

COOPERATIVE VIDEO GAME PLAY AND GENEROSITY: OXYTOCIN PRODUCTION
AS A CAUSAL MECHANISM REGARDING PROSOCIAL BEHAVIOR RESULTING
FROM COOPERATIVE VIDEO GAME PLAY

By

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ABSTRACT

COOPERATIVE VIDEO GAME PLAY AND GENEROSITY: OXYTOCIN PRODUCTION AS A CAUSAL MECHANISM REGARDING PROSOCIAL BEHAVIOR RESULTING FROM COOPERATIVE VIDEO GAME PLAY

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Recent research has begun to examine whether contextual features of video game play, such as the cooperative versus competitive nature of interaction between game play participants, can mitigate aggressive responses related to violent video game play, or even lead to prosocial responses such as generosity. This research provided the foundation for the current dissertation that sought to (a) examine the effect of cooperative play on generosity and (b) associate cooperative game play with increased production of oxytocin, a neuromodulating hormone related to bonding, trust, and social interaction. The potential negative effects of video game play have been a central focus of psychological and communicological research, with the majority of studies using competitive, aggressive games as their stimulus materials. By utilizing a non-aggressive game, examining the role of cooperative versus solo play in that game, and assessing changes in oxytocin production and associating those changes with post-game play generosity, the current study provides an opportunity for determining potential prosocial effects of non-aggressive video game play and linking those effects with an endocrinological mechanism.

A random assignment (solo versus cooperative play) experiment with an offset control condition was conducted using a guitar-music video game as stimuli. Prior to and after game play oxytocin was measured using salivary samples. Following the final salivary sample, participants completed an ultimatum game designed to assess generosity. Contrary to expectations, playing the game solo increased generosity and playing cooperatively with another

person decreased generosity compared to the offset control. This evidence suggests the controversial potential that playing a non-aggressive game cooperatively can exert an antisocial influence under certain game-play contexts, as well as the possibility that playing such a game alone can have a prosocial influence.

The unexpected findings were explained as resulting from the combination of two potential mechanisms: ego depletion and synchrony. Together the ego depletion and synchrony explanations suggest that solo play in a non-aggressive video game increases generosity due to increased levels of synchrony while cooperative play with a co-present partner in a non-aggressive game reduces generosity due to increased levels of ego depletion.

A sudden, and unexpected issue with the lab contracted to analyze the salivary samples prevented their inclusion from the current study. However, the samples have been stored to allow for their inclusion at a future date.

The paper concludes by integrating the proposed mechanisms with previous studies and discussing the broader implications with regards to why and when (a) solo game play should increase and (b) cooperative game play should reduce generosity. The explanation offered provides a more nuanced and complete understanding of the role of cooperative video game play on prosocial behaviors by demonstrating findings that contradict previous research and providing hypothetical mechanisms for future research. Implications of the study suggest that in addition to the content and context of game play influencing outcomes, the interaction of video game content and context can fundamentally alter research findings and their interpretations.

This dissertation is dedicated to
my loving and supportive wife, Alison Hayes Grizzard,
our beautiful daughter, Violet Jane Grizzard,
and the memory of our son, Lyle Hayes Grizzard.

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“Gratitude is not only the greatest of virtues, but the parent of all the others.”

– Marcus Tullius Cicero

To my advisor, Dr. Ron Tamborini: Thank you for pushing me.

To my committee: Thank you for your critical eyes.

To my parents and grandparents: Thank you for your generosity.

To my friends: Thank you for distracting me.

To my wife: Thank you for loving me.

To my daughter: Thank you for a bright future.

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KEY TO ABBREVIATIONS

ANCOVA = analysis of covariance

ANOVA = analysis of variance

C = Celsius

CFA = confirmatory factor analysis

CFI = comparative fit index

CISBR = The Center for Interdisciplinary Salivary Bioscience Research

EEG = electroencephalographic

EIA = enzyme immunoassay

ERN = error-related negativity recording

ERP = event-related potential

FOF = Frets on Fire

LSD = least significant difference

OT = oxytocin

PCA = principal component analysis

pg/ml = picograms per milliliter

SRMR = standardized root mean squared residual

INTRODUCTION

Recent research indicates that playing video games cooperatively with others can lead to increased prosocial tendencies as indicated by participant behaviors in economic decision-making games (Ewoldsen, Eno, Okdie, Velez, Guadagno, & DeCoster, 2012; Velez, Mahood, Ewoldsen, & Moyer-Gusé, 2012). In two experiments, participants played an aggressive video game either cooperatively or competitively and participated with their partner in a modified, iterated prisoner's dilemma game. Cooperative play was associated with (a) increased helping behaviors represented by more generous offers in the first and third rounds (out of ten total rounds) of the prisoner's dilemma game and (b) a stronger preference for the tit-for-tat strategy. The tit-for-tat strategy (devised by Anatol Rapoport; see also Rapoport & Chammah, 1965) is a strategy designed to elicit cooperative behavior from others (Ewoldsen et al., 2012). A person employing a tit-for-tat strategy would initially make a generous offer to their partner and then reciprocate the partner's offers throughout the remainder of the task. By reciprocating the partner's offer, the player can reward generous behavior and punish selfish behavior, thus encouraging cooperation from their partner.

One of the primary goals of this research was to demonstrate that the context of violent video game play was likely to moderate the antisocial and prosocial effects of exposure. The authors argued that competition between players should lead to increased aggression whereas cooperation between players should lead to decreased aggression and an increase in helping behaviors, which they operationalized as the participant's behavior in the prisoner's dilemma game. Although the research by Ewoldsen et al. (2012) and Velez et al. (2012) demonstrate cooperative play in a video game increased helping behaviors and a preference for the tit-for-tat

strategy, the authors do not specify a mechanism for why this relationship should occur. The current study seeks to test a specific mechanism for why cooperative behavior in a video game should lead to increased helping behaviors. This explanation is related to production of the hormone oxytocin (OT).

Psychological research examining the effects of video game play has been almost single-mindedly focused on video games' antisocial and aggressive effects (see Anderson et al., 2010; Ferguson, 2007a; Ferguson, 2007b; Sherry, 2001). This relentless focus on documenting the aggressive effects of video games has diverted attention from mechanistic explanations regarding the effects of video game play as they relate to aggression as well as other antisocial and prosocial responses. Recent communication research has begun to examine other effects of video game play. Yet, this research is still deeply couched within the video game aggression literature and fails to explicate causal mechanisms that would explain its observed effects. For instance, the Ewoldsen et al. (2012) research mentioned earlier in the paper begins to examine the effects of cooperative play in video games, but it focuses primarily on whether cooperative play in an aggressive game can mitigate antisocial behavior and provides no explanatory mechanism other than learning. That a learning mechanism would drive the findings of Ewoldsen et al. (2012) seems unlikely for one fundamental reason: The participants of the study were undergraduates in college who are likely to have had previous experience in cooperative behaviors; as such, these participants are unlikely to have learned to cooperate from their game play experience. Since the original paper (Ewoldsen et al., 2012), Velez, Ewoldsen, and others (Velez, Greitemeyer, Whitaker, Ewoldsen, & Bushman, 2013) have begun to argue that reciprocation acts as the mechanism for increased prosocial behaviors after game play. This mechanism is based on the belief that reciprocation occurs during cooperative video game play, and that this reciprocation

then bleeds over into post-game play behaviors. In this sense, the mechanism explicated relates to cognitive priming.

Although the more recent work by Velez, Ewoldsen, and colleagues (Velez et al., 2013) begins to consider mechanisms that explain how cooperative game play in a violent game context might mitigate antisocial aggressive response, it is still limited in several key ways. First, by focusing on the tit-for-tat strategy, the authors limit their ability to argue that cooperative play leads to prosocial behavior, as the tit-for-tat strategy could also be considered an act of coercion rather than generosity. This limitation will be discussed in greater detail later in the paper. Second, the comparison of cooperative play to competitive play makes it difficult to argue that cooperation leads to prosocial behavior, as it could simply be the case that competition decreases prosocial behavior as compared to a control condition rather than cooperation increasing prosocial behavior. As stated, the goal of the research of Velez and colleagues was to determine whether playing an aggressive game cooperatively would reduce or eliminate antisocial effects of violent game play, and as such, it was not necessary to demonstrate that cooperative play can lead to prosocial behavior; the authors simply had to demonstrate that cooperative aggressive video game play could reduce antisocial tendencies. Finally, the reciprocation mechanism regarding the effects of Ewoldsen et al. (2012) is phenomenological in nature and little more than a priming argument. The current study seeks to move beyond these limitations and the aggression literature by examining a physiological mechanism that could not only explain the effects observed by Ewoldsen et al. (2012) and Velez et al. (2012), but also extend understandings of mechanisms related to cooperative game play as they lead to prosocial effects rather than merely the mitigation of antisocial effects.

Contributions of the Current Study

The current paper argues that cooperating in a video game leads to the production of oxytocin (OT), which increases generosity (an aspect of prosocial behavior). Evidence supporting this position has the potential to advance understandings in several ways. First, the current study provides the opportunity to determine the manner in which media exposure can influence biophysiological processes related to hormone production. Media effects research has historically been interested in how media can influence the behavior of its viewers. Hormones are important determinants of behavior, and the current study attempts to link media exposure to these determinants. By doing so, the current study can explicate mechanistic processes related to media's influence on behavior.

Second, the current study has the potential to bridge a gap in the literature examining the effects of OT. This research has focused separately on elicitors of OT production (e.g., breastfeeding, massage, social media interaction) and the prosocial effects of elevated OT (i.e., researchers introduce exogenous OT into a human through nasal sprays and observe its effects on generosity). Although a causal process suggesting that OT mediates the effects of social interaction on prosocial behavior is implicit in the combination of this research, the empirical evidence falls short of a causal explanation. By demonstrating that OT mediates the relationship between cooperative video game play and prosocial behavior, the current study could not only provide evidence of the causal process linking social interaction with prosocial behavior, but also extend understandings of the forms of social interaction that can elicit elevated OT.

Third, the current research provides the opportunity to unite separate findings into a unified mechanism describing the relationship between social interaction, OT, and prosocial behavior. Previous research has demonstrated separately (a) a link between positive social interaction (cooperative video game play) and prosocial behavior (Ewoldsen et al., 2012; Velez

et al., 2012), (b) a link between positive social interaction (not related to video game play) and OT (Feldman, Gordon, & Zagoory-Sharon, 2011; Holt-Lunstad, Birmingham, & Light, 2008; Nagasawa, Kikusui, Onaka, & Ohta, 2009), and (c) a link between OT and prosocial behavior (Zak, Stanton, & Ahmadi, 2007). However, previous research has not yet established a link between video game play and OT production, nor has it tested the ability of OT to mediate the relationship between positive social interaction and prosocial behavior. In addition, a link between mediated social interaction and OT production is suggested by unpublished research by Zak that demonstrates within subject increases in OT following social media use (Penenberg, 2010; personal communication, December 13, 2012). The preliminary indications from this research suggest that OT can be elicited by a variety of direct or mediated experiences. Moreover, it is consistent with newer interpretations regarding the role of OT in human behavior suggesting that its function is not limited merely to building social relationships between close others but extends to broader needs related to approach mechanisms (Campbell, 2010; Heinrichs, von Dawans, & Deoms, 2009).

Fourth, in addition to its value for research suggesting media elicit OT, the current research also provides much needed research into the potential positive effects of cooperative video game play. The focus of video game researchers on antisocial and aggressive effects of games was largely influenced by the manner in which games were played: Early video games tended to be single-player games or multiplayer games where players competed against each other. Today, games are a far more likely to include cooperative, social play components. However, despite this trend toward multiplayer cooperative game play, most research still focuses on content-related questions (e.g., does violent content lead to aggression?) and ignores the complexity of the current video game environment (Velez et al., 2013). By examining

cooperative video game play and the mechanisms that determine its social influence, the current study more accurately represents the current video game media landscape and brings greater attention to areas of this landscape with social implications that have, to date, been largely ignored. Beyond these contributions, the current study can also provide game makers, of both serious and entertainment games, with knowledge that could potentially influence game-design in a manner that would minimize the antisocial effects and increase the prosocial effects of their games.

Finally, the results of the current study would have important short-term and long-term practical implications related to individuals or organizations seeking to increase generosity and trust. If the current study demonstrates that video game play can increase OT, which then has impacts on generosity and trust, then it stands to reason that cooperative video games or similar experiences could be designed specifically to increase generosity and trust. For example, churches, non-profits, fundraisers, educators, and others interested in increasing generosity, either financially or through volunteerism might be able to benefit from the knowledge generated by the current study to affect behaviors of their target populations. In addition, relational partners or relationship counselors might benefit from utilizing cooperative game play to increase relational closeness. Finally, and perhaps most closely related to the current study, educators and schools could utilize cooperative games to increase cooperation among students and between students and their teachers. In addition to the short-term implications, while important in and of themselves, there may be potential long-term implications as well. Although only speculative at this point, it is reasonable to argue that the repeated induction of OT through cooperative game play as well as the shared experiences that result from this repeated induction may have the potential to create habitual responses that promote sharing, cooperation, and generosity. With

both short-term and long-term implications, perhaps the most valuable area for this study affecting practical knowledge is in serious game creation.

Serious games are games that have “been developed with the intention to be more than entertainment” (Ritterfeld, Cody & Vorderer, 2009, p. 6). Serious games attempt to educate, increase awareness, and motivate social change (Ratan & Ritterfeld, 2009). With regard to education as the goal of serious games, previous research shows that competitive frames can increase learning (Bryant & Fondren, 2009; Burguillo, 2010; Graesser, Chipman, Leeming, & Biedenbach, 2009; Inal & Cagiltay, 2007), and thus the inclusion of competition in educational games is valuable. However, previous research also indicates that competitive frames can increase aggression (Adachi & Willoughby, 2011; Anderson & Morrow, 1995; Eastin, 2007). If the intent of a serious game maker is to mitigate antisocial behaviors and increase prosocial behaviors, the inclusion of purely competitive frameworks may be counterproductive. Against this concern, knowledge from the current study may provide game makers with actionable intelligence regarding the production of serious games with prosocial intents.

Demonstrating that cooperative game play increases prosocial tendencies in the form of generosity, even if changes in OT are not detected, would be valuable for several reasons. First, the previous work by Ewoldsen and Velez (Ewoldsen et al. 2012; Velez et al., 2012) demonstrated that cooperative game play led to less aggression than competitive game play. However, because this investigation focused on the comparison of competitive versus cooperative frames, it is not clear whether cooperation decreased aggression and increased prosocial tendencies or whether competition increased aggression and decreased prosocial tendencies. The current research can overcome this limitation as will be discussed later in the paper. Second, demonstrating that cooperative game play leads to increased generosity in a non-

violent setting (as opposed to the aforementioned work of Ewoldsen and Velez) would provide meaningful theoretical arguments for why cooperative game play mitigated the antisocial effects of violent game play. Finally, demonstrating that cooperation leads to increases in prosocial tendencies would provide further evidence that perhaps competition is the cause of the relationship between violent video games and aggression rather than the violent content, a proposition asserted in previous studies (cf. Adachi & Willoughby, 2011; Anderson & Morrow, 1995; Eastin, 2007).

The paper begins with a discussion of OT and its effects on human behavior, particularly prosocial behavior. Next, logic is presented that would indicate OT as the mediating mechanism between cooperative game play and prosocial generosity. This logic describes how cooperation can lead to increased production of OT within the individual, which in turn leads to increased trust and generosity with others. Finally, a study is proposed to test the mediating mechanism.

Oxytocin

OT is a mammalian hormone that facilitates social behaviors in numerous species, including humans (Campbell, 2010; Heinrichs et al., 2009). Research indicates that OT reduces fear responses leading to increased acceptance of risks and fostering social approach (Heinrichs et al., 2009). This research is supported by findings that OT attenuates the responsiveness of the amygdala, a brain structure related to fear conditioning (Phelps & LeDoux, 2005) and aggressive behavior (Adolphs, Tranel, & Damasio, 1998).

OT has been dubbed the “moral molecule” by some (Zak, 2011) due to its extreme effects on individuals’ behavior. Experiments where OT was artificially increased in participants through nasal administration demonstrate that OT has a strong negative impact on selfish behaviors and a strong positive impact on selfless behaviors. A double-blinded, placebo-

controlled experiment was conducted where participants were injected with OT or a placebo (Zak, Stanton, & Ahmadi, 2007). Participants who were injected with OT were 80% more generous than control participants when splitting a sum of money with a stranger with risk of rejection of the offer. A follow up study found that participants injected with OT gave 48% more money in a charitable donation than participants injected with a placebo (Barraza, McCullough, Ahmadi, & Zak, 2011).

The potential effects of OT have been examined far more than its potential elicitors, due in large parts to the difficulty and invasiveness of measuring OT and the ease with which OT can be induced through nasal and intravenous administration (Campbell, 2010). However, recent advances in measurement have allowed for increased examination of OT levels within an individual. These advances have led to several potential elicitors of OT production including physical touch, behavioral synchrony, and social interaction. Experimental research demonstrates that physical touch, such as massage, leads to increased production of OT as measured through salivary assays (Holt-Lunstad, et al., 2008). Couples were randomly assigned to an intervention condition or observe-only control condition. Couples in the intervention condition were trained in neck, shoulder, and hand massage and encouraged to engage in massage with their partner for 30 minutes, three times per week. This intervention led to significantly larger ($p < .0001$) amounts of OT present in the intervention condition's saliva ($M = 14.73$ pg/ml, $SEM = 1.41$) as compared to the observe-only control condition ($M = 6.52$ pg/ml, $SEM = 1.80$). In addition to physical touch, research indicates that behavioral synchrony is correlated with higher levels of salivary OT (Feldman, Gordon, & Zagoory-Sharon, 2011). Parents and offspring who had higher levels of emotional synchrony coded from a play session also had higher levels of salivary OT ($r = .27, p < .05$).

