HOLISTIC GAMING: USING THE PHYSICAL AND PSYCHOLOGICAL EFFECTS OF VIDEO GAMES TO BETTER OUR LIVES

By

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Thesis Summary

Games and play coalesce with humanity and illuminate life. Through technological advancements, games and play have transcended to video games and video game play, which have become cultural titans in their own right. Video games are played at home, in society, and on the go—they're everywhere. During their development, video games united with education to improve the quality of the human experience. Video game designers, educational researchers, and scientists from various fields have examined video games and video game play to understand their intelligibility and to use their instrumentality. A new development in video game design and research—holistic gaming —has joined the battle. By quantitatively measuring and identifying the affect video game elements have on physical and psychological processes, game engineers can design innovative experiences that address a plethora of problems, phenomena, and people.

Video games and video game play have measurable effects. Video games produce cognitive improvements, e.g. visual attention processes, as well as physical changes, such as the brain areas responsible for processing and learning. However, video games also produce impairments that cause mental deficits, e.g. inhibition and decision-making skills, from physiological effects, i.e. prolonged stress mechanisms. Holistic gaming recognizes both positive and negative aspects of video game play, and it works to design games that reinforce positive effects while minimizing the negative effects.

Various research indicates that video games help prevent the onset of neurological disorders, correct impairments, and adjust behavior as well as treat physical problems brought about by accidents and illnesses. Depending on the condition, video games can

be designed for a specific circumstance or individual. They serve as useful tools to educate and train professionals. Whether medical, military, or any other profession, individuals can benefit from video game simulator training on various levels. As well, the purposeful design and creation of future video games can serve as powerful pedagogical tools to teach a process, phenomenon, or any particular interest, e.g. an immune response and the immune system.

Through holistic gaming, video game research and design can improve the quality of our world. There are a number of ways holistic gaming will develop and grow, and the most fruitful endeavor will involve a complete systems learning game. By increasing the quality and quantity of our educational system, video games and video game play provide humanity with the greatest chance to live long and prosper. Holistic gaming is a valuable cornerstone for human growth and development.

Abstract

Holistic gaming is a game design philosophy that recognizes that video games and video game play produce physical as well as psychological effects. Holistic gaming works to understand this relationship between humans, video games, and video game play in order to design games that facilitate education, research, healthcare, and human development. Whether they're training doctors or offsetting Alzheimer's disease, video games can exercise both mental and physical features, train specific skills for a number of jobs, educate players about events and phenomenon in our world, research and understand natural human processes, and they can be designed for a number of other purposes. Multiple studies in the fields of psychology, biology, educational media, and the like, have demonstrated the effects of video games on physical and psychological levels— positive, negative, and everything in between. This thesis identifies and explains the role of games and play in society, their evolution into video games, their application in education, the various physical and mental effects that video games produce, ways in which video games can be used in the future, and how they will get there.

Defining Holistic Gaming

Holistic gaming is a game design philosophy that recognizes that video games and video game play produce physical as well as mental effects. By thoroughly analyzing the physical, i.e. various physiological mechanisms, and mental, i.e. psychological and cognitive, effects produced by video games and video game play, scientists and designers can create a plethora of games that facilitate education, research, healthcare, human development, and life, e.g. to prevent the onset of a neurological disease or provide pedagogical support to learn how the immune system functions. I am developing holistic gaming as a novel approach to understand and use video games.

A holistic approach recognizes collective parts of a system as intricately and intimately connected, and it maintains a balance amongst these parts (Holistic, n.d.). For example, holistic medicine is characterized by the treatment of physical, mental, and social factors (Holistic, n.d.). With regards to video games, a holistic approach recognizes that a number of physical and mental effects occur during video game play, and these effects are products of human interaction with specific video game elements, processes, and architectures.

A game is any mental and/or physical activity that is defined by goals, rules, challenges, a feedback system, voluntary participation, and results in a quantifiable outcome (Game, n.d.; McGonigal, 2011, p. 21-22; Salen & Zimmerman, 2004, p. 80). A video game is a complex form of digital media that incorporates these gamic properties, and it requires the active interaction between a human and computer (Galloway, 2006, p. 1-2; Wardrip-Fruin, 2009, p. 7-12). Video games come in different shapes and flavors;

however, they inherently possess fundamental features that can be designed and understood. These features include the player(s) of the game, i.e. who is the decision-maker that interacts with the system; the purpose(s) of the game, i.e. the reason for the game's existence; the procedure(s) of the game, i.e. what actions and methods guide the player and help him/her acquire skills; the rule(s) of the game, i.e. what boundaries limit and control the player's behavior; the resistance(s) of the game, i.e. the uncertainty, opposition, tension, and conflict the player experiences; the resource(s) of the game, what objects, attributes, and states the player acquires and uses; the feedback(s) of the game, i.e. how the system evaluates and responds to player actions; and finally the format(s) of the game, i.e. the game's blackbox—formal elements and the physical engine that contain the game (Dignan, 2011, p. 87-110; Fullerton, 2008, p. 49-81). Under a holistic approach, the combination and manipulation of these properties create a unique video game play experience that has physical and psychological effects on the player.

Video game play is a process and a state of mind (Dignan, 2011, p. 23-31). Play requires a participant to voluntarily interact with a game, and through his or her voluntary participation, the player enters a 'magic circle' that transforms the activity into entertainment and recreation (Huizinga, 1955, p. 7-13; Play, n.d.). This experience becomes fun. Play is enjoyable, and it is biologically encouraged. Human brains are wired to motivate exploration and learning 'in the moment'—in one's immediate experience (Dignan, 2011, p. 23-26). This relationship has a neurobiological connection between the experience of play and centers in our brains, such as activation and interaction between the basal ganglia, the limbic system, and other structures in the

medial forebrain circuit as well as the perception of psychological phenomena, e.g. liking, wanting, pleasure, and reward (Dignan, 2011, p. 23-26; Gazzaniga et al., 2009, p. 73, 78, & 364-385; Kalat, 2013, p. 94-97; Linden, 2011, p. 3-4, 18-19, & 144-145). The act of playing activates physical, neurobiological structures and produces psychological sensations that can be identified and understood. For example, games provide the player with the ability to flow, which is the satisfying and exhilarating feeling that occurs through active engagement, creative accomplishment, and heightened function (Csikszentmihalyi, 1990; McGonigal, 2011, p. 35-36).

Holistic gaming works to understand this relationship between humans, video games, and video game play. By quantitatively measuring and connecting these effects back to a source—to specific video game characteristics—these elements can be identified and categorized so that game engineers can design innovative experiences that address a plethora of problems, phenomena, and people.

An Account of Games and Play: A Love Story

Games and play have been prominent components of human culture. As Huizinga (1955) indicates, games and play complement life (p. 4). Through the combination of repetition, alternation, tension, excitement, and the like, play creates a new, varying environment—a magic circle—with each experience (p. 10-11). This 'magic circle' promotes individual meaning, reason, value for expression, and spiritual associations as well as cultural implications and collective significance (p. 9). Games and play are integral to cultural and social functioning (p. 4). They augment physical and cognitive skills, such as knowledge and strength, along with attributes, like courage, through

activities, such as exercise, reflection, and competition (p. 48). Through a cyclical

process, these gamic properties affect our culture. Games that test feats of strength value

strength and physicality, and so culture glorifies and advocates the existence of strong,

physical individuals. Culture shapes individual identities through the surrounding

environment, and as Huizinga states, "culture arises in the form of play" (p. 46). This

cycle can be simplified to: culture shapes individuals, individuals play, and play shapes

culture.

This relationship between games and play exists in nature and flows through life.

