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Mining Creativity: Video Game Creativity Learning Effects

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Mining creativity: Video game creativity learning effects

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The student author and the program of study committee are solely responsible for the content of this thesis. The Graduate College will ensure this thesis is globally accessible and will not permit alterations after the degree is conferred.

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ABSTRACT

Most psychological studies concerning the learning effects of video games have focused on action video games. These popular games emphasize quick-paced combat, narratives, player agency, and problem solving. Although many studies have focused on aggression or visual-spatial cognition effects from the quick-paced combat, the problem-solving aspects have been largely ignored. The present study seeks to expand the existing literature on video game effects by focusing on a rarely-tested outcome: creative production.

As a game with few rules and a high amount of player freedom, *Minecraft* exemplifies a game that fosters players' abilities for creative expression. This experimental study compares the effect of playing *Minecraft* on creativity measures compared to watching a TV show (passive control), a driving game (game control), and playing *Minecraft* with specific instructions (an instructional control).

A within-subjects analysis (n=350) found a significant correlation between trait creativity and game play habits. Between-groups analyses showed that players randomly assigned to play *Minecraft* without instruction demonstrated significantly higher scores on post-game creativity measures compared to those who played *Minecraft* with instructions to "be creative,", those who played a driving game, or those who watched a television show. Results indicate that effects are not solely predicted by game mechanics, but also by the way the player plays.

CHAPTER 1: INTRODUCTION

The Growth of Video Games in Society and Research

In 1999, the leading video game company had sold over a billion games across the previous 12 years, and more than 40% of American families owned a gaming console (Dill & Dill, 1999). This led to the average child in 1999 spending 26 minutes a day playing video games (The Henry J. Kaiser Family Foundation, 2002). By 2012, one research group estimated the average American adult spent 3 hours a day playing video games (Entertainment Software Association, 2015). In 2014, the video game industry received over $22 billion in yearly revenue, and 80% of American households owned a gaming console (Entertainment Software Association, 2015). In the last couple of decades, video games have entrenched themselves as a popular medium.

Concerns about the prominence of video games in children's lives and its potential effects on children have driven much of the video game research to date. Research into several domains of media effects have illustrated that the behaviors players practice in games generalizes outside of the game.

Most of this research has focused on two aspects of popular video games: violence and visual-spatial cognition. On one hand, research on violence in video games has revealed that players of violent video games experience increased aggression compared to non-violent video game players (Gentile, Lynch, Linder, & Walsh, 2004; Anderson, Shibuya, Ihori, Swing, Bushman, Sakamoto, Rothstein, & Saleem, 2010). On the other hand, players of action video games, which require quick reactions to a variety of visual cues, benefit from faster reaction times and increased performance in a range of visual-spatial cognitive tasks (Green, & Bavelier, 2003; Dye, Green, & Bavelier, 2009; Achtman, Green, & Bavelier, 2008). These video game categories are not exclusive, and often refer to specific game dimensions that researchers are

interested in. As such, a game can fit into multiple categories and have both beneficial and harmful effects. For example, the *Call of Duty* series of games is both a violent video game and an action video game. Its gameplay requires fast paced aggression and shows both aggression effects and visual-spatial benefits (Anderson et al., 2010; Achtman, Green, & Bavelier, 2008).

Players of prosocial video games illustrated more prosocial thoughts and behaviors than non-prosocial video game players (Gentile, et al., 2009; Greitemeyer, Osswald, & Brauer, 2010; Prot, et. al., 2014). Players of real-time strategy video games, which require storing and processing multiple short- and long-term goals while simultaneously attending to new cues, show gains in working memory (Basak, Boot, Voss, & Kramer, 2008; Basak, Voss, Erickson, Boot, & Kramer, 2011; Kühn, Gleich, Lorenz, Lindenberger, & Gallinat, 2014).

Although the social behavioral and cognitive effects of video games are fruitful areas of research, the video game market has genres beyond shooting and helping others. Researchers have overlooked how games can foster creativity.

Most game genres encourage players to practice some creativity. For example, role-playing games encourage players to create a character, a backstory, and a long-term strategy for character development that fits into an imaginary world created in collaboration with other players and the game designers. Competitive games often reward creative strategies with victory against one's opponents. Even the popular and seemingly-straightforward first-person shooter (FPS) games engender creative practice as players rethink strategies and pursue exploits that give them advantages in combat. Many computer games thrive on the creative practice of their "modding" community, in which users alter (modify) the game itself to add new levels, visuals, and modes.

Games like *Minecraft* (a game that has sold over 100 million copies) don't revolve around helping others, shooting people, or fast-paced action. They revolve around open-world exploration of a virtual "sandbox," player-created content, and manipulation of game rules to accomplish player created goals (Duncan, 2011). The game allows players to explore unique worlds and create anything they can imagine in that world. With games fostering creativity, would playing games with creative elements have an impact on players' creativity, in a manner analogous to the way playing games with violent elements influences players' aggression? These games offer academia new avenues of research into possible creativity benefits.

Minecraft

Minecraft in particular is a game especially tuned to foster creativity. It can be thought of as Legos: the Video Game. Players in the game have been able to rebuild locations (real or fictional): Battlestar Galactica, Westeros, London, Earth, etc. They have built fully functional droid armies, computing systems, and cities with electrical systems and running water. The self-motivated players create these complex systems in a game with very basic rules and properties, otherwise known as mechanics.

The core game mechanic of *Minecraft* is to create and implement ideas within the constraints of the game. This may seem vague, but that is because the game itself is vague. When a player begins to play *Minecraft*, they see a world of blocks procedurally generated in front of them. They are not given any narrative of the game world, any instruction of how to play the game, any goals, or rules. The player has to decide how to react to this game world. Do they explore the world by walking around? Do they explore the limits of their character by experimenting how their character reacts to different keyboard commands or interaction with the environment? Once they realize they can collect (mine) the blocks that make up the world, do

they choose to keep collecting or do they decide to organize the blocks in order to craft some new structure?

If players decide to create objects they tend to follow a creative process of coming up with ideas (ideating), deciding which ideas they want to pursue (evaluation), and then figuring out how to carry out those ideas (creative problem solving). *Minecraft* is an effective tool for creative expression because it allows for a wide range of creative expression. The game has the potential to foster many different creative products.

Theories and Measures of Creativity

It is hard to operationalize creativity. In the multidisciplinary creativity literature, there are over 100 different descriptions of creativity (Ackoff & Vergara, 1981). There is little consensus or agreed upon organizational framework in the creativity literature. Some argue that creativity is little more than originality or novelty. A common viewpoint describes creativity as novelty and appropriateness (Paletz, & Peng, 2008). Creativity can also be described with the criteria of divergent thinking: novelty, elaboration, fluency, and flexibility (Guilford, 1966). Mumford, Mobley, Uhlman, Reiter-Palmon, and Doares (1991) have also proposed a cyclical and dynamic description of creativity as problem construction, information encoding, relevant category search, specification of fitting categories, combination of category information, reorganization of categories, idea evaluation, implementation of ideas, and monitoring. Finally, some models summarize creativity as ideation-evaluation cycles influenced by knowledge and motivation (Basadur, Graen, & Wakabayashi, 1990).

Given the variety of creativity definitions, it is outside the scope of this study to make claims about the effects of video games on creativity as a single construct. Instead, this study employs a range of creativity-related measures and refers to findings specific to those particular

measured aspects of creativity. However, in an attempt to cross the breadth of the field and its definitions, the measures selected for this study will attempt to capture and analyze several of the dimensions along which creativity has been conceptualized. These approaches to creativity assess it either as an individual difference, cognitive process, or with regard to its products.

Trait Creativity. The individual differences approach analyzes the difference between high-creativity people and low-creativity people by self-reported measures, peer reports, motivation, attitudes, and adjective checklists. As a tool that allows for a great variety of creative expression, *Minecraft*, might attract high creativity individuals. Additionally, since playing *Minecraft* usually involves creative practice, playing *Minecraft* should result in higher reports of creativity. The Imaginative Capability Scale will be used as a measure of self-report trait creativity. This scale is based on Liu and Noppe-Brandon's description of imagination as the ability to conjure new possibilities and realities, conceive of ideas deliberately or intuitively, and make connections between things that previously seemed to not have a connection (2009). Their self-reported motivations, past experiences and products, attitudes, personality traits, self-conceptions, and interests have all proven to be valid predictors of real-life creative accomplishments (Hocevar, 1981).

Creative Process. The cognitive process approach focuses on understanding divergent thinking and convergent thinking as the cognitive processes that underlie creativity.

Divergent Thinking. Divergent thinking focuses on measuring the ability to come up with ideas or ideate, in the language of this literature. It can also be conceptualized as the ability to overcome functional fixedness. Functional fixedness is the inability to perceive objects as having functions other than those for which they are commonly used (Amabile, 1983). For example, functional fixedness might not allow participants to give responses other than cutting

for a knife. In contrast, an example of divergent thinking would be to use the top of a knife as a straightedge to draw a line. Due to *Minecraft*'s open-world design and lack of instruction, player's first step in playing is to practice ideation. They have to come up with their own goals, their own ideas of how to play the game, what to create, and how they will achieve their goals.

Divergent thinking will be captured using the Alternative Uses Task. This task requires participants to generate as many possible appropriate answers for a problem as they can, an exercise in ideation (Guilford, 1966). The Alternative Uses Task is commonly used as a measure of divergent thinking and functional fixedness.

Convergent Thinking. In contrast to divergent thinking, convergent thinking is the ability to evaluate ideas and to identify the optimal idea that fits a particular criterion. In *Minecraft*, this thought process is seen when players need to decide on a plan of how to effectively carry out construction projects and mining strategies. Effective land survey strategy to find required materials, proper management of resources, combination of blocks to create tools, and proper combination of tools to create complex mechanisms is necessary to create a lot of the possible structures in the game. Out of game convergent thinking can be seen in things like crossword puzzles, creative problem solving scenarios, shopping for the most price efficient items, etc.

Convergent thinking will be captured using the Remote Association Test developed by Mednick (1962). This task measures creativity from the associative theory perspective by testing participants' ability to derive a single correct answer from a set of criteria (Cropley, 2006). The assumption is that creative thinkers have flat associative hierarchies as opposed to steep associative hierarchies. Flatter associative hierarchies increase the likelihood of forming novel connections between concepts. The Remote Association Task is commonly used as a measure of

creativity (Akbari Chermahini, Hickendorff, & Hommel, 2012; Chermahini, & Hommel, 2012; Colzato, Wildenberg, & Hommel, 2013).

Creative Production. The creative products approach analyzes creative practice through the products participants are asked to write, draw, or create. The relevant domain skills, motivations, and cognitive processes of the creative person coalesce into a creative product. Since the creative product is the culmination and expression of all the creative aspects of the person it has been argued to be the most valid way to measure creativity. The players in *Minecraft* have a lot of practice in making products. Most of the game's public servers to group play centers around players banding together to make creative products. The collaboration, creation, sharing, and modifying of creative products is seen as a core experience for *Minecraft* players.

Creative production will be captured using the Alien Drawing Task. In the Alien Drawing Task participants are instructed to imagine and draw a creature living on a planet very different from Earth (Ward, 1994; Ward, Finke, & Smith, 1995), They are encouraged to be as creative and imaginative as they can, and not to worry about how well drawn the alien is. Measuring creativity of a person's product is a direct method of measuring their creativity (Feldhusen, & Goh, 1995; Polman, & Emich, 2011; Maddux & Galinsky, 2009; Miller & Tal, 2007; Kharkhurin, 2009).

Video Game Effects as Learning Experiences

As *Minecraft* offers players the ability to practice creative production and processes, it also offers them the learning experiences in creativity. These learning experiences can lead to *Minecraft* having a creative learning effect on players. Researchers often conceptualize the effects of video games on their players as a series of learning experiences (Gentile et al., 2009).