Although the previous two studies indicate that increases in OT may be related only to physical touch, a study examining human-animal interaction indicates that increases in OT are not solely the result of physical touch (Nagasawa, Kikusui, Onaka, & Ohta, 2009). An experiment examining interaction between humans and their pet dogs indicates that visual contact is necessary to increase OT. Researchers had individuals play with their pets under two separate conditions: One in which they made eye contact with their pet and the other in which they avoided eye contact. Duration of physical contact was positively associated with increases in OT when eye contact was present ($r = .54$) but was unrelated to increases in OT when eye contact was absent ($r = -.19$). Overall, research indicates that social contact can lead to increases in OT production. Moreover, recent unpublished work by Zak indicates that even mediated social contact can lead to increases in OT production (Penenberg, 2010). In three separate studies, participants experienced increases in OT after they engaged in social media behaviors, such as Tweeting (personal communication, December 13, 2012; Penenberg, 2010). These studies provide initial evidence that even a person's perception that s/he is engaging in social interaction can lead to increases in OT production. Findings from studies, such as those discussed above, have led to Uvnäs-Moberg's (1998) suggesting OT as a mediator between positive social interactions and emotions.

Oxytocin as Mediating Mechanism between Cooperative Game Play and Generosity

Previous research indicates that positive social interactions can lead to an increase in OT production and that increases in OT lead to prosocial behaviors. These findings indicate that OT may serve as the mediating mechanism for the findings observed by Ewoldsen et al. (2012) and Velez et al. (2012; see Figure 1 for a visual depiction of this process). On its surface the findings of Ewoldsen et al. (2012) and Velez et al. (2012) are consistent with this process. Positive social

interaction (cooperation) led to increased generosity and an increased use of the tit-for-tat strategy. In addition, other findings of Velez et al. (2012) are in line with explanations based on OT as a mechanism for their findings. Velez and colleagues found that participants who engaged in cooperative game play felt less fatigued, more energetic, and were less aggressive than participants who engaged in competitive game play. These findings are consistent with known effects of OT administration. In a double-blind experiment involving OT administration, individuals who received OT felt less fatigued, less deactivated, and less angry (Pietrowsky, Braun, Fehm, Pauschinger, & Born, 1991).

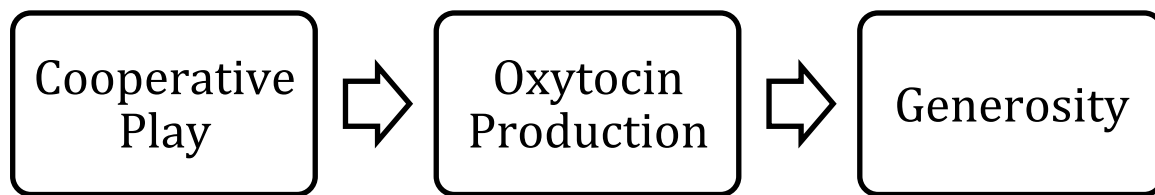


Figure 1. Graphical depiction of the hypothesized mediating role of oxytocin

Although the findings of Velez et al. (2012) are largely consistent with an OT explanation, their findings indicate a somewhat weak effect. This weak effect may be accounted for by methodological limitations related to the type of video games used to induce cooperation and the techniques used to measure generosity.

Limitations of Previous Research

The goal of the Velez et al. (2012) and Ewoldsen et al. (2012) studies was to shed light on the shortcomings of current video game aggression theories and research. The authors argued that contextual factors related to aggressive game play, such as whether players are competing with each other or cooperating, are important factors in determining aggressive video game

play's effects. As such, the authors selected aggressive games that could be played either cooperatively or competitively. This selection of aggressive games may have attenuated the effects of cooperative video game play on player's generosity. For example, meta-analyses of violent video game research indicate an average negative effect of video game violence on prosocial behavior (Anderson & Bushman, 2001). Using a violent game may have reduced the potential positive effects of cooperation by including a competing factor into the experiment. The current study will attempt to overcome this problem by using a video game that allows for cooperation without including aggressive content that would lead to a decrease in prosocial behaviors, such as generosity.

In addition to their selected stimulus material, the prisoner's dilemma measure used confounded trust and distrust. Moreover, this confound may have produced a measure of reciprocal expectations (which should not vary between competitive and cooperative conditions) rather than a measure of generosity (which should vary between these conditions). As previously stated, a tit-for-tat strategy involves making an initial generous offer to a partner, followed by reciprocation of the partner's offers. As such, the initial offer in a prisoner's dilemma game is an indicator of generosity, and observing an increase in this offer for the cooperative condition as compared to the competitive condition indicates increased generosity related to cooperative play.

At the same time, the reciprocation of the partner's offer is not an indication of generosity, but rather a tool for punishing social defectors. In this sense, the use of the tit-for-tat strategy is an indicator of distrust as well as trust, introducing error into the measure and reducing expected systematic variance between the conditions. Although one might expect differences in initial offers as related to competitive versus cooperative play to be indicators of generosity, the use of tit-for-tat strategies in subsequent rounds would not be indicative of

generosity and as such differences would not be expected in these rounds. The evidence provided by Velez et al. (2012) and Ewoldsen et al. (2012) are consistent with this explanation. Velez et al. (2012) observed that the cooperative condition led to more generous offers in the initial rounds as compared to the competitive condition. Moreover, offers became less generous (i.e., more tit-for-tat reciprocation) over the subsequent rounds (Ewoldsen et al. 2012; Velez et al., 2012).

The use of the tit-for-tat strategy, while leading to cooperation between individuals, can also lead to a spiral of uncooperative behavior. If one of the two participants defected from cooperation, a participant utilizing a tit-for-tat strategy would follow the defector resulting in a reciprocal chain of punishment, reducing cooperation. In this sense, the use of the tit-for-tat strategy is both an indicator of trust and distrust. Tit-for-tat is the safest and most effective strategy for encouraging cooperation from an individual whom the initial person does not trust as it provides a punishment mechanism for social defectors. As such, the use of the prisoner's dilemma is less of a measure of prosocial generosity (a correlate of OT) and more an indicator of reciprocal expectations. To overcome the measurement confound of these previous studies (Ewoldsen et al., 2012; Velez et al., 2012), the current study used an alternative measure of generosity, a modified ultimatum game. This ultimatum game provided a measure that is both consistent with measures of generosity used in previous OT research and more representative of generosity as discussed in behavioral economics research (Zak, Stanton, & Ahmadi, 2007; Zak et al., 2009).

The current study sought to examine whether cooperative video game play could lead to increases in OT and whether these increases lead to increased generosity. As such, the current study proposes the following hypotheses:

H1: Cooperative play will lead to larger increases in OT from a pregame baseline to after game play than the solo play condition.

H2: Participants in the cooperative play condition will be more generous than participants in the solo play condition.

H3: There will be a positive correlation between OT levels and generosity.

H4: OT will mediate the relationship between cooperative play and generosity.

METHOD

To test the hypotheses, a study manipulated cooperative play and measured OT and generosity. This study employed a 2 (between subjects: cooperative play manipulation) x 3 (within subjects: time) mixed design. Participants played a video game either cooperatively or alone. OT was measured at three points in time: (1) Baseline at the beginning of the experiment, (2) after the study was described, and (3) after playing the video game. Generosity was measured immediately after the final OT measurement through the use of a modified ultimatum game. All other measures immediately followed the ultimatum game. The following sections describe in greater detail an explication of cooperative behavior, the proposed study manipulation and stimulus material, the measures, and the participants.

Explication of Cooperative Behavior, Manipulation of Cooperative Behavior, and Stimulus Material

To fully operationalize cooperative behavior in the current experiment requires an explication of cooperation. According to Bonta (1997), cooperation is related to goal structures. Cooperation as such is defined as a situation in which “people attain their goal structures only when other participants do also” (p. 300). This definition is placed in contrast to other goal structures by Bonta (1997), such as competitive (i.e., “people attain their goals only if others do not,” p. 300), and individualist (i.e., “people attain their goals without affecting the goal attainment of others,” p. 300). The current study defined cooperative behavior as individuals working together to achieve a common goal or joint reward. Moreover, to overcome limitations of comparing cooperative behaviors against competitive behaviors, the current study compared cooperative behaviors with what Bonta called individualist behaviors (i.e., behaviors enacted by

an individual to achieve a goal, which do not interfere with the ability of others to achieve the same goal) through the use of a solo play condition. This comparison provides the ability to determine whether cooperation increases generosity compared to baseline as opposed to compared to competition.

The current study had participants play with a confederate (in the cooperative condition) or alone (in the solo play condition). A confederate was used in order to eliminate random error introduced by individual differences in perceived cooperativeness and game skill associated with the use of other participants. To operationalize cooperation consistently with the current explication, participants in the cooperative behavior condition were told that if as a team they reached a “certain level” on their score, they would be entered into a raffle to win a \$50 gift certificate to Gamestop. A certain level is a vague term. However, being vague is one of its strengths. In the current experiment, all participants were told that they reached this mark to ensure that no participant felt as if he failed in playing the game. The use of a predetermined level could have prevented some participants from reaching that level, and as such, a vague term was used. The inclusion of a gift card and a goal for which to strive was designed to give participants in the cooperative behavior condition a common goal for which to strive. To operationalize individualistic behavior, participants in the solo play condition were told that they must individually achieve a “certain mark” during their game play to be entered into the raffle. Both of these goal structures closely map onto the cooperative and individualist goal structure as defined by Bonta (1997). Both encourage participants to try their hardest and both allow for the team or the individual to reach their goal (i.e., being entered into the raffle) without their behavior interfering with other teams or individuals’ ability to reach the same goal.

Whereas the previous definition for cooperation indicates certain aspects necessary for an operationalization of cooperation (i.e., ensuring that there is a common goal for participants), it does not link cooperative behavior and cooperation to human's evolutionary environment. The current experiment seeks to link cooperation and cooperative behavior to biophysiological responses (i.e., production of the hormone OT). From an evolutionary perspective, any linkage between cooperation and biophysiological response must take into account the conditions under which early humans and their primate cousins would encounter cooperation, as biophysiological mechanisms related to cooperation may be limited by the environmental conditions under which cooperation was typically encountered by early humans and other primates. In other words, the environmental conditions under which cooperation was typical encountered are likely to influence biophysiological mechanisms.

Chimpanzees and bonobos, the two closest living relatives of modern humans, cooperate extensively in their natural environment, including grooming, food sharing, and hunting (Hare & Tan, 2012). Notably, chimpanzees and bonobos do not cooperate automatically. Rather they tend to cooperate only when it is required to achieve a goal. For example, when presented with a joint-task for a food reward in an experimental setting (i.e., pulling two ropes to receive the food), chimpanzees only enlist the help of another chimpanzee when the ropes are far enough apart that the task cannot be accomplished alone (Hare & Tan, 2012). As such, the joint reward incentive used in the cooperative behavior condition of the current experiment mirrors the behavior of non-human primates.

In addition to the features of joint reward, another key component of the environmental conditions of early human/primate cooperative behavior was co-presence of others. Human communication allows for cooperation to occur with or without the presence of others (e.g.,

written language allows for cooperation across time and space). Moreover, modern technologies allow humans to cooperate across vast distances synchronously with others without the physical presence of others. In fact, online video game play is an example of this type of cooperation. However, although modern technology allows for asynchronous and mediated cooperation that does not require the physical presence of others, cooperative behavior in humans evolved in a situation in which co-presence was a necessary condition. The lack of modern technology and even standardized language prohibited cooperation without co-presence. As such, co-presence may be a necessary, but insufficient, condition for the elicitation of biophysiological responses related to cooperation.

The procedure used in this study included co-presence to strengthen the correlation between the current operationalization and cooperative behavior as it existed in natural environmental conditions of early humans/non-human primates. If a significant relationship were found in the current study between cooperative behavior and OT, future research would be needed to disentangle the extent to which cooperation and co-presence are necessary conditions for that relationship. In addition to co-presence, certain verbal and nonverbal features of early communication may have been central in eliciting cooperation. (Brinck & Gärdenfors, 2003).

Eye contact is one of the key non-verbal communication behaviors that encourages cooperation in human and primates. In the current study, the confederate was instructed to make eye contact with the participant. In addition to eye contact, the confederate made several encouraging statements to the participant before and during game play to maximize the salience of the joint goal. Prior to playing the confederate introduced himself to the participant. Next, the experimenter explained the incentive. Once the experimenter explained, the confederate said, “Wow. That’s awesome. *We’re* going to make a great *team*. Let’s do *our* best to get into that

raffle.” The experimenter then told the participant and confederate to begin. After they began, the confederate said encouraging things to the participant between songs. After the first song, he said, “Nice job! You and me make a great team.” After the second song, he said, “*We* played really well together on that song. Keep it up. *We* have a shot at reaching the goal.” After the third song, he said, “*We’re* great! *We* killed it. *We* rock!” This type of verbal and non-verbal communication was included to increase the cooperative mindset of the participant and more closely mirror real-life cooperation.

Stimulus Material

Frets on Fire (FOF), an open source guitar music video game, was selected as the stimulus material because this type of music game provides opportunities for cooperation (i.e., playing a song together) without introducing the type of violent content that might be expected to decrease OT production or decrease prosocial behavior. Game play in *FOF* consists of playing the guitar parts of songs in rhythm with a song. The player plays the game using a plastic guitar controller with five different colored “fret” buttons representing different notes and a “strum” bar representing the strumming of the notes (see Figure 2). On screen, the player sees a “fretboard highway” that stretches off into the distance on the screen. Different colored notes travel down this fretboard highway toward the player. The player must hold down the matching colored fret button before the note reaches the player, and strum the strum bar in synchrony with the note reaching the fret-button indicator bar at the end of the highway. Playing notes successfully keeps the music of the song going, while missing notes causes the guitar part to skip. If a player misses too many notes in a row, s/he will lose the game. In single player modes, the player controls the lead guitar part of the song. In multiplayer modes, one player controls the lead guitar part (i.e., the participant in the current study), while the other (i.e., the confederate in the current study)

controls the bass guitar. Each part has its own fretboard highway and its own individual notes. See Figure 3 for a depiction of the game in single player mode, and see Figure 4 for a depiction of the game in the multiplayer mode.

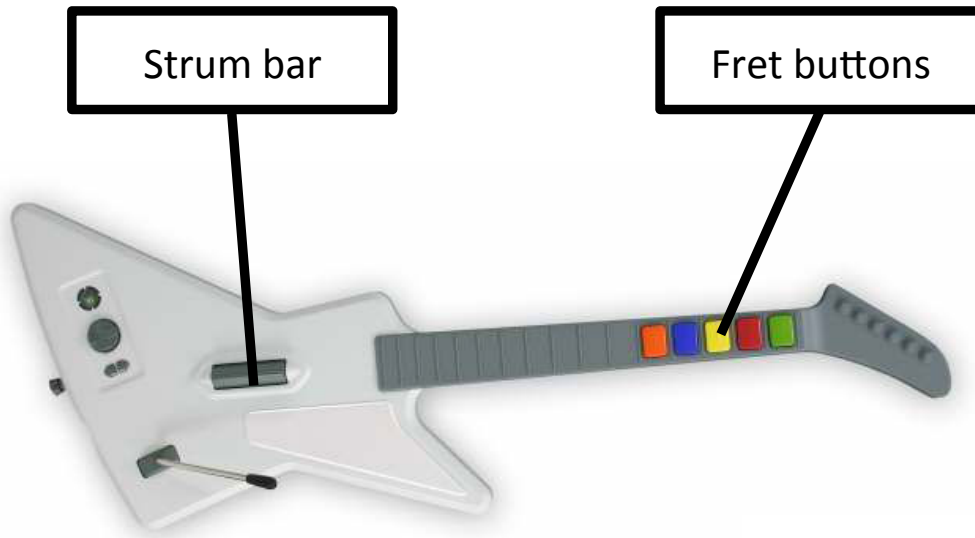


Figure 2. Guitar controller used to play *Frets on Fire*. For interpretation of the references to color in this and all other figures, the reader is referred to the electronic version of this dissertation.

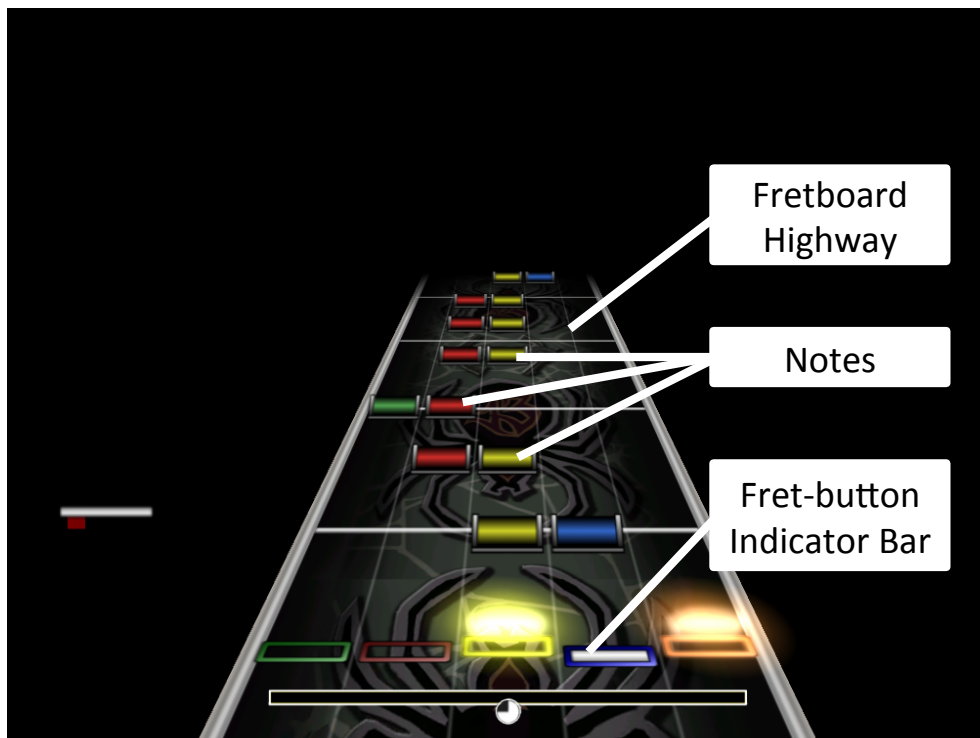


Figure 3. Depiction of single player mode in *Frets on Fire*



Figure 4. Depiction of multiplayer mode in *Frets on Fire*

In the both conditions, participants played a series of three songs (total game play lasted approximately 15 minutes). In the cooperative condition, the participant was assigned to play the lead guitar part of the song and the confederate was assigned to play the bass guitar part of the song. In the solo condition, participants played the lead guitar part of the same song by themselves. In this condition, the bass guitar part was played by the computer, but its part was not indicated on screen. The solo play condition for the current experiment allowed for an exact replication of the game content excepting the presence of a co-player.