Games and play have been apparent in a number of areas and disciplines: language, law,

war, self-awareness, poetry, stories, philosophy, art, business, and in various other aspects

of civilization (Huizinga, 1955). They occur across cultures, and they even occur across

phyla: "Animals play just like men" (p. 1). Dogs growl and bite—or barely bite—when

playing with a human or gamboling with another dog. Lions learn to hunt by modeling

and playing, wherein play serves as a learning mechanism and influences social

interaction (Van Eck, 2006, p. 18). These tendencies to play serve a plethora of behaviors

—educational, agonistic, cultural, spiritualistic, etc. (Huizinga, 1955, p. 173; Van Eck,

2006, p. 18). They have persisted throughout life in various shapes and forms. As humans

grow and develop, games and play develop too. Culture, games, and humans form an

intricate web that advance technology, society, and literacy (Dignan, 2011, p. 2, 17-18).

The Birth of a Prodigy

Within the last century, games and play have donned a new form—video games

and video game play. The rise of this technology has had massive cultural and societal

significance. In the 1950s, students at large universities, such as MIT, and programmers in military facilities, e.g. Brookhaven National Laboratories, created the first video games (Rogers, 2010, p. 4). These developments inspired Atari founders to produce the first arcade video game, *Computer Space*, in 1971; thus, the 1970s dawned the arcade machine in bars and the construction of video arcades across the country (p. 4). From vector graphics of black and white lines to pixels of color, video games produced classic experiences, such as *Asteroids* and *Pac-Man*, which in turn produced classic, pop-culture characters, such as Donkey Kong and Mario (p. 5).

As well, the 1970s brought video gaming to the home front with the advent of the console and personal computers, which allowed video gamers to program and play their games from home, and within a decade, video games entered into the homes of millions of people worldwide (p. 6-8). Whether they played on an arcade cabinet, on a cocktail table, in an arcade cockpit, on a console, or with a PC, video gamers became enthralled with this new media, and video games swept the world over with new and varied genres, themes, controllers, graphics, and game play experiences (Rogers, 2010, p. 5). As video game culture increased, its influence on technology and society grew in parallel; for example, mini-theme park rides, virtual simulators, and fighting booths arose in the form of grand arcades and facilities, like Virtual World's BattleTech Centers with their battle tech 'mechs' (p. 5-6). By the late 1970s and early 1980s, video games were played at home, in society, and on-the-go through handheld gaming (p. 7). Video games were everywhere.

Video games came in all kinds of shapes, colors, and flavors: *Oregon Trail*
(1971), *Centipede* (1981), *Frogger* (1981), *Castle Wolfenstein* (1981), *Ms. Pac Man*
(1982), *Mario Bros.* (1983) *Where in the World is Carmen Sandiego?* (1985), *Super
Mario Bros.* (1985), *Math Blaster* (1989), *DOOM* (1993), *Myst* (1993), *Golden Eye*
(1997), and many, many more (Dignan, 2011, p. 11). By the 1990s, console and PC
gaming began to rival arcade games in controls, graphics, and price (Rogers, 2010, p. 6).
Not only did personal gaming devices increase, but LAN gaming centers as well as
internet cafes became a staple in many video gamers' diets (p. 6). Advancement after
advancement fueled the video game craze: the Atari (1972), Intellivision (1979),
Nintendo Entertainment System (1983), Macintosh (1984), Apple IIGS (1986), Sega
Genesis (1988), Game Boy (1989), the incorporation of the Internet (1990s), Neo Geo
(1990), Super Nintendo (1990), Playstation (1994), Nintendo 64 (1996), Palm Pilot
(1997), mobile phone games (1998), Dreamcast (1998), iPods (2001), Xbox (2001), and
the list goes on (Dignan, 2011, p. 12). These developments can be attributed to the
entwining of technology, human interest and enjoyment, and the cultural environment
that surrounded video games and video game play.

For the Greater Good

As video games grew in quality and quantity, one facet of society—education—
began to take notice of this new phenomenon. The late 1970s and early 1980s produced a
new educational paradigm through the development of educational video games, i.e.
children's software, learning games, and edutainment (Ito, 2009, p. 2-5). By
incorporating gaming and entertainment, educators developed a new software genre to

approach education, and they designed video games that employed "play as a site of learning" (p. 1-5). In an attempt to appeal to children, games like *Number Munchers*, *Oregon Trail*, *Reader Rabbit*, *KidPix*, and *Where in the World is Carmen Sandiego* began the battle between balancing entertainment with education through a combination of play, learning, and literacy, i.e. a player's knowledge (p. 5 & 31).

Video game researchers and educational designers like Marc Prensky, James Paul Gee, Clark Aldrich, Tracy Fullerton, Katie Salen, Eric Zimmerman, Steven Johnson, Aaron Dignan, and numerous others, have published a number of essays, articles, and books that present, analyze, synthesize, and critique educational methodologies and learning stratagems for educational video games, such as digital game-based learning, behavioral games, and game design fundamentals (Dignan, 2011; Salen & Zimmerman, 2004; Van Eck, 2006, p. 17). These researchers and designers approach educational video games from different perspectives and with unique schema; however, their thematic work understands and uses video games in an educational setting.

Educational video game methodologies vary. On the one hand, there are elaborate video games that immerse players in a world of challenge wherein players actively solve problems and reflect over the dynamics of processes, such as history and politics; on the other hand, there are 'brain fitness' games that provide mini-tasks for players to practice in a rinse-and-repeat fashion; then there are games that fall everywhere in between (Green, 2012, p. 198; Ito, 2009, p. 8-9). For example, the mundane 'drill and practice' style of games like *Math Blaster* lowers the quality of video game play in order to supply the acquisition of specific educational content, i.e. sugar coating an academically rigorous

task; this 'chocolate covered broccoli' approach has helped children learn their addition, subtraction, multiplication, and division, but it merely provides an extrinsic reward for participating in a rote task (Green, 2012, p. 198; Ito, 2009, p. 8). Conversely, a game like *Civilization* provides macro and micro concepts that challenge literacy through situational learning and immersion (Ito, 2009, p. 8). Games like *Civilization* and *Math Blaster* challenge and explore the perception of 'good' vs. 'bad' video games and video game play styles: the value of social and cognitive learning versus academic content, community learning versus individual development, methods to acquire transferable skills, and a number of other educational values and paradigms (Ito, 2009, p. 4-16 & 187-188).

Educational video games have produced a variety of results: some good, some bad, and some ugly. In order to understand these results, educational video games should be approached and understood like any other process or phenomenon—scientifically. The analytical, empirical, and pragmatic methodologies that help explain our world can provide intelligible and instrumental results for video games and video game play (Dear, 2006). Educational video games have been successful and unsuccessful in many regards; some games, techniques, and learning strategies work for one individual, but those same aspects and features may not work for another player. Through a combination of genetic factors and environmental influences, human beings learn, develop, and grow in unique ways (Dawkins, 1976; Weiner, 1994). It is difficult to identify the reason(s) as to what, how, or why certain methodologies work for specific individuals; however, the collection of quantifiable results produced from video games and video game play research can

provide useful information. That is to say, the direct effects of educational video games are unpredictable from individual to individual, but the collective matrix of results can be understood and utilized for scientists and designers alike.

Under a holistic approach, no discrete instance reflects the whole. Instead, the aggregate serves as a valuable assessment of the system. As with educational video games, varying design methodologies have laid a foundational framework to understand video games and video game play. A number of educational game design researchers, such as Mizuko Ito, James Paul Gee, Kurt Squire, Ian Bogost, and David Shaffer among others, propose a variety of concepts and practices that understand educational media in intelligible ways—contemplating educational games to understand their true aesthetical nature—as well as to be instrumental—producing efficacious results (Ito, 2009, p. 4-16; Dear, 2006, p. 173-176 & 191). This collective work has started to mold our perception of educational video games, but it needs to be quantitatively investigated and characterized before it is fired, fixed, and ready for functional use. Academic fields of psychology, biology, and cognitive neuroscience have begun glazing and characterizing video game research, and through these fields—specifically cognitive neuroscience— video game researchers and engineers will be able to produce instrumental and intelligible results.

