THE EVOLUTIONARY PSYCHOLOGY OF VIDEO GAMES:
THE DIGITAL GAME AS SUPERNORMAL STIMULUS

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Abstract

This paper explores how supernormal stimuli may have contributed to the remarkable popularity of several types of video games: first-person shooters (FPSs), massively multiplayer online role-playing games (MMORPGs), and *Minecraft*. Human culture, technology, and environments have advanced so rapidly in the last 10,000 years that the brains of *Homo sapiens* have not been able to keep up. Humans survive in the modern world, but still retain a mind stuck in the Pleistocene. Supercharged representations of ancient stimuli, which appealed to prehistoric human ancestors in the environment of evolutionary adaptedness (EEA), appear in many video games and may be hyper-stimulating humans' adaptive instincts. These supernormal stimuli appear to correlate with the remarkably engaging, pleasurable, and satisfying experiences human players derive from playing these games. This paper goes on to propose that greater recognition of the potential of supernormal stimuli, and experimentation with the creation of virtual worlds stand to improve not only digital games, but the way in which humans live, work, and play in the real world.

Keywords: supernormal stimuli, evolutionary psychology, video games, digital games, mismatch theory, environment of evolutionary adaptedness, EEA, first-person shooters, FPS, massively multiplayer online role-playing games, MMORPG, *Minecraft*

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Introduction

Over the last half-century, video game worlds have evolved from two-dimensional blips of light, into persistent fully-rendered three-dimensional alternate realities inhabited by millions of players. Prior to the late 1950s, electronic games were limited to versions of Tic-Tac-Toe, Checkers, and Chess, built principally for research purposes (Donovan, 2010). A leap forward was made in 1958, when Willy Higinbotham, physicist and head of instrumentation design at Brookhaven National Laboratories, created a basic tennis simulation which he dubbed, *Tennis for Two*. Composed of an oscilloscope, a small computer, and several basic push buttons, the game was immediately popular, and visitors to the lab lined up for their chance to play (Demaria & Wilson, 2004). However, it was not until the Spring of 1962 that the first original electronic game was completed by Steve Russell and the Tech Model Railroad Club at the Massachusetts Institute of Technology. Programmed on MIT's $120,000 PDP-1, *Spacewar!* let players engage each other in outer space combat, as two spaceships maneuvered and fired torpedoes at one another while avoiding being pulled into a black hole (Donovan, 2010).

In the intervening half-century, this digital medium has come of age, exploding in number, variety, and form. In the past few years, the widespread penetration of the Nintendo Wii, Facebook, and Apple's iPhone & iPad has done a great deal to place video games into mainstream hands. It is now difficult to catch a subway or run an errand without spotting someone thoroughly absorbed by a video

game. As developers have refined their craft, games have become steadily more engrossing, with some of today's most successful titles captivating their players' attention over years of regular play. In the process, video games appear to have developed a unique relationship with the human species.

Through years of experimentation and iteration, game designers have refined how their games attract the interest of their players, transforming that engagement into massive commercial success. The past decades have seen designers sculpt gameplay experiences which closely resemble a particular collection of environmental conditions that contributed to the evolution of the modern human species. This resemblance to the ancient environment in which our early ancestors lived, the Environment of Evolutionary Adaptedness (or EEA), has resulted in digital games presenting stimuli which appeal to some of the human race's oldest adaptive instincts.

Humans are better adapted to the conditions of the world of our ancient ancestors than to today's modern world, and thus find it particularly appealing to interact with environments similar to that of the EEA (Barrett, 2010). Video games do more than simulate the prehistoric world, but in fact depict environments that offer improvements over the conditions of the distant past, targeted to make them even more appealing to our prehistoric minds. These hyper-attractive features are known as supernormal stimuli, and their presence in games appears to correlate with the source of some of the most successful video games' popularity.

After providing some background on the EEA, supernormal stimuli, and mismatch theory, this paper will examine how the design of several types of today's most popular video games appeal to our species ancient evolutionary adaptations. It will be shown how the conditions of the EEA have been refined into supernormal stimuli, and explore how these facets of games may be providing modern players with irresistible, rewarding, and challenging gameplay experiences. It is hoped that a more complete and widespread understanding of this phenomena will lead to further investigation of this correlation, and will inspire the creation of new video game genres and lead to innovative ways in which video games can be used to improve the human experience.

The Environment of Evolutionary Adaptedness (EEA)

The human Environment of Evolutionary Adaptedness (EEA) is an atemporal amalgam of the environmental conditions responsible for each of the adaptations which, together, comprise a modern human being. Tooby & Cosmides describe the EEA more specifically as the cumulative result of numerous environmental selection pressures which, over time, result in the appearance of a new adaptation within a given species (Tooby & Cosmides, 1992). It is important to note, however, that this process operates at the adaptation level, meaning that each individual trait that comprises a complete organism is possessed of its own individual EEA. As such, it is impossible to specify the precise Environment of Evolutionary Adaptedness for an entire organism, as each element that contributes to the being has developed out of its own evolutionary lineage, and been honed via its own set of selection pressures (Buss, 2004).

At its most broad, the human EEA comprises all of the accumulated influences over tens or hundreds of millions of years that contributed to the modern human form (Foley, 1996). For example, the set of selection pressures responsible for the development of bipedal locomotion (its EEA) stretch back over 4.4 million years. Meanwhile, it took hundreds of millions of years for the many components of the eye to be teased out by selection pressures. Thus, while both of these adaptations are evident in modern humans, their individual EEAs cover vastly different periods of time and occurred across a wide range of different physical locations (Buss, 2004).

In practice, the human EEA usually refers to the last period in which significant adaptations took place in humans' evolutionary history (Foley, 1996). This roughly corresponds with the geologic time period known as the Pleistocene epoch (~2.588 million years ago - 10,000 years ago), (Lourens, Holgen, Shackleton, Laskar, & Wilson, 2004), and is referred to by prehistorians as the Paleolithic, or Stone Age (McClellan & Dorn, 2006). It was at this point that members of the *Homo habilis* species began to move out onto African savannahs from the riparian woodlands (Shepard, 1998). Modern humans (*Homo sapiens sapiens*) first appeared in Africa 200,000 - 100,000 years ago (Chazan, 2011). By 40,000 years ago, they had migrated into Asia, Australia, and Europe, and after 30,000 years ago, our species was the sole member of the *Homo* genus inhabiting earth. The Paleolithic ends after 10,000 years ago, as humans began to leave the hunter-gatherer lifestyle and take up forms of agriculture (Mithen, 1996).