The difficulty of the game for all participants was set to “easy,” and it was impossible to fail to complete the songs. These decisions helped to ensure that game play did not induce stress or anxiety in the players, emotions that can induce OT production (Holt-Lunstad et al., 2008; Jezova, Skultetyova, Tokarev, Bakos, & Vigas, 2006; Nishioka, Anselmo-Franci, Li, Callahan, & Morris, 1998; Taylor, Klein, Lewis, Gruenewald, Gurung, & Updegraff, 2000). The increased production of OT brought about by stress related to playing the game at higher difficulties could have occluded the ability to detect differences between conditions in the current study. Notably, the selection of the easiest difficulty may have reduced ecological validity in that challenge is one of the top motivations for playing video games (Sherry, Lucas, Greenberg, & Lachlan, 2006) and the selection of the easiest mode may have reduced challenge (see Tamborini, Grizzard, Bowman, Reinecke, Lewis, & Eden, 2011). However, because the goals of the current study were to determine for the first time whether cooperative play can increase OT and to determine whether cooperative play can lead to increased generosity, the reduction in ecological validity was secondary to preserving internal validity.

Measures

Oxytocin. Recent advances in OT measurement have allowed for the measurement of OT

through non-invasive means of saliva collection (Carter, Pournajafi-Nazarloo, Kramer, Ziegler, White-Traut, Bello, & Schwartz, 2007; Grewen, Davenport, & Light, 2010). Originally, saliva was not considered a valid measurement technique for assessing OT levels because of the small quantity of OT in saliva (Horvat-Gordon, Granger, Schwartz, Nelson, & Kivlighan, 2005). However, concentration techniques have been developed whereby samples are concentrated four times to allow for measurement of OT at levels of 3 pg/ml (Carter et al., 2007; Grewen et al., 2010). These techniques were validated in a study with new mothers by Grewen et al. (2010) who showed that previously established lactation-related increases in plasma OT corresponded with increases in salivary OT ($r = .59, p = .02$).

The current study planned to assess the level of OT in an individual through the same salivary technique used by Grewen et al. (2010). Participants provided a sample of saliva using a Sarstedt 2.0 ml ring tube purchased from Sarstedt. A passive drool collection method was used whereby participants collected saliva in their mouth for 1 minute before placing it into the tube (Grewen et al., 2010). To aid in saliva collection, participants also used the SalivaBio collection aid, which was attached to the Sarstedt 2.0 ml tube. Participants avoided major meals 1 hour before collection and drinks and snacks within 30 minutes of collection. Participants rinsed their mouths with water 10 minutes prior to collection. Next, participants sat leaning forward to allow saliva to pool in their mouth. Participants then filled the collection device with 1.5 to 2.0 ml of saliva.

Oxytocin collection procedure. The collection procedure required preliminary preparation, as the saliva sample had to remain cold throughout the collection process. To ensure that the samples remained cold, the 2.0 ml Sarstedt ring tube were pre-chilled in a -20° Celsius (C) freezer for at least 30 minutes prior to collection. After chilling, the Sarstedt ring tube was

placed in a Styrofoam container filled with crushed ice to maintain a cold temperature. This cup containing the collection tube was then given to the participant for the collection. Once collection was completed, the sample was sealed, labeled, and placed in a dry ice ethanol bath for flash freezing. Samples were then stored in a -20°C freezer until daily data collection was completed when they were transferred to a -80°C freezer for longer-term storage.

Three samples of saliva were obtained from each participant. The first sample was obtained when the participant arrived at the lab. Based on previous saliva collecting protocols for assessing OT, the participant rested for ten minutes before providing the sample (Grewen et al., 2010). This sample served as the participant's baseline measure of OT. The second sample was obtained immediately after participants were informed that they would be playing a video game, again consistent with previous protocols (Grewen et al., 2010). At this point, participants had been informed of whether they would be playing the game together or alone; prior to this point, participants had not been informed that they would be playing a video game at all. Games may be considered a form of positive social interaction in and of themselves, and because changes in hormones can occur with expectations of future behaviors to prepare the body for the expected behavior (Mazur, Susman, & Edelbrock, 1997), participants may have indicated an increase in OT that was simply associated with preparations to play a game. The second sample allows for examination of this possibility. After the second sample was obtained, participants were taken to the room with the game and allowed to play. Participants in the solo condition played by themselves and participants in the cooperative condition played with a confederate that was unknown to the participant. The third and final sample was obtained immediately after game play finished.

The Center for Interdisciplinary Salivary Bioscience Research (CISBR) at Johns Hopkins University was hired to analyze the samples to determine the level of OT present in each sample. Their technique for analysis was based on previous research (Grewen et al., 2010) and consisted of concentrating the samples four-fold through dry-down steps and reconstitution in an enzyme immunoassay (EIA) buffer. This concentration procedure allowed for a minimum threshold of detection of 3.0 pg/ml. These levels are below control and baseline levels of salivary OT found in previous studies (Feldman et al., 2011; Holt-Lunstad, et al., 2008).¹ Prior to shipping the samples for analysis but after data collection was complete, CISBR ceased analysis of OT in saliva due to concerns regarding accuracy of their techniques and the consistency of the EIA buffer, which they were purchasing from another independent lab. Their concerns were warranted as up to 90% of samples sent to their lab for analysis from other researchers were being returned below the minimum threshold of detection (Tracey Hand, Senior Laboratory Coordinator/Manager at CISBR, personal communication, April 2, 2013). CISBR is currently developing a new EIA buffer in house, but a timetable for completion is indeterminable (T. Hand, personal communication, April 2, 2013). As such, the spit samples collected in the current study will be held in a -80°C freezer at Michigan State University until CISBR's development of a new EIA buffer is completed, at which point the samples will be analyzed using the new technique.

Generosity. Consistent with prior research examining the effects of OT on generosity, the current study employed a modified ultimatum game as its measure of generosity (Zak et al., 2007; 2009). In the traditional Ultimatum Game, participants are assigned to one of two roles: Proposer or Responder. The proposer is given a resource (typically money) and is told that s/he can distribute that resource with the responder any way s/he wishes, as long as the responder

accepts the proposer's offer. If the responder accepts the offer, s/he receives the amount allocated to him/her by the proposer and the proposer keeps the remaining amount. If the responder rejects the offer, neither party receives any of the resource. As an example, consider a situation in which a proposer has 10 tokens, and s/he offers 4 tokens to the responder. If the responder accepts this offer, the responder would receive the 4 tokens offered and the proposer would keep the remaining 6. If the responder rejects this offer, neither the proposer nor the responder would receive any tokens.

Previous research examining OT's influence on generosity (Zak et al., 2007; 2009) has modified the game slightly. This modification asks the participant to first play the role of proposer and decide how the resource should be split between him/herself and an anonymous other, knowing that the other has the power to reject the offer. After the participant decides on his/her offer, s/he is asked what is the minimum that s/he would accept if s/he were the responder. The participant's minimum acceptance is then subtracted from his/her original offer. This difference indicates how generous the participant was in his or her offer: A difference greater than 0 represents that the participant offered more to the responder than his/her own minimum acceptable offer (i.e., a generous offer); a difference less than 0 represents that the participant offered less to the responder than his/her own minimum acceptable offer (i.e., a stingy offer). Research indicates that, as expected, OT leads to increased generosity in the modified ultimatum game (Zak et al., 2007; 2009) indicating the validity of the measure.

As previously stated, the current study employed the modified ultimatum game from Zak et al. (2007; 2009). Participants were told that they had 10 tokens, each of which represented an entry in a raffle for an additional \$50 gift card, to distribute between themselves and another anonymous participant from the experiment. They were told that they could decide how many

tokens to give the other participant, but that the other participant had the power to reject their offer, resulting in both parties receiving nothing. On the other hand, if the other participant accepted the amount given to him, each participant would receive the amount allocated by the participant. The amount given to the other participant in this first offer (henceforth referred to as the offer) served as one indicator of generosity.

After the participant decides on their offer, he was then asked what their minimum acceptable offer would be if he was offered tokens from another anonymous participant. This minimum acceptable offer (henceforth referred to as the minimum acceptance) served as a second indicator of generosity, as it can be reasoned that the less one is willing to accept (i.e., the more one is willing to let the other have at a cost to oneself) is also a measure of generosity.

In addition to these two measures of generosity, a final generosity score was also calculated. Based on Zak et al. (2007; 2009), the participant's minimum acceptance was subtracted from their offer to form a generosity composite (henceforth referred to as generosity).

Covariates. Several potential covariates were included as they may relate to video game play outcomes or OT levels. These covariates included state variables related to game play (perceived stress, perceived anxiety, perceived enjoyment, perceived excitement of the game, and perceived effort put into playing), state variables related to emotions after game play (fatigue, energeticness, irritability, agreeableness, and meanness), and trait variables (attitude toward video games, self-rated musical ability, and enjoyment of playing games with partners). See Appendix A for the scales and corresponding items. With regard to OT levels, previous research indicates that fatigue, energeticness, irritability, agreeableness, and meanness are related to OT levels (Pietrowsky et al., 1991). Moreover, these constructs were previously measured by Ewoldsen et al. (2012), and as such, their measures of these constructs will be included in the

current study. Covariates were measured after participants completed the ultimatum game.

To determine whether and which covariates would be included in analyses, correlations between covariates and the independent variable, dependent variables, and the other covariates were examined. Covariates were included if (1) they significantly correlated with the dependent variable and (2) they did not significantly correlate with the independent variable. In addition, if covariates correlated with each other greater than $r = .50$, the covariate that correlated most strongly with the dependent variable was included and the others were excluded. This criterion was included to ensure that power would not be reduced by the inclusion of multiple covariates with high inter-correlations.

Participants. To control for potential sex differences in the overall amount of OT present within the individual and the responsiveness of the body to produce OT, the current study used males as subjects. The decision to use males only was based also on research showing that women feel more anxiety related to playing video games than men (Brown, Hall, Holtzer, Brown, & Brown, 1997). As mentioned earlier, anxiety and stress can lead to increased production of OT (Holt-Lunstad et al., 2008; Jezova et al., 2006; Nishioka et al., 1998; Taylor et al., 2000), which would interfere with the ability to test differences between conditions in the current study. Based on this same concern regarding the need to minimize inducing stress and anxiety in the participants, participants included only gamers. It was reasoned that gamers would be less likely to feel stress related to video game play than non-gamers. Finally, the inclusion of only males is consistent with previous research examining the effect of OT on generosity (Zak et al., 2007). This research introduced exogenous OT to humans and used only men as their sample due to a risk of miscarriage of pregnancy related to the introduction of exogenous OT.

A power analysis was conducted to determine the appropriate number of subjects regarding the manipulations used in the current study. This analysis was based on Stevens (2009) discussion of samples sizes and the results of Grewen et al. (2010). According to Stevens (2009), the samples size needed for a single-group, 3-time point repeated measure experiment with an estimated medium effect size, power of .80, and a correlation between measures of .30, is 39 (see Stevens, 2009, p. 430).² However, this sample size seems somewhat small.

To further refine the sample size estimate for an adequately powered study, data from Grewen et al. (2010) was examined. This research measured salivary OT of mothers at baseline and after interacting with their child. Although the study provided means, standard errors, and results from a paired-samples *t*-test, $t = -2.69$, $p = .023$, the correlation between the two mean values had to be estimated to determine the within subject effect size. The study provided the correlation between plasma and salivary levels of OT ($r = .59$), and this correlation was used to estimate the correlation between salivary levels of OT. Because plasma and salivary OT correlated at .59, one can estimate the correlation between salivary OT measurements as the squared product of the plasma OT-salivary OT correlation. This reasoning is supported by the assumption that plasma OT is a direct measure of actual OT levels (or at least the most direct measure possible) and salivary OT is an indicator of “true” OT levels. Based on this reasoning, the correlation between salivary OT levels was estimated to be .35 (i.e., $.59 * .59$).

Using the data from Grewen et al. (2010) and the estimate of the salivary OT correlation, the estimate of the within subject effect becomes Cohen’s $d = .395$. Using this effect size, a power analysis was conducted using G*Power software (Faul, Erdfelder, Buchner, & Lang, 2009) for an analysis of variance (ANOVA) within-subjects test assuming .80 power, a significance level of .05 (two-tailed), and a correlation among the repeated measures of .35.

Results from the power analysis indicate a total sample size of 56 will be needed for adequate power.

Based on the power analysis, a total of 76 participants were recruited with 38 being randomly assigned to the cooperative condition and 38 being randomly assigned to the solo condition. This total exceeds that which was suggested by the power analysis. The power analysis suggested sample size of 28 per condition was exceeded because some participants ($n = 16$) had a difficult time producing enough saliva for the sample collection. In addition to the 76 participants recruited to the game play conditions, a no-exposure, offset control condition ($n = 30$) was also collected from the same population. This offset control condition completed the outcome measures without playing the game to give a baseline level for the behavioral data in the study. Because this offset control condition was not added until data collection was underway, participants for the offset control condition (a) were recruited separately from participants for the main experiment (despite coming from the same population) and (b) did not undergo random assignment to condition. As such, the offset control condition is only used as a comparison in post hoc analyses and is not used in the testing of hypotheses.

The average age of the participants was 20.46 ($SD = 1.58$, min = 18, max = 29). The majority of the sample was white ($n = 85$, 80.2%), with African Americans making up the second largest number of participants ($n = 11$, 10.4%). Asian ($n = 5$, 4.7%), Hispanic ($n = 2$, 1.9%), and multiracial ($n = 2$, 1.9%) individuals comprised the rest of the participants excepting one individual (.9%) who declined to provide his race.

The sample of participants indicated that they actively played video games weekly, with 85 out of 106 participants (80.2%) reporting that they played a least one or two hours per week. Only five participants in the sample indicated that they played less than an hour a month. The

amount of game play per week did not differ between the three conditions, $F(2, 105) = .51, p = .60$.

RESULTS

Data Reduction

Prior to hypothesis testing, data was reduced through factor analyses. The first step of data reduction consisted of testing the construct validity of individual scales through confirmatory factor analyses (CFA). The primary indicators for assessing fit of the measurement model were the comparative fit index (CFI) and the standardized root mean squared residual (SRMR). A comparative fit index greater than .9 and a standardized root mean squared residual less than .05 were considered acceptable indicators of model fit (Hu & Bentler, 1999).

Confirmatory factor analyses. Confirmatory factor analyses (CFA) were conducted on the twelve scales measuring (1) game enjoyment, (2) perceived stress from the game, (3) perceived anxiety from the game, (4) game excitement, (5) game effort, (6) fatigue, (7) energeticness, (8) irritability, (9) agreeableness, (10) meanness, (11) attitude toward video games, and (12) musical ability. After testing for the fit of the scale using all items, eight of the scales were found to have acceptable fit. Composites were created for these scales by averaging responses to scale items, with results of the CFA and inter-item reliability as follows: Enjoyment (CFI = 1.00, SRMR = .02, α = .88), game excitement (CFI = 1.00, SRMR = .046, α = .68), game effort (CFI = .96, SRMR = .048, α = .90), fatigue (CFI = .95, SRMR = .046, α = .88), irritability (CFI = 1.00, SRMR = .03, α = .86), agreeableness (CFI = .99, SRMR = .03, α = .92), meanness (CFI = .97, SRMR = .03, α = .89), and music ability (CFI = .94, SRMR = .03, α = .94). Analysis of the four remaining scales (perceived stress, perceived anxiety, energeticness, and attitude toward video games) indicated that, in all cases, a single item from each scale was negatively affecting construct validity. After dropping the single item, the remaining items, in all cases,

indicated an acceptable fit. Composites were then created for these scales in the same manner as the other eight scales, with results of the CFA and inter-item reliability as follows: Perceived stress (found (CFI = .99, SRMR = .04, α = .75), perceived anxiety (CFI = 1.00, SRMR = .03, α = .82), energeticness (CFI = .99, SRMR = .03, α = .87), and attitudes toward video games (CFI = .99, SRMR = .02, α = .86).

Further data reduction through principal component analysis. To reduce the data further, the state scales (enjoyment, perceived stress, perceived anxiety, perceived excitement of the game, perceived effort put into playing the game, fatigue, energeticness, irritability, agreeableness, and meanness) were subjected to a principal component analysis (PCA) using Varimax rotation.³ Further data reduction was employed to ensure that the inclusion of numerous individual covariates would not negatively impact the predictive utility of the hypothesis testing, as increasing the number of predictors by mathematical definition increases the amount of variance accounted for by inferential statistical analyses. The first round of analysis yielded a 3-factor solution that explained 69.69% of the variance. The first factor was comprised of the game excitement, game enjoyment, game effort, and state energeticness scales. The second factor contained the meanness, irritability, fatigue, and agreeableness scales. The third factor was comprised of the game anxiety and game stress scales. All items loaded cleanly on their individual factor (i.e., factor loadings on their factor $>.6$ and factor loadings on all other factors $<.4$), except for the agreeableness scale, which loaded on its factor at $-.58$ and loaded on factor 1 at $.44$. The agreeableness scale was thus dropped and another PCA was conducted.