By the Old Gods and the New

The most effective way to apply video games and video game play in an educational setting involves understanding their effects and processes, and the best way to understand these effects and affect our world is through scientific study (Dear, 2006, p.

1-14). Through this intellectual and practical activity, video game play research can be

systematically analyzed by observations and experimental methods, which in turn can

promote purposeful design (Science, n.d.). Video games are versatile in form and

function. These instruments facilitate experimental study as well as reflect scientific

methodology through their intrinsic characteristics, i.e. video game play is an intense and

engaging form of the scientific method (Boyan & Sherry, 2011, p. 83-84). As a general

example, the player asks a question, "How do I get past this boss?" He or she does

research, which can be external but most likely internal, "This weapon weakens his shield

and leaves him vulnerable." The player constructs a hypothesis, "If I can remove its

defenses using this weapon, I can attack the boss while its vulnerable." The player tests

this hypothesis, which typically involves trail and error, "I'll shoot this at you now. Or

now. Or now. Ah!" Then he or she analyzes the result, "Was that successful?" If

successful, the player can rinse and repeat until a new obstacle or question arises. If

unsuccessful, the player goes back through the process until he or she is successful and

can move on. This process occurs over varying temporal and spatial scales—spanning the

course of the game or within a momentary event.

  As Dignan and other researchers point out, "games are learning engines," and

video games are intrinsically equipped to educate and train players (2011, p. 92). Video

games naturally provide challenges that train a number of cognitive skills, e.g. attention,

memory, and problem solving, which allow for the mastery of educational content

(Boyan & Sherry, 2011, p. 82-85). Mastery refers to the expert performance or literacy of

an individual, and it occurs through deliberate learning and practice (Ericsson et al.,

1993, p. 392). Deliberate learning consists of three key components: setting specific goals, obtaining immediate feedback, and concentrating as much on technique as on outcome (Levitt & Dubner, 2009, p. 61). Video games intrinsically encourage deliberate learning because they provide players with an engaging learning environment that motivates, provides feedback, and develops problem solving and decision-making skills. When people have the will for something, they're more inclined to deliberately put effort, energy, and enthusiasm into the experience (Dignan, 2011, p. 2). Through a cyclical process, video games promote volition—the will to do something—and faculty—the ability to do it—which drive deliberate learning, which in turn develop student motivation and mastery, and ultimately, provide the student with the will and ability to continue to train (Dignan, 2011, p. 2-3). Video games have the potential to produce mastery over educational content, and they can be created, modified, and integrated with instructional strategies for specific outcomes (Van Eck, 2006, p. 28-30).

Since the 1980s, educational technology researchers have been studying the effects of video games in an educational context. A 1982 meta-analysis found that instructional simulation games moderately facilitated cognitive learning (Szczurek). This analysis was not specific on whether these games were digital or not, and it recommended that more research should be conducted and elaborated on in this field (p. 60-61). A 1985 study investigated the role of mathematical education games across varying learning levels (Van Eck, 2006, p. 22). The investigators identified 3 types of games for learning: pre-instructional strategy games for advanced organization, co-instructional strategy games, which provide examples and practice of learning in a

domain, and post-instructional strategy for assessment and synthesis. Further research has used psychological principles to produce instructional and intelligible results for educational video games, e.g. Piaget's assimilation and accommodation concepts produce a continuous cycle of cognitive disequilibrium and resolution, which can serve as an effective teaching tool (Van Eck, 2006, p. 18-26). Other psychological theories can help support video games as effective learning tools: anchored instruction, feedback behaviorism, constructivism, narrative psychology, and various cognitive principles (Van Eck, 2006, p. 20). In order to grok the relationship between video game play and education, further research using psychological theories, e.g. cognitive behavioral therapy, and intelligible design stratagems, e.g. digital game based learning, will need to investigate video game features, content, and processes, e.g. breadth vs. depth, student responsibility and engagement, endogenous (diegetic) story elements, exogenous (nondiegetic) gameplay actions, flow, and additional video game characteristics (Dignan, 2011, p. 4-5; Galloway, 2006, p. 12-28 & 37; Van Eck, 2006, p. 26).

Current Evidence to Support Holistic Gaming

From light and food to singing and dancing, our world is characterized by phenomena, events, and processes that have a physical and mental effect on us. Our environment and our experience shape us—physically and psychologically. As cultural artifacts, video games work in a similar fashion. Video games are instruments that simulate how we process the world, i.e. tools testing problem solving and decision-making skills. Once we understand the physiological and psychological effects of video

game play, we can use these processes to help us interpret and navigate our world, e.g. constructing beneficial stratagems for education and public health.

Video games exercise and train cognitive skills. Cognition is defined as the mental processes associated with memory, language, perception, attention, problem solving, decision-making, and reasoning (Goldstein, 2011, p. 5 & 393). Video games create engaging environments that allow for cognitive growth and development in mental rotational skills, object location ability, attention, visual attention, targeting, iconic and verbal representation of processes, verbal fluency, executive control, and both short- and long-term memory skills (Boyan & Sherry, 2011, p. 84-85). Cognition develops through bottom-up and top-down processes. The bottom-up process is input and data driven, which involves perceiving the world, remembering features and characteristics about it, and navigating the environment. The top-down process applies previously learned knowledge to affect perception, memory, problem solving, decision-making, and the like (Goldstein, 2011, p. 50-76, 392, & 408). Similarly, video games incorporate and challenge various cognitive processes through a cyclical flow of bottom-up and top-down processing. A player perceives and interacts with the video game environment— processing bottom-up—and in order to succeed in the game, he or she must solve problems and use several cognitive skills to overcome obstacles and challenges— processing top-down. Through their intrinsic qualities, video games promote cognitive growth and development.

The brain-mind relationship suggests that physical changes are occurring in parallel to these mental developments (Gazzaniga et al., 2009). Video games impact

human physiology in various physical ways. For example, they act as powerful stimuli: They can affect stress levels through increased heart rate and heightened cortisol production as well as produce pleasurable stimulation in the form of dopamine and opioid release (Boyan & Sherry, 2011, p. 82; Koepp et al., 1998, 266). Furthermore, traditional games, such as *Ms. Pac-Man*, have been shown to increase heart rate, blood pressure, oxygen consumption, and energy expenditure (Segal, 1999, p. 1034). More physically intensive video games such as exergames, e.g. Dance Dance Revolution and Wii Sports, are being used as health tools to increase caloric expenditure and heart rate (Staiano & Calvert, 2011, p. 93-95). As well, Staiano and Calvert have shown that using aerobic exercise through video game play affects the structure and function of the brain in a number of ways: It increases cerebral circulation via enhanced cardiorespiratory functioning, and it also decreases the risk of disease by providing an enriched environment of increased neurotransmitters, enhanced physiological and neurological mechanisms, and healthy molecular and neurochemical changes (2011, p. 95-96). This is only the tip of the iceberg; it is still unclear how video games affect human physiology in a comprehensive and temporal manner, e.g. neuronal communication, hormone interaction, and other physiological changes over different periods of time.