The Pleistocene encompasses the latest part of the Late Cenozoic Ice Age. Glacial formation had spread from the polar regions, and taken hold of large portions of the northern hemisphere. The large amount of water bound up in the frozen glaciers resulted in a decrease in sea level. Tropical regions became drier, transforming large areas of the South American and African rainforests into grasslands (Roberts, 1984). During the Middle and Upper Pleistocene, Earth underwent a series of climatic swings, oscillating between cold glacial periods, and warm interglacial periods. During interglacial periods, melting ice sheets receded,

revealing greater areas of land and raising sea levels. Plants, trees, and animals

expanded into the newly uncovered areas. During glacial periods, ice sheets refroze

and expanded across high altitudes, recovering land, and lowering sea levels. The

climate at lower altitudes became drier, with expanding grasslands and, in some areas,

drought-like conditions returning (Mithen, 1996). This unstable picture of the climate

was the case for the last 1.8 million years, with the last 700,000 years alone

experiencing eight full cycles from glacial to interglacial (Chazan, 2011). This

cyclical climate change likely helped shape the direction of human evolution. The

varying environmental conditions would have made adaptability a significant

advantage. Overcoming the repeated environmental stresses gave early man a leg up

over other animals, and made it possible for mankind to eventually colonize and

thrive in a variety of climates around the globe (Roberts, 1984).

 Throughout these environmental shifts, human ancestors lived as mobile

hunter-gatherers in genetically related social groups, with small populations and low

reproductive rates, using simple tools and minimal technology to subsist on naturally

occurring resources, possessing little material culture, and suffering from low rates of

infection and communicable disease. These ways of life arose as a product of

ancestral hominids' evolutionary heritage interacting with the Earth's erratic climate

swings (Foley, 1996). The hunter-gatherer way of life persisted as perhaps the most

successful behavioral adaptation ever achieved by mankind, and was adopted in a

variety of forms by human ancestors for as long as 2 million years (Lee & DeVore, 1968). The principal concerns of these ancient humans would likely have included:

> "giving birth, winning social support from band members, remembering the locations of   edible plants, hitting game animals with projectiles, …, recognizing emotional   expressions, protecting family members, maintaining mating relationships, …, assessing   the character of self and others, causing impregnation, acquiring language, maintaining   friendships, thwarting antagonists" (Cosmides & Tooby, 2003).

Any adaptation which helped to develop an individual's ability to accomplish these goals could be expected to be selected for, and activities which allowed individuals to develop these skills would likely have been attractive and enjoyable to ancient humans.

Anatomically modern humans enjoyed the Paleolithic lifestyle in a stabilized environment for about 30,000 years at the end of the Pleistocene. They existed comfortably with low levels of work; consumed many different types of foods, including significant quantities of meat; were clothed in animal fur and hides; built shelters; hunted with atlatls and bows and arrows, and controlled fire for light, warmth, and animal control, and domesticated dogs (McClellan & Dorn, 2006). It was only in the last 12,000-10,000 years of humanity's journey that they turned instead to agriculture for sustenance, with this point in time marking the end of both the geological Pleistocene epoch and the historical Paleolithic era.

Mismatch Theory & Supernormal Stimuli

Two theoretical concepts are of particular import to understanding how video games are acting upon humanity in the modern world. These are mismatch theory and supernormal stimuli. The first, mismatch theory, articulates the lag inherent in the evolutionary process as organisms adapt to environments in flux. In response to the particular conditions of a given environment, natural selection acts upon a species over long periods of time, altering them to become increasingly well-adapted to survive in that environment. However, if an environment changes rapidly, organisms may remain better adapted to the environment's prior state, and become mismatched to the conditions of their present environment. If this mismatch is too severe, that species may be unable to survive and could become extinct, however, it is not uncommon for organisms to experience some degree of mismatch as they compete for survival in changing environments.

Humans, while far from extinct, are not ideally adapted for the modern world. Our species retains many traits and instincts which are better adapted for the human Environment of Evolutionary Adaptedness. The genetic evidence for hominids indicates that our genes experience a slow rate of change, somewhere on the order of a few gene changes every 100,000 years (Shepard, 1998). Human environments, meanwhile, began to change very rapidly after the rise of agriculture around 10,000 years ago (Barrett, 2007). With the ability to cultivate their own food, ancient humans were able to settle in one area for extended periods of time, resulting in the

formation of permanent settlements, with cities, society, and modern civilization not

far behind. Most left behind the hunter-gatherer lifestyles of the last few million

years, and mankind set to radically altering the environment around himself to cater to

his needs. These sweeping environmental changes happened quickly enough to

outpace the response from human evolution. The modern human, a product of the

Pleistocene, has seen little evolutionary change in the last 10,000 years, beyond a few

gene shifts related to resistance to certain diseases, food allergies, and other minor

location-based selection pressures (Shepard, 1998). As a result, humans are actually

quite mismatched to their current man-made environment, with the modern world's

high-density, urban, industrial lifestyle representing a drastic shift from our species'

ancient past (Foley, 1996). *Homo sapiens* evolved to live in the Pleistocene

environment of our ancestors.

The second concept to consider is that of supernormal stimuli. Supernormal

stimuli are artificial versions of objects, events, or activities which appeal to an

organism's adaptive instincts more than the natural versions of those stimuli for which

that organism's instincts were actually selected (Barrett, 2007). The term was coined

by ethologist Niko Tinbergen as a result of his investigations into the begging and

feeding behavior of herring gull chicks. Upon teasing out precisely which aspects of

the parent gull's beak and head elicited the chick's begging response, Tinbergen and

his students were able to construct artificial dummy stimuli which exaggerated these

characteristics and elicited a greater response than the naturally-occurring stimuli. In

the case of the gulls, the chicks peck at a red spot on the underside of the bird's beak

to start the parent gull feeding. Tinbergen deduced that the most attractive

characteristics to the chicks' instincts were the redness, contrast and thinness of the

stimuli. By exaggerating these, he was able to craft an entirely abstract supernormal

stimulus, a pointed rod, painted red, with three high-contrast white stripes painted at

the end. This rod elicited the highest level of reaction from the chicks, more so than

other, more realistically enhanced dummies, and far more than an actual gull's head

(Tinbergen & Perdeck, 1950).

Tinbergen demonstrated this principle in a number of other animal species,

including stickleback fish, which instinctually attack conspecific males with bright

red underbellies, demonstrating that they could be induced to attack models shaped

nothing like fish, so long as their undersides were painted red. One of his most

studied supernormal stimuli dealt with avian egg preference. Birds were found to

prefer large eggs with exaggerated versions of their own species eggs' typical

markings. Tinbergen showed that birds would prefer to attempt to incubate giant

artificial eggs, even eggs that were so much larger than the birds that supposedly laid

it, that they would be unable to perch atop the egg without sliding off (Barrett, 2007).