The effects of video games can sometimes generalize beyond the game environment, transferring to other, related domains. For example, in a first-person shooter, players practice solving their problems (a population of bad guys) through aggression (shooting said bad guys). This aggression is rewarded through points, game progression, positive feedback, and other game mechanisms. Over periods of frequent practice, these short term learning encounters become more deeply ingrained and show longer-term effects on aggressive behavior, cognition, and affect, both inside and outside the game world (Anderson et al., 2010).

Gentile and colleagues (Gentile & Stone, 2005; Khoo & Gentile, 2007; Stone & Gentile, 2008) have suggested the amount, content, context, structure, and mechanics of video games influence the lessons they teach their players. This confluence of factors can be understood through the General Learning Model (Gentile et al., 2009). In this model, learning occurs from the interaction of a person with their environment (see Figure 1). This interaction influences the person's internal state which, in turn, influences their reaction to the situation (their appraisal of the situation, decision making process, and behavior). Their reaction leads them to a learning encounter. If their reaction led to success in their interaction with the situation, then those appraisals, decision making processes, and behaviors are reinforced. In contrast, if the reactions

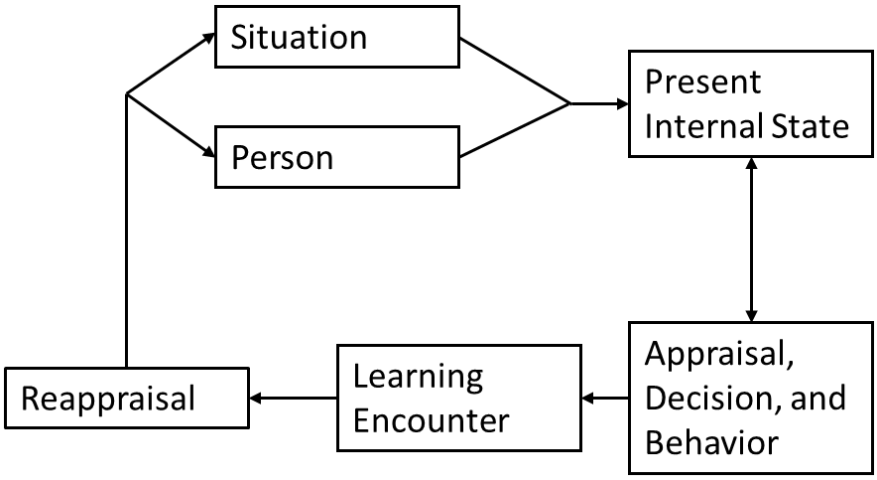

Figure 1. *Simplified figure of General Learning Model.*

lead to failure, the learner's behavior can be punished. Learners can reappraise their actions at any point in the cycle, but usually do so after the learning encounter. The cycle then starts again as the learner continues to interact with the evolving situation.

Minecraft's potential benefit to creative measures can be analyzed through the lens of the General Learning Model. At the start of the game a randomly generated world is created in front of the person. They are surrounded by a world comprised of blocks representing the substance of the world: water, dirt, stone, trees, metals, lava, and more. The game does not ask or direct the player to do anything. The situation is a game world with no instructions and unknown rules to the person. The person has to decide how to react to the world (and the learning encounter

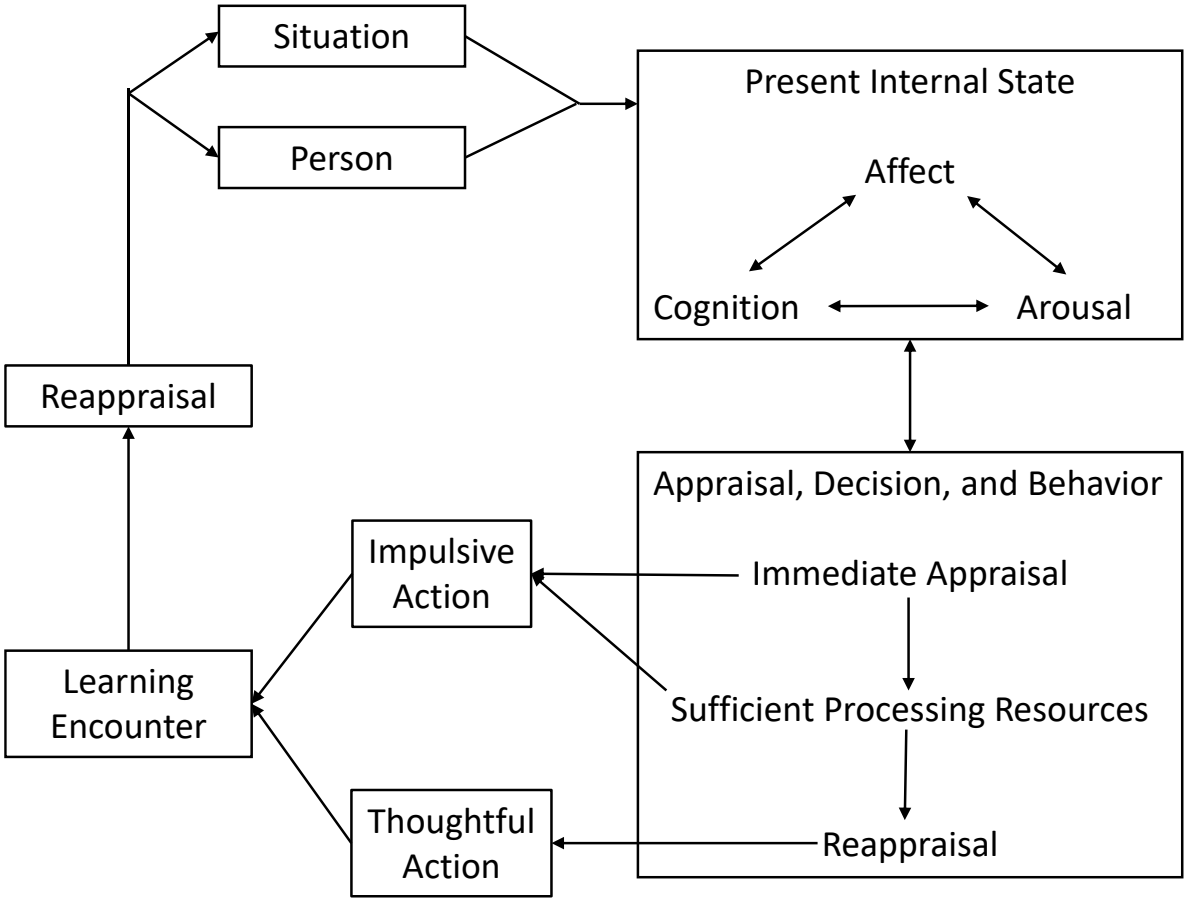

Figure 2. *Detailed Figure of the General Learning Model.*

begins; see figure 2). If they have no game experience, they might have to experiment with the controls to learn how to interact with the game. Their present internal state has no memory of what the keys do, and they are curious about how to interact with the game. As such they decide to press keys and see how the game reacts. They start to learn how the keyboard keys control the game through trial and error. If they have experience with games, they might remember the standard control scheme most games use, and go on to either understand the rules of the game world or create their own goals in the game.

The person can have their first interaction with the completely modifiable and explorable game world with no instruction, they may begin picking a direction to explore and walking off in that direction. Alternatively, they could start clicking on the world around them, which would translate into digging into the ground or chopping down a tree. Whatever they choose to do is a product of who they are as a person, and how the game world has influenced their internal state. If they are familiar with games focused on exploration or if they find the experience discovery rewarding, the person may decide to dig around. If they are familiar with simulation games or if they find building things to be rewarding, they may start to trying to understand how to build structures.

According to the General Learning Model, the player can take an impulsive action or a thoughtful action. An impulsive action is likely to happen if they do not have sufficient mental resources to process the situation or if they think the current outcome of their actions will be insignificant or unsatisfactory. If, on the other hand, the outcome is something they care about and they have enough mental resources to dedicate to thinking, they are likely to make a thoughtful action. For a player digging in *Minecraft*, they are not likely to make a thoughtful decision for every block they mine. The action is repetitive, common, and depending on the

player's set up can take anywhere from 1 to 10 seconds per block to mine. The action does not demand much attention or thought to be done well. Their goal is to dig in a certain direction or gather a certain type of block. If they keep seeing the same type of block, they are likely to impulsively continue digging. If they see a lava block, suddenly the outcome of their decision becomes important (virtual life or death): The player must make a thoughtful action to avoid the lava.

Once players decide on a course of action, the game immediately gives them feedback. If they decided to run in one direction to explore, they will be rewarded with more to see as the game generates new landscapes. Thus, the act of exploration is rewarded. If they decided to dig down into the world to gather resources so they can then build a shelter, they might find minerals or other useful materials, which would also be rewarding. If they dig incorrectly or build a sloppy shelter the player may find themselves punished by the monsters that inhabit the world. Over time, the player learns that they must think about how they gather and use resources. Every action in the game will have feedback available for the player. Most of the game mechanics revolve around the player being able to explore, gather resources, use the resources to modify their environment, and to understand the constraints of the game world. *Minecraft* provides the player a multitude of learning experiences. Over multiple play sessions and repeated learning encounters, players could experience benefits to their creative processing and production.

Creative practice in video games could have practice effects similar to aggressive practice and visual cognitive practice in games. Playing video games with creative practice should have short term creativity effects, which leads to long term creativity effects as seen in other media effects. In fact, many game journalists, teachers, and games-for-good advocates have reported uses of *Minecraft* as an educational intervention in school to teach students about science, math,

engineering, and social dynamics (DeBruler, Freidhoff, Kennedy, & Cavanaugh. 2016). These groups praise the level of creativity that the game brings out in players. At the time of writing this paper, there have been no empirical studies on *Minecraft* or any other game being able to improve a player's creative practice. This study is focused on providing evidence that *Minecraft* can have a short term benefit players' performance on creativity measures. If a short term benefit is found, future studies will have to find long term benefits to provide evidence for learning.

CHAPTER 2: METHODS

Power Analysis

Jackson et al. (2012) showed a correlation of .60 between video game play and trait creativity. Given an effect size of .60, a beta of .20, and an alpha of .05, the minimum sample size per group in a two-tailed hypothesis is 45. Throughout the video game effects literature, effect sizes are commonly measured around .20. Given an effect size of .20, a beta of .20, an alpha of .05, and 4 conditions, the minimum sample size per group is 70. For this study, the target sample size per group was 80 to have sufficient power (Faul, Erdfelder, Buchner, & Lang, 2009; Soper, 2016).

Participants

IRB approval was obtained before recruiting participants. Three hundred fifty-two (190 females, mean age = 19.33, *SD* = 1.67) participants were recruited from Iowa State University's Department of Psychology's research participation pool. The pool is composed of undergraduate psychology and communication students. Students were compensated for their participation in studies through course credit, and could withdraw from the study at any time without penalty.

Conditions

Undirected *Minecraft*. There were four conditions in this study: Undirected *Minecraft*, Directed *Minecraft*, NASCAR, and T.V. In the Undirected *Minecraft* condition, participants played *Minecraft* in survival mode after a brief tutorial on how to play the game. Survival mode, in contrast to creative mode, does not give players unlimited resources, health, unrestricted travel, and ability to manipulate the basic rules of the game. Instead, players must gather resources themselves, their movements are restricted by in-game gravity and walls (which they can mine through), and they can die from a variety of perils. Challenges or difficulties to work

against provide players with a motivation and a framework to work around (Reiter-Palmon, Mumford, & Threlfall, 1998). The survival mode was chosen for both *Minecraft* conditions to capture how people would most naturally play *Minecraft*, and to give participants challenges to overcome in the game.

Directed *Minecraft*. The second condition, Directed *Minecraft* (instructional control) was identical to the Undirected *Minecraft* condition, except participants were explicitly instructed to "play as creatively as [they could]."