The Good

     Video games and video game play produce a number of positive effects on humans. A 2003 study by Green and Bavelier demonstrated cognitive growth through video game play, specifically attentional processes that rapidly and accurately extract visual information from the environment and process that information (p. 534; Gentile et

al., 2012, p. 62). In addition to improvements in visual-attention processes, video games affect and enhance spatial skills, executive function, task-switching, multi-tasking, visual short-term memory, and a number of other cognitive skills (Boyan & Sherry, 2011, p. 84-85; Green & Bavelier, 2012, p. 201 & 203-204; Green & Bavelier, 2006, p. 4-15). Further research suggests that intense, consistent cognitive training can greatly enhance memory, language, attention, executive function, and visuo-spatial skills (Croisile, 2007), and by actively exercising specific cognitive skills, this training can produce both short- and long-term benefits that generalize to everyday life, such as driving, managing money, and solving problems (Banks, 2007). Moreover, physiological effects occur concurrently with these psychological changes, and together they can lead to improved physical and cognitive performance, social interaction, and academic performance (Staiano & Calvert, 2011, p. 95-96). As an example of these parallel effects, a 2000 study by Skosnik et al. looked at the effects of moderate stress on attention, and it revealed that video game play increased attentional capabilities through a neurochemical-hormonal stress-response.

The Bad

Video games and video game play produce a number of negative effects on humans. In 2000, the American Academy of Pediatrics, American Psychological Association, American Academy of Child Adolescent Psychiatry, and American Medical Association issued a statement that revealed a "casual connection" between media violence and aggressive behavior; however, it is a complex effect (Gentile et al., 2004, p. 19). Several studies have found correlational effects between aggressive behavior and video game habits (Gentile et al., 2004, p. 6-8). Further research reveals video games

induce impulsivity and an inhibition on attention abilities, i.e. the ability to sustain

adaptive, goal-oriented behavior or mental processes in effortful or boring contexts, e.g.

school work, and equally, if not more, when those games have a violent element attached

to them (Gentile et al., 2012, 62 & 67-69). As well, Carnagey et al. found that violent

video games increased desensitization, i.e. a reduction in emotion-related physiological

reactivity to real violence (2007, p. 489-491 & 494-495). While this effect might be

efficacious for surgeons and soldiers, it is discouraged for children and civilians (p. 490).

Additionally, there may be limits to cognitive growth from video game play; recent

research indicates that video games possess limits on what can be transferred because

human learning is specific to task, content, and context (Green & Bavelier, 2012, p. 198).

And the Ugly Duckling

Due to their complex nature, video games affect people in various ways, and it is

difficult to establish a one to one ratio comparing and analyzing video game elements and

effects—most results are correlated with several factors (Gentile et al., 2012, p. 62 &

67-79; Gentile et al., 2004, p. 6-7 & 18-20). Through surveys, models, experimental tests,

and correlational studies, researchers report mixed results, concerns with methodology,

and requests for more research, specifically on content (Carnagey et al., 2007, p.

489-491; Gentile et al., 2012, p. 62-64 & 68; Gentile et al., 2004, p. 6-9; Hertzog, 2009,

p. 47-48; Wang et al., 2011). Video game research is still a fledgling, and more

experimentation, specifically in the field of cognitive neuroscience, needs to be

conducted before the beauty of this work can be appreciated. If given significant time,

energy, effort, and experimental analysis, video game research can yield a plethora of intelligible and instrumental results.

A more developed understanding of video game play and its affect on players will allow video game design and research to excel. As Green and Bavelier (2012) indicate, "characterizing game play factors" and dissecting the components of games will reveal physical and cognitive changes that can be controlled and understood, i.e. elements A, B, and C cause effect X, Y, and Z (p. 204). Under a holistic approach, researchers must be cognizant of psychological and physical effects produced by video game play. If there is a psychological component, e.g. aggression, then there will likely be a physical component, e.g. cerebral activation/inactivation (Wang et al., 2011). Similarly, if there is a physiological effect, e.g. stress mechanisms, produced from a video game, then there are probably mental effects as well, e.g. increased attentional resources (Skosnik, 2000).

As video game research grows and develops, experiments and studies will need to be carefully planned and rationalized. For example, cognitive training possesses a number of difficulties that need to taken into account when designing such studies, such as maintaining blind recruitment and active control groups (Green & Bavelier, 2012, p. 200-201). Similarly, it is difficult to ensure blind cognitive training studies. The assessment of cognitive training produces a complementarity effect wherein video game experts can test differently due to 'pressure to perform' rather than only cognitive abilities. As with quantum mechanics, the simple act of an observer changes the experiment from a test of cognitive abilities to a 'test for success' with other psychological factors affecting game play (Green & Bavelier, 2012, p. 200-201; Gribbin,

1984). In order to prevent this change, the experimental environment must be carefully controlled. Differences must be carefully monitored, e.g. difficulty level or specific content, while other aspects remain constant, e.g. the 'fun' factor, amount to learn, skill improvement, etc. (Green & Bavelier, 2012, p. 200-201). As methods grow and develop, video game play research will become more successful in collating video game elements and effects; however, the landscape of research will never be completely painted black and white—there will always be some gray. Under a quantum perspective, it is impossible to know and control everything because there is an element of unpredictability that always exists, and it is from this randomness that the fun comes in to play for future research.

A Future for Holistic Gaming

Since video games produce a number of cognitive, psychological, physical, and physiological effects, we can develop and apply these instruments to help facilitate our growth and success. As Skosnik et al. (2000) indicate, video games affect biological systems, which create a psychological effect as well. These results suggest that we can regulate specific processes for productive means, e.g. increase attention for the acquisition of new material or to understand and cope with stress more effectively. As well, this research suggests that other cognitive processes, such as language and memory, might be affected by neurobiological interactions in the brain, and if so, we can attempt to modify and modulate them through purposeful video game design. One way to go about this is trial-and-error testing, i.e. reducing a game to one element and testing that effect. Another method incorporates existing cognitive and physical tests that produce effective

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results with video games and video game play, such as neurofeedback using video game play (Aart et al., 2007). A third way would be to identify target areas, i.e. working-memory or other cognitive domains, for improvement, and then experimentally testing the effectiveness or ineffectiveness of certain video games, i.e. pre-testing a subject with the Working Memory Battery (WOMBAT) or the Woodcock Johnson Tests of Cognitive Abilities, playing video game X for Y time, and then re-testing the subject with the same test (Englund, 2013; Schrank et al., 2001).

Video games have enormous potential to study human growth and development, as training simulators, for various jobs and skills, for education at primary, secondary, and collegiate institutions, in healthcare practices, and so much more. Imagine a world where you could ask someone a question and through his or her answer, you could identify if he or she had a neurological problem, and that the procedure for this process is nothing more than playing a game. This may be a future for video game play. As Griffiths (2002) states, "Videogames can be used as research and/or measurement tools. Furthermore, as research tools, they have great diversity" (p. 47). As assessment tools, video games can measure individual performance over a variety of tasks, which can be changed, standardized, and understood (Griffiths, 2002, p. 47-48). Whether their underlying designs test for reading comprehension or measure neuronal activity in a particular region of the brain, video games have great potential in analyzing human behaviors and characteristics.