Humans, masters of reshaping the world around them, have become expert

manufacturers of supernormal stimuli. Today, supernormal stimuli are prevalent in

the industrialized world, with perhaps the simplest example of a supernormal stimulus

being the common potato chip. In the human EEA, salty and fatty foods were

uncommon and difficult to acquire, with the best source being other animals. When

these foods were available, humans with genes spurring them to eat as much of these

foods as possible were more likely to receive more (or any) of these resources, and

were more likely to be able to survive and increase their reproductive success. By

leaving more offspring with the instinct to devour salty and fatty foods, the genes for

this behavior became more prevalent in the human population, to the point where the

vast majority of modern humans enjoy the taste of salty and fatty foods, such as

potato chips. The invention of this popular snack food represents a supernormal

stimulus, in that it appeals directly to an ancient instinct, which in our ancestors'

ancient environment played a large role in helping our species survive. However,

potato chips also reveal how humans are mismatched to their current environment.

An insatiable appetite for salty and fatty foods was useful when such foods

were scarce, and a hearty appetite ensured that an individual could maximize their

share when such foods were available. In the modern world, salty and fatty foods are

cheap and easy to obtain, but our instincts remain the same, unfortunately leading

humans to consume far more of these foods than they need and resulting in an

epidemic of related health issues. What was once an evolutionary advantage has

become a deficit. Our environment has changed, but our species has remained the

same - a highly evolved hunter-gatherer in the modern world.

Humans' mismatched appetite for fatty foods serves to support a massive food

industry that has sprung up to create and sell products appealing to our ancient

instincts. In this regard, supernormal stimuli are not being used to pursue the most

prosocial goals. However, this paper seeks to explore how video game design has

naturally gravitated towards the use of supernormal stimuli to make great games.

While the powerful influence of supernormal stimuli can be exploited, it is the

author's hope that a better understanding of how they function will allow game

designers to use these phenomena as tools with which to first improve virtual worlds,

and then, perhaps, to help better our rapidly changing modern world.

First-Person Shooters: Man the Space Marine

The First-Person Shooter (FPS) has become more than just one of today's most popular video game genres; they have become one of the world's most popular forms of entertainment. *Call of Duty: Modern Warfare 3* (2011), a modern-day military-themed FPS which was released last November, passed $1 billion dollars in sales in just 16 days, breaking sales records. In comparison, *Avatar*, the highest grossing movie of all time took 17 days to reach the same mark (Bilton, 2011). Shooting projectiles in one form or another has been a popular game scenario since the earliest video games. *Spacewar!*, the first video game that was not based on an existing non-digital game, involved trying to shoot your opponent's spaceship with a torpedo, and many early arcade games utilized projectile motion to great effect. For example, consider *Pong* (1972), *Space Invaders* (1978), and *Asteroids* (1979).

Doom (1993) popularized and fully established the *First-Person* Shooter as a genre, inserting the player into the skin of their avatar by placing the viewpoint of the player just behind their virtual representation's eyes. Typically this view includes a depiction of the barrel of the player's weapon, often arranged to appear as if it were being held by the player; a reticule providing feedback on where the weapon is being aimed in the game world; and a heads-up display (HUD) overlaying relevant game information onto the player's view such as amounts of health, ammunition, or time remaining. The player controls their movement and aim with a game controller or keyboard and mouse. At its most basic, the object of FPS games is to engage other

players or computer-controlled enemies and hit them with your projectile before they

are able do the same to you. Popular modern incarnations of this type of game

include *Halo* (2001) (players battle aliens for the survival of the human race as a

futuristic space marine), *Counter-Strike* (1999) (players step into the role of either a

group of terrorists seeking to plant and detonate an explosive, or the team of counter-

terrorist officers sent to stop them), *Left 4 Dead* (2008) (four players must work

together to survive onslaughts of zombies). Today's newest FPSs feature almost

photo-realistic graphics, realistic physics simulations, and cooperative online

multiplayer experiences, while calling on individuals or small teams of players to

successfully hunt and kill other hunter teams, cooperate with their teammates, hit

moving targets with projectiles, and communicate effectively in order to claim victory

over their opponents. Many of these stimuli are quite similar to those encountered by

our ancient human ancestors while hunting wild game hundreds of thousands of years

ago.

   Hunting behavior has been a part of our genetic legacy for millions of years.

Chimpanzees, close genetic relatives to mankind, hunt without tools, relying on

cooperation to trap and kill their prey. The chimpanzees of the Tai Forest utilize a

particular strategy to successfully hunt small monkeys. Some of the chimps chase the

monkeys up a tree, while other members of the group "camp" in a favorable location

and pounce on monkeys as they try to flee. This advanced cooperative behavior is

notable, and it seems likely that early hominids would have used similar strategies to

hunt prey. It should also be noted that the distribution of hunted meat from

chimpanzee kills plays a large in determining the dominance hierarchy within the

group, and is a key factor is setting the social structure of the group (Chazan, 2011).

One particularly important facet of human hunting is its use of projectile

weapons. By the Upper Paleolithic, humans had developed an advanced arsenal of

weapons including the bow and arrow and the atlatl (spearthrower) (McClellan &

Dorn, 2006). The Sohöningen gives evidence of wooden spears being u sed as

projectiles as early as 400,000 years ago, but as wood is only very rarely preserved in

the archaeological record, it is likely that wooden weapons and projectiles were being

produced earlier than this point, and possibly being used as far back as millions of

years ago (Mithen, 1996). Indeed, throughout the archaeological record,

advancements in the size, symmetry, and craftsmanship of stone facilitated its use in

the manufacture of increasingly efficient and accurate projectiles (Washburn &

Lancaster, 1968). Modern hunter-gatherers have continued to use projectile weapons,

in varieties including harpoons, spears, bows and arrows, and atlatls (Laughlin, 1968).

Another core feature of human hunting behavior, cooperation, is theorized to

have played a large role in human hunting during the EEA. A 400,000 year-old site at

Sohöningen, Germany contains the remains of approximately 22 horses along with

more than a half dozen wooden throwing spears, and is believed to be the oldest

archaeological evidence of group hunting in our ancient ancestors (Wrangham, 2009).

Hunting of other larger and more dangerous ancient creatures such as mastodons,

mammoths, and cave bears is difficult to envision without highly cooperative and

carefully coordinated organization of prehistoric hunting parties, particularly in the

earliest periods, when hunters would have been forced to utilize significantly more

primitive weapons. Cooperative hunting is also a feature of modern hunter-gatherers,

requiring significant communication, planning, knowledge of animal behavior, and

skill (Washburn & Lancaster, 1968). For example, the Hadza of North Tanganyika

coordinate carefully orchestrated night raids on troops of slumbering baboons (Isaac,

1968).

    The relationship among status, prestige, and human hunting should also be

considered. The subsistence economy of Paleolithic human ancestors resulted in little

surplus food, and without the institutions required to store, tax, or otherwise control

large amounts of resources, these societies did not experience significant social

ranking or dominance hierarchies from accumulated wealth or possessions (McClellan

& Dorn, 2006) . Rather, individuals likely built reputations on the backs of their

personal accomplishments, such as success in hunting (Renfrew, 2007). This is

evidenced in modern hunter-gatherer populations where superior hunters experience

significantly higher levels of reproductive success. They have more wives and

children, and their wives are better able to bring pregnancies to term, and able to

become pregnant again sooner, while children are also healthier, and thus more likely

to survive and reproduce themselves (Laughlin, 1968). While food is still believed to

be shared equally in these groups, it seems likely that the strong correlation between

skilled hunters and increased reproductive success derives from some combination of preferential treatment of good hunters and their families, their higher social status, and hunters' access to higher quality mates, as well as the possibility of some additional provisioning from small game and honey, which do not tend to be widely shared (Smith, 2004).

