and Boon's study took place in a virtual space, it avoided a number of problems that sometimes interfere with traditional study design. For one, it provided a multiplayer group experiment without being restricted by geography or other physical limitations. Similarly, it provided an equalizing and democratizing impact by mitigating the disparity of various player social dynamics (i.e. appearance, pitch of voice, ethnic or national identity, etc.) that might exist in a real-world context. In such a way, the study reduced the impact of overt unproductive competition, which in turn resulted in a reduction of stress in its participants.

We may be tempted from all of this to conclude that the oxytocin effects felt in games may translate to real-life, but like Moray points out earlier, that connection between the real and the digital world may be more tenuous than some would predict. This contrast leads us naturally to a number of core hypotheses, which this study will seek to address:

> **Hypothesis 0:** The oxytocin effects felt in games may not translate to real-life experiences.
>
> **Hypothesis 1:** Certain simulated game states and player encounters may stimulate OT-mediated prosocial behaviors.

These hypotheses look at the fundamental connections and disparities between the real and the digital world. This is not to say that virtual environments perfectly mirror in-person experiences. However, these questions remain relevant to the overall landscape of OT and thus warrant further investigation. To build on the work of Bateman, Boon, and others, this study aims to explore how games and multiplayer games can impact OT levels and what types of multiplayer games can most powerfully impact people's stress levels. It is our belief that the data will indicate a strong positive impact on the prevalence of oxytocin-related behaviors, with an overall quality of reducing anxiety and lowering stress levels in players.

MATERIALS AND METHODS

Participants: physically healthy human participants (N = 30: 16 males, 14 females) were recruited at the University of Utah campus in Salt Lake City, UT, USA. All participants had normal or corrected-to-normal vision and no history of neurological or psychiatric disorders. Most participants were part of the Games (specifically Entertainment Arts and Engineering) major and other participants came from Computer Science, Philosophy, and Fine Art. Students majoring in psychology or economics and those who had participated in any similar study before were specifically excluded from participation. All participants provided a digital consent form informing them of potential risks and of their right to withdraw from the study at any time. All participants completed the study successfully, for a total retention rate of 100%.

We used the video game *Minecraft* as our experimental media. *Minecraft* is a well-known exploration and crafting game where players gather resources by mining and then construct different objects and buildings to progress through the game. We created a pared down instantiation of a *Minecraft* level, that allowed players to mine, send positive expressions, and use hugging actions within the game. All of these are standard capabilities within the mainstream game. In our custom deployment of *Minecraft,* we removed several standard abilities, including the ability to attack and deal damage.

Before playing, players were first briefed on the test content and then provided confirmation of their understanding. They were first asked about their current mood, age, gender, and heart rate before the test. They spent about six minutes playing through the level, in sessions of two minutes each occurring before and after completing the questionnaire. After playing, they were asked about loneliness, their first impressions of others, whether they helped others, whether they were willing to continue building relationships with them after the game was over, their current mood (stress), and their heart rate after playing. Heart rate was obtained using a wearable Samsung watch, which takes readings over a 30-second time period.

In the control group, 14 participants (all college students, 7 males, 7 females) were randomly assigned to play alone in the same version of *Minecraft,* and in the same level. The experimental group of 16 participants (all college students, 9 males, 7 females) were assigned to play alongside another tester in the same version and level as the control group.

We use ordinal scales to reflect the players' mood ratings and responses to other questions. Data was collected for each participant, without the ability to pass or not provide input on a single question. All of these data were put into IBM SPSS Statistic software for analysis (Version 29.0.2.0(20)). The Control Group was set as group 0, and the Experimental Group was set as group 1. Firstly, we compared results from before the test [Std. D= 3.899] to after [Std. D= 4.023]. We ran the One-Way ANOVA on the data [0, 1] to compare heart rates across the different groups.