Research Instruments

As a research instrument, video games can reveal psychological and physical effects produced by video game play, and they can provide insight into the specific actions, processes, characteristics, and behaviors that cause these effects. In a 2011 Chicago press release, an fMRI analysis found lasting effects of violent video game play on brain regions in young adult men after one week of game play (Wang et al.). After a week without play, these changes diminished; however, these results indicate that violent video games can be detrimental to brain function. If we maintain a holistic approach when dealing with video game play, we can investigate these effects and provide instruction on their implementation, i.e. incorporate less violence in video games while maintaining competition or making the player cognizant of these violent effects. In a 2010 study by Erickson et al., a connection was found between striatal volume, video game acquisition, and video game improvement (p. 2528-2529). The striatum relays input from the cortex to the basal ganglia, which plays a role in the initiation of actions as well as shifting between actions that offer the greatest reward (Gazzaniga, 2009, p. 78-81 & G-2). Subjects revealed an increase in cortical involvement and processing, and this provides a direct link between brain neurology and video game performance; regions in the brain responsible for learning grew in relation to video game play. Once a multitude of video game effects are understood, we can design video games with specific features and for specific purposes, e.g. to identify if feedback in the form of progress and percentages vs. points and grades contributes more towards the player achieving success and accomplishing missions (Dignan, 2011, p. 151-156). Intrinsically, video games are

valuable instruments that allow us to study various changes and developments in human psychology and physiology.

Prevention and Treatment Strategies

Video games provide an effective prevention and treatment strategy for a variety of problems, such as Alzheimer's and ADHD. Cognitive activities, such as playing games, have shown a reduction in the age at onset of Alzheimer's disease (Croisile, 2006; Hertzog et al., 2009, p. 39). These cognitive changes might be influenced by top-down processing, i.e. problem solving and decision making in games, or through bottom-up processing, i.e. learning and remembering rules, pieces, etc., attending to new points of interest, visually and mentally modeling the environment, and so on. Aart et al. (2007) report a number of problems that video game neurofeedback can be applied to as medication; these include alleviating attention and hyperactivity disorders, muscular tonicity recovery for cardiovascular patients, relaxation and meditation to cope with mental stress, and improvements in weight loss and overall fitness. By wielding the intrinsic motivation within video games, video game neurofeedback is effective in training and facilitating patient progress.

Video games serve as effective tools in treating a number of physical problems because they provide results that address the cause as well as the symptoms. For instance, video games provide an effective treatment option to amblyopia patients who have difficulty in visual processing (Astle et al., 2011, p. 569). To help correct these neurological problems, amblyopia patients use a treatment—perceptual learning—that parallels video game play. Similar to perceptual learning, video games provide an

engaging task, immediate feedback with rewards for good performance, and changes in difficulty to challenge the player. Video games intrinsically support the treatment of patients with amblyopia by reconstructing neurological connections and perception mechanisms. Another example of video game treatment involves video game play and virtual reality improvements on arm strength and function after a stroke (Saposnik & Levin, 2011). While the results weren't dramatic, they provided positive evidence of virtual reality gaming as a useful, alternative treatment compared to traditional methods. As Saposnik and Levin (2011) state, "VR and video game applications may be promising strategies to increase the intensity of treatment and to promote motor recovery after stroke" (p. 1385). Video games are a relatively cheap and abundant source for alternative treatment, and they can be customizable for a number of patients and conditions.

Educational Value

Video games are excellent pedagogical tools. As Gentile (2011) reports, video games can provide immediate feedback, motivate players, set specific goals, promote mastery, encourage distributed learning, teach for transfer, adapt themselves to the level of the learner, and provide various other teaching techniques (p. 75). Whether it's promoting long-term learning through distributed practice or increasing a player's mastery of educational content, various elements of game-based learning intrinsically provide challenges that develop their students (Boyan & Sherry, 2011, p. 82-84; Gentile et al., 2011, p. 75-76). Additionally, video games train a variety of mental skills, such as memory recall and problem solving, that can be implemented in a number of ways; for example, a video game that teaches players about the immune system can help solidify

immunology-specific information and can potentially help improve general healthcare practices and behaviors. There have been a number of video game genres, i.e. edutainment, children's software, and learning games, that have entwined interactive gaming and entertainment elements to help K-12 students explore the complex dynamics of microworlds, e.g. Sid Meier's *Civilization*, *SimEarth*, and *Railroad Tycoon* (Ito, 2009, 2-5; Squire, 2003, p. 3-4). More recently, digital game-based learning (DGBL) is being incorporated into classrooms to provide specific content, e.g. teaching history with *Civilization*, to practice specific skills, e.g. engineering and management tasks in *RollerCoaster Tycoon*, and for a number of other purposes (Van Eck, 2006, p. 22-24).

As Boyan and Sherry (2011) reveal, game play increases strategic thinking, cognitive skills, and kinesthetic skills. Through increased hand-eye coordination from kinesthetic skills, video game playing surgeons perform significantly better in laparoscopic surgical skills than non-video game playing surgeons (Boyan & Sherry 2011, p. 84). As well, other surgeons—and the patients they operate on—could benefit from exercising and honing specific surgical skills, e.g. operating the da Vinci Surgical System, neurosurgeons working in the brain, and other disciplines. Through rigorous training on a video game with similar controls and actions, doctors could reduce operation time, patient injuries, and patient fatalities as well as lower overall healthcare costs for the hospital. Additionally, the military and other instructional institutions use video game simulators to drill and practice specific skills, such as training jet pilots (Hays, 1992). A study in 2002 by Morgan et al. investigated the success of simulator-assisted learning vs. video-assisted learning. Both educational methods were equal in

their educational benefit; however, students enjoyed the simulator more, and it provided

an additional element of preparing individuals to face real world problems. By training

and learning real world skills through video games and simulations, we can provide

ourselves with better medical, professional, and cultural care.

Immunis: A Holistic Model

As an example of a holistic game, Immunis provides pedagogical support by

educating players about a real world phenomenon—an immune response. Furthermore, it

has great potential in progressing intelligible and instrumental results for future video

game research and design. Immunis is a real-time strategy game where in a player

experiences and directs an immune response. The player controls several leukocytes, i.e.

white blood cells with unique abilities, and defends the body from an infection. Immunis

was conceived in Simon Tarr's *Serious Games and Digital Ecology* class at the

University of South Carolina. The game started off as a turn-based, chess-style game—

similar to *Disgaea* and *Final Fantasy Tactics*. After the class, the concept gained more

attention and support, and in the Fall of 2010 and Spring of 2011, students Collin-Jamal

Smith, David Corso, and William Hoskins received an Exploration Scholars from the

University of South Carolina's Honors College to develop the Game Design Document as

well as a demo for Immunis. In the Fall of 2011, Particle Systems, LLC. began to develop

Immunis by forming Immunis, LLC.—a collaborative endeavor amongst students at the

University of South Carolina. Since 2011, Immunis has been working with the Columbia

Technology Incubator to develop a full version of the game. The current version of

Immunis pits the player against an onslaught of bacteria. The player moves from the skin,

through a lymph vessel, to a lymph node, and back to the skin through a blood vessel

(Appendix I: Immunis Screenshots). The player controls macrophages, various types of T

and B cells, and other leukocytes. However, this is only the beginning. Future levels,

battles, and versions will depict various immunological functions, which will require the

player to extensively manipulate and maneuver the immune system, e.g. bacterial vs.

viral infections, how smoking affects the lungs, immune activation during a prosthetic

implant, vaccination, acne, HIV, and the list goes on.

Immunis is designed to educate and entertain teachers, students, and gamers. The

game world reflects a real event in our world, i.e. an immune response. In order to

combat the infection, the player needs to recruit more white blood cells to fight—exactly

as the immune system does. As Boyan and Sherry state, "If designers were to place

formal educational content (e.g. cell physiology rules and affordances) in a game world

as the challenge, players would be more likely to experience flow and master the content"

(2011, p. 82). Immunis layers these real and natural processes of the immune system with

the intrinsic, educational elements of video games and video game play to challenge

players into solving cognitive problems. Through self-learning and purposeful play,

Immunis is designed to teach players by developing meaning behind their actions within

the game. Immunis motivates, provides feedback, and develops problem solving and

decision-making skills—all of which are responsible for deliberate learning. The game

teaches players the dynamics and processes of the immune system rather than focus on

names and terminology; however, if the player chooses, he or she can delve further into

the educational experience by visiting Immunis' website and Immunary—an in-game log

of terms and definitions. To provide a more natural feel, Immunis does not posses a user interface like traditional games; so, the player simply interacts with the microenvironment according to realistic events and processes, such as phagocytosis, chemical gradients, and antigen recognition.