These effects represent strong selection pressures for hunting and projectile weapon skills which have been acting upon our human ancestors for hundreds of thousands or even millions of years. It is perhaps not surprising then that a bridge has been built between hunting and human psychology. Hunting behaviors are in part motivated by the immediate pleasure it gives to the (typically male) hunter. The skills needed are innately enjoyable to learn, satisfying, and are socially rewarded in most cultures. It has been the practice in the more recent past for royalty to maintain large tracts of land to facilitate their sport hunting, while today the United States spends significant resources and energy to enable to hunting pastimes of many of its citizens. In modern hunter-gatherer groups, the skills needed to use projectile weapons and hunt successfully dominate much of the time and attention of the male youth, and it is particularly notable that these lessons are often reinforced by means of practice games and play (Washburn & Lancaster, 1968).

Play-like behavior has been observed in all mammals, as well as many bird species, and it seems that play becomes more frequent, complex, and organized in long-lived organisms with extended juvenile periods. The common argument for the

evolutionary significance of play behavior is as a means by which young members of

a species can develop and practice physical and cognitive skills which will allow

them to better survive and reproduce (McGhee, 1979). Humans, with their neotenous

cognitive flexibility, demonstrate play behavior, and engage in formal games

(including sports, board games, and video games) throughout their lives. While some

video games can be seen as providing practice and conferring a training benefit

applicable to modern behaviors (racing games, for example have been shown to have

a positive effect on real world driving skills), many more are exercising skills which

we find appealing and fun, yet no longer utilize in our modern lives (Backlund,

Engstrom, & Johannesson, 2006).

       In many ways, it seems that First-Person Shooters are attempting to recreate

the adrenaline rush of our ancient ancestors hunting and raiding (Mendenhall, Saad, &

Nepomuceno, 2010). Play involving projectiles forms the heart of many human

sports, and simulated projectiles in a variety of forms played a prominent role in

many video games, from early arcade games to the quintessential mobile game, *Angry

Birds* (2009). However, FPSs present a representation of projectile weapons that is

much closer to the way in which they were experienced by our human ancestors than

do many alternate forms of projectile play. In FPS games the perspective of the

player is, perhaps not suprisingly, always first-person. While this is by no means a

revelation, it is important to note, as it removes many forms of abstraction from the

player's impression of launching their projectile into the game world. While

depictions of projectiles in profile or viewed from the top-down still draw on related

instincts, the first-person view best matches what one sees while actually throwing a

spear, and thus requires less cognitive load for the on-screen action to be interpreted

by our cognitive systems, and to trigger our evolutionary responses to this stimulus.

     Similarly, the use of projectile weapons by the player is inherent to all

members of the FPS genre. In many ways, the simple innate enjoyment of firing a

virtual weapon has played a large role in the success and popularity of this genre, and

fascination with this mechanic has driven hundreds of FPS games. While the effects

of these weapons may be varied, and are occasionally non-lethal, they are almost

always violent, and intended to kill or do great harm to their target. It is the process

of aiming these weapons and carefully timing shots to hit rapidly moving targets that

appeals to our ancient instincts. Many FPSs actually employ a modified model of

projectile motion to make it easier for players to aim and hit their targets. In many

cases, the player's projectiles travel instantaneously along a completely straight path.

That is, they do not drop downwards as they fly - in fact, they do not even travel the

distance between the player's weapon and the target. Rather, at the time the player

fires, the software draws a straight invisible line stretching out from the player's

weapon and marks a hit whenever it comes into target with a "solid" object. This

makes it easier for players to succeed at performing the core FPS mechanic, shooting,

making the game more fun and fulfilling for players. A skill that makes real-world

weaponry more difficult to use is removed, in favor of granting the player's

Paleolithic mind more successful kills, thus demonstrating one way in which FPS games serve as supernormal stimuli. As the technology and its consumers have developed their skills, more realistic, complex, and challenging models of projectile motion have begun to appear in games. This recognizes the skill that has been developed by players, but it should be noted that while players' practice was reinforced along the way with successful kills garnered by modified physics, in the ancestral environment, accuracy could only be developed through long periods of initially fruitless practice. The design of this supernormal stimulus has removed that barrier to entry for modern humans.

Further supernormal effects occur due to the fact that in most FPSs players utilize modern weapons rather than atlatls and arrows. Inherent to modern firearms are features that function as supernormal stimuli, such as the ease of use of guns compared to ancient weapons. Not only is it easier for inexperienced individuals to fire a gun than to launch an atlatl dart, it also requires far less exertion, as the bulk of the kinetic energy that is transferred to the bullet comes from the ignition of its propellant, rather than the splitting of ATP by human muscle. Also, automatic and semiautomatic weapons are equipped with magazines that allow them to fire multiple shots without reloading. This is a great advantage over ancient weaponry, which allowed for only one projectile to be launched at a time. Multiple shots allow the player to develop their aim more rapidly, score more hits, and simply to engage in the enjoyable experience of launching projectiles more quickly than they would otherwise

be able to. The combined effect of these features is that players are able to achieve

more virtual kills with less effort, skill, and expenditure of time. Players are able to

quickly and easily engage in a simulated experience which would be difficult and

energetically taxing, if not entirely impossible, if one were to attempt to recreate it in

real life. A player can easily play a video game for several hours, engaging in

constant instinctual gratification, but would find it much harder to sprint, dive, and

fight for more than a few minutes. By making these already desirable activities even

easier for humans to engage in, a supernormal stimulus is created. The virtual space

and tools allows players to engage in these normally rare and costly activities with

very little effort, making these stimuli even more attractive to the player. Players are

able to cut straight to the heart of what their instincts have been selected for, thus

highlighting how significant a supernormal stimulus is FPS games' depiction of

projectile weapons.

Cooperation in another feature of first-person shooters that draws on our

evolved preference for this behavior. Frequently featured as a game type in the online

multiplayer portions of FPSs, where teams of players battle one another, cooperation

is also utilized by some games to allow two or more players to play through games'

single-player campaigns together. Valve's *Left for Dead* series is designed to be

played by four players working in tandem. The cooperation, communication, and

organizational skills required by these small-group hunts for opposing players or

groups of enemy controlled AI resemble the cooperative hunting tactics selected for

in our ancient ancestors, and which are utilized by hunter-gatherer societies to successfully bring down large prey or groups of animals (Buss, 2004). As described above, successful hunting in the EEA required ancient human ancestors to be able to efficiently navigate complex terrain in three dimensions, invent innovative tactics, accurately communicate these plans to others, and coordinate the group during the undertaking's execution. The teamwork required by FPS games is much the same, with players who work together to execute carefully practiced "plays" dominating individuals and less-organized teams.