The second round of analysis yielded a 3-factor solution explaining 71.64% of the variance. Similar to the first analysis, the first factor was comprised of the game excitement, game enjoyment, game effort, and state energeticness scales. The second factor this time was

made up of the meanness, irritability, and fatigue scales. The third factor was comprised of the game anxiety and game stress scales. Again, all items loaded cleanly on their individual factor (i.e., factor loadings on their factor $>.6$ and factor loadings on all other factors $<.4$), with the exception of the fatigue scale, which loaded on its factor at .64 and loaded on factor 3 at .44. As such, the fatigue scale was dropped and another PCA was conducted.

The third round of PCA yielded a two-factor solution that explained 62.93% of the variance. This time, all items loaded cleanly their factors (i.e., factor loadings on their factor $>.6$ and factor loadings on all other factors $<.4$). Factor 1 (henceforth referred to as negative affect) was comprised of the irritability, game anxiety, game stress, and meanness scales, and Factor 2 (henceforth referred to as positive affect) was comprised of the game excitement, game enjoyment, game effort, and energeticness scales. See Table 1 for the rotated component matrix.

Table 1.
Rotated Component Matrix of PCA

	Factor 1 (Negative Affect)	Factor 2 (Positive Affect)
Irritability	.83	-.02
Anxiety	.76	-.08
Stress	.76	-.22
Meanness	.73	-.06
Game Excitement	.12	.87
Game Enjoyment	-.27	.86
Game Effort	-.10	.70
State Energeticness	-.13	.72

Dependent Variables

Behavioral data. The responses to the two behavioral dependent variables (offer and minimum acceptance) were examined prior to hypothesis testing. Responses on the offer variable centered around 5 ($M = 5.14$, $SD = 1.73$, $\min = 0$, $\max = 10$) and were highly leptokurtic (kurtosis = 6.72) and slightly positively skewed (skewness = 3.75) due largely to 7 individuals offering all of their tokens to the other partner (see Figure 5).⁴ Responses on the minimum

acceptance variable centered around 4 ($M = 3.72$, $SD = 1.99$, $\min = 0$, $\max = 10$); responses here were not skewed (skewness = 1.32) but were still slightly leptokurtic (kurtosis = 2.57; see Figure 6).

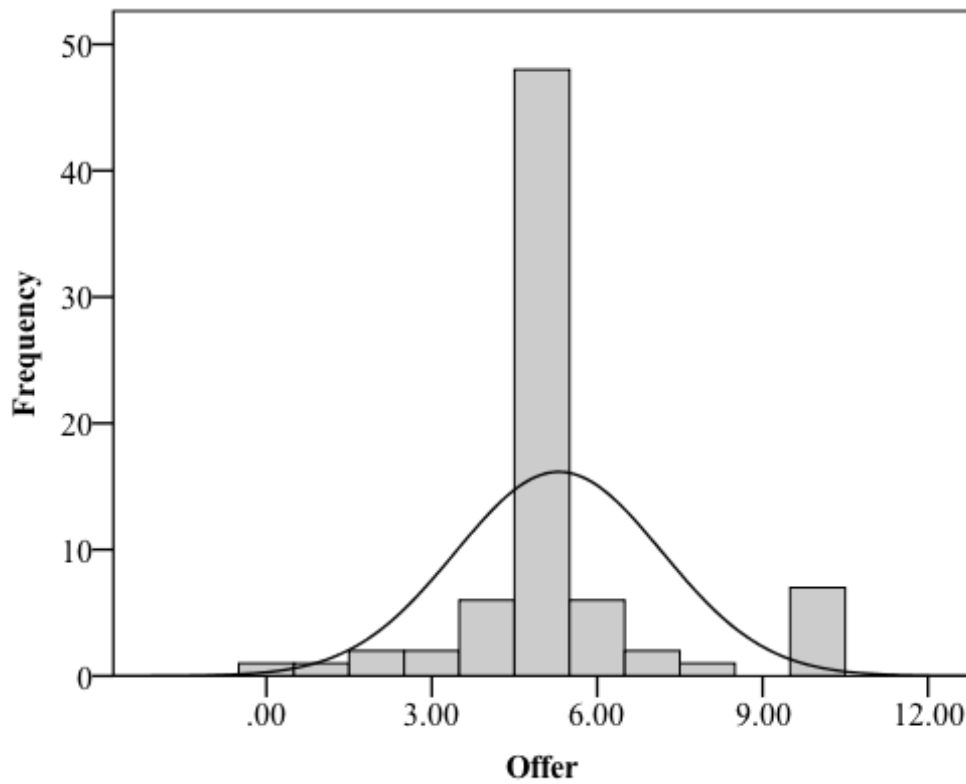


Figure 5. Histogram presenting the distribution of the offer variable

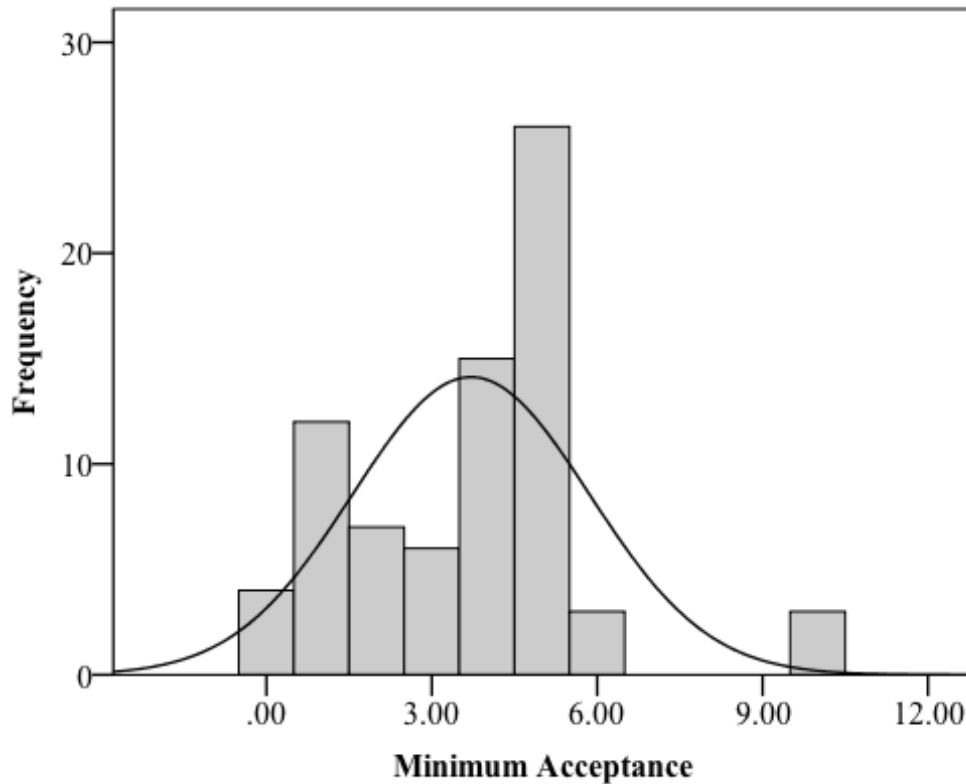


Figure 6. Histogram presenting the distribution of the minimum acceptance variable

When examining the data, an unusual pattern emerged indicating some illogical behavior by participants: For the offer variable, seven individuals offered all of their tokens to the anonymous participant, and for the minimum acceptance variable, two individuals said they would reject any offer from the other participant that was less than all of the other person's tokens (notably one of the individuals who offered all of their tokens to the anonymous participant also had a minimum acceptance of 10; in total, there were 9 individuals who either offered all of their tokens or had a minimum acceptance of 10). These offers and acceptance decisions seem illogical because of the rules of the game and may indicate that these participants did not understand the rules of the game or believe that the tokens had actual value. Because these participants' behavior seems illogical, and because they appear to be outliers based on the distribution curves (see Figure 5 and Figure 6), they were dropped from further analysis.

Although the exclusion of participants due to illogical behavior is not typical for studies using economic decision-making games, it is not unheard of to exclude participants due to highly illogical decision making (e.g., rejecting all offers; see Hertel, Aarts, & Zeelenberg, 2002; Scheres & Sanfey, 2006; van 't Wout & Sanfey, 2011). The exclusion of the illogical participants in the current study seems warranted as indicated by the discussion below.

As discussed in the front end of the paper, participants in the ultimatum game assume two roles: the proposer and the responder. The proposer makes an offer to the responder. If the responder accepts, the responder receives the tokens offered to him and the proposer keeps any tokens not offered to the responder; if the responder rejects the offer, neither player receives anything. Based on these rules, an individual offering all of his tokens to another person is highly illogical, as the responder could not reject this offer, and as such, by offering all of his tokens to the responder, the proposer would guarantee that he would not receive any tokens, as he has given them all away. Only seven participants offered all of their tokens to the other responder; the next closest highest offer was 8, and only two proposers acted this generously.

Similarly, based on the rules of the game, it would be highly illogical to only accept all 10 of the other participant's tokens. By setting the rejection bar at the maximum end of the scale, the responder is guaranteeing that he would reject an ultra-generous 90% of the proposer's tokens. In fact, only three participants set their rejection level at 10 and the next closest participants ($n = 3$) set their rejection level at 6.

Because offering all of the tokens and rejecting any offer other than all of the other participant's tokens are illogical responses to the current game; and because these responses seem to be outliers based on other participants' responses (see Figure 5 and Figure 6), participants who offered all of their tokens and participants who rejected all offers other than all

of the other participant's tokens ($n = 9$) were removed from further analyses.⁵ The removal of these participants led to an offer that was slightly less than 5 ($M = 4.88$, $SD = 1.05$, $\min = 1$, $\max = 8$). The distribution of the offers were slightly negatively skewed (skewness = -2.53) and highly leptokurtic (kurtosis = 7.74; see Figure 7). The removal of the illogical participants led to a minimum acceptance that centered around 3.5 ($M = 3.67$, $SD = 1.60$, $\min = 0$, $\max = 6$). The distribution of this variable was negatively skewed (skewness = -3.14) and slightly platykurtic (kurtosis = -1.50).

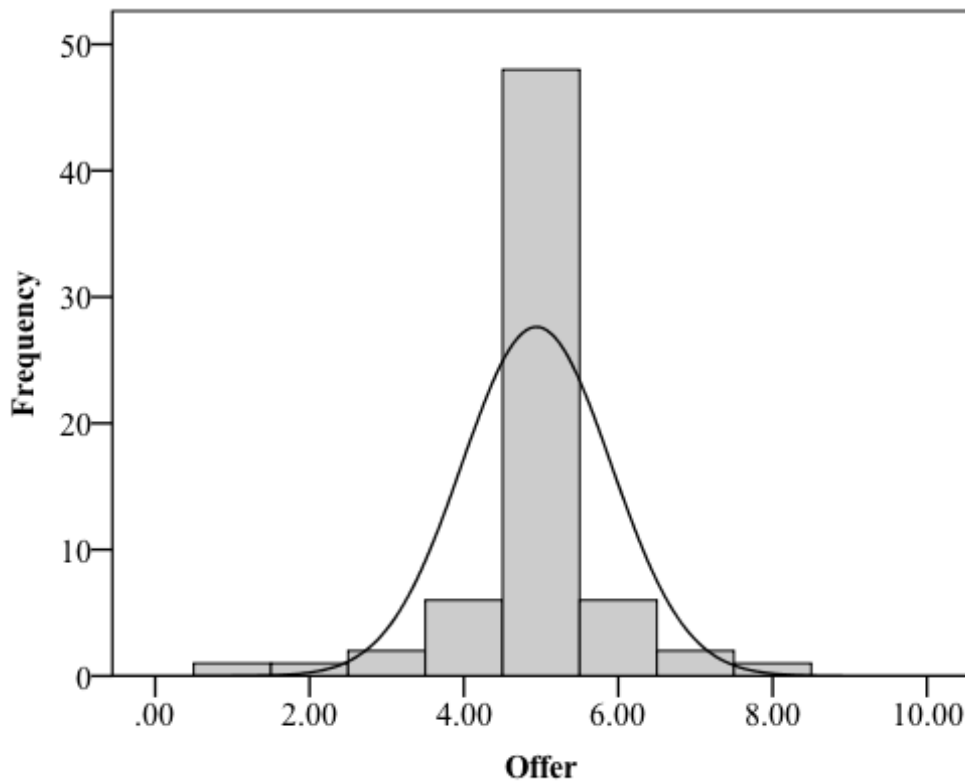


Figure 7. Histogram presenting the distribution of the offer variable with outlier participants removed

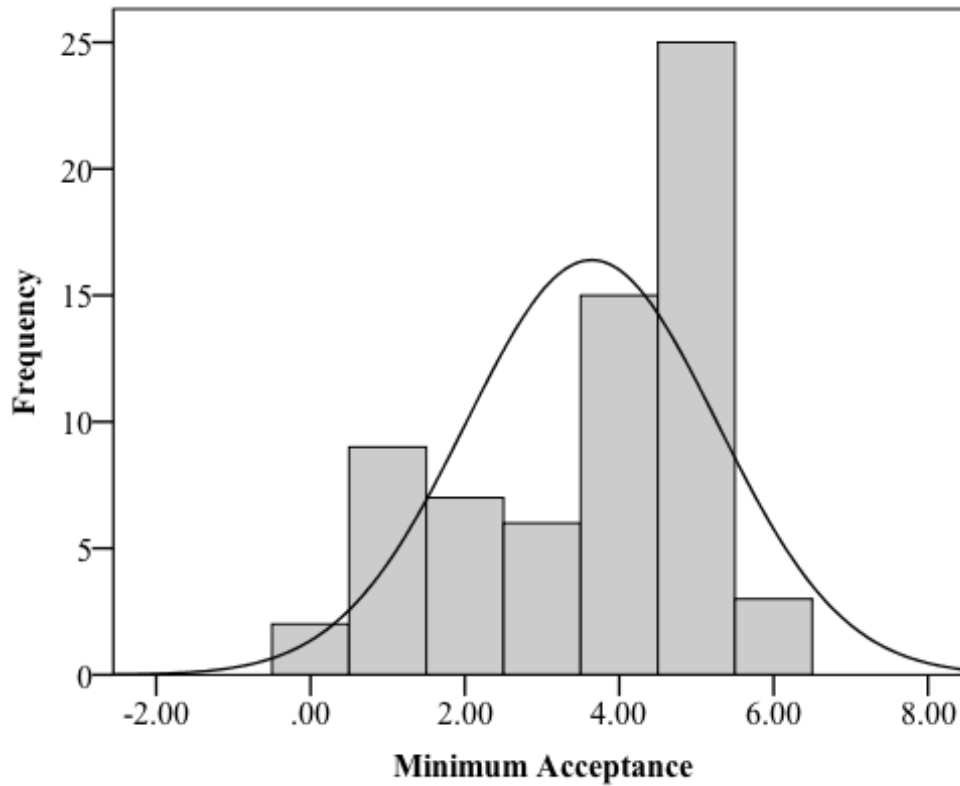


Figure 8. Histogram presenting the distribution of the minimum acceptance variable with outlier participants removed

To form the generosity score, minimum acceptance was subtracted from offer for each participant. Positive scores indicate generosity (i.e., the participant offered more than his minimum acceptance) whereas negative scores indicate stinginess (i.e., the participant offered less than his minimum acceptance). The generosity distribution centered around 1 ($M = 1.21$, $SD = 1.97$, $\min = -4$, $\max = 7$), was positively skewed (skewness = 3.44), and was leptokurtic (kurtosis = 2.45; see Figure 9).⁶

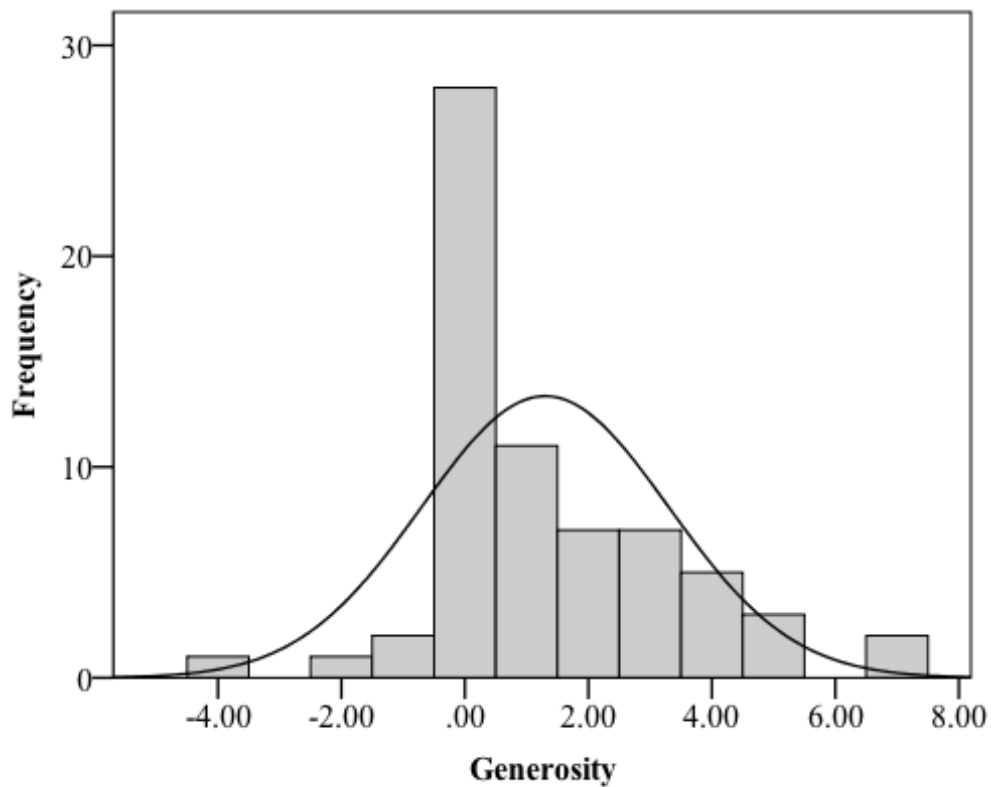


Figure 9. Histogram presenting the distribution of the generosity variable

Hypothesis Testing

Hypothesis testing began by examining which covariates should be included in analysis. Although it is true that one could simply add all covariates and the independent variable to a regression model predicting the dependent variables, this procedure is not ideal as it could result in numerous statistical problems, including violation of the lack of multicollinearity assumption (i.e., regression assumes that unique predictors do not correlate with each other highly). In addition to violating the lack of multicollinearity assumption, the amount of variance explained in a regression equation is partially a function of the number of predictors one includes in the model. By including all of the numerous covariates measured in the current study without assessing their importance for inclusion using a priori criteria, one increases the amount of variance of the dependent variable the predictors account for by mathematical definition.