As a holistic game, Immunis will accomplish three goals:

1. Immunis will provide educational value in the way of pedagogical support for immunology specific information.

2. Immunis will help prevent a number of illnesses, e.g. lung cancer, by making the player cognizant of how these illnesses arise and the damage they cause.

3. Immunis will assess cognitive growth and development.

The first two goals will occur by playing the game, and if additional instruction and guidance is provided, such as a teacher or parental support, then they have a higher chance of being realized sooner. The third goal will require extensive research and experimentation with a variety of tests and procedures. Ultimately, Immunis is designed to help students learn academic information, specifically immunology, and it will work to facilitate student learning and development in every conceivable way.

For the Kids

People enjoy playing more than working, and they will be found engaging in activities more related to a game or leisurely endeavor than most school or job-related work (Displacement hypothesis, Gentile et al., 2012, p. 63). Video games are an example of this engagement. Video games attract people for a number of reasons, and we should utilize that lure (Attraction hypothesis, Gentile et al., 2012, p. 63). We live in the Digital

Age, and our education needs to reflect that (Excitement hypothesis, Gentile et al., 2012, p. 63; Rushkoff, 2010). It is time we change the current educational paradigm to be more engaging, more enjoyable, and more effective. The most efficacious way to instill positive change is through holistic gaming, and in order to instill holistic gaming and make it successful, the world requires gamers. Gamers are needed to design the games. Gamers are needed to play the games. Most importantly, gamers are needed for their natural abilities. Gamers are experts in solving puzzles, problems, and the like. It takes ~10,000 hours to become an expert in something, and if American students were to play video games instead of attending regular class from 5th to 12th grade, then they would be experts at playing video games by age 18 (McGonigal, 2011, p. 266-267). In other words, these students would be expert problem solvers and decision makers by the end of high school, and they would be adept at handling and solving challenges. Our world and existence are characterized by the fight to survive. From the micro to the macro and everywhere in between, we experience problems on a day-to-day basis. By training gamers, we create a force that is capable of tackling and solving humanity's greatest challenges.

Through their nature, gamers can possess increased cognitive abilities that allow them to navigate the world more efficiently; that is to say, their training provides them with enhanced perceptional skills, the ability to attend to points of stimuli quicker and more frequently, stronger memories, more effective problem-solving stratagems, and various cognitive improvements. Gamers voluntarily develop this potential through consistently intense, cognitive training. They acquire a variety of knowledge and skills

that allow them to move into any field, subject, or discipline that suits their specific

interest(s). For example, Child A understands and solves logic problems as well as holds

an exceptional memory, and so he or she becomes well suited as a lawyer. Child B excels

at kinesthetic skills in addition to possessing excellent attentional resources, and his or

her "life's calling" is to operate a da Vinci Surgical System. Perhaps Child C doesn't fit

into one area perfectly, and so he or she assumes a life of multiple jobs and skills.

Ultimately, all of these Children have played a variety of video games over a long period

of time, which has made them experts in solving problems and puzzles as well as helping

them find their niche and succeed in life.

Story of the Horseshoe

The Story of the Horseshoe (SotH) is a theoretical example of a holistic game.

The SotH was conceived in Heidi Rae Cooley and Duncan Buell's *Gaming the*

Humanities class, alongside and apart from the critical interactive *Ghosts of the*

Horseshoe. SotH is designed to accomplish two tasks. First, the SotH is an attempt to

'game,' i.e. manipulate, the humanities (Game, n.d.). The humanities are various

disciplines, e.g. literature and philosophy, that study the human condition (Humanity,

n.d.). These academic disciplines study social, cultural, and personal experiences of

human beings, and they use analytical, critical, and speculative philosophy to analyze the

human condition. The idea is to 'game' these disciplines and examine the human

condition through a game, i.e. the SotH, which consists of various methods and styles, i.e.

games, that test human rationality, situational perspective, cognitive abilities, and

educational understanding via content and context.

Second, the game is a model—the beta version—for a concept: the creation of a complete systems learning game. The SotH is designed to inform and train people about the natural world through a virtual world. The SotH starts with the player walking onto the Horseshoe, and as the player walks around, he or she sees objects or 'stories' to interact with and play through. Each object or story, e.g. an oak tree, is unique in its gameplay, i.e. how the player interacts with the environment and what the player experiences and learns. Yet, it combines these games and stories with other objects and stories on the Horseshoe to create the experience of "life" on the Horseshoe. Examples of games and stories include: foraging as ants, running through trees as a squirrel, hunting as a hawk, constructing buildings during the late 18th and early 19th centuries as slaves, growing as a plant or tree, individual stories from the bricks with names and dates on them, attending class, listening to music on an iPod, throwing a Frisbee, special events, and of course, human interactions, which all contribute to the player's reflection on humanity and life. In essence, the player works through personal challenges in the form of various games, which reveal him or her as part of greater ecology, history, and society.

To understand the SotH in another perspective, numerous mini-games create a larger, more involved game. These mini-games are distinctly different, but they intertwine to create a unified experience, e.g. *Mario Party*. As Green and Bavelier (2012) point out, "variety is an essential characteristic of training regimens that lead to more general learning" (p. 199), and the SotH will contain a lot of variety regarding content and game play styles. Gamers can play individual games, cooperative games, and competitive games. Additionally, the player's success in the game reflects the game

experience, i.e. the better he or she does in the game world, the more the game world opens up to him or her with new and harder games, stories, and the like. The Story of the Horseshoe is intended to reflect the human condition: what we go through, how we interact with our world, our personal experiences, decisions, and the like. It educates. It entertains. It's an interactive, online game that connects players in various single and multiplayer games. It will allow for the development, engineering, designing, and marketing of ideas, technology, information, and education. For example, the Story of the Horseshoe, which would be engineered, tested, and played by USC students, could be given for free to students physically located on USC's campus through Cloud technology, and once outside the cloud, it would have to be purchased to play. This style and type of video game play will exist as a new form of education to supplement and enhance the learning of class material, natural events, processes, phenomena, and the like. However, the Story of the Horseshoe is the beta. The end game—Particle—is the alpha.

Particle

One Game to rule them all,

One Game to find them,

One Game to bring them all,

And in the darkness, mind them.

Particle is the complete systems learning game, i.e. a video game that educates the player about every system, process, and phenomenon that occurs in our natural world. While it only exists as a hypothetical model, its potential is limitless. The game is based off reality, and it encompasses various components, mechanisms, and aspects of the

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natural world, e.g. biological, chemical, historical, societal, and political systems. The premise: the player is a "god" particle that exists. He or she interacts and flows through anything and everything in the world. The "god" particle controls and manipulates the environment, objects, systems, etc., but still abides by the laws of the natural world. The player learns these laws and how the world works through the game play. For example, the player starts off as an apple tree—growing from a seed to a fruitful tree as a puzzle game. Then, the game shifts to a person plucking an apple and eating it, wherein the "god" particle, i.e. the player, travels with the apple to the human consuming it. The player then learns how it gets broken down and converted into energy through an action, racing game. Finally, the game changes to a real-time strategy game where the player controls the immune system and fights off an infection caused by the apple, similar to Immunis.