NASCAR. The third condition, the NASCAR condition, was an active control condition. The *Minecraft* conditions will be compared to the NASCAR condition to examine if any creativity effects came from video games in general or from the specific creative game mechanics in a game like *Minecraft*. Participants in this condition played a NASCAR car racing game in race mode after a brief tutorial on how to play the game. The NASCAR racing car game involved participants driving a NASCAR race car on an oval track for forty minutes. Instead of having to make decisions on where to go, how to play, what to create, what to modify, or solve a variety of problems, participants in the NASCAR condition had to drive straight and turn left. NASCAR should still provide the general engagement of any video game play, while lacking the complexity and depth of decision making required in creative games, like *Minecraft*.

T.V. The fourth condition was a passive control condition in which participants watched an episode of the TV show, *Crocodile Hunter*. A condition without a game was desired to examine if creativity was driven by interactivity alone (i.e., all of the video game conditions), and to examine how well the NASCAR condition functioned as a control condition. Since boredom primes creativity and sitting without anything to do for forty minutes would be quite

boring, a T.V. episode was chosen to keep participants occupied and hopefully equally engaged (Feldhusen, & Goh, 1995). This episode had the least amount of animals common in phobias.

Measures

Covariates. It is possible that any differences found in the measures of creativity could be due to aspects of the conditions other than the ability to practice creative problem solving. For example, if one condition is more boring than another, that condition might yield higher creativity scores because boredom is known to be a positive predictor of creativity (Bench & Lench, 2013). Similarly, some conditions might have effects on mood or motivation by being more engaging or frustrating. Therefore, we asked participants how bored, engaged, and frustrated they felt in their condition. If conditions are different on these aspects, it would be important to control for those differences to ensure that differences in creativity are likely due to differences time practicing creative behaviors rather than to boredom, engagement, or frustration. That is, we desire to test whether creative game mechanics are the most likely explanation for any differences in creativity.

Participants were also asked how creative they tried to be in their condition as a manipulation check. The *Minecraft* conditions were expected *a priori* to be more creative, more engaging, slightly more frustrating, and less boring than the other conditions.

Trait Creativity (Independent Variable). The Imaginative Capability Scale is a 29-item measure of trait creativity in which participants indicate their agreement with each given statement on a scale from 1 (strongly disagree) to 6 (strongly agree). In a factor-analysis with a Kaiser-Meyer-Olkin measure of .939 (indicating proper sampling for factor analysis), Liang and Chia (2014) found the Imaginative Capability Scale to have three factors. Factor 1, initiating imagination, includes items related to novelty, productivity, and exploration. Factor 2,

conceiving imagination, includes items related to sensibility, intuition, concentration, effectiveness, and dialectics. Factor 3, transforming imagination, includes items related to crystallization and transformation. They found goodness of fit to be acceptable (χ^2 = 1867.17, *df* = 374, $p < .005$, RMSEA = .078, SRMR = .068, CFI = .96, NFI = .95, TLI = .96). They also found the composite reliability of each factor was initiating imagination = .90, conceiving imagination = .92, and transforming imagination = .89. Standardized factor loadings for the Imaginative Capability Scale ranged from .52 to .80, implying convergent validity. Discriminant validity was also found with chi-squared differences and confidence intervals for inter-factor correlations. Because the Imaginative Capability Scale is a trait measure of creativity, and is thus not expected to be affected by the gameplay manipulation, we will be assessing its relationship with participants' habitual game playing.

Divergent Thinking. In the Alternative Uses Task, participants were given two minutes to list as many uses as they could for a knife, two more minutes for a paperclip, and two more minutes for a newspaper (Wallach & Kogan, 1965). The Alternative Uses Task is commonly used as a measure of creativity and has demonstrated a Chronbach's alpha value from .81 to .90 (Vosburg, 1998; Chung, 2012; Silvia, Winterstein, Willse, Barona, Cram, Hess, Martinez, & Richard, 2008; Silvia, Martin, & Nusbaum, 2009). This measure is assessed in three categories: fluency, flexibility, and originality. Fluency is scored as the total number of responses. Flexibility is scored as the number of different categories similar responses could be organized into (e.g. "to stab" and "to slash" might be grouped into one categorical type). Originality equaled how uncommon each particular idea is. Scoring originality involves comparing the responses of the single participant to the responses from all the participants. Responses given by only 2-5% of the participants are unusual and score one point, and responses given by 1% or

fewer of the participants are rare and score two points. The originality score was divided by the total number of responses to avoid contamination concerns (avoiding the fluency score from affecting the originality score).

Several studies have supported the validity of this scoring method (Silvia, Winterstein, Willse, Barona, Cram, Hess, Martinez, & Richard, 2008; Silvia, Martin, & Nusbaum, 2009; Benedek, Mühlmann, Jauk, & Neubauer, 2013; Beaty, Silvia, Nusbaum, Jauk, & Benedek, 2014). Plucker (1999) reviewed 20 years of Alternative Uses Tasks data and found a predictive validity of .70 with future creative achievement. Treffinger (1985) found test-retest reliabilities between .60 and .70. In the current study, the Alternative Uses Task had a Cronbach's alpha of .827. The data from the Alternative Uses Task will be analyzed by category (fluency, flexibility, and originality) using a univariate analysis of covariance to compare scores across conditions.

Convergent Thinking. In the Remote Association Test participants were shown 30 triplets of words with the task of finding one word that was associated with each word in the triplet. For example, bag would be remotely associated with sleeping, bean, and trash (sleeping *bag*, bean *bag*, trash *bag*). The order of presentation for the triplets was randomized. Participants were instructed to work as quickly and as accurately as possible in the 15 minutes given to them. Remote Association Task scoring is done by totaling the number of correct responses from 30 problems. Data from the Remote Association Task will also be analyzed with a univariate analysis of covariance to compare scores across conditions.

In previous work, the Remote Association Test has demonstrated a Cronbach's alpha of .85. (Morgan, D'Mello, Abbott, Radvansky, Haass, & Tamplin, 2013). Moderate correlations with the Raven's Matrix test and insight problems (both exams designed to measure mechanisms of creative thinking) have convergent validity (r= .47, r=.39, respectively; Chermahini,

Hickendorff, & Hommel, 2012). Scores on the Remote Association Test have also shown a .70 correlation with ratings from instructors in a university level design course (Kasof, 1997). To avoid a possible floor or ceiling effect, only items with a solution rate between .70 - .30 from a previous study were selected (Bowden & Jung-Beeman, 2003).

Creative Production. In the Alien Drawing Task, participants were given seven minutes to imagine and draw a creature that had developed on a world much different from Earth. This task requires participants to actively generate novel material, and is seen as a practice of creativity through creative production. The drawing is scored on criteria in three categories; eyes, limbs, and bilateral symmetry (Kozbelt, & Durmysheva, 2007). Creatures with the Earth norms of bilateral symmetry, two eyes, and four limbs received zero points in each category. Creatures with superficial asymmetry, with more or fewer than two eyes, and with more or fewer than four limbs received one point per category. Creatures with asymmetry, no relevant eye structure, or no relevant limb structure received two points in each category. Since the Alien Drawing Task has participants produce a creative product, it is a face valid measure of creative production. After the scores of both raters are compiled and averaged, the data from the Alien Drawing Task are analyzed with a univariate analysis of covariance to compare scores across conditions.

Previous Video Game Experience. The Video Game History Questionnaire is a self-report survey of the participant's video game use. Participants were asked to name five of their favorite games, how often they have played them in the last few years, and how creative they found their video game experience to be for each. Frequency and creative perception were reported on 7-point scale questions. creative game exposure was calculated by multiplying self-reported frequency of play by self-reported creativeness of game played (similar to the method of calculating aggressive game exposure used in Anderson et. al.,2008).

Procedure

Before arriving at the lab, participants were randomly assigned to one of the four conditions. Participants read and signed an informed consent form detailing their rights, a summary of the activities they would participate in, and possible risks. They also completed a sheet asking for basic demographics: age, gender, race, and social-economic background. Participants played or watched their respective game or show for approximately 45 minutes.

Afterwards, they were instructed to complete four measures of creativity: the Alternative Uses Task, Remote Association Task, Imaginative Capability Scale, and Alien Drawing Task. The order of the creativity measures was randomly presented across the conditions. The Video Game History Questionnaire, covariate questions, and manipulation checks were administered last. An attention check question was randomly inserted into the survey portion of the study to catch any participants that were inattentive to the study.

Hypotheses

Cross-sectional Hypotheses. In order to replicate previous studies, bivariate correlations between trait creativity (measured the Imaginative Capability Scale) and video game play habits will be analyzed (Jackson et al., 2012). Replication is important to establish that the possible video game effect is significant enough to be seen long term. A correlation between game play and creativity measures would suggest a relation between the two.

Another relation in the video game literature is the negative relation between grade point average and video game playing habit. Generally, grade point averages correlate negatively with overall video game playing habits and positively with creativity. Nonetheless, some video game playing habits correlate positively with creatively. It is possible, therefore, that there may be an indirect positive relationship between game playing habits and grade point average mediated

through trait creativity. This analyzes expands the current literature from simply asking if there is a relation between video game habits and grades to can the relation be positive in some cases and negative in others.

H_{1a}: If creative people are drawn to games or games provide players opportunity practice creative production, then trait creativity (measured by Imaginative Capability Scale) will correlate positively with game playing habits (measured by the Video Game History Questionnaire).

H_{1b}: If game playing habits correlate positivity with creativity and negatively with grade point average, then video game playing habits will have an indirect positive relationship with grade point average mediated by trait creativity.

Experimental Hypotheses. Through the lens of the General Learning Model the *Minecraft* conditions should provide participants with learning encounters that benefit creative practice and processes. The NASCAR condition and the T.V. condition should not provide this practice and hence, the *Minecraft* conditions should perform better in the creativity measures than the non-*Minecraft* conditions.

H_{2a}: If the creative practice in *Minecraft* can lead to short-term creativity benefits to divergent thinking, then performance on the Alternative Uses Task should be higher in the *Minecraft* Conditions than in the NASCAR and T.V. conditions.

H_{2b}: If the creative practice in *Minecraft* can lead to short-term creativity benefits to convergent thinking, then performance on the Remote Association Test should be higher in the *Minecraft* Conditions than in the NASCAR and T.V. conditions.

H_{2c}: If the creative practice in *Minecraft* can lead to short-term creativity benefits to creative production, then performance on the Alien Drawing Task should be higher in the *Minecraft* Conditions than in the NASCAR and T.V. conditions.

Exploratory Analysis. Since this is the first study to examine the potential effects of video games on creative measures, exploratory contrasts between each condition will be analyzed. Differences between two conditions can display what game elements or instructions result in differences in creative measures. Contrast differences can influence plans for future studies. For example, if the two *Minecraft* conditions show no differences to each other but are significantly higher than the control conditions then future work should focus on comparing *Minecraft* to other activities. On the other hand, if the two *Minecraft* conditions do significantly differ, then future work should focus on how the difference in instructions led to different effects. As such, contrasts between each pair of conditions will be reported for each measure.

CHAPTER 3: RESULTS

Twenty-two out of 374 participants were omitted from the analyses due to failing an attention check during the survey portion of the study. Out of the remaining 352, 45% were male. The age of the participants ranged from 18 to 33 (M=19.33 (1.67)). There were 92 participants in the Undirected *Minecraft*, 88 in the Directed *Minecraft*, 86 in the NASCAR condition, and 86 in the T.V. condition.

Covariates and Manipulation Checks

Means for each factor are shown in Table 1. A multivariate analysis of variance with Bonferroni adjustments confirmed that condition significantly affected engagement (F (3,336) = 14.83, $p < .001$), boredom (F (3,336) = 25.15, $p < .001$), and frustration (F (3,336) = 30.86, $p < .001$). Therefore, these should be controlled in any analyses comparing the conditions, given that we were intending to manipulate creativity through our conditions, and not boredom, engagement, or frustration. Self-reported creativity does seem to have been manipulated successfully, as there were significant differences in our manipulation checks, namely creative feeling (F (3,336) = 35.95, $p < .001$), and creative effort (F (3,336) = 40.32, $p < .001$). The Table 2 shows a pairwise comparison contrasts between each condition for each factors. Table 3 shows correlations between these factors.