The design of the virtual levels used in FPS games often function as large mazes with many twists, corners, and separate areas through which players battle. The speed at which play takes place requires players to quickly and accurately assess the layout of the level and their location within it in order to efficiently navigate during play. Assessment of these spaces, learning their strategic details, and being able to effectively navigate this terrain is an essential part of playing these games, and also one which draws upon the enhanced ability of males of our species to be able to navigate long distances and three-dimensional mazes. Human males, and in fact, those of other mammalian species, have been found to be better able to find their way through mazes and to navigate novel environments, as would be predicted by the probable division of labor in the EEA and in present-day hunter-gatherers (Moffat, Hampson, & Hatzipantelis, 1998).

FPS games sport a number of features which make player cooperation even easier and more attractive than it was in the EEA. Perhaps the largest of these is the fact that players do not need to physically exert themselves as much while playing as they would if they were hunting or raiding in the real world. Merely by tapping a few keys and pressing a few buttons, players can send their avatars careening through maps, sprinting, jumping, and diving for cover. This means that cooperative tactics are not restricted in any way by the physical endurance or capabilities of the team - only the limits of the rules put in place by the game designers, and the span of the players' attention hold sway. Further, these games often have built in voice chat systems that allow players to communicate with one another via headset microphones. Older FPSs included text chat systems. This allows players to instantly communicate clearly across large virtual distances in-game. This makes planning maneuvers, as well as altering them as they unfold, significantly easier than it would be in the chaotic reality of battle. These advantages over hunting and fighting in the real world mean that these game improvements function as supernormal stimuli, making the hunt easier, more enjoyable, and more appealing to our Paleolithic brains.

The presence of maps or "radars" on the heads-up display represents another supernormal stimulus. These handy bits of data constantly update where the player, his teammates, and sometimes even the enemy are located relative to the player. In the case of maps, their icons are overlaid over a map of the area, while in the case of the "radar" they appear only as blips. Either case represents a significant supernormal

stimulus by giving the player a great deal of information about the territory around

him and/or providing him with an idea of where other players are on the field. A

further supernormal stimulus can be found in the fact that games include a limited

number of maps. This means players frequently "hunt" on the same terrain. Players

quickly learn these maps, giving them a huge advantage when navigating, seeking

cover, or preparing ambushes. Our ancestors and modern hunter-gatherers do traverse

the same area for a time, but they often hunt across very large ranges, and also move

periodically, exposing them to new hunting grounds. They did not have the luxury of

months or years of hunting in exactly the same area and deciphering all of its secrets.

Another feature of FPS games is that they are played online, with a large pool

of other players. This means that any time of day or night, from anywhere in the

world with an internet connection, players and their friends can set off hunting. If

one's friends are unavailable, one can simply join up with strangers and play. This

represents a supernormal stimulus - any time that an individual feels the urge to

engage in hunting with projectile weapons, they can, almost instantly, without having

to wait for the sun to come up, the weather to clear, prey to be located, or your fellow

hunters to join you.

It is perhaps not so surprising then that the player base of these highly

cooperative, projectile weaponry-themed games set in spatially complex mazes is

almost exclusively comprised of young males (around age 18). A 2007 study found

that the men tended to play for both the social interaction (cooperation) as well as the

competition which the game offered (Jansz & Tanis, 2007), while another study

recently demonstrated that the simulation of competition plays a large role in making

FPS games so appealing to their players (Oxford, Ponzi, & Geary, 2010). Just as is

the case in modern hunter-gatherer societies, and would presumably have been the

case in the EEA, prestige and status in FPSs are earned through player's performance

at hunting the enemy. Players who perform well are rewarded through several means

including points, encouraging messages, celebratory audio and visual effects, in-game

currency, and the awarding of special "achievements," as well as by earning the

admiration of their friends and fellow players. These positive reinforcements of

accomplishment and status simulate the prestige and privilege garnered upon skilled

hunters in hunter gatherer groups. In fact, the most skilled video gamers in the world

are able to turn their status into resources which could actually increase their

reproductive success by means of a certain degree of fame, corporate endorsements,

and prize money.

For most gamers, however, FPSs offer only the lure of supernormal stimuli,

rather than actual Darwinian fitness rewards. The points awarded by games give

players an empirical means by which to compare their performance with other

players. Any subjectivity regarding who is the better player is removed, as one need

only check and see who has the higher score or has achieved a higher experience

level. Text-based and auditory feedback is delivered to players instantly by the game,

regardless of what the other players may be feeling towards one another, and also

regardless of where other players are located and looking. Even if no one sees a

player's incredible shot, the game system acknowledges its skill, often with appealing

sights and sounds which would not be present in real life. Celebration of one's

performance is further reinforced by the ability to record and replay these pride-

inducing acts. YouTube hosts scores of videos documenting players' one-in-a-million

in-game kills.

This celebration of a player's abilities is further supported by large online

pools of players, which conveniently supply an inexhaustibly stream of new players to

compete with and impress with one's hunting prowess. Achievement badges earned

by accomplishing certain goals set by the game can be displayed on the player's

profile inside the game, but are also often made displayable on outside websites or

sharable via social media, widening the reach of the player's ability to garner

admiration. Currency awarded by FPSs can be used to unlock more effective

weapons or abilities that the player can employ to give themselves a competitive

edge, however, vanity items are often also offered which allow players to signal their

status. Sometimes these items even take the form of costly signals, actually making

the player easier to detect and target, and thus indicating that they are confident that

they will prevail even in spite of this disadvantage. All of these serve to enhance the

player's ability to accrue status and prestige among his peers in ways which were not

present in the EEA. Their convenience and wide reach position them as powerful

forms of supernormal stimuli which appear to be highly appealing to players, and

particularly to young males, who would be most likely to be attracted to hunting scenarios in our species ancient past. In fact, highly engaged players find the genre to be such a desirable way to spend their time, that they averaged 2.6 hours of FPS gaming per day (Jansz & Tanis, 2007).

Man's history as a hunter appears to stretch back millions of years, perhaps even touching his last common ancestor with chimpanzees. This behavior has played a large role in human evolution, and as such supernormal stimuli which appeal to instincts keyed for arousal by shooting, projectile weapons, and hunting have proven to be a reliable means by which video games attract and satisfy their players. First-person shooters appear to be rife with features which exaggerate ancient human instincts into hyper-attractive supernormal stimuli, particularly with regard to features involving projectile weapons, cooperation, and social status. This has likely contributed greatly to the massive success of the FPS genre.

Massively Multiplayer Online Role-Playing Games: Hunter-DPSers

The massively multiplayer online role-playing game (MMORPG) is a recent

permutation of more traditional role-playing games (RPGs), both digital and analog.