Particle combines video game play styles, elements, and characteristics with real phenomena that occur every day. Any event, experience, or process that occurs in the natural world is subject to be a game, e.g. a plant performing photosynthesis, an immune reaction in the body, a sound wave as it passes through the air, wind currents, windmills, corporation management, world affairs, relationships, epidemics, and exponentially more; any topic—broad or specific—can be used by Particle to educate people, such as history, chemistry, nutrition and food, sports, music, natural disasters, marine biomes, state law, and the list goes on. If it can happen in the real world, it can happen in Particle, and gamers learn by playing through each phenomenon and process.

Particle will immerse players into the experience through both software, i.e. the game play, and hardware, i.e. glove controllers. The gloves would contain buttons and joysticks to allow the "controller" to remain a part of the game. Additionally, there would be a motion sensor control that allows players to manipulate and control the environment —literally with their hands. By moving the gloves in a particular fashion, an action would correspond in the game, such as picking up objects, cranking a wheel, drawing a line with a finger, writing sentences with a stylus, flying around, hunting down prey, building elaborate systems, and the possibilities go on. As well, the game would connect players worldwide, and gamers could play with people in the same room or a continent away.

Under a holistic perspective, Particle redefines education. Through the systematic and scientific analysis of the game and its effects, Particle provides instrumental and intelligible results that work on various levels—physical, psychological, educational, meta-cognitive, and many more. Gamers will learn from the game, i.e. educational value. Scientists will learn from the gamers, i.e. research tools. Designers will learn form the scientists, i.e. future games that facilitate research, education, and prevention/treatment stratagems. And humanity will learn from the collective. We have the ability to create games that entertain and educate. We need to provide ourselves with the best opportunities for success in this world, and holistic gaming serves as a valuable catalyst for that change.

Conclusion

Games and play have an involved and intimate history. Over the last 60 years, their prodigy child—video games—has had a massive impact on human society and culture. One area in particular—education—has teamed up with video games and video game play to improve the quality of the human experience. A new addition to the team—holistic gaming—works to understand this relationship between humans, video games, and video play. Holistic gaming provides intelligible and instrumental results. Through experimental analysis, researchers can measure and identify the affect video game elements have on physical and psychological processes. From these findings, game engineers can design innovative experiences that address a plethora of problems, phenomena, and people.

Video games and video game play have quantifiable effects. Video games produce physical and psychological improvements as well as impairments. These effects have a reciprocal relationship, and they are products of neurobiological processes. As long as we approach video games in a holistic sense, we can design them to make us smarter and stronger while minimizing negative effects. The cognitive training, physical affordances, and learning opportunities created by video games are priceless, and they can be developed to improve cognitive resources, physiological processes, and educational knowledge.

Video games can help treat physical problems brought about by accidents and illnesses as well as to prevent the onset of neurological disorders, impairments, and behaviors. Additionally, they can be designed and tailored for a specific circumstance,

condition, or individual, and these differences can address a range of characteristics, experiences, and problems. Video games serve as useful tools to educate and train medical and military professionals, and future video games can serve as powerful pedagogical tools to teach a process, phenomenon, or any particular interest. Through analytical and pragmatic study, purposeful video game design can produce efficacious results.

Holistic gaming can improve the quality of this world. There are many ways holistic gaming will develop and grow, and the most fruitful endeavor will involve a complete systems learning game. By increasing the quality and quantity of the educational system, video games will change humanity and facilitate its development in a number of ways. Holistic gaming serves as a valuable stimulus for that change.

My Beautiful Dark Twisted Fantasy

"Hey teacher teacher, tell me

How do you respond to students,

And refresh the page,

And restart the memory?

Respark the soul,

And rebuild the energy?

We stopped the ignorance,

We killed the enemy.

Sorry for the night demons that still visit me."

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Appendix I: Immunis Screenshots

Image 1 – Immunis 0.0 Title Screen

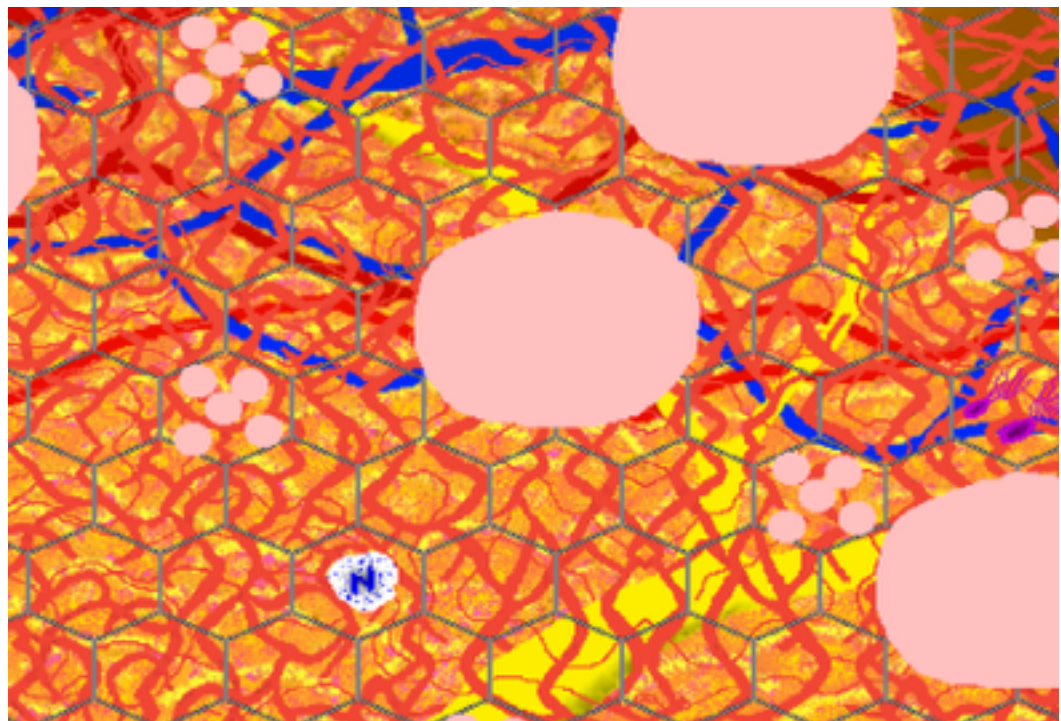Image 2 – Immunis 0.0 Gameplay I
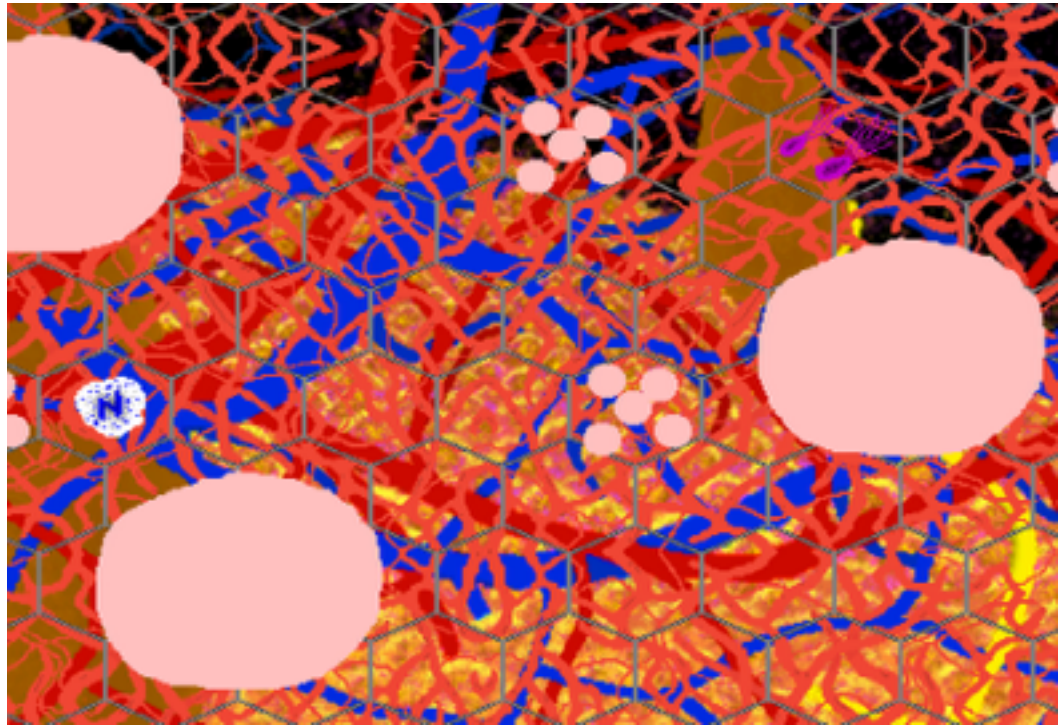
Image 3 – Immunis 0.0 Gameplay II
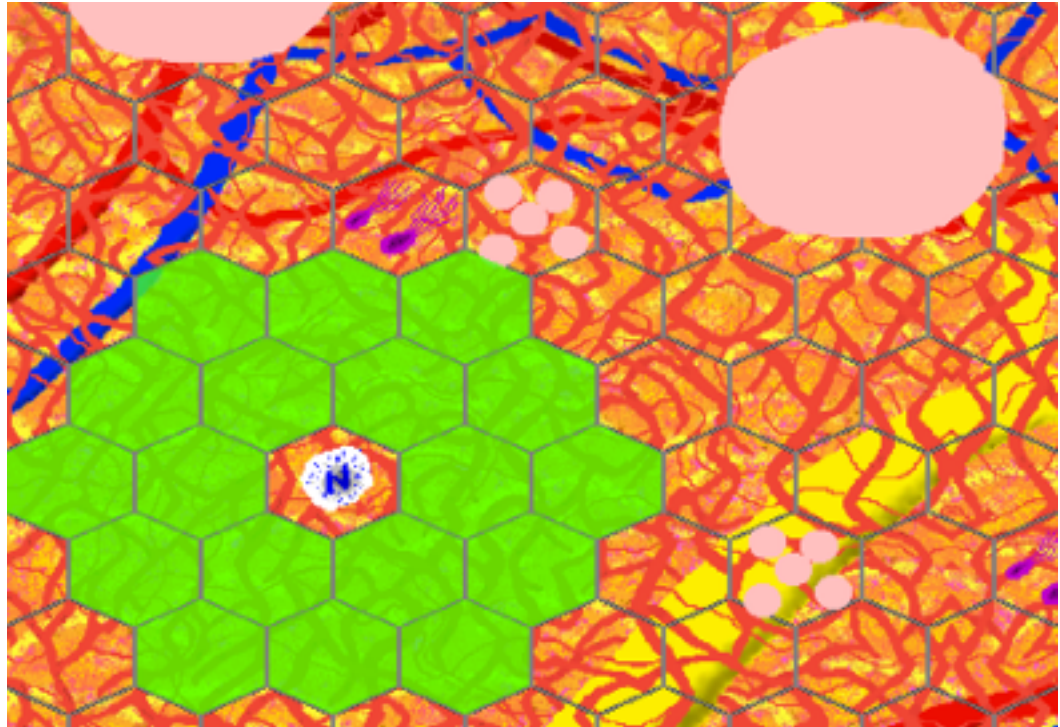