Table 1: *Potentially Relevant Confounding Factors and Manipulation Checks*

Mean (Standard Deviation)	Undirected *Minecraft*	Directed *Minecraft*	NASCAR	T.V.
Boredom	3.07 (1.43)	2.70 (1.35)	4.10 (1.07)	2.51 (1.24)
Engagement	3.12 (1.31)	3.60 (1.16)	2.45 (1.15)	3.42 (1.11)
Frustration	3.32 (1.31)	3.16 (1.35)	2.89 (1.15)	1.71 (1.05)
Creative Effort	2.73 (1.16)	3.12 (1.16)	1.65 (.88)	1.91 (.98)
Creative Feeling	3.16 (1.05)	3.63 (.95)	2.30 (1.21)	2.02 (1.15)

Table 2: *Contrasts of Motivational Factors Means by Condition*

Factor	Condition	Compared Condition	Mean Difference (Std. Error)	Sig.[b]	95% Confidence Interval for Difference[b] Lower - Upper Bound
Boredom	Undirected *Minecraft*	Directed *Minecraft*	.39 (.196)	.304	(-.136, .905)
		NASCAR	-1.00* (.198)	.000	(-1.527, -.477)
		T.V.	.57* (.196)	.023	(.050, 1.091)
	Directed *Minecraft*	Undirected *Minecraft*	-.39 (.196)	.304	(-.905, .136)
		NASCAR	-1.39* (.197)	.000	(-1.910, -.863)
		T.V.	.19 (.196)	1.000	(-.333, .705)
	NASCAR	Undirected *Minecraft*	1.00 (.198)	.000	(.477, 1.527)
		Directed *Minecraft*	1.39(.197)	.000	(.863, 1.910)
		T.V.	1.57* (.197)	.000	(1.049, 2.096)
	T.V.	Undirected *Minecraft*	-.57* (.196)	.023	(-1.091, -.050)
		Directed *Minecraft*	-.19 (.196)	1.000	(-.705, .333)
		NASCAR	-1.57* (.197)	.000	(-2.096, -1.049)
Engagement	Undirected *Minecraft*	Directed *Minecraft*	-.50* (.181)	.038	(-.980, -.018)
		NASCAR	.64* (.183)	.003	(.150, 1.122)
		T.V.	-.31 (.181)	.513	(-.794, .168)
	Directed *Minecraft*	Undirected *Minecraft*	.50* (.181)	.038	(.018, .980)
		NASCAR	1.14 (.182)	.000	(.651, 1.619)
		T.V.	.19 (.181)	1.000	(-.294, .666)
	NASCAR	Undirected *Minecraft*	-.64* (.183)	.003	(-1.122, -.150)
		Directed *Minecraft*	-1.14* (.182)	.000	(-1.619, -.651)
		T.V.	-.95* (.182)	.000	(-1.433, -.465)
	T.V.	Undirected *Minecraft*	.31 (.181)	.513	(-.168, .794)
		Directed *Minecraft*	-.19 (.181)	1.000	(-.666, .294)
		NASCAR	.95* (.182)	.000	(.465, 1.433)
Frustration	Undirected *Minecraft*	Directed *Minecraft*	.16 (.186)	1.000	(-.339, .649)
		NASCAR	.40 (.188)	.199	(-.097, .901)
		T.V.	1.61* (.186)	.000	(1.114, 2.103)
	Directed *Minecraft*	Undirected *Minecraft*	-.16 (.186)	1.000	(-.649, .339)
		NASCAR	.25 (.187)	1.000	(-.250, .744)
		T.V.	1.45* (.186)	.000	(.961, 1.946)
	NASCAR	Undirected *Minecraft*	-.40 (.188)	.199	(-.901, .097)
		Directed *Minecraft*	-.25 (.187)	1.000	(-.744, .250)
		T.V.	1.21* (.187)	.000	(.709, 1.704)
	T.V.	Undirected *Minecraft*	-1.61* (.186)	.000	(-2.103, -1.114)
		Directed *Minecraft*	-1.45* (.186)	.000	(-1.946, -.961)
		NASCAR	-1.21* (.187)	.000	(-1.704, -.709)

Table 2 continued

MANIPULATION CHECKS					
Creative Feeling	Undirected *Minecraft*	Directed *Minecraft*	-.40 (.161)	.083	(-.826, .029)
		NASCAR	1.07(.162)	.000	(.636, 1.498)
		T.V.	.81* (.161)	.000	(.383, 1.238)
	Directed *Minecraft*	Undirected *Minecraft*	.4 (.161)	.083	(-.029, .826)
		NASCAR	1.47(.162)	.000	(1.036, 1.895)
		T.V.	1.21* (.160)	.000	(.783, 1.635)
	NASCAR	Undirected *Minecraft*	-1.07* (.162)	.000	(-1.498, -.636)
		Directed *Minecraft*	-1.47* (.162)	.000	(-1.895, -1.036)
		T.V.	-.26 (.162)	.686	(-.686, .173)
	T.V.	Undirected *Minecraft*	-.81* (.161)	.000	(-1.238, -.383)
		Directed *Minecraft*	-1.21* (.160)	.000	(-1.635, -.783)
		NASCAR	.26 (.162)	.686	(-.173, .686)
Creative Effort	Undirected *Minecraft*	Directed *Minecraft*	-.48* (.167)	.028	(-.918, -.032)
		NASCAR	.88* (.168)	.000	(.429, 1.323)
		T.V.	1.13* (.167)	.000	(.687, 1.572)
	Directed *Minecraft*	Undirected *Minecraft*	.48* (.167)	.028	(.032, .918)
		NASCAR	1.35(.168)	.000	(.905, 1.796)
		T.V.	1.61* (.166)	.000	(1.163, 2.046)
	NASCAR	Undirected *Minecraft*	-.88* (.168)	.000	(-1.323, -.429)
		Directed *Minecraft*	-1.35* (.168)	.000	(-1.796, -.905)
		T.V.	.25 (.17)	.788	(-.192, .699)
	T.V.	Undirected *Minecraft*	-1.13* (.167)	.000	(-1.572, -.687)
		Directed *Minecraft*	-1.61* (.166)	.000	(-2.046, -1.163)
		NASCAR	-.25 (.168)	.788	(-.699, .192)

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Boredom. The NASCAR condition was significantly more boring than all other conditions. The T.V. condition was unexpectedly reported as the least boring condition. *The Crocodile Hunter* was a critically acclaimed show hosted by the late Steve Irwin. Boredom showed a positive correlation with frustration and negative correlations with creative feeling and creative effort (see Table 3).

Engagement. The NASCAR condition was significantly less engaging than all other conditions. Unexpectedly, the Directed *Minecraft* was more engaging than the Undirected *Minecraft* condition. It is unclear why the Directed *Minecraft* condition was perceived as more engaging. Correlations also showed the more engaged participants were, the less they reported feeling bored or frustrated (Table 3). They also they reported feeling creative, and more effort in being creative with higher engagement.

Frustration. Both the *Minecraft* conditions were reported as more significantly frustrating than the T.V. condition.

Table 3. *Correlation Table of Subjective Feelings about the Manipulation (Across Conditions)*

Variables		1	2	3	4	5
1.	Boredom	-				
2.	Engagement	-.73**	-			
3.	Frustration	.40**	-.26**	-		
4.	Creative Feeling	-.46**	.54**	-.04	-	
5.	Creative Effort	-.25**	.35**	.12*	.66**	-

Manipulation Check 1: Creative Feeling. As expected, participants in both *Minecraft* conditions reported feeling significantly more creative than participants in the NASCAR or T.V. conditions (Table 2). Even though this analysis shows that those playing *Minecraft* reported feeling more creative than those playing a racing game or watching a television show, the vagueness of creativity as a word limits interpretation into what feeling more creative means. Future work would benefit from implementation of a psychometrically validated scale measuring participants' creative mechanisms. Nonetheless, we were intending to manipulate creative feeling with the *Minecraft* conditions and appear to have succeeded.

Manipulation Check 2: Creative Effort. Similarly, and as expected, participants in both *Minecraft* conditions reported more creative effort than participants in either the NASCAR or T.V. conditions (Table 2). The instruction to "be creative" also seems to have been effective as participants in the Directed *Minecraft* condition reported significantly more creative effort than in the Undirected *Minecraft* (Table 2). Similar to the Creative feelings question, the creative effort question would benefit from more specific questions on creative mechanisms. Nonetheless, it appears that creative effort was manipulated as intended.

Correlations among Measures

In the VGHQ, 89.8% of the participants in the study reported playing some kind of video game in the last 6 months. For the games reported by participants, the correlation between the frequency they played that game and how creative they perceived the game to be was .392 ($p <$ .001). The correlation between trait creativity (measured by Imaginative Capability Scale) and creative game exposure was .356 ($p < .01$) when controlling for gender and grades.

Table 4 shows zero-order correlations among independent and dependent variables in the study. The correlation table shows that grades are correlated with most measures of creativity. As such, grades were controlled for in all analyses.

Table 4: *Correlation Table of Relevant Variables (Gpa= Grade Point Average, Cge= Creative Game Exposure, Ics= Imaginative Capability Scale, Adt= Alien Drawing Task, Rat= Remote Association Task, Aut= Alternative Uses Task, Ori= Originality, Flx= Flexibility, Flu= Fluency)*

VARIABLES	1	2	3	4	5	6	7	8	9	10
1. Gender Male= 1	-									
2. Age	-.22**	-								
3. GPA	.08	.04	-							
4. Play Time	-.32**	-.03	-.17**	-						
5. CGE	-.32**	-.04	-.17**	.85**	-					
6. ICS	-.08	.02	.18**	.26**	.33**	-				
7. ADT	.08	-.06	.08	-.07	-.10	.00	-			
8. RAT	.06	-.02	.19**	.06	.05	.05	.07	-		
9. AUT ORI	-.08	.11*	.14**	-.05	-.05	.22**	.18**	.23**	-	
10. AUT FLX	.04	.03	.17**	.00	-.01	.27**	.16**	.27**	.63**	-
11. AUT FLU	.09	.00	.17**	-.01	-.02	.27**	.13*	.22**	.50**	.91**

Amount of time playing video games correlated negatively with school performance (see Table 4). It also correlated positively with trait creativity, and trait creativity correlated positively with school performance (see Table 4). It is possible that playing creative games can have a positive indirect effect on school performance by increasing trait creativity. To test this, a 5000-sample bootstrapped mediation analysis was run using the SPSS macro PROCESS (Hayes,

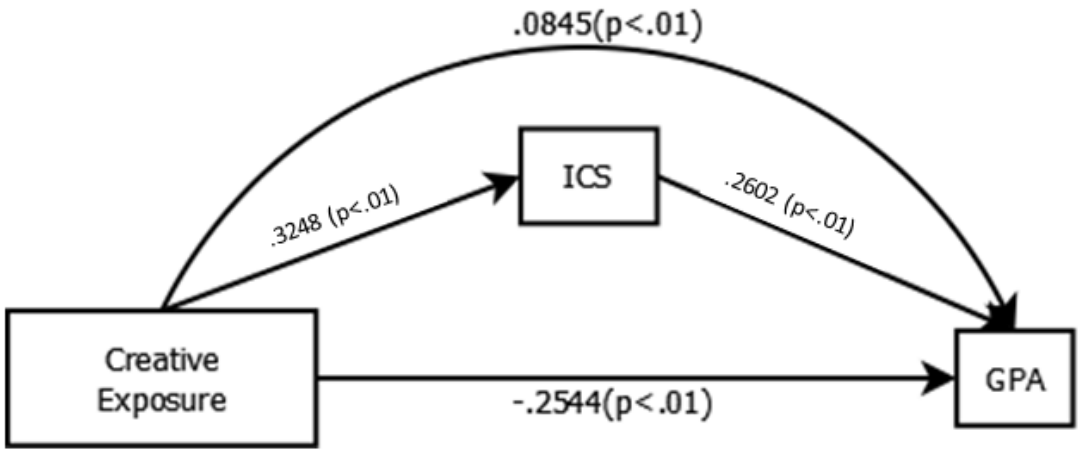

Figure 3. *Model of the mediated relationship between creative game exposure and GPA through the Imaginative Capability Scale.*

2013). The model supports the idea that exposure to creative video games has a negative relationship with GPA, one that is suppressed in part by an indirect path through trait creativity (R = .307, MSE = 3.185, F = 16.33, p < .01; see Figure 3).