Furthermore, including only those covariates that warrant inclusion (or none at all if no covariate warrants inclusion) leads to more robust tests of hypotheses.

To determine which covariates warrant inclusion in the current study, a correlation matrix of the independent variable (0 = solo play, 1 = cooperative play), the dependent variables (offer, minimum acceptance, and generosity), the two PCA-derived factors (negative affect and positive affect), agreeableness, fatigue, race (0 = not white, 1 = white), attitude toward video games, self-rated musical ability, and enjoyment of playing games with partners was created. None of the potential covariates were significantly correlated with the dependent variables (see Appendix B). As such, hypothesis testing was conducted through the use of independent samples *t*-tests.

Hypothesis 2 predicted behavioral differences between participants in the cooperative play condition and solo play condition, with participants in the cooperative play condition predicted to be more generous than participants in the solo play condition. To test this hypothesis, *t*-tests were conducted on the offer variable, the minimum acceptance variable, and the generosity variable.⁷

Contrary to predictions, results from the *t*-test on the offer variable indicated that participants in the solo play condition ($M = 5.16$, $SD = .88$) offered marginally more than participants in the cooperative play condition ($M = 4.74$, $SD = 1.01$), $t(65) = 1.78$, $p = .08$, Cohen's $d = .44$.

Similar to the *t*-test on the offer variable, results from the *t*-test on the minimum acceptance variable also were contrary to predictions. Participants in the solo play condition ($M = 3.19$, $SD = 1.75$) were willing to accept significantly less than participants in the cooperative play condition ($M = 4.06$, $SD = 1.41$), $t(59.66) = -2.23$, $p = .03$, Cohen's $d = .58$.⁸

Results from the *t*-test on the generosity variable mirrored the previous *t*-tests indicating

that participants in the solo play condition ($M = 1.97$, $SD = 2.19$) were more generous than participants in the cooperative play condition ($M = .69$, $SD = 1.60$), $t(56.46) = 2.71$, $p = .009$, Cohen's $d = .72$.⁹

DISCUSSION

Behavioral Data

Overall the behavioral data was in the opposite direction of what was predicted: Generosity was lower in the cooperative condition than it was in the solo play condition. This finding is a direct contradiction to the findings and implications discussed in Ewoldsen et al. (2012) and Velez et al.'s (2012) research on violent video games, which demonstrated that cooperative play in violent video games could lead to increased cooperation and helping behaviors and decreased aggression. This research demonstrates that cooperative play in non-violent video games led to a decrease in cooperation and generosity. After playing a non-violent video game cooperatively, participants offered fewer tokens to an anonymous participant, had a higher bar for accepting offers from an anonymous participant, and were less generous with an anonymous participant as compared to the solo play condition. The current section examines (a) how the data from the experimental conditions compare to an offset control condition, (b) whether mood and enjoyment as measured in the current study differed by condition leading to the reversed pattern, and (c) provides two potential mechanisms derived from previous research to explain why the current findings were in the opposite direction of the findings of Ewoldsen et al (2012) and Velez et al. (2012). Following this discussion, future research directions are proposed.

Comparing the two experimental conditions with an offset control condition. During initial stages of data collection, preliminary examination of participant responses indicated a pattern of game-play's influence on generosity that was clearly inconsistent with the outcomes predicted. In converse to hypothesis 2, respondents in the solo play condition appeared to be

more generous than those in the cooperative play condition. However, due to the fact that the experimental design was limited to include only a solo play and cooperative play condition, it was not clear whether solo play was increasing generosity more than cooperative play or whether cooperative play was decreasing generosity more than solo play. Based on this possibility, it was determined that an offset control condition (i.e., a control condition that did not experience any form of video game play or saliva collection procedures) should be collected to serve as a comparison for responses to the ultimatum game in the two experimental conditions. It was determined that the inclusion of the offset control would allow for comparisons between the offset control condition and the two game play conditions in order to determine whether game play (a) increased generosity for both the solo and cooperative play conditions, (b) decreased generosity for both conditions, or (c) had a differential effect (i.e., it increased generosity in the solo condition but decreased generosity in the cooperative condition). Notably, this control condition did not significantly differ from the solo play or cooperative play condition on any of the covariates measured including video game play habits (smallest p value for all comparisons was .49).

Analyses of variance (ANOVAs) were conducted comparing the scores on the three dependent variables (offer, minimum acceptance, and generosity) across the three conditions (solo, cooperative, and control). The results of the ANOVAs on offer, $F(2, 94) = 1.71, p = .19$, and minimum acceptance, $F(2, 94) = 2.59, p = .08$, were non-significant. However, the ANOVA on generosity produced significant differences, $F(2, 96) = 4.00, p = .02$. Further inspection of these differences with post hoc least significant difference (LSD) analyses indicated that the control condition was slightly less generous than the solo play condition at $p = .049$.

Overall, the examination of the pattern of means for solo play, cooperative play, and the offset control conditions demonstrates that with regard to the proposal, participants in the control condition ($M = 4.73$, $SD = 1.23$) offered slightly less than those in the cooperative condition ($M = 4.74$, $SD = 1.01$). In addition, as discussed earlier in the results, those in the cooperative condition showed a tendency to offer less than those in the solo condition, but the pattern fell just below significance ($M = 5.16$, $SD = 0.88$), $t(65) = 1.78$, $p = .08$, Cohen's $d = .44$.

With regard to the minimum acceptable offer, examination of the pattern of means shows that the control condition ($M = 3.73$, $SD = 1.55$) fell between the cooperative ($M = 4.06$, $SD = 1.41$) and solo play ($M = 3.19$, $SD = 1.75$) conditions. Notably, this difference was stronger than the mere tendency of the offer variable; as stated in the results, those in the cooperative condition had a minimum acceptance that was significantly higher than those in the solo play condition, $t(59.66) = -2.23$, $p = .03$, Cohen's $d = .58$.

With regard to generosity, the pattern of means again shows that the control condition ($M = 1.00$, $SD = 1.93$) fell between the two game play conditions, with a mean higher than the cooperative condition ($M = 0.69$, $SD = 1.60$) and lower than the solo play condition ($M = 1.97$, $SD = 2.19$). Here results again indicate a stronger difference than that observed in either the offer or the minimum acceptance variables. As stated in the results, those in the cooperative play condition were significantly less generous than those in the solo play condition, $t(56.46) = 2.71$, $p = .009$, Cohen's $d = .72$. Moreover, the ANOVA and its post hoc results comparing the solo play, cooperative play, and control conditions indicates that the participants in the solo play condition were significantly more generous than participants in the control condition, $F(2, 96) = 4.00$, $p = .02$, LSD $p = .049$.

Taken together, the patterns here suggest that playing alone produced a moderate increase in offer size, an even larger decrease in minimum acceptance as compared to the control condition, and an even larger increase in generosity. Although cooperation did not seem to have an effect on offer size when compared to the control condition, it did produce an increase in minimum acceptance that mirrored the effect of solo playing. When combined in the generosity measure, the emerging patterns suggest that, in contrast to expectations, playing solo seemed to increase generosity compared to the control condition whereas playing cooperatively decreased generosity (see Figure 10 for a graphical depiction of the comparison of conditions on all three dependent variables).

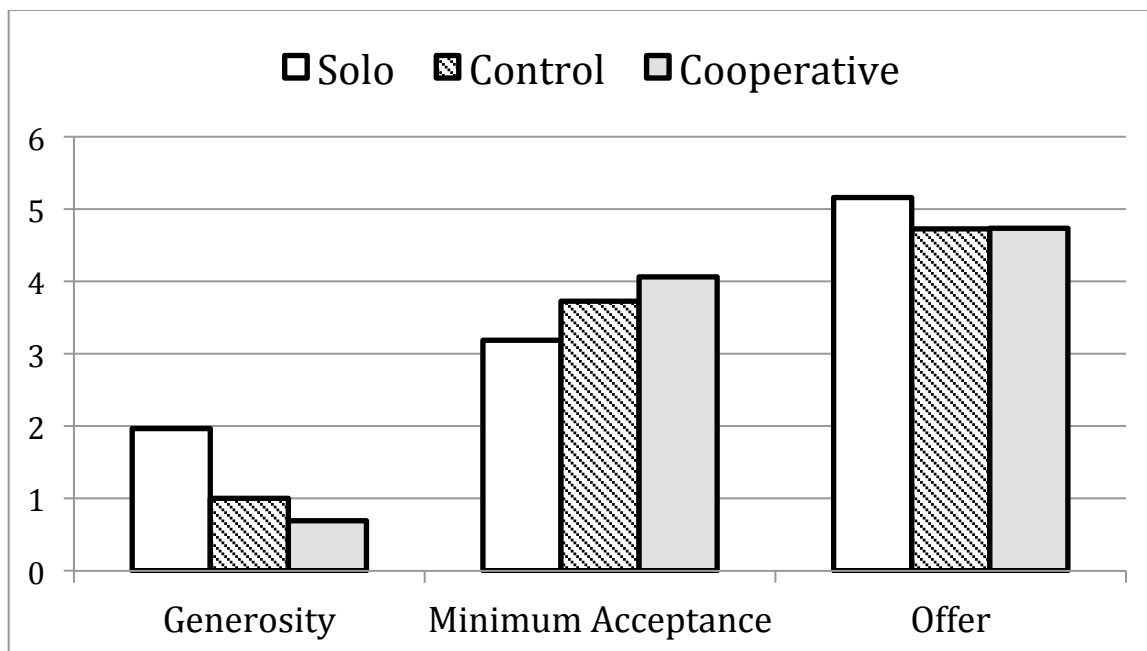


Figure 10. Graphical depiction of the dependent variable means by condition

The impact of state and trait variables on the findings. Comparisons between the two experimental conditions and the offset control condition indicate that playing alone increased generosity while playing with a confederate decreased generosity. Although none of the covariates measured during the study qualified for inclusion in analyses, the current section

examines whether mood after game play correlated with the game play conditions, and as such, could account for the observed pattern.

Correlations between condition and (a) the mood composites (positive affect and negative affect), (b) the mood variables, which were not encapsulated in the mood composites (fatigue and agreeableness), and (c) the trait variables (attitude toward video games, partner enjoyment, and musical ability) were examined. None of the correlations were significant; however, one of the variables (partner enjoyment) was marginally significant ($r = -.21, p = .08$). Despite this marginal significance, the inclusion of this variable in analyses of covariance (ANCOVAs) with the three dependent variables did not alter any of the previous findings. The impact of condition on (a) offer is still marginally significant, (b) minimum acceptance is still significant, and (c) generosity is still significant (see Table 2).

Table 2.
ANCOVAs of Offer, Minimum Acceptance, and Generosity on Condition Controlling for Partner Enjoyment

	Offer Adj. $R^2 = .02$		Minimum Acceptance Adj. $R^2 = .04$		Generosity Adj. $R^2 = .08$	
	<i>F</i>	<i>p</i>	<i>F</i>	<i>p</i>	<i>F</i>	<i>p</i>
Condition	3.44	.07	4.73	.03	7.45	.008
Partner Enjoyment	.37	.55	0.00	.98	.08	.78

The fact that the game play conditions were not significantly related to the state or trait variables indicates both that (a) the experimental conditions did not elicit systematically different levels of the state variables, and (b) randomization did not produce systematic trait differences across conditions. These findings limit the likelihood that the observed effect of game play on the dependent variables was caused by differences in states or traits.

Explanatory Mechanisms that Account for the Divergence of Findings

The findings in the current study were in the opposite direction of what was predicted based on the work of Ewoldsen et al. (2012) and Velez et al. (2012). The current observations indicate that solo play increased generosity and cooperative play decreased generosity as compared to baseline scores. I proffer that these patterns may be explained by two separate processes that involve: (1) synchrony, which I argue is responsible for the increase observed with solo play, and (2) ego depletion, which I argue is responsible for the decrease observed with the cooperative play. Based on procedural choices for the current experiment, participants may have experienced synchrony from playing the music game, and ego depletion from sharing space and resources with the confederate. The current section explains these processes and why they may underlie the current results.

Synchrony. Previous research indicates that performing synchronous behaviors with other individuals can lead to increased cooperation in economic decision-making games (Wiltermuth & Heath, 2009). In this research, participants performed activities (e.g., walking around campus and singing songs while moving cups) synchronously or asynchronously and then completed a weak link decision task designed to measure cooperation. Participants who performed the activities in synch with others cooperated more in the weak link decision task than participants who performed the activities asynchronously. Notably, the act of singing in synch with others was capable of producing increases in cooperation.

It is potentially the case that the activities performed in the solo play condition of the current study produced feelings of synchrony, which fostered cooperation and the increased generosity scores observed. This type of outcome seems reasonable when considering the activities performed in *FOF*. As stated in the method, the primary activity of game play consists of playing a guitar controller in synch with the music of a song. As such, participants playing the

lead guitar part were performing in synch with the lead guitar music of the song, while participants playing the bass guitar part were performing in synch with the bass guitar music of the song. This simple act of playing along with the song may have led to feelings of synchrony.

The argument that synchrony resulting from playing *FOF* led to increased generosity is in line with recent research by communication scholars who have begun to apply the concept of synchrony to positive media responses, including those related to flow, enjoyment, and moral evaluations of narratives (see Weber, Popova, & Magnus, 2013 and Weber, Tamborini, Westcott-Baker & Kantor, 2009). Weber and colleagues (2009) synthesized findings from diverse literatures, including research in neuroscience on the synchronization of neuronal firing and research in physics related to the inherent efficiency of synchronized systems, to propose that the ability of media experiences to induce synchrony is directly related the categorization of those experiences as pleasurable. This research began by focusing on intra-subject synchrony (i.e., synchrony between the firing of neurons within an individual). However, this research has been extended to show that certain media events (such as witnessing bad characters being punished) can lead to inter-subject synchrony (i.e., functional synchrony between the brains of different individuals; Weber, Eden, & Mathiak, 2011). Applied to the current study, it could be reasoned that the act of pressing buttons and strumming in time with the music from playing *FOF* induced intra-subject synchrony and the resulting increase observed in generosity.

Notably, although the logic provided here may explain why synchronous behavior in the solo play condition of this study would lead to increased generosity, the same logic could be applied to the cooperative play condition. As such, why was increased generosity not observed in the cooperative condition of the current study? First, it is possible that the solo play condition resulted in greater synchrony than the cooperative play condition. Second, ego depletion may

have negatively influenced the cooperative participants, a negative influence that may have been absent from the solo play condition. Below the paper discusses why the solo condition may have led to more synchrony than the cooperative condition, followed by a transition into discussion of ego depletion.

In both the solo and cooperative conditions, participants attempted to be in synch with the game by pressing buttons and strumming the guitar controller in time with the notes of the song. However, the game placed additional synchrony constraints on the cooperative condition, which were not present in the solo condition. In the cooperative condition, participants had to be in synch both with their on-screen part and with their partner. In the solo condition, participants simply had to be in synch with their on-screen part. In essence, synchrony may have been greater in the solo condition simply due to the fact that it is easier to place two things in synch (i.e., the participant and the game) than it is to place three things in synch (i.e., the participant, the confederate, and the game). The claim that this increased task demand could have hindered the experience of synchrony is consistent with previous research on the relationship between challenge, enjoyment, and flow (Sherry, 2004; Weber et al., 2009). Sherry (2004) applied flow logic to video game play specifically, arguing that pleasure results from media when the demands of a media experience are in synch with the capabilities of a user to address those demands. Research by Tamborini and colleagues (2011) provided evidence consistent with Sherry's logic by examining the effect of increasing task demand on enjoyment: As task demand increased, enjoyment decreased.

Notable, and in addition to the reasoning discussed above, the cooperative condition in the current study should not have resulted in increased synchrony as compared to the solo condition, as playing with the confederate would not correspond to an increase in synchrony as

defined by Wiltermuth and Heath (2009). In their study, participants' synchronous behavior was defined as participants doing the same thing (individuals walking in step and singing songs and moving cups in synch). In fact, the Wiltermuth and Heath study was inspired by examining whether synchronous movement (i.e., doing the exact same thing), such as an army marching in step or religious followers reciting a chant, can have beneficial effects.¹⁰ In the current study, however, participants in both the solo and cooperative condition were synched with the game. However, the participant and the confederate in the cooperative condition were not synched with each other, as the participant and the confederate were not doing the exact same thing. Rather, participants in the cooperative condition in the current study were completing complementary actions with the confederate rather than synchronous actions. The participant and the confederate were controlling separate guitar parts (i.e., the lead and the bass, respectively), each having a different rhythm and each having different notes. Although these complementary actions adhere closely to the definition of cooperation advanced in the introduction of the paper, they adhere only loosely to a definition of synchronous behavior. Moreover, there is no reason to believe that game play in the cooperative condition should necessarily have led to a systematic increase in synchrony compared to the solo play condition. In fact, cooperative play may have led to decreased synchrony, as the cooperative play condition had an additional opportunity for the participant to get out of synch (i.e., by failing to play synchronously with the confederate).

Based on the discussion above, it seems possible that the heightened generosity in the solo play condition of this study resulted from the fact that synchrony was higher in the solo play condition, where participants had to simply maintain synchrony between themselves and the game. In addition, a second process (ego depletion) may have reduced the positive impact of synchrony on generosity for participants in the cooperative condition. Notably, this second

process should have decreased generosity for participants in the cooperative condition even if synchrony did not necessarily differ between the cooperative and solo play conditions. The following section describes ego depletion and how its presence in the cooperative condition would have negatively affected generosity.