RESULTS

Descriptive Statistics

The mean and standard deviation for each group of people are as follows:
For the Before-Game group[=BeG], *M [Average Heart Rate=AHR] =* 86.20 bpm, *SE*= 0.7120. For the After-Game group [AfG], *M[AHR]=* 73.43 bpm, *SE*= 0.7350. For the multiplayer test group, *M=* 0.6250, *SE*=0.1250. For solitary game participants, *M*= 1.1429, *SE*= 0.14286. For the people who played Pressure test after the game, *M*= 1.8750, *SE*= 0.1250.

Main Analysis

ANOVA was performed to investigate the hypotheses of interest, with comparisons for each of the two hypotheses. The result of the overall F tests was significant (F (1,29)= 15.014, $p<0.001$). Results of the One-way ANOVA also showed support for the hypothesis that there is a statistically significant difference between Solitary participants and Multiplayer participants (F (1,29) =10.538, p=0.003). Further, there is support for the hypothesis[H0] that the performance of Players with interaction on either side is significantly different from the performance of Players without Interaction (F (1,29) = 4.428, $p<0.044$). The second hypothesis[H1], that People *with* Interaction perform differently than people in the non-interaction group on both sides, was not supported, (t (29) = 1.675, p=0.206). We were surprised that the AHR performance of people in the non-interaction group was actually better than people with interaction, on both sides of the analysis.

Side Analysis

The Base heart rate average based on mood and Avg change based on mood are quite telling. The mood rank level is from "-2" to "1"["Sad," "Not good," "Not bad," "Doing well"]. We found that people in a bad mood had more significant heart rate changes than people in a good mood, *M [I am doing well]* = 85.63158 bpm (beats per minute), *M [MC=Mood Change]*=10.68421 bpm; *M [Not bad]* =

86.375 bpm, *M[MC=Mood Change]* = 13.875 bpm; *M[Not good]* = 89.33333 bpm, *M[MC=Mood Change]* = 23 bpm.

In Non-interaction [Ctrl Group] Average Heart Rate Reduced [AHRR] *M* = 15.3571 bpm, But the Average Heart Rate Reduced *M* = 11.2 bpm in Multiplayer situation [Ex Group]. We believe that this and the multiplayer interaction element in the experiment caused the Player's heart rate decrease caused by oxytocin to be partially covered by the multiplayer interaction. In short, heart rate changes cannot solely be attributed to OT.

DISCUSSION

Initially, we set out to discover whether it is possible to detect the impact of oxytocin during digital play using physiological (quantitative) and response based (qualitative) measures. Using randomly assigned groups, we determined that within our specific play environment, and our specific population, heart rate, which is generally impacted by oxytocin, was significantly diminished during both the experimental and the control group play sessions. However, the effect was much greater in the experimental group, which incorporated prosocial interactions centrally. This points toward the central hypothesis that digital experiences could be intentionally designed to elicit oxytocin responses for stress relief, empathy building, and general encouragement of prosocial play in online settings.

Initial study results showed that heart rate is not strongly connected to emotional state, as we predicted. We believed that OT would stabilize people's emotions rather than simply increase or decrease heart rate, but our data on AHR performance was not strongly supported. For example, when participants were in a bad mood and their stress level and heart rate were very high [measured by Samsung Smart Watch 4], a similar digital high OT environment was able to calm their emotions and cause their heart rate to decrease. Most young people have a higher resting heart rate, so when their heart rate drops it is more noticeable than when it rises.

Image 1- A screenshot of a smart watch to show the participant current heart rates(bpm).

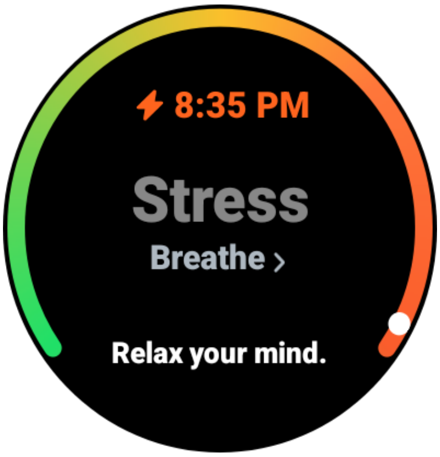

Image 2- A screenshot of a smart watch to show the participant current stress level.