MMORPGs trace their roots back to the classic table top role-playing games in the

vein of *Dungeons and Dragons*. As computing technology advanced, RPGs' paper

and pencils were transmuted into digital form with games known as MUDs or Multi-

User Dungeons. MUDs were text-based games (with a style and feel similar to the

single player adventures *Adventure* (1976) and *Zork* (1980), and which interacted

with the player entirely through text, with no substantial visuals). These games

allowed their players to venture out on epic adventures, battle computer controlled

monsters, and communicate with a limited number of other players in a shared online

world. Over time, as these games were augmented with increasingly advanced

graphics and became capable of supporting larger numbers of online players (now

typically in the thousands on each server), the genre adopted its current moniker,

MMORPG.

In a standard RPG, the player assumes the role of a character in the game's

virtual world. Often set in Tolkienesque high fantasy worlds, the player's character is

typically assigned to one of several disciplines, such as warrior, wizard, or bard,

which each possesses different abilities, can utilize different items, and frequently

feature unique play mechanics. The game's story sets the player on a journey or

adventure, through which the player develops their character, learning new skills,

becoming more powerful, and outfitting themselves with better items. Many optional

side adventures, or quests, are also available to the player, and their completion

rewards the player with additional experience points, currency, or items. MMORPGs

operate similarly, but instead of adventuring alone, the player experiences the game in

a world filled with other human player with which to ally with or compete against.

Examples of MMORPGs include *Everquest* (1999) and the recently released,

Star Wars: The Old Republic (2011).The most successful MMORPG of all time is the

current mega-hit *World of Warcraft* (2004), with over 12 million subscribed players

(Holisky, 2010). A large part of the massive appeal of MMORPGs like *World of*

Warcraft (*WoW*) lies in their supernormal treatment of a number of stimuli borrowed

from the human EEA. As this chapter will explore, MMORPGs take the

accumulation of status, prestige, and achievement to an extreme, require their players

to learn how to cooperate efficiently in order to hunt massive prey, and make foraging

and locating game much easier and more rewarding.

As was discussed in the previous chapter, while the inability to accumulate

and store many worldly possessions prevents significant material hierarchical

structures from developing in modern hunter-gatherer groups and ancient human

ancestors, status, prestige, rank are awarded to individuals based on their individual

achievements, and particularly from hunting skill. These high ranking individuals

gain preferential treatment within the group resulting in greater access to mates,

access to more desirable mates, and likely some form of higher quantities or quality

of nutritional resources. These factors lead to high status individuals producing more

and healthier offspring, which substantially increased these individuals' reproductive

success. Particularly fierce and unstable social hierarchies have been observed in

wild primates, and aggressive competition for these valuable benefits would not have

been unlikely behaviors to expect of our ancient ancestors. In ancient pre-humans the

ability to accurately assess the status of conspecifics was important, as proper

acknowledgement of others' dominance would be critical to continued acceptance by

the group. In addition, being able to identify status would allow subordinate

individuals to accrue benefits through other means such as deception and cunning,

coalition formation and friendship, or appeasement (Cummins, 1998). Thus, both

acquiring status and the ability to accurately assess and respond to the status of others

would have been desirable traits in the EEA.

At the same time as fierce social jockeying might be taking place, well-

executed group cooperation was necessary for our ancient ancestors to successfully

hunt and kill megafauna or large groups of animals. The necessity for, and evidence

of, this behavior was also examined in the prior chapter, however, it should also be

noted that the success of hunters is often highly dependent upon specialized

knowledge of the behavior and habits of their intended prey. While their projectile

weapons offer hunter-gatherers a great advantage, the primitive forms of these tools

limits their range and accuracy, requiring hunters to use a good deal of ethological

knowledge to execute complex stalking methods in order to close range with their quarries.

In addition, successful hunts depend upon hunters using in-depth knowledge of animal behavior and environmental conditions to accurately assess when, where, and what to hunt. Tracking animals demands that hunters use a variety of clues to deduce the animal's condition, age, sex, size, rate of travel, and heading. Once engaged, the hunter must accurately calculate the moment and trajectory of his prey's flight, while at the same time, remaining vigilant of signals of aggression indicative of an impending attack. Such complexities require significant cognitive effort from hunters, and discussion of animal behavior, environmental indicators, and tactics makes up much of the conversation of males in modern hunter-gatherer groups (Laughlin, 1968). It is likely that similar specialized knowledge assisted our ancient ancestors in becoming the prodigious hunters they were.

While a great deal has been written here about human hunting behavior, and in practice hunter-gatherers expend much effort in the hunt and award social prestige to its most skillful practitioners, foraged resources are the source of the majority of most modern hunter-gatherer groups' calories. Meat is a special treat, a fortuitous break from vegetable staples, but it is far from routine. Game is hard to locate, always on the move, and difficult to predict, resulting in relatively low kill rates among hunters. It is perhaps, then not so surprising that skilled hunters are esteemed. In any case, in comparison, foraged vegetables are plentiful, easy to find, immobile, and easy to

catch. In general, hunter-gatherers, "eat as much vegetable food as they need, and as much meat as they can" (Lee R. B., 1968).

Chimpanzees have been observed to make quite adept foraging decisions (Mithen, 1996), and despite an absence of plant remains at pre-human archeological sites, it is most likely that our ancient ancestors were no strangers to foraging for their meals. Indeed, campsites abandoned by modern hunter-gatherers also tend to show a lack of evidence of plant material, so it's absence from the archaeological record is not so surprising (Lee R. B., 1968). Also likely to have had a long history with our ancient ancestors is a division of labor with regard to foraging. In most modern hunter-gatherer groups, gathering is largely the province of women, whose efforts provide the majority of the groups calories, and serve to balance the inconsistent results of the hunters, who are primarily male (Wrangham, 2009). Men do contribute a small amount of plant material, but principally focus on hunting medium and large game (Lee R. B., 1968).

The persistent virtual worlds of modern MMORPGs present many stimuli which appeal to our ancient drive for status, need for cooperation, and practice of subsistence foraging behaviors. *World of Warcraft* allows the player to pursue in-game status via several different merit-based approaches. Further, the game provides many opportunities for the player's achievements to be broadcast widely and acknowledged by others. This facilitates the formation of status hierarchies within

the game, tapping directly into the player's evolutionary desire to increase their social

worth (Henrich & Gil-White, 2001).

The most straightforward approach to earning status in *WoW* is by earning

experience points and increasing one's "level". Experience points are awarded for

performing a wide variety of constructive activities, such as killing a monster, mining

a piece of ore, or exploring new parts of the world. Once the player has accrued a

certain amount of experience points, they "level up," signified by incrementing an

actual numerical value, and the player moves one step up the social chain. In doing

so, the player's statistics and abilities increase, allowing them to deal more damage to

enemies, survive longer in battles, and use new weapons and spells. As players reach

higher levels, they are able to explore deeper into the world, visiting areas in which

they were previously too weak to survive. They also gain the opportunity to purchase

or win better armor and weapons, unlock advanced abilities (such as learning how to

ride a horse, or gaining the ability to become invisible), and to engage powerful

computer controlled enemy "bosses" in combat. A player's level is easily viewable

by other players, and serves as the principle determinant of a player's social worth for

the first portion of the game.