Alternative Uses Task

The Alternative Uses Task takes the responses for multiple uses of everyday objects and provides three scores – fluency, flexibility, and originality. The fluency and flexibility data showed skew of 4.04 and 3.65, respectively. To correct for skew in these count variables, Osborne (2010) recommends a square root transformation. Hence, Alternative Uses Task data in the fluency and flexibility categories were square root transformed and standardized. Scores in the originality category of the Alternative Uses Task were also standardized to examine effect size. All the tests below controlled for self-reported grade point average.

Table 5: *Means Of Alternative Uses Task By Condition*

MEANS (STANDARD DEVIATION)	**UNDIRECTED *MINECRAFT***	**DIRECTED *MINECRAFT***	**NASCAR**	**T.V.**
Alternative Uses Task: Fluency	2.98 (.49)	2.89 (.55)	2.77 (.55)	2.87 (.42)
Alternative Uses Task: Flexibility	2.73 (.39)	2.68 (.50)	2.57 (.47)	2.66 (.41)
Alternative Uses Task: Originality	.74 (.21)	.76 (.23)	.69 (.22)	.71 (.22)
Standardized Alternative Uses Task: Fluency	.21 (.92)	.04 (1.04)	-.25 (1.18)	-.01 (.79)
Standardized Alternative Uses Task: Flexibility	.16 (.83)	.07 (1.07)	-.25 (1.17)	.02 (.87)
Standardized Alternative Uses Task: Originality	.08 (.96)	.14 (1.04)	-.15 (.99)	-.10 (.99)

Fluency. Figure 4 shows the standardized means of the fluency scores in the Alternative Uses Task with 95% confidence interval bars. In the fluency category of the Alternative Uses Task condition, an univariate analysis of covariance showed that condition was not significant overall ($F(3,341) = 2.31$, $p = .076$).

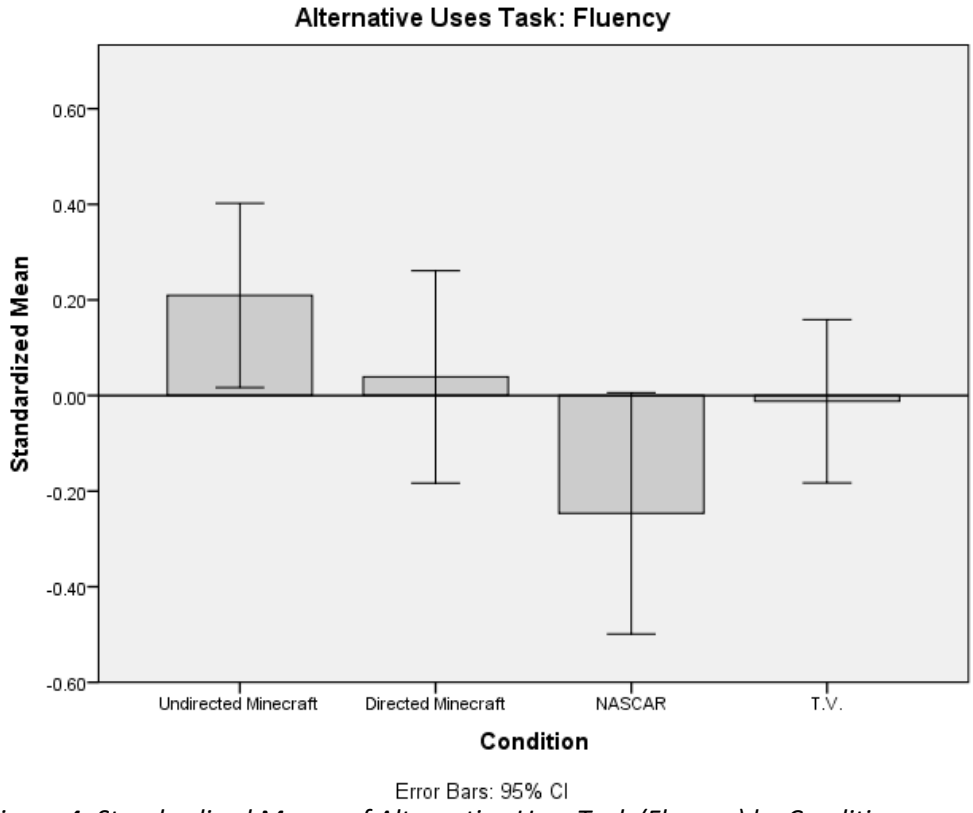

Figure 4: Standardized Means of Alternative Uses Task (Fluency) by Condition

Despite not having an overall significant ANCOVA, pairwise comparisons were conducted for two reasons. First, this study is a novel exploratory study. Second, we had some specific pairwise comparisons we were interested in testing with each of our outcome variables (e.g., undirected vs. directed Minecraft conditions). Table 6 displays the pairwise comparisons of the standardized means for Fluency. The Undirected *Minecraft* condition (M = .198 SD=.103) was significantly higher than the NASCAR condition.

Table 6: *Alternative Uses Task (Fluency) Contrasted by Condition*

Condition	Compared Condition	Mean Difference (Std. Error)	Sig.[b]	95% Confidence Interval[b] Lower Bound	Upper Bound
Undirected	Directed *Minecraft*	.173 (.148)	.242	(-.118,	.463)
Minecraft	NASCAR	.389* (.149)	.009	(.096,	.683)
	T.V.	.224 (.148)	.131	(-.067,	.516)
Directed	Undirected *Minecraft*	-.173 (.148)	.242	(-.463,	.118)
Minecraft	NASCAR	.216 (.151)	.153	(-.080,	.513)
	T.V.	.051 (.150)	.732	(-.243,	.346)
NASCAR	Undirected *Minecraft*	-.389* (.149)	.009	(-.683,	-.096)
	Directed *Minecraft*	-.216 (.151)	.153	(-.513,	.080)
	T.V.	-.165 (.151)	.276	(-.463,	.133)
T.V.	Undirected *Minecraft*	-.224 (.148)	.131	(-.516,	.067)
	Directed *Minecraft*	-.051 (.150)	.732	(-.346,	.243)
	NASCAR	.165 (.151)	.276	(-.133,	.463)

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference

Flexibility. Figure 5 shows the standardized means of the flexibility scores in the Alternative Uses Task with 95% confidence interval bars. A univariate analysis of covariance showed that condition was not significant overall (F (3,341) = 1.80, p = .148). Because this is the first study of its kind, to our knowledge, and because we have some specific directional hypotheses, we conducted exploratory pairwise comparisons despite the non-significant overall test.

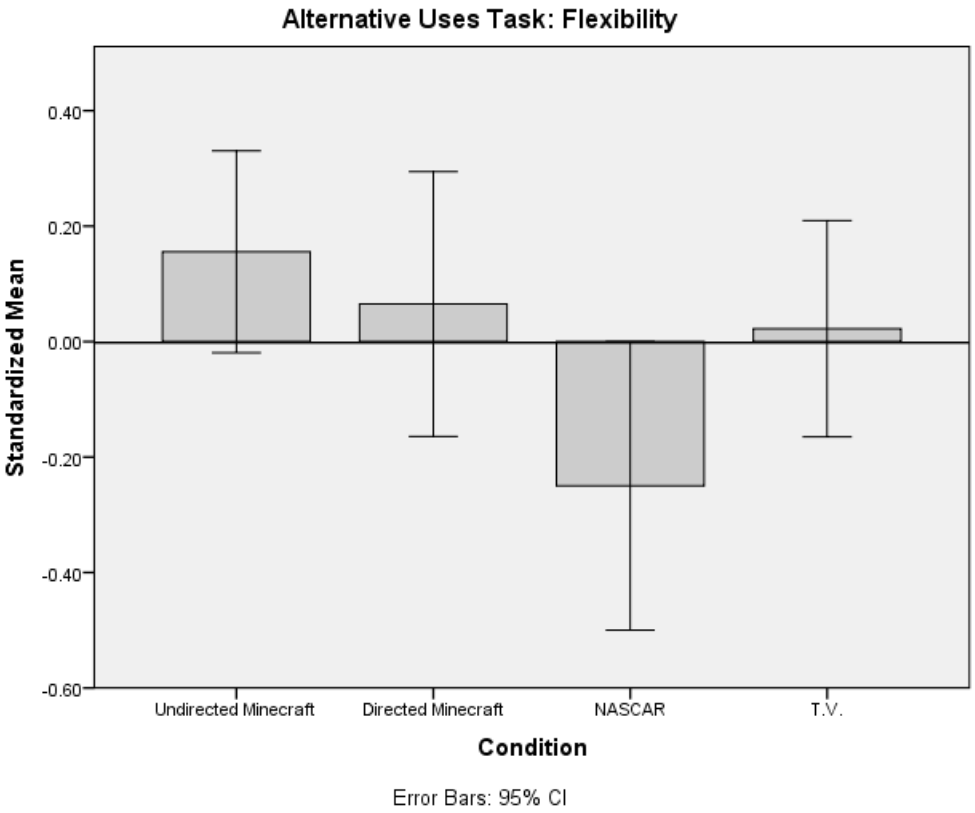

Figure 5: *Standardized Means of Alternative Uses Task (Flexibility) by Condition*

Table 7 displays pairwise comparisons of the standardized means for Flexibility. The contrast between Undirected *Minecraft* condition (M = .155 SD=.835) and the NASCAR condition (M = -.234 SD=1.163) showed Undirected *Minecraft* scoring significantly higher than NASCAR (mean difference = .338, p = .024, 95% CI [.044, .632]), although this was not sufficient to yield a significant overall ANCOVA.