Ego depletion. Ego depletion is “a temporary reduction in the self’s capacity or willingness to engage in volitional action (including controlling the environment, controlling the self, making choices, and initiating action) caused by prior exercise of volition” (Baumeister, Bratslavsky, Muraven, & Tice, 1998, p. 1253). According to the ego depletion hypothesis, an individual’s executive or volitional control over their decisions and behavior is powered by a limited resource, and making conscious decisions or enacting control over non-conscious behaviors reduces this resource and, subsequently, an individual’s ability to maintain executive control over their actions.

A typical research paradigm for testing the ego depletion hypothesis is as follows: First individuals complete a task in which they are asked to engage in self-control over their behavior; afterwards, participants’ self-control is tested in a follow-up activity. Findings generally indicate that individuals who have exerted conscientious control over their behavior have reduced self-control in the follow-up activity. Examples of initial self-control behaviors include selecting healthy as opposed to tempting snacks (e.g., radishes versus chocolates; Baumeister et al., 1998), endorsing a counter-attitudinal belief (e.g., arguing for tuition increases when one is actually against tuition increases; Baumeister et al., 1998), and suppressing an emotional response (e.g., watching an emotional film while attempting to suppress emotional responses; Inzlicht & Gutsell, 2007). Notably, suppressing an emotional response may be similar to the experiences of the participants in the present study’s cooperative condition, which is discussed below.

Research on ego depletion and ultimatum games indicates that ego depletion can result in lower offers in an ultimatum game and higher rejection rates (Achtziger, Alos-Ferrer, & Wagner, 2011; Halali, Bereby-Meyer, & Meiran, 2011). This pattern (lower offers and a higher rejection threshold) is consistent with the current study's definition of decreased generosity. In the current study, the co-presence of another participant in the cooperative play condition may have led to greater ego depletion than solo play. In the solo play condition, only the experimenter was present in the room with the confederate, and he was seated at a table behind and out of eyesight of the participant. By comparison, in the cooperative play condition, the confederate was also in the room. Moreover, the participant had to interact and share close proximity with the confederate, who sat directly next to the participant (within 1.5 feet) and engaged the participant in conversation between game rounds.

Ego depletion logic would argue that the close proximity and interaction between the confederate and the participant should place additional self-regulatory burdens on the participant. Under these conditions, the participant would be more motivated to engage in greater suppression of their emotions and kinesics (acts of executive control), not unlike the emotional suppression procedures used in ego depletion research (cf. Inzlicht & Gutsell, 2007). The participants in the cooperative condition had more normative pressure to engage in socially acceptable conversation than the participants in the solo condition. In addition, the participants in the cooperative condition had to be more aware of their bodily movements due to the closer proximity of the confederate as compared to the solo condition. These additional suppressive motivations may have led to greater ego depletion.

This potential explanation is supported by social-neuroscientific research on ego depletion. In a study by Inzlicht and Gutsell (2007), participants watched a documentary of

animals suffering and dying with half of the participants randomly assigned to the ego depletion condition and the other half serving as a control condition. Participants in the ego depletion condition were asked to suppress their emotional feelings while participants in the control group were simply asked to watch the film. This type of emotional suppression seems similar to the type of suppression experience by participants in the cooperative condition in the current study.

Results from the Inzlicht and Gutsel study (2007) indicate a reduction in self-control associated with emotional suppression as measured using a Stroop task: The words “red” and “green” were presented in either red or green font; participants were tasked with categorizing the color of the font. This crossing of word (“red” and “green”) with font color (red and green) resulted in congruent (“red” displayed in red font or “green” displayed in green font) and incongruent trials (“red” displayed in green font and “green” displayed in red font). Mean reaction time and error rates were recorded for both congruent and incongruent trials. In addition to the behavioral measure, the researchers also recorded event-related potential (ERP) and error-related negativity (ERN) through electroencephalographic (EEG) recording.

The researchers hypothesized that the ego depletion condition would show decreased executive control (slower response time and more errors in the Stroop) and decreased executive control indicated by reduced ERN activity. The researchers further hypothesized that the reduced ERN would mediate the relationship between ego depletion and the behavioral data. Overall, the data showed that ego depletion (a) significantly increased Stroop interference (i.e., the increase in reaction time for incongruent trials) as compared to the control condition and (b) significantly decreased ERN. Furthermore, the reduction in ERN mediated the relationship between condition and Stroop interference.

This research has led Inzlicht and Schmeichel (2012) to propose two mechanisms that underlie the ego depletion process. The first mechanism, which they refer to as a shift in motivational orientation, is defined by ego depleted individuals becoming less motivated by suppression and inhibition drives and becoming more motivated by approach and gratification drives. The second mechanism, which they refer to as a shift in attentional focus, is defined by ego depleted individuals' attention being shifted from "cues signaling the need to exert control and toward cues signaling gratification" (Inzlicht & Schmeichel, 2012, p. 451). These two mechanisms act in tandem leading individuals to be less drawn to self-control behaviors and more drawn to gratification behaviors through motivational (e.g., "I do not want to control myself;" "I want to go with my gut;" *ibid*, p. 453, 455) and attentional mechanisms (e.g., "Do I need to control myself now?;" "I see rewards;" *ibid*, p. 455, 457). In essence, this process model argues that individuals are more likely to seek out and engage in self-gratifying behaviors after they have engaged in a self-controlling behavior.

The model of ego depletion advanced by Inzlicht and Schmeichel is applicable to the current study. It could be argued that participants in the cooperative condition shared space and resources (e.g., screen time) with another game player. This sharing of space in the cooperative condition placed the participant in closer connection with another person (i.e., the confederate) than the solo condition and caused the cooperative condition to share resources that the solo condition did not have to share (i.e., game screen). These differences may have resulted in increased behavioral monitoring which led to ego depletion.

Based on this reasoning, the shift to gratifying motivations and the shift of attention toward rewards should have been stronger for participants in the cooperative condition than for participants in the solo condition. As such, it seems possible that individuals in the cooperative

condition would be more motivated for self-gratification and more attentive toward rewards leading to decreased generosity. In essence, after game play, the rewards of the ultimatum game (i.e., the raffle tokens) may have been a stronger “temptation” for participants in the cooperative condition leading to less generosity in that condition. Notably, the method and results of a previous study (Chambers & Ascione, 1987), cited and dismissed by Ewoldsen et al. (2012) and Velez et al. (2012), are similar to the current investigation lending credence to this interpretation of the current findings.

Chambers and Ascione (1987) examined the effects of prosocial and aggressive games on children’s generosity. In the study, children (half were third or fourth graders aged 8 to 10 years and half were seventh or eighth graders aged 12 to 15 years) played either an aggressive game or a prosocial game. In the prosocial game condition, children played either by themselves (solo) or cooperatively with another child. After game play, children were paid \$1.00 in nickels and were given an opportunity to donate as much as they wanted to “Logan’s poor children”¹¹ by placing coins in a donation box.

The two prosocial game conditions of Chambers and Ascione (i.e., solo versus cooperative) are strikingly similar to the current manipulation. In their solo condition, participants played a Smurf’s video game by themselves, which is similar to the current solo condition where participants played *FOF* by themselves. In their cooperative condition, two participants shared a monitor with one participant controlling the forward and backward movement of the character and the other participant controlling the jumping and ducking of the character. Their cooperative condition is particularly similar to the current cooperative condition for two reasons.

First, both their participants and the current participants controlled complementary game play actions in the cooperative game play mode (forward/backward progress and jumping/ducking in their study and lead guitar and bass guitar in the current study). Second, their participants and the current participants both shared a screen for game play (a procedural choice that was absent in Ewoldsen et al., 2012, and Velez et al., 2012; in their studies, participants played in separate rooms over a network connection).

Although Chambers and Ascione's study did not specifically compare differences between the two prosocial conditions (i.e., cooperative versus solo play), a *t*-test was conducted using the means and standard deviations reported in the manuscript to determine whether solo play in the prosocial condition produced significantly lower generosity than cooperative play in the prosocial condition. Results of the *t*-test indicate that participants in the solo play condition ($M = 9.91$, $SD = 7.92$, $n = 40$) were significantly more generous than those in the cooperative play condition ($M = 6.59$, $SD = 5.25$, $n = 40$), $t(78) = 2.21$, $p = .03$, Cohen's $d = .50$.

This effect size is similar to the effect sizes observed in the present study for the solo play and cooperative play conditions. Providing further credence to the accuracy of the pattern observed in the current data is the fact that the offset control condition in the Chambers and Ascione (1987) study fell between solo play and cooperative play conditions, just as it did in the current study (see Figure 11).

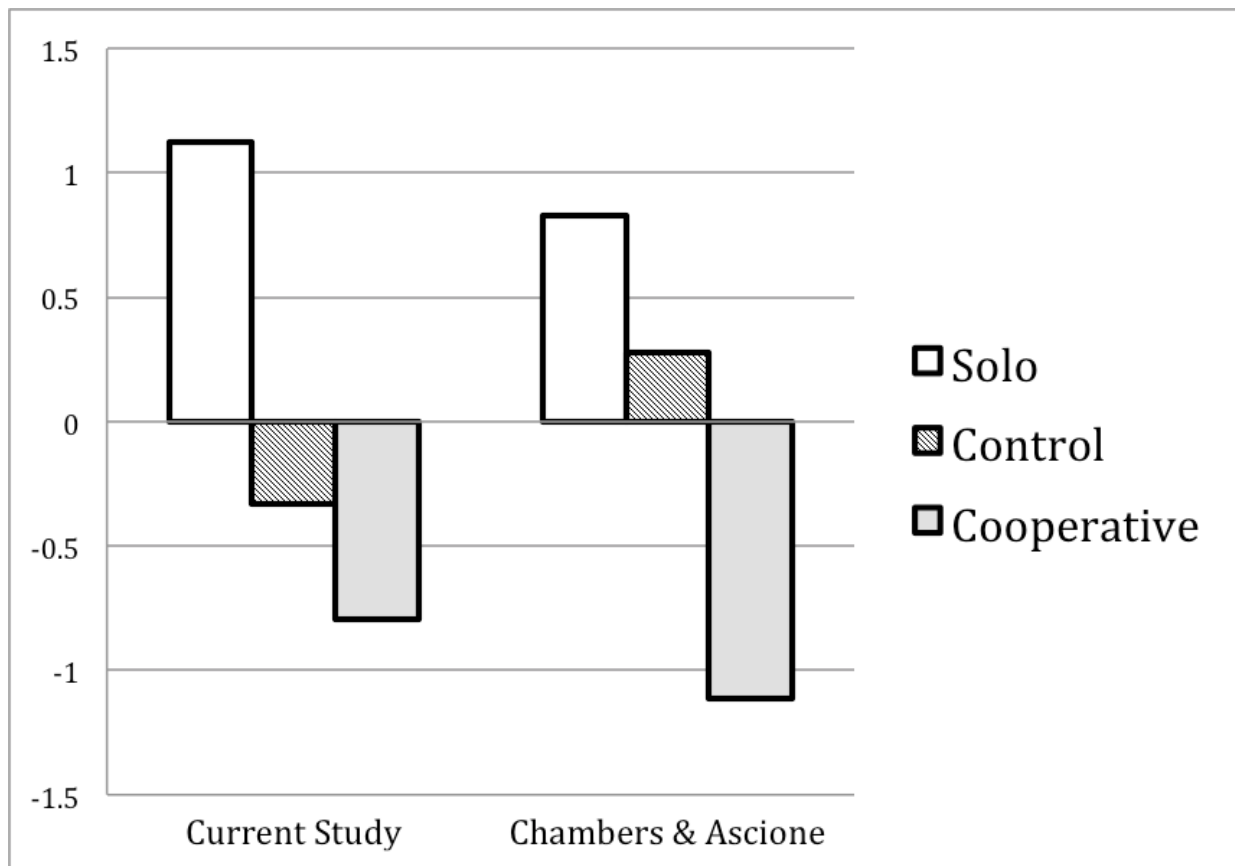


Figure 11. Graphical depiction of generosity scores for the solo, control, and cooperative conditions from the current study and Chambers and Ascione (1987) standardized to be on the same scale

The point of this discussion is that the findings of the current study replicate those of Chambers and Ascione (1987), and both studies show decreased generosity following cooperative video game play. This observation is somewhat at odds with previous research suggesting that cooperative video game play increases generosity, and may seem suspect to scholars supporting this view. However, though the findings in the present study are consistent with the view that cooperative video game play can decrease generosity, it is important to note that the logic underlying the findings this study suggest specific conditions under which this decrease in generosity should occur. Cooperative video game play, if it occurs with both players being co-present and sharing a screen, may result in decreased generosity. As stated earlier, the

ego depletion hypothesis, particularly the motivational and attentional mechanisms proposed by Inzlicht and Schmeichel (2012) that shift an ego-depleted individual toward rewards and self-gratification, seem to support this contention. Sharing screen time and resources seems to result in a motivational and attentional shift whereby self-gratification and rewards become more salient to an individual.

The ego depletion explanation for the current findings seems to make intuitive sense. In addition, the current procedure and results closely replicate a previous study (i.e., Chambers & Ascione, 1987). That being said, the current results differ greatly from the results and implications reported in Ewoldsen et al. (2012) and Velez et al. (2012), which suggest cooperative game play should lead to increased generosity. The next section explores differences between the current study's procedure and theirs in an effort to explain their findings and account for these differences.

Explaining the Findings of Ewoldsen et al. and Velez et al.

Overall, the findings of the current study were very different from those of Ewoldsen et al. (2012) and Velez et al. (2012). Three explanations exist for explaining why both study's observed data were so different from each other. First, it could be that the current data are flawed, and the data from Ewoldsen et al. and Velez et al. are accurate. As such, this study's data would not accurately reflect the influence of cooperative video on prosocial behavior. This explanation suggests that cooperative play does indeed bring about greater generosity, but some methodological choice (e.g., game, procedure, etc.) occluded the current study's ability to see evidence of this process. A second explanation is that the data from Ewoldsen et al. (2012) and Velez et al. (2012) were flawed, and the current data are accurate. This explanation suggests playing cooperatively reduces generosity, and some methodological choice in Ewoldsen et al.

and Velez et al. caused their data to come out in the opposite direction. A third explanation is that both the findings or previous research and the data observed here represent separate underlying processes, but disparate choices between method and procedures resulted in the observation of opposing findings.

Upon first glance, the findings of Ewoldsen et al. (2012) and Velez et al. (2012) appear to suggest that cooperative game play increased prosocial behavior. However, one should be careful to note that instead of interpreting their findings as suggesting that cooperative game play increased prosocial behavior, it may be more plausible to interpret their findings as suggesting that cooperative play merely decreased prosocial behavior less than competitive play decreased prosocial behavior. This alternative explanation seems particularly important to note when one considers the types of violent video games they used as their stimulus material.

Theory and research on video game effects indicate that aggressive games can reduce prosocial behaviors, such as generosity (Anderson & Bushman, 2001). Meta-analysis shows that the average effect of aggressive video game play on prosocial behaviors is $r = -.17$ for experimental studies and $r = -.14$ for non-experimental studies (Anderson & Bushman, 2001). Of course, merely noting that Ewoldsen et al. (2012) and Velez et al. (2012) used a violent game does not explain their findings. A comprehensive explanation of their findings must explain how the violent content in their stimulus material produced the patterns of generosity observed in their study. In fact, there are several factors that should have contributed to their findings being so different than the current investigation.

First, their study should not have resulted in the same type of ego depletion that was observed in the current study due to methodological differences related to the presence of their confederate. Second, their two conditions (i.e., cooperative versus competitive) resulted in an

overall different comparison than the current game play conditions (i.e., cooperative versus solo). Third, their economic bargaining game was played between their participants and their confederate. In fact, the confederate for their bargaining game was the same confederate that participants played the video game with. This final difference is particularly important when it is coupled with the fact that they were comparing competitive versus cooperative game play. Below, each of these mechanisms is addressed as it relates to their findings.

As noted above, the reduced generosity observed for the cooperative condition in the current study may have resulted from the participant sharing space with the confederate. Notably, ego depletion related to the presence of the confederate should not have occurred in the Ewoldsen et al. (2012) and Velez et al. (2012) studies. In their studies, confederates and participants played the game together over a network connection and used separate computers in separate rooms. As such, the current study featured co-presence of the participant and confederate while their study featured telepresence of both participants. The ego-depletion mechanism referenced in the current study argues that co-presence led to ego depletion through the self-regulation of participants' bodily functions, kinesics, and verbal interactions with the confederate. Because their participants interacted over a network connection and played in separate rooms, participants did not need to monitor their bodily functions or kinesics, and simply had to monitor their verbal communication. In addition, the Ewoldsen et al. (2012) and Velez et al. (2012) studies lacked a solo play condition. As such, any ego depletion experienced by the cooperative condition should have been similar to the ego depletion experienced by the competitive condition.¹²

Apart from the difference related to ego depletion, the Ewoldsen et al. (2012) and Velez et al. (2012) studies also employed a fundamentally different comparison from the current study.

Their analytical comparisons, particularly those in the more substantial Velez et al. (2012) piece, focused on comparing cooperative play versus competitive play. As such, cooperative play may have increased prosocial tendencies compared to competitive play, but perhaps not compared to solo play.

The final factor, in addition to the lack of ego depletion and the different comparison, relates to the lack of anonymity in the bargaining games found in the Ewoldsen et al. (2012) and Velez et al. (2012) studies. In Ewoldsen et al. (2012) and Velez et al. (2012), participants completed the bargaining game with their partner from game play. As such, participants in the cooperative condition had a fundamentally different experience with their bargaining game partner (i.e., s/he was cooperative) than participants in the competitive condition (i.e., s/he was competitive). This previous experience may have led to fundamentally different expectations about their partner. Participants in the cooperative condition may have perceived their partner as being cooperative and expected that such cooperation would continue in the bargaining game, whereas participants in the competitive condition may have perceived their partner as being competitive and expected that such competition would continue in the bargaining game. As such, it seems plausible to believe that cooperative play would only lead to increased prosocial behaviors toward the individual with which you played. In other words, cooperative play leads to increased future cooperation with the same individuals rather than increased cooperation with people in general.