Image 4 – Immunis 0.0 Gameplay III

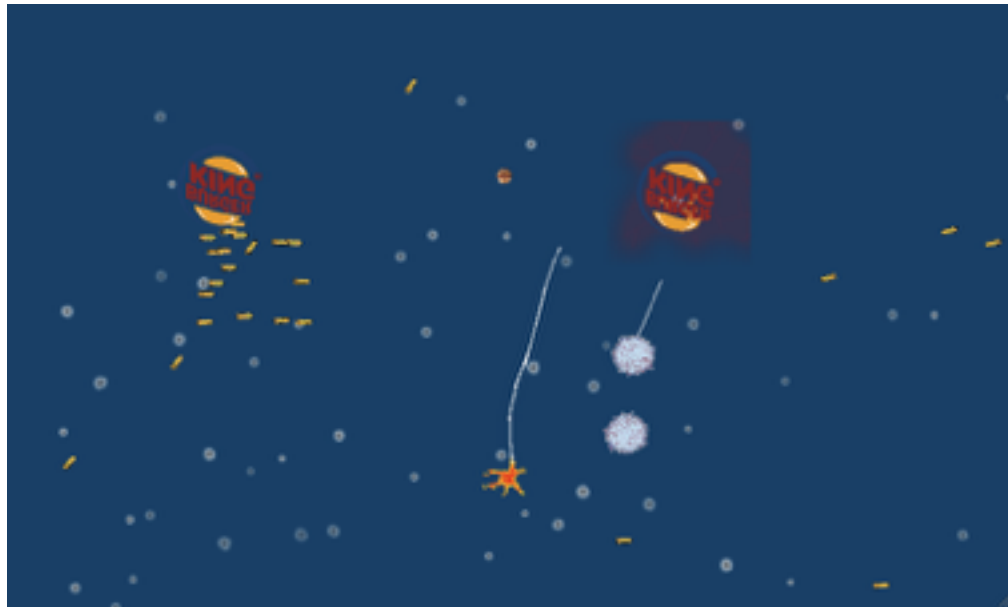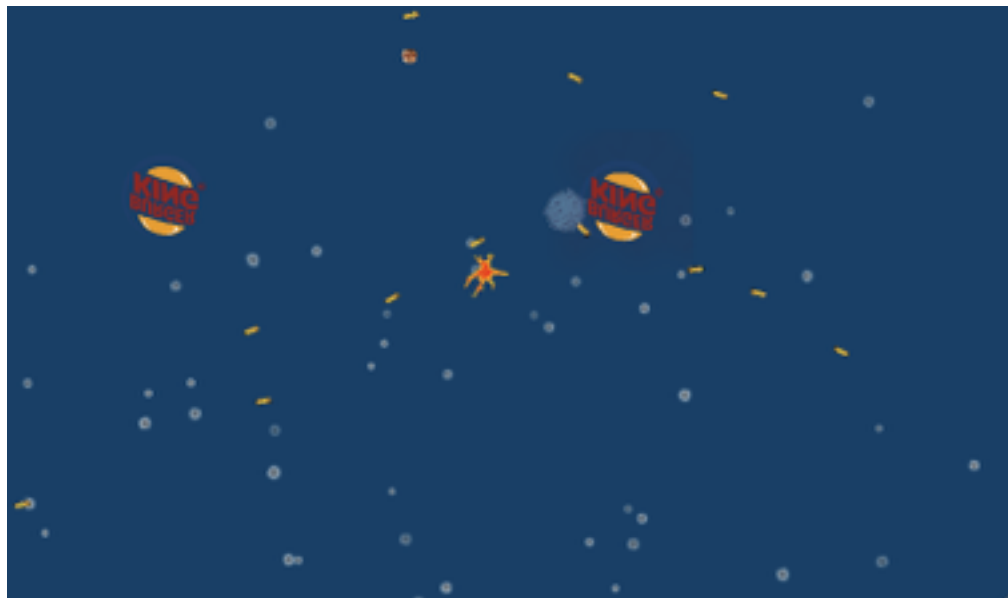Image 4 – Immunis 1.0 Gameplay I

Image 5 – Immunis 1.0 Gameplay II

Image 6 – Immunis 1.0 Gameplay III

Image 7 – Immunis 1.0 Gameplay IV