Table 7: *Alternative Uses Task (Flexibility) Contrasted by Condition*

Condition	Compared Condition	Mean Difference (Std. Error)	Sig.[b]	95% Confidence Interval[b] (Lower Bound - Upper Bound)
Undirected *Minecraft*	Directed *Minecraft*	.093 (.148)	.531	(-.198. .384)
	NASCAR	.338* (.149)	.024	(.044. .632)
	T.V.	.136 (.148)	.360	(-.156. .428)
Directed *Minecraft*	Undirected *Minecraft*	-.093 (.148)	.531	(-.384. .198)
	NASCAR	.245 (.151)	.106	(-.053. .542)

Table 7 continued

	T.V.	.043 (.150)	.774	(-.252. .338)
NASCAR	Undirected *Minecraft*	-.338* (.149)	.024	(-.632. -.044)
	Directed *Minecraft*	-.245 (.151)	.106	(-.542. .053)
	T.V.	-.202 (.152)	.184	(-.500. .097)
T.V.	Undirected *Minecraft*	-.136 (.148)	.360	(-.428. .156)
	Directed *Minecraft*	-.043 (.150)	.774	(-.338. .252)
	NASCAR	.202 (.152)	.184	(-.097. .500)

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Originality. Figure 6 shows the standardized means of the originality scores in the Alternative Uses Task with 95% confidence interval bars. A univariate analysis of covariance showed that condition was not significant overall (F (3,341) = 1.46, p = .255). Again, because of

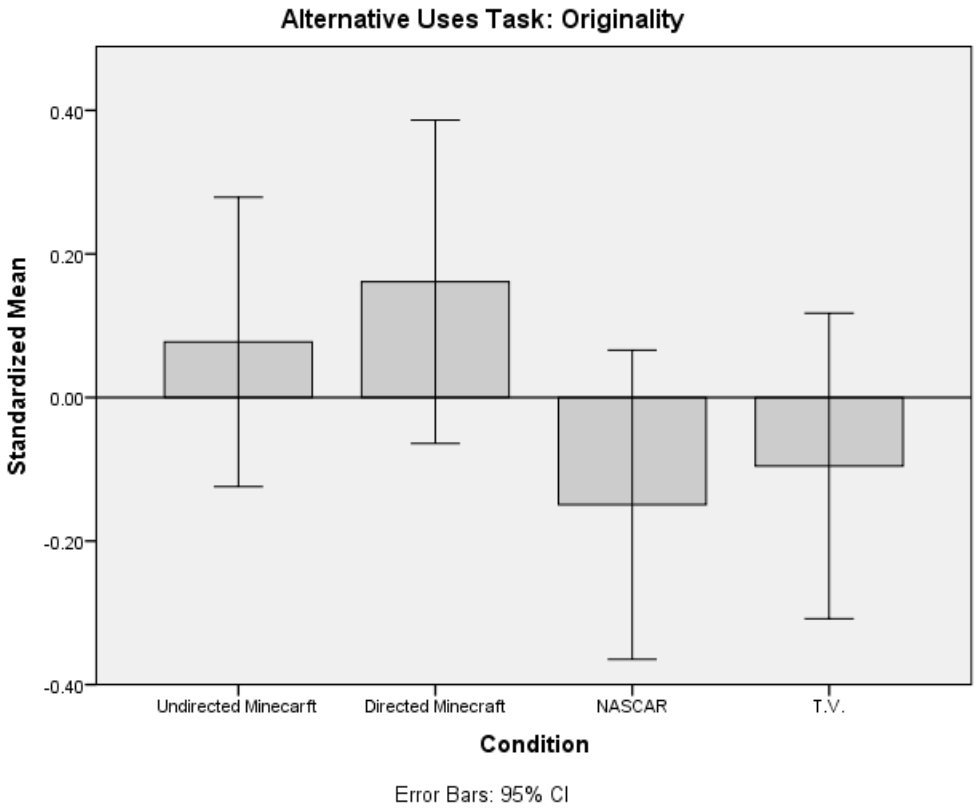

Figure 6: *Standardized Means of Alternative Uses Task (Originality) by condition*

the exploratory nature of this study, we conducted pairwise comparisons despite the non-significant overall ANCOVA.

Pairwise comparison table 8 of the standardized means shows the effect sizes of the Alternative Uses Task in the Originality category. No pairwise comparisons were statistically significant.

Table 8: *Alternative Uses Task (Originality) Contrasted by Condition*

Condition	Compared Condition	Mean Difference (Std. Error)	Sig.[b]	95% Confidence Interval[b] Lower Bound- Upper Bound
Undirected	Directed *Minecraft*	-.083 (.150)	.579	(-.378, .211)
Minecraft	NASCAR	.187* (.152)	.220	(-.112, .485)
	T.V.	.175 (.150)	.243	(-.119, .470)
Directed	Undirected *Minecraft*	.083 (.150)	.579	(-.211, .378)
Minecraft	NASCAR	.270 (.154)	.081	(-.033, .573)
	T.V.	.258 (.152)	.090	(-.041, .557)
NASCAR	Undirected *Minecraft*	-.187 (.152)	.220	(-.485, .112)
	Directed *Minecraft*	-.270 (.154)	.081	(-.573, .033)
	T.V.	-.011 (.154)	.941	(-.315, .292)
T.V.	Undirected *Minecraft*	-.175 (.150)	.243	(-.470, .119)
	Directed *Minecraft*	-.258 (.152)	.090	(-.557, .041)
	NASCAR	.011 (.154)	.941	(-.292, .315)

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Remote Association Task

The Remote Association Task is a measure of convergent creative thinking. A univariate analysis of covariance controlling for self-reported grade point average showed that condition was not significant overall ($F(3,346) = 1.30$, $p = .274$). Performance on the Remote Association Task was low across all condition and items (Table 9). The average score was 14.73% or 4.42 out 30 items correct. This indicates a floor effect and, as such, no further analysis was conducted on the Remote Association task.

Table 9: *Remote Association Task Means*

Mean Correct Responses (Standard Deviation)	Undirected *Minecraft*	Directed *Minecraft*	NASCAR	T.V.
Remote Association Task	4.18 (2.75)	4.41 (2.94)	4.76 (3.60)	4.34 (2.97)

Alien Drawing Task

The Alien Drawing Task is a measure of creative production. Table 10 shows the means and standardized means of the Alien Drawing Task in each condition. Alien drawing task scores were standardized to analyze effect size differences. Figure 7 shows the standardized means of the conditions in the Alien Drawing Task.

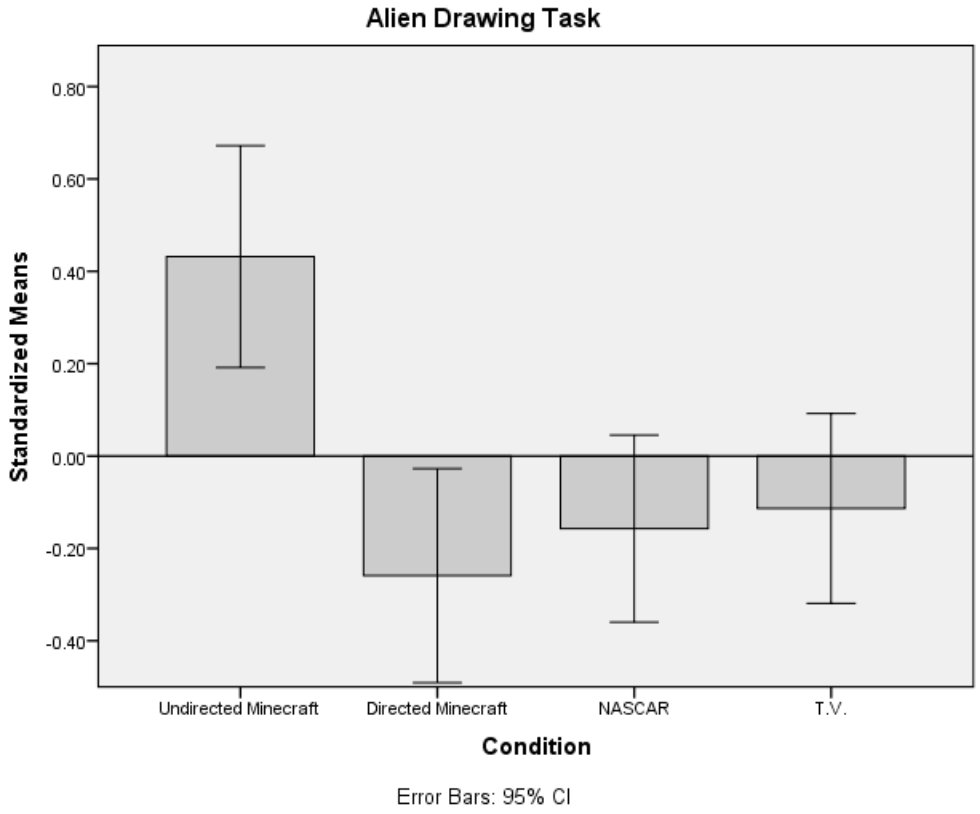

Figure 7: *Alien Drawing Task Standardized Means by Condition*

Table 10: *Alien Drawing Task Means*

Mean (Standard Deviation)	Undirected *Minecraft*	Directed *Minecraft*	NASCAR	T.V.
Alien Drawing Task	2.31 (1.08)	2.18 (1.20)	1.96 (.91)	1.88 (1.06)
Standardized Alien Drawing Task	.43 (1.11)	-.26 (.91)	-.16 (.89)	-.11 (.91)

A univariate analysis of covariance controlling for self-reported grade point average showed that condition was significant (F (3,294) = 7.739, $p < .01$). Table 11 displays the pairwise comparisons of the standardized means. Participants in the Undirected *Minecraft* condition scored significantly higher on the alien drawing task than all other conditions. The standardized mean difference between Undirected *Minecraft* and Directed *Minecraft* was .691

Table 11: *Alien Drawing Task Contrasted by Condition*

Condition	Compared Condition	Mean Difference (Std. Error)	Sig.[b]	95% Confidence Interval[b] Lower Bound - Upper Bound
Undirected *Minecraft*	Directed *Minecraft*	-.683* (.161)	.000	(.366, 1.001)
	NASCAR	.552* (.155)	.000	(.248, .856)
	T.V.	.543 (.152)	.000	(.244, .842)
Directed *Minecraft*	Undirected *Minecraft*	-.683* (.161)	.000	(-1.001, -.366)
	NASCAR	-.131 (.166)	.431	(-.459, .196)
	T.V.	-.140 (.165)	.396	(-.464, .184)
NASCAR	Undirected *Minecraft*	-.552* (.155)	.000	(-.856, -.248)
	Directed *Minecraft*	.131 (.166)	.431	(-.196, .459)
	T.V.	-.009 (.158)	.955	(-.320, .302)
T.V.	Undirected *Minecraft*	-.543* (.152)	.000	(-.842, -.244)
	Directed *Minecraft*	.140 (.165)	.396	(-.184, .464)
	NASCAR	.009 (.158)	.955	(.302, .320)

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

SD (95% CI [.373, 1.008]). The standardized mean difference between Undirected *Minecraft* and NASCAR was .589 SD (95% CI [.289, .889]). The standardized mean difference between Undirected *Minecraft* and T.V. was .545 SD (95% CI [.246, .844]).

CHAPTER 4: DISCUSSION AND CONCLUSION

Discussion

This study sought to test whether a type of game that allows for practicing creativity can have a short term effect on measures of creativity. Similar to previous research, we also expected to find a positive correlation between long-term game playing habits and creativity. We also expected to find a negative correlation between game playing habits and grade point average. Through the lens of the General Learning Model, the *Minecraft* conditions were expected to show higher performance on the Alternative Uses Task, the Remote Association Test, and the Alien Drawing Task. Findings were semi-consistent with hypotheses.

Hypotheses 1a and 1b were supported by the findings. Similar to Jackson et al. (2012), in this study there was an overall positive correlation between self-reported gameplay exposure and trait creativity ($R = .257$, $p < .01$). A bootstrapped mediation analysis also showed a negative relation between video game playing habits and grade point average ($R = -.25$, $p < .01$), and a small positive indirect relation between gameplay habits and grade point average through trait creativity ($R = .085$, $p < .01$; see Figure 3). This provides tentative evidence that although playing video games tends to negatively correlate with grade point average, a certain amount or type (i.e., creative) of gameplay might actually be beneficial. This is a more nuanced interpretation of the usual negative relation between grades and gameplay usually reported in the literature (e.g., Gentile et al., 2004). In general, there were no significant relations between parental income, age, or gender in any of the creativity measures.

Hypothesis 2a, that both Minecraft conditions would show higher creativity as measured by the Alternative Uses Task, was not fully supported. In the Alternative Uses Task flexibility and fluency categories, the only significant difference was that the Undirected *Minecraft* condition resulted in higher scores than the NASCAR condition. As can be seen in figures 4-6,

the NASCAR condition performed worse than all other conditions. This finding might highlight the potential for certain games to reinforce functional fixedness in their players rather than to increase creativity. Functional fixedness is when someone cannot think of an object as anything other than what they think it must be for (Adamson, 1952). For example, when they see a paperclip, they know the purpose of a paperclip is to hold papers together. They fixate on this function, and cannot think of using it for anything else. They don't think of using it for punching holes, as an electric conductor, as jewelry, etc. The Alternative Uses Task asks participants to ideate as many uses as they can for everyday objects, and having a high functional fixedness would lower one's score on this measure. A game like NASCAR, where players are constantly performing the same action might reinforce functional fixedness through practice. The players become accustomed to repetitive thought and behavior. They have one goal for the entirety of their gameplay experience, and practice responding to a variety of stimuli with similar methods.