The leveling system is just the beginning of achievement in *WoW*. It takes

players just a few months of regular play to reach the highest level (at present, 85).

As many players play a given MMORPG for several years, there is often a large

proportion of the player community who quickly attain the game's highest level, and

so look to other venues in which to demonstrate their skill and better their in-game character. Once players have achieved level 85, there are three main ways in which they can gain status in *WoW*'s endgame: 1) by acquiring rare and difficult to obtain in-game items, and completing "achievements" and quests which award the player means in which to visually display their accomplishments on their avatar, 2) by defeating other players in duels and tournaments to increase their Player vs Player (PvP) ranking, and 3) by joining a player-run guild and participating in events and "raids" to increase their individual reputation, and that of the guild. These overlapping status vectors ensure that there is always a new goal for players to pursue, and always another way for the player to improve.

One of the most visible ways a player can increase their status is by acquiring rare "loot," or equipment, in the game. A common feature of MMORPGs, players can acquire new weapons, armor, clothing, spells, and tools through a variety of means, including defeating computer controlled enemies, successfully completing a quest (that is, a task assigned to the player by a non-player character [NPC]), or by purchasing items using in-game currency. The elements of this route to status are analogous to the *prestige* pattern of human social status, as proposed by Henich and Gil-White (2001). This pattern in human societies refers to individuals who become respected for their skills, accomplishments, or knowledge. Rare and powerful items are granted by killing more challenging enemies and by completing longer and more complex quests. When players "equip" items (that is choose what items they'd like to

be actively using), a visual representation of that item appears on their avatar, and is

visible to all other players. Players soon learn to distinguish between common and

high-status items, allowing them to assess a player's skill at the game with just a

glance at their in-game representation.

Similarly, by accomplishing involved, long term goals, such as exploring the

entire game world, or completing almost all of the quests offered in the game, *WoW*

players unlock "achievements" and earn achievement points. While the achievement

points themselves serve as another empirical measure of a player's worth, completing

achievements also often awards uniquely visible awards to the player such as titles

which appear next to the player's character name ("the Explorer" for example), rare

mounts (such as colorful dragons), or companions (small pet animals that will

accompany the player's avatar through the game). All of these increase the visible

evidence of a player's merit and skill at playing the game, making it easy for players

to demonstrate their status, and to feel pride simply by observing their own avatar.

Players might also seek to gain social status in *WoW* by engaging in duels and

PvP combat. Most aggression in the game takes place between players and the game

system, with players battling computer-controlled monsters. Players can choose to

initiate one-on-one duels where they can test their skills and their characters stats.

The game also has an entirely separate mode comprised of "battlegrounds" in which

players face off in specially designated zones against the game's opposing faction to

compete in a variety of capture the flag and combat scenarios. Players can also

participate in annual 2v2, 3v3, and 5v5 tournaments curated by Blizzard, the game

company responsible for *WoW*. These routes are analogous to the dominance path of

human social status attainment, whereby one consolidates power via intimidation,

control, and the induction of fear (Henrich & Gil-White, 2001). Each of these

competitive combat situations serves as a venue for player ability, affecting player

status via empirical gain of honor points and official rankings, the awarding of special

titles and equipment, and through good old reputation spread by word of mouth.

Players can also gain social status by participating in one of *WoW*'s many

guilds. In the game, a guild is a group organized, run, and maintained entirely by

other players. Guilds are particularly helpful for players attempting *WoW*'s endgame

dungeons and raids. Dungeons are instanced adventures for groups of up to five

players which contain harder than average enemies who have a chance of dropping

rare and powerful items. Raids feature even more challenging content and more

difficult "boss" enemies (that is, very large enemies who are very difficult to kill, but

will drop very valuable items if players succeed in doing so), and require groups of

either 10 or 25 players in order to be tackled. Raiding guilds will organize their

players to take on these challenges several times a week, helping players to coordinate

the large numbers needed to take on this high-end content, as well as offering the

players more shots at winning rare items for their avatar. Guilds can also serve to

assist players in leveling their characters, so they can participate in endgame content,

and play a large social role, often serving as a venue for players to make friends or

engage socially while playing. Regular players can develop relationships and friends

which can serve to help players with real life issues, or simply to admire a player's

new sword. With their many styles and goals, guilds serve to help players pursue

both the prestige and dominance social status paths described above.

    While guilds play a large role in helping players to gain status in MMORPGs

like *World of Warcraft*, their discussion points to another important facet of this genre

of video game - the need for player cooperation. Perhaps the best source of status in

WoW comes from defeating boss enemies. The most powerful of these computer-

controlled opponents require a large number of players to defeat, but successfully

vanquishing one results in a deluge of status boosts for those involved, in the form of

powerful items, achievements, and player recognition, making them tempting prizes

for any player. The cooperation players must practice in order to defeat these

challenging foes is quite similar to that used by our ancient ancestors in the pursuit of

wild game in the EEA. The coordination of the large numbers of players involved is

similar to that required by ancient man in order to take down large ancient beasts or to

execute strategies to kill packs of animals. In *WoW*, bosses demand that players learn

their attack patterns, develop strategies to overcome them, and then be able to

communicate with their group to execute precisely timed tactics and maneuvers. This

also requires players to closely study the behavior of bosses, and results in much

discussion among players, both in-game and via the internet, as they work to develop

optimal strategies for their engagements. This in-depth knowledge is quite similar to

the intricate knowledge of prey behavior developed by modern hunter-gatherer groups

which allows them to effectively take down game using only primitive weapons.

Meanwhile, many of the player's interactions with the game environment in

MMORPGs are similar to human foraging behavior. The "collection" quest is a staple

of the genre, and sends players off in search of an arbitrary number of a certain plant

or object to collect, or of a particular animal to kill. Players are given more or less

information on where they should venture in order to search for the missing items.

Similar to real-world foraging, knowledge of the surrounding area, as well as an

understanding of the properties of the item or prey in question grant an advantage to

the seeker. Searching for five plagued villagers? The farm next to the Infested Forest

might be a good place to start. In addition to this predictability, further similarity can

be seen in the fact that once located, collectable items can be found again in the same

areas and will reappear in those areas over time. *WoW* does diverge slightly by

augmenting the player's ability to find their quarry by providing detailed instructions

of where to go, indicating the general area of the target item's location on a HUD

map, and making quest-related objects with sparkles or other effects to make them

easier to spot in the game world. However, the prevalence of this form of quest is

additionally notable for its similarity to the typical foraging of the hunter-gatherer

lifestyle.