Although the mechanisms discussed above provide a coherent explanation for the findings of the current study and the findings of Ewoldsen et al. (2012) and Velez et al. (2012), it is impossible to determine which of the mechanisms proposed are correct. The section below

provides directions for future studies on the effects of cooperative game play suggesting critical tests for some of the speculative mechanisms discussed above.

Future Research Directions

The current section explores differences between the procedures used in the current study compared to those used by Ewoldsen et al. (2012) and Velez et al. (2012) to suggest potential avenues for future research studies. There are four salient procedural differences between the current study and theirs: Game genre (aggressive versus non-aggressive), presence of the video game partner (co-presence versus telepresence), anonymity of the partner in the bargaining game (familiar versus anonymous), and player collaboration (solo versus cooperative and cooperative versus competitive). The presence and absence of these factors in the current study compared to the studies by Ewoldsen et al. (2012) and Velez et al. (2012) makes it impossible to confirm or contest the speculative mechanisms discussed above. However, these mechanisms could be tested easily by future research.

Ego depletion. I speculated that ego depletion led to decreased generosity in the cooperative condition due to the presence of the confederate. As I argued in the discussion, co-presence of a partner during video game play should cause participants to more closely monitor their non-conscious behaviors resulting in ego depletion, while telepresence should not. A 2 (co-presence versus telepresence) X 2 (cooperative versus solo) experiment should provide a critical test of this mechanism (see Table 3).

Table 3.
Depiction of the 2 X 2 to Provide a Critical Test of the Ego Depletion Mechanism's Influence on Decreased Generosity

	Cooperative	Solo
Co-presence of Game Partner	Current	Current
Telepresence of Game Partner	Proposed	Proposed

Current = Cell found in the current study

Proposed = Cell proposed for future research

This design allows for a replication of the current study (the co-present cooperative and solo cells), while introducing telepresence as a moderating factor. If the current findings are accurate, the proposed experiment should yield a significant interaction whereby cooperative play leads to less generosity than solo play when the game partner is co-present, but the relationship disappears when the game partner is telepresent. In addition to adding these two cells, future research should also measure ego depletion. The additional measures of ego depletion could help to determine whether ego depletion mediates or moderates the interaction described above, whereas the addition of a competitive game mode would help to determine whether cooperative play leads to greater generosity than competitive play.

Synchrony. In the discussion, I argued that synchrony was responsible for the observed increase in generosity for the solo condition. I argued that playing a music game where buttons had to be pressed in sync with the music should have led to an increase in generosity. However, it is important to point out the possibility that simply listening to music would result in the same type of increase apart from the synchrony of playing the game. This possibility is supported by the research of Wiltermuth and Heath (2009), which demonstrated that singing along to music lead to increased generosity. Future research should attempt to test whether synchronous button presses (such as those that would be achieved through video game play) or simple exposure to music (that could be experienced with or without video game play) may result in the type of increased generosity observed in the current study. A simple way to test whether the music alone, synchrony alone, or a combination of the two is needed to result in increased generosity would be a 2 (music present versus music absent) X 2 (active game play versus simple viewing of game play; see Table 5) experiment using the current game. Playing the game would represent

synchrony being present (i.e., pressing buttons in synch with the notes on the screen) while viewing game play would represent a lack of synchrony. The alternative conditions (i.e., music present versus absent) would represent music being present or absent given the musical nature of the game.

Table 4.
Depiction of the 2 X 2 to Provide a Critical Test of the Synchrony Mechanism's Influence on Increased Generosity

	Game Play	Viewing
Music Present	Synchrony with music	Music without synchrony
Music Absent	Synchrony without music	Neither synchrony nor music

If music results in increased generosity, there should be a main effect whereby the means for the cells “synchrony with music” and “music without synchrony” in Table 4 would be higher than the means for cells “synchrony without music” and “neither synchrony nor music.” If synchrony alone is capable of increasing generosity, the cell “synchrony without music” in Table 5 should have a higher mean than the cell “music without synchrony” and the cell “neither synchrony nor music.” If synchrony and music each contribute independently to increased generosity, there should be two main effects and a pattern of means such as that depicted in Table 5, where the increase in generosity is highest when both synchrony and music are present, next highest when music or synchrony are present, and lowest when neither music nor synchrony is present.

Table 5.
Depiction of the Two Main Effects Indicating a Combination of Synchrony and Music's Influence on Increased Generosity

	Game Play	Viewing
Music Present	Highest increase	Moderate increase
Music Absent	Moderate increase	Lowest increase

Finally, if both synchrony and music are necessary conditions for an increase in generosity, there should be a “magic cell” interaction as depicted in Table 6, where the highest increase would be observed for the condition that included both synchrony and music and all other conditions would represent no increase.

Table 6.
Depiction of the Magic Cell Interaction Indicating Both Synchrony and Music Result in Increased Generosity

	Game Play	Viewing
Music Present	High increase	No increase
Music Absent	No increase	No increase

Partner Expectations and Findings of Ewoldsen et al. and Velez et al.

When discussing mechanisms for explaining the findings of Ewoldsen et al. (2012) and Velez et al. (2012), I proposed that their participants’ previous experiences with their economic decision-making game partners may have led to differential expectations for their partners’ behaviors during the bargaining game: Participants who played against a competitive game partner may have expected that partner to be competitive in the bargaining game while participants who played against a cooperative game partner may have expected that partner to be cooperative in the bargaining game. Subsequently, one might predict decreased generosity from those expecting a competitive partner and increased generosity from those expecting a cooperative partner. As such, the use of an anonymous partner in their studies may not have led to the same findings. A 2 (competitive versus cooperative) x 2 (anonymous versus familiar) should be conducted to determine whether the explanation proposed in the current study holds true (see Table 7).

Table 7.

Depiction of the 2 X 2 to Provide a Critical Test of the Expectation Mechanism

	Cooperative	Competitive
Familiar Partner	Cooperation with familiar partner	Competition with familiar partner
Anonymous Partner	Cooperation with anonymous partner	Competition with anonymous partner

If this reasoning is correct, one should expect that (a) cooperative game play would lead to an *increase* in generosity that extends to the game player's familiar partner and not an anonymous partner, whereas (b) competitive game play would lead to a *decrease* in generosity that extends to the game player's familiar partner and not an anonymous partner. This should result in a replication of Velez et al. (2012) and a significant interaction whereby (a) generosity would be greater for participants who cooperated with their ultimatum game partner during video game play than for participants who had no experience with their ultimatum game partner and (b) generosity would be less for participants who competed with their ultimatum game partner during video game play compared to participants who had no experience with their ultimatum game partner. No prediction is made regarding the comparison of generosity in the anonymous cooperation versus anonymous competition conditions. It is possible that competition with an anonymous partner would lead to less generosity compared to cooperation with an anonymous partner. However, any difference between these two conditions should be less than the difference between cooperating with a familiar partner and competing with a familiar partner, leading to the same interaction discussed above.

Notably, the mechanism underlying the hypothesized findings above would be similar to the influence of guilt on generosity. Previous research indicates that guilt has a positive effect on helping behaviors, but only for helping behaviors performed toward individuals wronged (de Hooge, 2008). In fact, this increase of helping behaviors toward the wronged individual can

simultaneously reduce helping behaviors performed toward anonymous others. In this manner, cooperation could act as a motivator of generosity, but only for individuals with whom the person cooperated.

Limitations of the Current Study

The current study does suffer limitations that warrant discussion, including the relatively small sample size, the exclusion of participants based on their illogical decision making, and the use of undergraduates as participants. Though only 67 participants were used in this study, the sample size exceeded that which was suggested by a power analysis. Notably, the small sample size did not prevent the current study from observing medium to large effect sizes (i.e., .44 to .72). However, the overall sample size is still relatively small and as such, its estimation of effects lacks precision. Future research should attempt to replicate the current study's findings using a larger sample size to improve the precision associated with the effect size estimation.

The second limitation relates to the fact that some participants were excluded due to their illogical decision making during the ultimatum game. The decision to remove these participants seems warranted in the current study as their responses seem to indicate that they did not understand the task or that they did not believe the tokens truly had value (see Andersen, Ertac, Gneezy, Hoffman, & List, 2011, for an overview of the importance of value in ultimatum games). Leaving these participants in the sample does not change the pattern of means (see Figure 12). However, their inclusion does change the effect size and associated level of significance (see Table 8). Despite the proposition that the removal of these participants was warranted, future research replicating the current findings is needed to increase confidence that the reliability of patterns observed here are accurate.

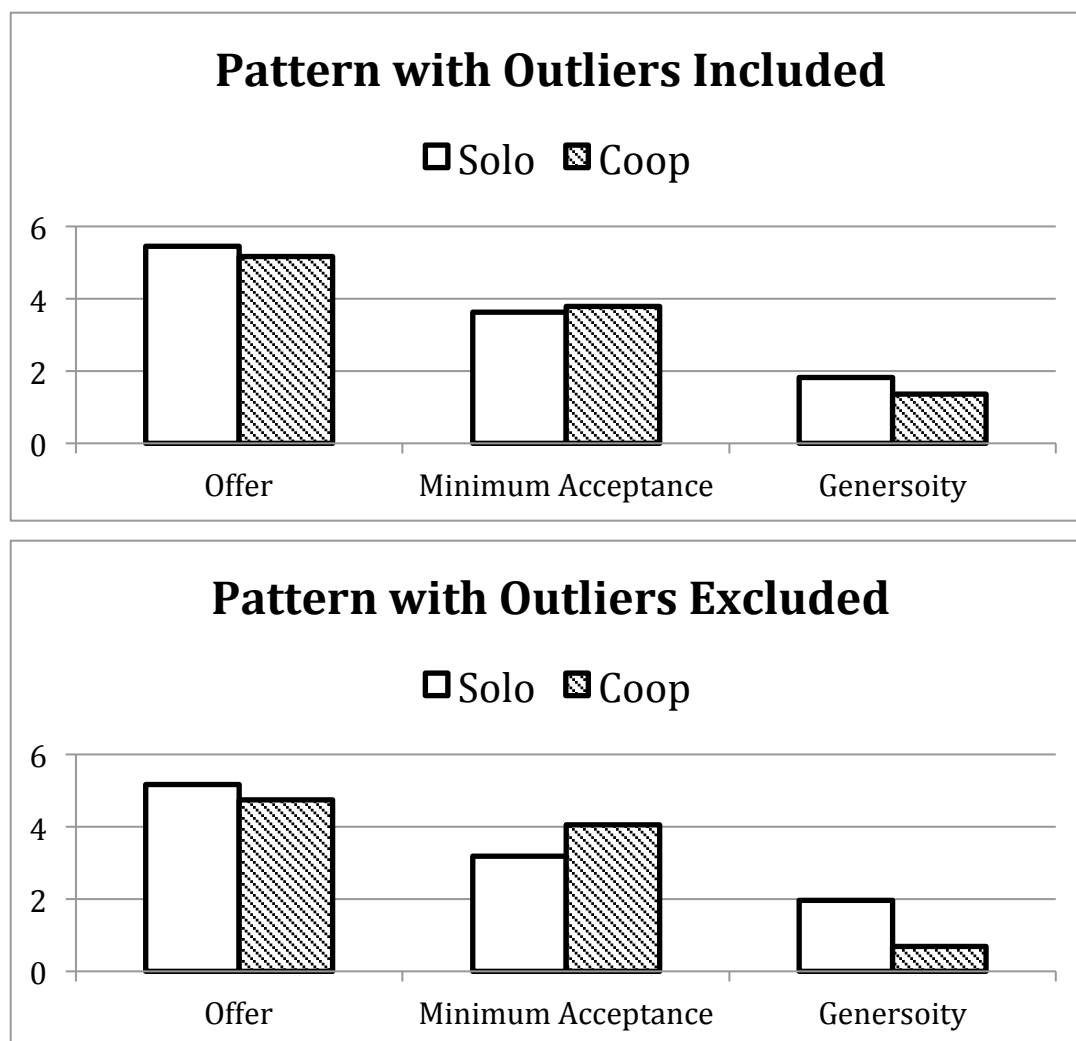


Figure 12. Comparison of the data including and excluding outliers

Table 8.

Comparison of Statistical Tests Examining Differences between Cooperative Play Versus Solo Play on the Three Dependent Variables

	Outliers Included	Outliers Excluded
Offer	$t(74) = .67, p = .51, \text{Cohen's } d = .15$	$t(65) = 1.78, p = .08, \text{Cohen's } d = .44.$
Minimum Acceptance	$t(62.96) = -.32, p = .75, \text{Cohen's } d = .07$	$t(59.66) = -2.23, p = .03, \text{Cohen's } d = .58$
Generosity	$t(62.96) = .59, p = .56, \text{Cohen's } d = .14$	$t(56.46) = 2.71, p = .009, \text{Cohen's } d = .72$

The final limitation regards the use of undergraduates as participants. Behavioral scientists have demonstrated concern regarding the use of undergraduate students as the primary

population of study for psychological experiments (Henrich, Heine, & Norenzayan, 2010).

Henrich and colleagues deem undergraduates “WEIRD” (i.e., Western, educated, industrialized, rich, and democratic), and thus, fundamentally different from the average human. The primary use of these students is particularly concerning for behavioral economists and economic decision-making games, as Western populations differ from the populations of developing countries in their responses to these games (Henrich, 2000). This concern is only partially valid in the current study as the study focuses on the effects of video games rather than the process of economic decision making in general. Due to costs and technological requirements, video games are likely to be restricted to educated, industrialized, rich, and democratic populations. As such, the use of undergraduates provides a more ecologically valid test of the proposed hypotheses. Indeed, the appropriateness of using student populations for research on video games is supported by survey research indicating that almost 70% of undergraduates play games (Jones, 2003). However appropriate the use of undergraduate student populations in the current study, future research should attempt to replicate these findings using both older and younger populations than the participants used in the current study to fully squelch concerns regarding the current study’s use of undergraduate students.

CONCLUSION

The combined effects of the current study suggest that solo play in a non-aggressive video game increases generosity while cooperative play with a co-present partner in a non-aggressive video game reduces generosity. This conclusion is somewhat confounding, as evidenced by the fact that the data were predicted to be in the opposite direction. Based on the current conclusions though, which are supported by research and theory, the current study suggests that cooperative play where players share resources, such as screen time, may be socially concerning in that it can reduce future generosity. At the same time, the study suggests that solo game play of non-aggressive games does not warrant the same kind of concern in that solo play led to increased generosity. The current section provides broader implications about (a) why and when cooperative game play should reduce generosity and (b) whether ego depletion could negatively influence generosity after solo play. It ends with a final note on further research examining OT, and its potential to add insight to some of the explanations offered for the unexpected findings in this study.

Cooperative and Solo Game Play's Influence on Generosity

Based on the explanatory mechanism of ego depletion presented earlier, cooperative game play reduces generosity because cooperative game play induces ego depletion. Put simply, the increased self-monitoring of one's behavior induced by interacting with another person and the sharing of resources increased ego depletion resulting in lower generosity. Notably, this explanation is based on the fact that participants were playing with an unknown confederate. Because the confederate was unknown to the participant, the current study proposed that participants were more conscientious of their behavior (i.e., they exerted greater executive

control over their behavior) and, as such, underwent greater ego depletion than the solo play condition. This increased ego depletion then accounts for the decreased generosity in the cooperative condition. If participants played with a familiar partner (e.g., a friend), it seems unlikely that they would undergo as much ego depletion as when they were playing with a stranger because they should be less concerned about monitoring their behaviors. As such, playing with a familiar partner or a friend should not lead to the same decreased generosity observed in the current experiment.

Co-presence was another factor in the current study that may have increased ego depletion apart from playing with an unknown partner. Based on the mechanism of ego depletion proposed by Inzlicht and Schmeichel (2012), ego depletion causes individuals to seek out self-gratifying experiences due to a previous lack of gratification. As such, the simple act of sharing resources with another person (i.e., friend or stranger) may be enough to lead to ego depletion. As such, if game play had taken place over a local area network connection where players did not have to share screen space because they were not in the same physical location, ego depletion might not have occurred. This reasoning is further supported by the idea that individuals playing in the same location have to monitor bodily functions and kinesics, two factors that would not necessarily need monitoring when physical space was not shared. However, at the same time, participants would have to monitor their vocal behaviors equally online or in person due to audible chat technologies that allow online gamers to hear each other over their network connections. As such, online game play with an unknown partner may lead to the same kind of ego depletion as co-present game play with an unknown partner.

Based on the above discussion, one should expect cooperative game play to decrease generosity when cooperative game play interacts with (a) knowledge of the partner (friend versus

stranger) and (b) co-presence of the partner (same versus separate physical locations). Increased knowledge and comfort with a partner should decrease ego depletion that occurs when playing and thus reduce the negative effect of cooperative game play on generosity. In addition, co-presence of a partner should increase ego depletion and increase the negative effect of cooperative game play on generosity. If these factors act in the way predicted, crossing the factors should lead to the following observations: The highest generosity produced by cooperative game play should occur when an individual plays with a known partner who is in a separate physical location (this should lead to the lowest level of behavioral monitoring and the lowest level of ego depletion). The next highest levels of generosity for cooperative game play should occur when an individual plays (a) with a known partner in the same physical location or (b) with an unknown partner in a separate physical location (these conditions place the factors at odds with each other leading to moderate levels of ego depletion). Finally, the lowest level of generosity for cooperative game play should occur when an individual plays with an unknown partner in the same physical location (the condition observed in the current study).

Despite these proposed relationships, it is unclear whether there are conditions under which playing cooperatively could increase generosity and, if so, how this might compare to solo play. In the current study, solo play led to increased generosity compared to an offset control. It seems feasible that playing cooperatively with a friend over a network connection could increase generosity over a no-exposure control condition. However, it is unclear whether these conditions would increase generosity more than solo play.