Counterintuitively, quantitative measures for the study, provided by the wearable Samsung watch, indicated that most players were *more* stressed after playing. However, qualitative survey responses showed overall decreases in stress levels post-intervention compared to readings beforehand. This disparity can be easily explained in the realization that the Samsung watch's stress levels are interpretive, and take into account not only heart rate but also heart rate variability, exercise states, and other factors. Similarly, the Samsung smart watch's stress reading operates functionally on a stress spectrum that can be influenced by other factors like excitation, fear, and boredom. Future studies would benefit from controlling for these other emotions and looking more closely into how the effects of oxytocin could be better isolated and observed.

The effectiveness of the study was also impacted by staffing and temporal limitations. Complex digital environments become prohibitive for larger studies with small staff. Future studies should be simplified as much as possible and constrained much more tightly to temporal limits. Notwithstanding, the digital environment did in fact make resetting the scenario very easy, and it could be easily scaled with more work to refine the scenario parameters.

We also found that the digital nature of the study greatly facilitated recruiting, as people are generally very willing to participate in studies that involve video games. Where traditional studies have issues recruiting people to participate, the study team was able to enlist many people very easily, in a short amount of time, and with little to no staff support. This was in part due to the fact that we intentionally limited the functionality of the core game to prevent participants from engaging in certain non-related behaviors. This approach streamlined recruiting, onboarding, and participation in the study, greatly increasing the feasibility of the study as a whole. Future studies could, however, still benefit from greater simplicity and stricter time limits. Despite these challenges, the ease of resetting scenarios in the digital environment suggests that scaling up could be feasible with further refinement of the scenario.

CONCLUSION

To review our experiment result, the change in heart rate for the Experimental Group was not as strong as that of the Control Group, *M [Ctrl G-AHRR]* = 15.3571 > *M [Ex G-AHRR]* = 11.2. We believe that there are three reasons that could explain this result. Although negative communication did not specifically occur during experiments, there were some instances of toxic or anti-social behavior, such as using the environment to cause harm, stealing resources from companions, and blocking companions' paths. This may have contributed to the elevated heart rate in the experimental group. The second conjecture is that players in a social context may feel the desire to present themselves in a better light, which can lead to impression management. This behavior can increase their stress levels. According to Leary & Kowalski, "private behaviors can be affected by self-presentation motives (1990)." Lastly, in a group setting, players might be motivated by a sense of responsibility or obligation to their companions. According to Social Comparison Theory (Leon Festinger, 1954), People want to compliment others to demonstrate their social status. This desire to see others succeed gives them an opportunity to show off one's social status and satisfy one's overly high self-awareness. If this is not achieved, people will feel nervous and anxious, which will increase their stress level.

To compare the SE of both groups, the *SE* of the experiment group is smaller than the control group [0.1250 < 0.14286]. In the experimental scenario, players need to understand and integrate into the social group through behavioral observation, which promotes the desire to actively engage with and understand other players. The experience of unity, prosocial behavior, and enhanced trust may be related to the effects of oxytocin. It is further speculated that the experience of unity brought about by this teamwork may be related to the role of oxytocin. In multiplayer interactions, oxytocin may reduce the differences in the overall experience by enhancing trust and prosocial behavior between players and reducing emotional fluctuations between individuals.

There is still much discussion to be had around how effectively digital environments can be mobilized to stimulate the release of oxytocin, as in this study. However, it is clear from the data that prosocial interactions within our experimental group were correlated with lower overall heart rates and stress levels, as measured through qualitative surveys. This gives us hope that future interventions could be developed specifically with pro-sociality in mind, in stimulating prosocial behavior, reducing state and trait stress levels, and helping gamers to play nice.

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