Hypothesis 2b, that the Minecraft conditions would show higher scores on the Remote Association Task, was not supported. The Remote Association Test seemed to demonstrate a floor effect. Despite selecting problems from previous research that had shown a solution rate between .70 and .30 (Bowden & Jung-Beeman, 2003), participants from Iowa State University showed a solution rate of .15. This may be due to a difference in the population of Iowa State University students and the Stanford students initially used to validate them. It is also possible that the Remote Association Test is a relatively stable measure that is highly influenced by education (given the high correlation to GPA), but resistant to short term manipulations. This measure has been criticized as a proxy for education or vocabulary, rather than as a measure of creativity, because its solutions heavily rely on participants' previous knowledge of the words

used or alluded to in its problems. It is unclear if the lack of conditional differences is due to a floor effect of solution rates, no genuine experimental effect, and/or measurement insensitivity.

Hypothesis 2c, that the Minecraft conditions would show higher scores on the Alien Drawing Task, was somewhat supported, but showed surprising results. Participants in the Undirected *Minecraft* condition performed better on the Alien Drawing Task than participants in all the other conditions (see Figure 7). Since the Undirected *Minecraft* condition outperformed the T.V. condition, it may be the case that video games that specifically provide opportunities for creative thought and expression can provide beneficial creativity effects. Since the Undirected *Minecraft* condition outperformed the NASCAR condition, this potential benefit to creativity may be reliant on the content of game played. Additionally, the Undirected *Minecraft* condition outperformed the Directed *Minecraft* condition, which suggests that how the game is played also seems to determine if a game can provide a creativity benefit.

The difference between the Undirected *Minecraft* and the other conditions might illustrate that for video game effects both the content of a game and how that content is approached matter. The standardized mean difference between the Directed *Minecraft* and Undirected *Minecraft* Conditions showed an effect size of approximately .60, meaning on average participants in the Undirected *Minecraft* condition scored .60 standard deviations higher than those in the Directed *Minecraft* condition. An effect size of d = .60 has been found before by Jackson et al. (2012) in a correlational study of trait creativity and gameplay, but most video game and media effect studies on other constructs (e.g. aggression or visual spatial cognition) have measured effect sizes around d = .20. Even with an observed power of .98, such a high effect size should be met with skepticism and replication will be necessary to check the magnitude of this effect size.

There are several possible mechanisms that could explain this surprising difference between the Directed and Undirected *Minecraft* conditions. First, it is possible that giving participants instructions on how to play changed the participants' motivation for play. The instructions could have shifted participants' intrinsic motivation to play to external motivation to follow directions. This change in motivation could have changed how the participants approached the game. This would have changed how they played the game, and hence, changed the experience of the game. However, it is unclear how different motivations would change gameplay, especially since self-reported engagement in the conditions was not different.

Secondly, it is possible that creativity as measured by the alien drawing task is a cognitive resource that can be used up. The participants in the Directed *Minecraft* condition could have exerted themselves more intently during the gameplay portion of the study. If so, by the time they have to complete the alien drawing task, their creative cognitive resource could have been exhausted. If this proves to be true, it could change how many researchers perceive the nature of creativity.

Another possibility is that giving the participant a set goal ("be creative") would compete with any internal goals they could have. These competing goals could lead to ineffective or conflictive play. For example, a participant could simply want to see how far they can walk in one direction, but they were told to be creative. Now they might struggle to play at all, unable to meet both the goals. They could be confused (e.g., how do I walk that way creatively?), or they could begrudgingly do what they think playing creatively means by forgoing their first goal. The conflicting goals could delay productive gameplay that leads to the creative benefit. However, conflicting goals should increase frustration, but self-reported frustration was similar in the Directed and Undirected *Minecraft* conditions.

Lastly, it is possible that the creative benefit arose from the decision making process of how to play the game in the Undirected *Minecraft* condition. Without any direction, participants in the Undirected *Minecraft* condition had a lot of decisions and problems to solve: what kind of game are they in, what is possible in the game, what goals (if any) they should set, how they should approach the game, and how they can pursue their goals. Essentially, the participants in the Undirected *Minecraft* condition were given a tool (the video game) and had to decide what kind of a tool it was, how it could be used, and how they wanted to use it. On the other hand, the Directed *Minecraft* condition had many of these questions answered for them when they were told how to play. The freedom of deciding how to play in the game could have led to the creative benefit by giving the participants more open-ended decisions to make. Players having agency over how they play seems to be an important factor in the creativity effect. It is unclear from the results of this study which, if any, of the above possibilities is correct. Future research will be needed to test these alternative hypotheses.

Limitations

This is the first study to test experimentally the effect video games can have on creativity measures. It demonstrates that a game believed to foster creativity can increase performance on creativity measures, at least under certain conditions on late adolescents/early adults. Replication with different samples and games are necessary to know how well these results may generalize to other games and to other populations. In addition, three areas appear valuable for focused improvements in future studies.

First, future studies would benefit from more accurate methodological approaches. The potentially confounding factors and manipulation checks could be measured with either behavior measures or better scales than a one-item question. The Remote Association Task should either

be replaced with a different measure of convergent validity or pilot tested with the current pool of participants to avoid floor/ceiling effects.

Second, it is unknown how strong or long lasting any of the effects found in this study are. Creativity measures were administered right after gameplay. As such, the data suggest only that there is an effect immediately after playing. More research is needed to determine if the effects last after a day, a week, or even more, and if there is a constant effect with regular play. More accurate measurements of participants' video game playing habits would also benefit analyses of relations between game playing habits and creativity.

Third, this study primarily used a homogenous sample of white college undergraduates, which represent a small portion of the population, and are not the intended audience for *Minecraft*. Even though basic learning principles should be the same regardless of age and ethnicity, better representation would be beneficial. Compared to the population at large, this sample might also be at their cognitive prime, which could ironically lead to underestimating the size of the effect. Other researchers have shown that video game training on working memory in senior adults works better than training on college students (Allaire, McLaughlin, Trujillo, Whitlock, LaPorte, & Gandy, 2013). This is considered to be because the senior adults have more room for improvement in working memory than college age participants. A sample of participants who are not at their cognitive prime, or are not in an environment where they are constantly learning or problem solving might show bigger benefits.

Future Work

Future work should focus on replicating the study across cultures and age groups. Particularly, it would be advantageous to replicate the study with elementary and middle school students. Many educational interventions using *Minecraft* have focused on children of this age. In elementary and middle school classrooms, the environment is by definition instructional and

may incline teachers to direct their students' play. Since this study showed giving players a direction of how to play *Minecraft* may lead to no benefit in creativity measures, it would be beneficial to these interventions to know the most effective way to implement creative play as a learning tool.

Future work should also examine why the Undirected *Minecraft* condition showed a benefit in the Alien Drawing Task whereas the Directed *Minecraft* condition did not. Ideally, the next step in this line of research would be to replicate these findings in a longitudinal training study. A longitudinal study design would be able to examine the strength of the effect by measuring the creativity at multiple times after several gameplay sessions and follow-ups. It also allows for better study of moderators, such as stress or extracurricular activity, as those variables fluctuate throughout the course of the study. The longitudinal study could be designed similarly to previous training studies in the literature (Green & Bavelier, 2003; 2008). Subjects could come into the lab for one pre-intervention measurement session, 10 training sessions, one post-intervention session, and one follow-up session a month after the post-intervention session. Since there would be no resource-draining activity before the measures, the post-intervention session would allow examination of creativity as a resource. The follow-up sessions could examine the long term strength of the effect.

Other replications could focus on different samples of the population, different instructions, and different games. Different samples (particularly middle-elementary, age 8-12, children), could add to the generalizability of the effect. Different games could be used to examine the game mechanics that are most beneficial for creativity. Finally, different instructions (e.g., non-creative goals, such as "build the tallest building you can") could be used to examine whether it is any direction, or specific types of directions that nullify the effect.

Conclusion

In sum, our results provided support for the hypothesis that creative video game play is related to some measures of creativity. Participants in the Undirected *Minecraft* condition showed short-term increases in creative production compared to a non-creative video game, a television show, and the same game (*Minecraft*) when directed to play creatively. Participants' self-ratings of Imaginative Capability showed an association between video game playing habits and trait creativity. The Alternative Uses Task results showed trends of some games being beneficial for creative measures while other games could be detrimental. These results showed the importance of both game content and game instruction on the creative learning effect. Future studies should examine the mechanisms underlying these finding and expand upon the games measured and the sample of participants.

Although much has been made of the negative effects video games can have, particularly as they affect children, there is truth in the argument that some games might be good for them. As policy-makers and educators consider changes to public health or education, it is important to not paint games with too broad of a brush, and to not disregard the potential they have as engaging, adaptive, inherently enjoyable educational opportunities. For many, video games are a regular hobby. They may provide opportunities for time with friends too far away to see in person, or to de-stress after work. Although pathological play or desensitization to violence are real concerns, they are not a universal and necessary outcome of gaming. It is at the intersection of game content and player that results are found; we become what we practice, for ill or good.

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APPENDIX A. IRB APPROVAL

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Institutional Review Board
Office for Responsible Research
Vice President for Research
1138 Pearson Hall
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515 294-4566
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Date: 12/11/2014

To: Jorge Blanco-Herrera
W113 Lagomarcino Hall

CC: Dr. Douglas A Gentile
W112 Lagomarcino Hall

From: Office for Responsible Research

Title: Television and Game Play

IRB ID: 14-570

Approval Date:	12/10/2014	**Date for Continuing Review:**	12/9/2016
Submission Type:	New	**Review Type:**	Expedited

The project referenced above has received approval from the Institutional Review Board (IRB) at Iowa State University according to the dates shown above. Please refer to the IRB ID number shown above in all correspondence regarding this study.

To ensure compliance with federal regulations (45 CFR 46 & 21 CFR 56), please be sure to:

- **Use only the approved study materials** in your research, **including the recruitment materials and informed consent documents that have the IRB approval** stamp.
- **Retain signed informed consent documents for 3 years after the close of the study**, when documented consent is required.
- **Obtain** IRB approval prior to **implementing any changes** to the study by submitting a Modification Form for Non-Exempt Research or Amendment for Personnel Changes form, as necessary.
- **Immediately inform the IRB of (1) all serious and/or unexpected adverse experiences** involving risks to subjects or others; and (2) **any other unanticipated problems involving risks** to subjects or others.
- **Stop all research activity if IRB approval lapses, unless continuation is** necessary to prevent harm to research participants. Research activity can resume once IRB approval is reestablished.
- **Complete a new continuing review form** at least three to four weeks prior to the **date for continuing review** as noted above to provide sufficient time for the IRB to review and approve continuation of the study. We will send a courtesy reminder as this date approaches.

Please be aware that IRB approval means that you have met the requirements of federal regulations and ISU policies governing human subjects research. **Approval from other entities may also be needed.** For example, access to data from private records (e.g. student, medical, or employment records, etc.) that are protected by FERPA, HIPAA, or other confidentiality policies requires permission from the holders of those records. Similarly, for research conducted in institutions other than ISU (e.g., schools, other colleges or universities, medical facilities, companies, etc.), investigators must obtain permission from the institution(s) as required by their policies. **IRB approval in no way implies or guarantees that permission from these other entities will be granted.**

Upon completion of the project, please submit a Project Closure Form to the Office for Responsible Research, 1138 Pearson Hall, to officially close the project.

Please don't hesitate to contact us if you have questions or concerns at 515-294-4566 or IRB@iastate.edu.

APPENDOX B. MATERIALS

Demographics.