The logic provided here does not preclude the possibility that playing cooperatively would increase generosity above that observed in the solo play condition. If the increase in generosity observed in the solo play condition was, in fact, a result of synchrony resulting from

game play, reason leads us to expect the same type of increase in those cooperative game play conditions where ego depletion should not occur. Moreover, one could argue that the experience of synchrony may be higher under some conditions of cooperative play than solo play. For example, classic games, such as the original *Contra* or *Double Dragon*, are extremely difficult in single-player mode. Playing these games in their two-player mode (which is cooperative), however, reduces their difficulty by allowing players to engage in synchronous attacks against enemies. These types of synchronous attacks fit the strong definitional requirements of synchrony (see Weber et al., 2009) in that players in synch would be completing the same action, at the same time. These types of games would be more likely to lead to higher synchrony in the cooperative mode than in solo mode due to the fact that the cooperative mode allows for synchronous, beneficial actions.

If the above interpretation and discussion are correct, individuals concerned about the negative effects of video game play should be less concerned when individuals play with their friends or when individuals play online. Moreover, individuals should not be concerned at all about solo video game play of non-aggressive games, as this type of play actually boosted generosity compared to the offset control. However, there may be situations under which this proposition is limited, particularly if solo video game play can lead to ego depletion.

Ego depletion research indicates that the execution of self-conscious behaviors result in ego depletion and ego depletion can lead to feelings of fatigue (Hagger, Wood, Stiff, & Chatzisarantis, 2010). In fact, fatigue has been conceptualized as an alternative explanation for the ego depletion findings. A meta-analysis of the ego depletion research suggests that subjective fatigue may serve as a mediator for the ego depletion hypothesis (Hagger et al., 2010), although it is important to point out that the present investigation did not implicate fatigue as a cause for

the effects observed here. Because fatigue is related to ego depletion, there may be occasions when solo game play would reduce generosity.

In the current study, participants only played three songs on a guitar game for approximately 15 minutes. This amount of play is not particularly taxing. However, longer play sessions and play sessions that are more difficult may increase fatigue, which could decrease generosity in a similar manner as seen here in the cooperative condition. As such, concerns about extended play sessions may provide cause for concern as they could lead to fatigue and decreased generosity. However, it again warrants pointing out that fatigue in the current study did not lead to decreased generosity as evidenced by the correlation matrix (See Appendix B).

A Final Note on Further Examination of Oxytocin Data

This study began as an investigation into whether hormonal, physiological reactions might mediate the beneficial effects of cooperative play in a video game. However, examination of this hypothesis was prevented by sudden and unexpected problems associated with analyzing OT from salivary samples. It was fortunate that these problems were observed and detected prior to analysis of the data as newer, more sensitive techniques are currently in the works. As stated in the method section, the salivary samples of the participants in the study will be held until the newer analysis techniques are completed. Once these samples are analyzed their inclusion with the behavioral data will provide additional research findings from the current data. Importantly, the expected improvement in the sensitivity of salivary sample analysis techniques holds greater promise for identifying potential changes in OT associated with game play and post-game play behavioral responses as well as OT's potential role in mediating the unexpected influence of game play on generosity.

The inclusion of the OT data with the behavioral data may provide insight regarding the veracity of some mechanisms postulated for the unexpected findings of the current study. For example, it could be the case that OT acts as predicted (i.e., OT mediates the relationship of game play and generosity). However, the current predictions may have simply been inaccurate in determining which condition would lead to greater production of OT. When considering the ego-depletion logic offered for the unexpected findings in this study, it seems reasonable to speculate that OT may be negatively related to ego depletion. Previous research indicates that some correlates of ego depletion (i.e., fatigue, which correlates positively, and positive affect, which correlates negatively; Baumeister, 2002) correlate in an opposing pattern with OT (Pietrowsky et al., 1991). Notably, the current data suggest that lower levels of fatigue and higher levels of positive affect were associated with solo play (see correlation matrix in Appendix B), a pattern that is consistent with OT being higher in the solo play condition. Other logic can connect OT production to the synchrony mechanisms offered above. For example, previous research suggests that synchrony, which was proposed to be higher in the solo play condition, can lead to increased OT production (Feldman et al., 2011). This research lends credence to the potential that solo play led to greater production of OT than cooperative play.

Once measures of OT are available from the salivary samples collected in this study, it will be possible to correlate OT with the two game play conditions to determine if the solo play condition led to a larger increase in OT production as compared to the cooperative play condition. If this interaction is confirmed in the data along with the hypothesized correlation between OT and generosity, mediation analyses could link game play with an endocrinological explanation underlying the effects of video game play on generosity. Furthermore, findings consistent with this explanation would suggest that a suppressing mechanism, such as the ego

depletion mechanism described in the paper, was active for participants in the cooperative play condition. If the OT findings indicate (a) that solo game play led to increased OT production and (b) that OT production led to increased generosity, the question remains why was this observation not also present in the cooperative play condition. The absence of this observation in the cooperative play condition would suggest that a separate mechanism was negatively affecting OT levels.

Even before the inclusion of OT data, the current study provides valuable insights into the influence of cooperative play on prosocial effects of game play. These insights indicate that the influence of cooperative game play on prosocial behaviors is far more complex than earlier research would suggest and should be important to all groups concerned with the social influence of video game play. The observation that solo play and cooperative play can respectively increase and decrease generosity under any circumstance has important implications for game developers, policy makers, and video game scholars alike. To my knowledge, this is the first time that empirical evidence indicates the possibility that cooperative video game play of a non-aggressive game can have an anti-social influence. It would not be at all surprising for this finding to elicit a strong response from different stakeholders concerned with related issues. For example, individuals invested in the proposition that all video game play causes negative effects might rejoice at hearing that even cooperative game play of non-aggressive games can lead to a reduction in prosocial tendencies. By contrast, this finding is likely to consternate individuals invested in the proposition that video game play has only positive consequences, or at least those who contend that potentially negative outcomes associated with video game play result from and are limited to problematic game content (e.g., sex and violence). At the same time, proponents of video game play are likely to be excited and opponents upset by the finding that solo play of a

non-aggressive game can lead to prosocial outcomes. In actuality, proponents and opponents of video game play along with researchers and practitioners should be reminded that video games are likely to have both positive and negative effects depending on the individual playing them, the content of the games, and the context of play. As such, the current study provides new research directions to further improve our understanding of how the context of game play can influence its effects. While these advances are valuable in and of themselves, the data associated with this project will continue to provide opportunities for research once the new techniques for examining OT levels in saliva are completed.

APPENDICES

APPENDIX A

Covariates Scales

Game Enjoyment (Response scale: 1 *Strongly disagree* to 7 *Strongly agree*)

1. I enjoyed playing this game very much.
2. This game was fun to play.
3. Playing made me feel good.
4. Playing the game was entertaining.

Perceived Stress from Game Play (Response scale: 1 *Strongly disagree* to 7 *Strongly agree*)

1. When playing the game, I felt nervous and “stressed.”
2. I felt confident about my ability to handle the game's challenges. (R)
3. When playing the game, I felt that things were going my way. (R)
4. When playing the game, I found that I was unable to cope with the demands of the game.
5. I felt overcome by the difficulty of the game.

Perceived Anxiety from the Game (Response scale: 1 *Strongly disagree* to 7 *Strongly agree*)

1. When playing the game, I felt calm. (R)
2. When playing the game, I was tense.
3. When playing the game, I felt upset.
4. When playing the game, I was relaxed. (R)
5. When playing the game, I felt content. (R)
6. When playing the game, I was worried.

Game Excitement (Response scale: 1 *Strongly disagree* to 7 *Strongly agree*)

1. This game was arousing.
2. This game was exciting.
3. This game was stimulating.
4. I could feel my heart racing while I was playing.
5. I thought this was a boring game (R).

Game Effort (Response scale: 1 *Strongly disagree* to 7 *Strongly agree*)

1. I paid a lot of attention to this game.
2. I put a lot of effort into playing this game.
3. I took the game seriously.
4. I focused a lot on playing this game.
5. I tried very hard on this game.

Fatigue (1 = strongly disagree, 7 = strongly agree)

1. I feel exhausted
2. I feel sluggish
3. I feel drowsy
4. I feel tired

Energeticness (Response scale: 1 *Strongly disagree* to 7 *Strongly agree*)

1. I feel aroused
2. I feel energetic
3. I feel alert
4. I feel excited
5. I feel lively

Irritability (Response scale: 1 *Strongly disagree* to 7 *Strongly agree*)

1. I feel irritated
2. I feel furious
3. I feel frustrated
4. I feel aggravated
5. I feel like swearing

Agreeableness (Response scale: 1 *Strongly disagree* to 7 *Strongly agree*)

1. I feel agreeable
2. I feel friendly
3. I feel good-natured
4. I feel amiable

Meanness (Response scale: 1 *Strongly disagree* to 7 *Strongly agree*)

1. I feel mean
2. I feel cruel
3. I feel disagreeable
4. I feel bitter

Attitude toward Video Games (Response scale: 1 *Strongly disagree* to 7 *Strongly agree*)

1. I generally enjoy playing video games.
2. Video games are a complete waste of time. (R)
3. I consider myself to be a gamer.
4. Playing video games is an important part of who I am.
5. Video games are an important cultural art form.

Musical Ability (Response scale: 1 *Strongly disagree* to 7 *Strongly agree*)

1. I am good at music.

2. It is important to me that I am good at music.
3. My music ability is important to my identity.
4. My natural music ability is: (Response scale: 1 *Very poor* to 7 *Very good*)

Enjoyment of Playing Video Games with Partners (Response scale: 1 *Strongly disagree* to 7 *Strongly agree*)

1. I enjoy playing video games with a partner.
2. I think I make a good teammate when I play games.
3. I would enjoy playing video games with the experimenter as a partner

APPENDIX B

Table 9.
Correlation Matrix of Behavioral Variables

	1	2	3	4	5	6	7	8	9	10	11
1 Condition (1 = Solo, 2 = Cooperative)	--										
2 Offer	-.22	--									
3 Minimum Acceptance	.27*	-.13	--								
4 Generosity	-.32**	.59**	-.88**	--							
5 Positive Affect	-.18	-.13	-.09	.01	--						
6 Negative Affect	.09	-.08	.20	-.20	.00	--					
7 Agreeableness	-.11	-.01	-.23	.18	.37**	-.54**	--				
8 Fatigue	.11	.22	.02	.09	-.40**	.35**	-.30*	--			
9 Race (0 = Not White, 1 = White)	-.08	.19	-.10	.17	-.07	-.15	.03	.07	--		
10 Attitude toward Video Games	-.02	-.01	-.04	.03	.40**	-.14	.39**	-.29*	-.05	--	
11 Musical Ability	-.12	.08	-.01	.05	.23	-.07	.22	-.08	-.21	.11	--
12 Enjoyment of Playing with a Partner	-.21	-.03	-.06	.04	.48**	-.38**	.37**	-.35**	.03	.53**	.12

* Correlation is significant at the .05 level (2-tailed),

** Correlation is significant at the .01 level (2-tailed).

ENDNOTES

ENDNOTES

¹ Notably, it is possible that baseline or post-game play levels of OT will fall below the minimum threshold of detection of 3.0 pg/ml, despite the indications from previous research. If the post-game play levels of OT are above the minimum threshold but the baseline levels of OT fall below the minimum threshold, the baseline level will be set to the minimum threshold of detection for any participants whose level is not greater than 3.0 pg/ml. This procedure will reduce the variance and ability to detect the hypothesized interactions between time and condition. If both the post-game play levels of OT and the baseline levels of OT fall below the minimum threshold of detection, the current study still provides valuable knowledge regarding the OT literature apart from its value to the video game effects literature. Currently the OT literature is hampered by the invasiveness of assessing changes in OT using either plasma or urine (Campbell, 2010; Grewen et al., 2010; Heinrichs et al., 2009). Some researchers have argued that saliva would provide a potentially non-invasive method for assessing changes in OT (Grewen et al., 2010), but this is currently not a firmly established method, despite initial successes (see Grewen et al., 2010; Holt-Lunstad et al., 2008). The current study would provide further evidence, either confirmatory or disconfirmatory, of the potential for saliva as a method for assessing variation in OT levels. Also of note, regardless of whether both post-game play and baseline levels of OT fall below the minimum threshold of detection, the current study still makes a valuable contribution to the video game literature. Even if there is no association with change in OT, the study tests whether cooperative behavior increases prosocial effects of video game play, a proposition not formally tested in previous research.

² The estimates for a medium effect size and a correlation between measures of .30 are based on the results of Grewen et al. (2010).

³ There is notable disagreement about the acceptability of PCA using Varimax rotation (see Morrison, 2009), as Varimax rotation maximizes the variance between factors leading to a correlation between factors that approaches zero. This type of rotation leads to factors, which should be highly correlated, correlating at or near zero. Notably, the factor structure (i.e., positive and negative affect) observed in the current study for the exploratory factor analysis could have been predicted a priori. However, because the purpose of including these scales was to maximally account for the influence of covariates on the relationship between the experimental inductions and the dependent variables, a PCA using Varimax rotation was implemented. Reexamination of the data using traditionally constructed composites (i.e., averaging of the scales) of the positive and negative affect factors did not affect any of the conclusions of the study.

⁴ Positive skew and leptokurtosis along with negative skew and platykurtosis were determined using ± 2.00 as the criterion of determination.

⁵ Comparisons were made using correlations to determine whether the 9 individuals who were removed from the study differed from the remaining 67 participants. Because of the small number of participants who were removed, it is difficult to determine how different these participants were on other variables in the study using null-hypothesis statistical tests. However, trends did emerge indicating that these participants felt more stressed ($r = .17, p = .075$ one-tailed) and more anxiety ($r = .22, p = .03$, one-tailed) after game play.

⁶ The distribution of the dependent variables differs largely from a normal distribution.

Parametric statistical tests, such as Student's *t*-test or ANOVA, assume a normal distribution of data. Large divergences from a normal distribution, such as the ones seen in the current study can result in inaccurate hypothesis testing (Erceg-Hurn & Mirosevich, 2008). In addition, Erceg-Hurn and Mirosevich (2008) suggest several modern robust, non-parametric statistical techniques for analyzing data when the data are not normally distributed. Winsorization, which is one of the data analysis techniques they suggest, provides an acceptable solution for simple between group comparisons of two groups. Winsorization is a statistical trimming procedure that involves replacing the top 20% and bottom 20% of responses with their respective 21% value. As an example, assume the values of a data set ($n = 10$) are 0, 1, 2, 4, 5, 6, 7, 10, 15, 16. Winsorization would replace the bottom 20% of responses (0, 1) with 2, and the top 20% of responses (15, 16) with 10. The resulting data set then becomes 2, 2, 2, 4, 5, 6, 7, 10, 10, 10. Winsorization reduces the influence of outliers on a data set and “can result in the estimation of more accurate standard errors” than those obtained using parametric statistical tests (Erceg-Hurn & Mirosevich, 2008, p. 596). Notably, in the present case, use of the Winsorization technique suggested by Erceg-Hurn and Mirosevich (2008) had implications beyond overcoming the limitations of using parametric statistics on non-normal data. As detailed further in endnote 7, analyses using Winsorization techniques produced results similar to those obtained after removing participants due to their illogical decision making in the ultimatum game.

⁷ As discussed in endnote 6, parametrical statistical tests may distort findings when data are not normally distributed, and non-parametric tests should be used (Erceg-Hurn & Mirosevich, 2008). However, at the same time Erceg-Hurn and Mirosevich (2008) note that if both parametric and non-parametric analyses “lead to the same substantive interpretation of the data, debate about

which analysis should be trusted is moot” (p. 595). Based on their discussion, non-parametric tests of the data were used in the current study through implementation of 20% Winsorization techniques and the creation of Winsorized means, variances, and confidence intervals. The results of these techniques are largely consistent with the results of the *t*-tests. Using the Winsorized techniques, the solo condition (Winsorized $M = 5.26$, Winsorized $SD = .47$) had slightly higher offers than the cooperative condition (Winsorized $M = 5.16$, Winsorized $SD = .37$), but this difference was not significant ($p = .15$). In addition, the solo condition (Winsorized $M = 3.29$, Winsorized $SD = 1.66$) trended toward a lower minimum acceptance ($p = .08$) than the cooperative condition (Winsorized $M = 3.76$, Winsorized $SD = 1.53$). Finally, the solo condition (Winsorized $M = 1.74$, Winsorized $SD = .28$) was more generous than the cooperative condition (Winsorized $M = 1.16$, Winsorized $SD = .24$), and this difference was significant ($p = .04$). These results are largely consistent with the results of the *t*-tests. Given that the interpretation of these non-parametric analyses are substantively the same as the interpretation of the parametric tests reported in the text, concern over which analysis should be used seems moot.

⁸ A decimal is reported as the degrees of freedom here because Levene’s test for equality of variances indicated that the assumption of equal variances was violated, $F = 5.30$, $p = .03$.

⁹ A decimal is reported as the degrees of freedom here because Levene’s test for equality of variances indicated that the assumption of equal variances was violated, $F = 5.75$, $p = .02$.

¹⁰ Wiltermuth and Heath explain in the introduction that many synchronous activities are used to improve group morale or group cohesion even when the end goal of the activity is never realized or utilized. Take for instance marching in step. Wiltermuth and Heath (2009) state: “The decline of the bayonet and the advent of the machine gun have made marching in step a terrible, if not

suicidal, combat tactic (McNeill, 1995). Yet armies still train by marching in step. Similarly, religions around the world incorporate synchronous singing and chanting into their rituals (Radcliffe-Brown, 1922). Why? We suggest that acting in synchrony with others can foster cooperation within groups by strengthening group cohesion” (p. 1).

¹¹ The study took place in Logan, Utah.

¹² The Ewoldsen et al. (2012) study did include an offset control condition. However, the study simply reports a composite of the use of tit-for-tat behaviors. It is unclear how this composite was created and how this composite would relate to prosocial behaviors such as generosity as measured in the current study.

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