Are you:
- ❍ Male
- ❍ Female
- ❍ Other

What is your current age? (in years)

How would you classify yourself?
- ❑ African American
- ❑ Asian/Pacific Islander
- ❑ Latino/Hispanic
- ❑ Multi-Racial
- ❑ Native American
- ❑ White
- ❑ Other(Specify) _____

What was your GPA (on a four point scale – i.e., 0.0 – 4.0) in the previous semester?
- ❍ 1.5 (D) or below
- ❍ 1.7 (C-)
- ❍ 2.0 (C)
- ❍ 2.3 (C+)
- ❍ 2.7 (B-)
- ❍ 3.0 (B)
- ❍ 3.3 (B+)
- ❍ 3.7 (A-)
- ❍ 4.0 (A)

What of the following fields describes your major best?
- ❍ Design
- ❍ Social Science
- ❍ Physical or Biological Science
- ❍ Business
- ❍ Mathematics/Statistics
- ❍ Computer Science
- ❍ Engineering
- ❍ Education
- ❍ Performing Arts
- ❍ Communication
- ❍ Humanities

Is English your native language?
- ❍ Yes
- ❍ No

What is your parent's current combined annual income?

- ❍ $19,999 or less
- ❍ $20,000-$39,999
- ❍ $40,000-$59,999
- ❍ $60,000-$99,999
- ❍ $100,000-149,999
- ❍ $150,000-$199,999
- ❍ $200,000 or more
- ❍ Don’t know

Alternative Uses Task.

In this task you will be presented with a series of objects. Your task will be to come up with creative and detailed uses for these objects. You will have 3 minutes to write as many uses as you can for each object. The survey will automatically advance when the 3 minutes have elapsed. For example, if the object presented is Brick. You might list: A paperweight A doorstop A weapon A construction tool A trail marker part of a floor part of a wall the body of an imaginary car

Click 'Next' to start

Please try to write as many uses as you can for a: Paperclip

Please try to write as many uses as you can for a: Newspaper

Please try to write as many uses as you can for a: Knife

Remote Association Task.

The test is called a Remote Association Test because it measures your ability to see relationships between things that are only remotely related. Look at the three words given and find a fourth word that is related to all three. Example: What word is related to these three words? hold doll cat The answer is "house": household, dollhouse, and house cat. You will have 15 seconds for each remote associate problem. Please, try your best, but be aware you are not meant to answer every question correctly. The first will appear on the next page, and the survey will automatically move to the next problem when time is up. Click the button to continue when you are ready.

Fox man peep – hole
Type ghost screen – writer
Teeth arrest start – false
Iron shovel engine – steam
Wet law business – suit
Off military first – base
Cut cream cold – ice
Shock shave taste – after
Break bean cake – coffee
Hold print stool – foot
Horse human drag – race
Oil bar tuna – salad
Bottom curve hop – bell
Tomato bomb picker – cherry
Back step screen – door
Test runner map – road
Keg puff room – powder
Time blown nelson – full
Rain test stomach – acid
Cover arm wear – under
Marshal child piano – grand
Tail water flood – gate
Blank list mate – check
Way board sleep – walk
Change circuit cake – short
Knife light pal – pen
Hammer gear hunter – head
Master toss finger – ring
Cat number phone – call
Pile market room – stock

Imaginative Capability Scale.

6-point scale (Strongly Disagree, Disagree, Slightly Disagree, Slightly Agree, Agree, and Strongly Agree)

I often have unique ideas compared to others.
I can develop ideas by examining different perspectives.
I often try untraditional approaches in a project.
I often have a rich diversity of ideas.
I often use a variety of ways to express ideas.
I can constantly come up with various ways to do a project.
I often challenge existing ideas.
I often analyze numerous possibilities on how a problem may develop.
I like to explore the unknown through a variety of experiences.
I am often emotionally involved in a project.
I can quickly sort out complicated messages.
I can quickly grasp the big picture.
I know how to concentrate on imagination and prevent myself from distraction.
I can continue to focus on a project until the ideas are formed.
I often invest prolonged time on the project until a resolution is found.
I can come up with an approach to meet the teacher’s requirements.
Please, select "slightly agree" here.
I often set goals in accordance with my ability.
I constantly revise my ideas to reach satisfactory results.
I can deliberately think through the contradictions of a problem.
I can make a connection between seemingly unrelated matters.
I can ruminate on an assigned project and put forward different ideas.
I often express my feelings by using concrete ideas.
I can express abstract ideas by using examples from daily life.
I can illustrate difficult ideas with some key concepts.
I can explain unfamiliar concepts with examples common to a target audience.
I can integrate different points of view into my way of thinking.
I often apply my experiences in daily life to class projects.
I can flexibly reproduce my ideas to multiple fields.
I can transfer similar ideas to various situations.

Alien Drawing Task.

Imagine a planet vastly different to Earth. Then imagine a being that has developed on that planet, and draw that alien below.

Video Game History Questionnaire.

Instructions: Please think of the five video games that you have played for the greatest amount of time from when you were in 7th grade until the present. Include computer, mobile, console/TV, and arcade games. Please write down the titles of these games on the blank lines below.

❑ If you have never played a video game in your life, please check here and go on to the next questionnaire.

What is the title of your most played game?

In recent months, how often have you played this game?

❍ Rarely 1
❍ 2
❍ 3
❍ Occasionally4
❍ 5
❍ 6
❍ Often7

During 11th & 12th grades, how often did you play this game?

❍ Rarely 1
❍ 2
❍ 3
❍ Occasionally4
❍ 5
❍ 6
❍ Often7

During 9th & 10th grades, how often did you play this game?

❍ Rarely 1
❍ 2
❍ 3
❍ Occasionally4
❍ 5
❍ 6
❍ Often7

During 7th & 8th grades, how often did you play this game?

❍ Rarely 1
❍ 2
❍ 3
❍ Occasionally4
❍ 5
❍ 6
❍ Often7

How creative is this game?

❍ Rarely 1

- ❍ 2
- ❍ 3
- ❍ Occasionally4
- ❍ 5
- ❍ 6
- ❍ Often7

How creative do you feel when you play this game?

- ❍ Rarely 1
- ❍ 2
- ❍ 3
- ❍ Occasionally4
- ❍ 5
- ❍ 6
- ❍ Often7

Which of the following categories best describes this game? Check all that apply.

- ❑ Logic/puzzle
- ❑ Driving
- ❑ Sport
- ❑ Role-playing
- ❑ First person shooter
- ❑ Third person shooter
- ❑ Real-time strategy
- ❑ Turn-based strategy
- ❑ Other

What is the title of your 2nd most played game?

In recent months, how often have you played this game?
- ❍ Rarely 1
- ❍ 2
- ❍ 3
- ❍ Occasionally4
- ❍ 5
- ❍ 6
- ❍ Often7

During 11th & 12th grades, how often did you play this game?
- ❍ Rarely 1
- ❍ 2
- ❍ 3
- ❍ Occasionally4
- ❍ 5
- ❍ 6
- ❍ Often7

During 9th & 10th grades, how often did you play this game?
- ❍ Rarely 1
- ❍ 2
- ❍ 3
- ❍ Occasionally4
- ❍ 5
- ❍ 6
- ❍ Often7

During 7th & 8th grades, how often did you play this game?
- ❍ Rarely 1
- ❍ 2
- ❍ 3
- ❍ Occasionally4
- ❍ 5
- ❍ 6
- ❍ Often7

How creative is this game?
- ❍ Rarely 1
- ❍ 2
- ❍ 3
- ❍ Occasionally4
- ❍ 5
- ❍ 6
- ❍ Often7

How creative do you feel when you play this game?
❍ Rarely 1
❍ 2
❍ 3
❍ Occasionally4
❍ 5
❍ 6
❍ Often7

Which of the following categories best describes this game? Check all that apply.
❑ Logic/puzzle
❑ Driving
❑ Sport
❑ Role-playing
❑ First person shooter
❑ Third person shooter
❑ Real-time strategy
❑ Turn-based strategy
❑ Other

What is the title of your 3rd most played game?

In recent months, how often have you played this game?
❍ Rarely 1
❍ 2
❍ 3
❍ Occasionally4
❍ 5
❍ 6
❍ Often7

During 11th & 12th grades, how often did you play this game?
❍ Rarely 1
❍ 2
❍ 3
❍ Occasionally4
❍ 5
❍ 6
❍ Often7

During 9th & 10th grades, how often did you play this game?
❍ Rarely 1
❍ 2
❍ 3
❍ Occasionally4

❍ 5
❍ 6
❍ Often7

During 7th & 8th grades, how often did you play this game?
❍ Rarely 1
❍ 2
❍ 3
❍ Occasionally4
❍ 5
❍ 6
❍ Often7

How creative is this game?
❍ Rarely 1
❍ 2
❍ 3
❍ Occasionally4
❍ 5
❍ 6
❍ Often7

How creative do you feel when you play this game?
❍ Rarely 1
❍ 2
❍ 3
❍ Occasionally4
❍ 5
❍ 6
❍ Often7

Which of the following categories best describes this game? Check all that apply.
❑ Logic/puzzle
❑ Driving
❑ Sport
❑ Role-playing
❑ First person shooter
❑ Third person shooter
❑ Real-time strategy
❑ Turn-based strategy
❑ Other

What is the title of your 4th most played game?

In recent months, how often have you played this game?
❍ Rarely 1

- ❍ 2
- ❍ 3
- ❍ Occasionally4
- ❍ 5
- ❍ 6
- ❍ Often7

During 11th & 12th grades, how often did you play this game?
- ❍ Rarely 1
- ❍ 2
- ❍ 3
- ❍ Occasionally4
- ❍ 5
- ❍ 6
- ❍ Often7

During 9th & 10th grades, how often did you play this game?
- ❍ Rarely 1
- ❍ 2
- ❍ 3
- ❍ Occasionally4
- ❍ 5
- ❍ 6
- ❍ Often7

During 7th & 8th grades, how often did you play this game?
- ❍ Rarely 1
- ❍ 2
- ❍ 3
- ❍ Occasionally4
- ❍ 5
- ❍ 6
- ❍ Often7

How creative is this game?
- ❍ Rarely 1
- ❍ 2
- ❍ 3
- ❍ Occasionally4
- ❍ 5
- ❍ 6
- ❍ Often7

How creative do you feel when you play this game?
- ❍ Rarely 1
- ❍ 2

- ❍ 3
- ❍ Occasionally4
- ❍ 5
- ❍ 6
- ❍ Often7

Which of the following categories best describes this game? Check all that apply.

- ❑ Logic/puzzle
- ❑ Driving
- ❑ Sport
- ❑ Role-playing
- ❑ First person shooter
- ❑ Third person shooter
- ❑ Real-time strategy
- ❑ Turn-based strategy
- ❑ Other

What is the title of your 5th most played game?

In recent months, how often have you played this game?

- ❍ Rarely 1
- ❍ 2
- ❍ 3
- ❍ Occasionally4
- ❍ 5
- ❍ 6
- ❍ Often7

During 11th & 12th grades, how often did you play this game?

- ❍ Rarely 1
- ❍ 2
- ❍ 3
- ❍ Occasionally4
- ❍ 5
- ❍ 6
- ❍ Often7

During 9th & 10th grades, how often did you play this game?

- ❍ Rarely 1
- ❍ 2
- ❍ 3
- ❍ Occasionally4
- ❍ 5
- ❍ 6
- ❍ Often7

During 7th & 8th grades, how often did you play this game?
❍ Rarely 1
❍ 2
❍ 3
❍ Occasionally4
❍ 5
❍ 6
❍ Often7

How creative is this game?
❍ Rarely 1
❍ 2
❍ 3
❍ Occasionally4
❍ 5
❍ 6
❍ Often7

How creative do you feel when you play this game?
❍ Rarely 1
❍ 2
❍ 3
❍ Occasionally4
❍ 5
❍ 6
❍ Often7

Which of the following categories best describes this game? Check all that apply.
❑ Logic/puzzle
❑ Driving
❑ Sport
❑ Role-playing
❑ First person shooter
❑ Third person shooter
❑ Real-time strategy
❑ Turn-based strategy
❑ Other