In these ways, MMORPG games like *World of Warcraft* present stimuli

similar to those that that selected for human behavior in the EEA. However, these

games, and *WoW* in particular go beyond simply replicating these stimuli, and instead

exaggerate them, turning these features into supernormal stimuli. The many different

paths to status in *WoW* represent a supernormal stimuli by ensuring that many more

players are able to feel powerful, and as thought they are at the top of the heap than

would have been able to in the ancient past. There are so many ways for players to

rank themselves, that players can always find something new to compete in. Many

more players have the opportunity to feel the thrill of being "the best," thanks both to

the existence of a number of different areas in which to compete, and to the many

parallel versions of the game which exist across multiple servers. This chunking of

players into groups of several thousand means that many more get to come in first. In

addition, the game makes it significantly easier and much less subjective for players

to determine their rank in the social hierarchy through the use of empirical leveling

systems, achievement points, and rankings. By using these methods, it allows players

to know exactly where they stand compared to others, as well as to see how much

ahead or behind of others they are. Knowing that one is just a few levels away from a

rival can serve to hearten and encourage players to achieve greater status. Finally,

WoW makes it much easier for players to share their achievements and status with

large numbers of others. The other players which populate the game fill the role of

audience, lending more meaning to a player's accomplishments than if they were to

achieve the same in a single-player game (Ducheneaut, Yee, Nickell, & Moore,

2006). There are several thousand players on each server, so no matter when a player

logs on or where they go, there are always others around to bear witness to the

player's virtual glory. Our ancient ancestors do not have access to admirers at all

hours.

The ways in which the game facilitates cooperation from its players also are a

form of supernormal stimuli. The game aids players in taking down large enemies by

including built-in text and voice communication systems which help to organize and

coordinate raids. Players are able to mark enemies with icons visible to all players to

aid in indicating targets. Players are able to see the health, energy, and status of all

other players in their group, as well as a good deal of information about the boss'

status, assisting them in strategically managing their attacks and healing spells. The

existence of guilds is a big help to players who take on group challenges frequently,

but for those that play more casually, the game offers a pick-up group player

matching system to help individual players find and organize the necessary players.

With regard to the complex behavioral patterns of bosses, players are able to glean a

good deal of information about the boss from feedback given by the game as they

engage it in battle. This information allows players to discern what the boss is doing,

what the effect of its attacks are, and how best to avoid them. Further, this

information is speedily made available to other players via the internet, allowing

newcomers to enter into battles fully briefed on their enemy's capabilities and

strategies. Together, these features act as significant supernormal stimuli, enhancing

the way in which players cooperate and making this style of play all the more

appealing to our ancient instincts.

Finally, a number of adjustments to the way players deal with collection quests

in MMORPGs and *WoW* causes them to act as supernormal stimuli as well. As

mentioned earlier, *WoW* augments the player's ability to find the objects they are

searching for by first telling them where to find the object, then showing them the

general area they should search on an easy-to-access map, then making the individual

objects easy to find by applying particle effects such as sparks. These features all

make the foraged objects much easier to find than they would be in nature. In

addition, the locations players are sent to find tend not to be too far from the location

of the quest-giver. Often, in fact, the goals of several quests will be in close

proximity to each other, making it easier for players to gather the components for

several at the same time. Also, in real hunter-gatherers, the collection and transport

of gathered material is often limited by the mass and weight of the gathered material

itself. In MMORPGs, players are able to carry unrealistically immense quantities of

items, their carrying ability expanded by multiple bags or containers which increase

their load to far beyond what would be realistic in the real world. Often hunter-

gatherers find themselves with more resources than they are able to carry, making this

artificial invention a valuable asset to players' virtual gathering.

Massively multiplayer online role-playing games such as *World of Warcraft*

offer a broad array of adaptively significant stimuli. It seems that by feeding players'

naturally stimulated desire for status and recognition, their adaptations for cooperative

hunting, and by improving upon our species experience of foraging and gather

resources, the MMORPG genre has become one of the most successful in video

games. In fact, many players of *WoW* have found its virtual world so satisfying that

some go so far as to prefer their virtual lives to their real experience in the modern

world (Yee, 2004). This would appear to be further evidence of supernormal stimuli

at work.

Minecraft: SimPaleolithic

The most adroit example of video games acting as supernormal stimuli is the massively popular independent game *Minecraft* (2011). This game essentially functions as a veiled simulation of the Pleistocene environment and of mankind's Paleolithic technological development. *Minecraft* allows players to reenact mankind's invention of tools beginning with wooden implements, then proceeding through the shaping of stone and metal, and delving into agriculture, while vividly driving home the theme of mankind's transformation of his entire world, the environment around him and everything in it, into his toolkit, for him to sculpt and shape to suit his needs and desires. No other game so elegantly encapsulates as many human supernormal stimuli as does *Minecraft*, and it may be this fact that holds the key to the games remarkable success.

The development of human tool-making has been studied extensively thanks in large part to the particularly durable nature of this type of prehistoric artifact. In addition, the tools crafted by ancient man give modern researchers the briefest of glimpses into the cognition of our ancient ancestors. The earliest stone tools appeared between 2 and 3 million years ago. Consisting mainly of flaked or smashed pebbles, tools of this period are easily mistaken for naturally occurring rocks. The Oldowan tool-making industry arose between 2 and 1.5 million years ago, and distinguished by the purposeful removal of stone flakes from larger stone cores. Generation of the sharp-edged flakes were the principal objective of Oldowan processes. The

subsequent period, known as the Acheulean, is characterized by generation of tools from both the flakes and the stone cores. The straight-edged cleavers and pear-shaped hand axes of this period appear around 1.4 million years ago. An advanced technique, known as the LeVallois method, arose about 250,000 years ago, and allowed stone points and flakes in shapes and sizes of the tool-maker's choosing to be removed from properly prepared cores. Around 40,000 years ago, long thin flint blades came to dominate tool production, with this industry being named the Aurignacian (Mithen, 1996).

Technological innovation began to move more quickly at this point. Ceramic technology came into use around 26,000 years ago, and became widespread by 8,000 years ago through the facilitation of pot-making. Domestication of plants and animals occurred around 10,000 years ago, writing nearly 5,000, and the smelting of metal at around 4,000 (Mithen, 1996). After a few million years of practice, our ancient ancestors' hunter-gatherer lifestyle finally reached the Earth's carrying capacity. Humans used their creativity to develop new technology to solve these problems, creating first improved forms of tools and weapons, and later, an entire new way of live. Increasingly, humans came to rely on agriculture and animal husbandry rather than hunting and foraging for their needs (McClellan & Dorn, 2006). Settlements, towns, and cities sprung up around these permanent, location-fixed food sources. While some practitioners of Paleolithic strategies persisted into the Neolithic (and a very few have managed to continue their hunter-gatherer way of life to this day

(McClellan & Dorn, 2006)), the rate of technological advance has only increased. It would be only 20,000 years from man's adoption of the bow and arrow to the deployment of the atomic bomb (Mithen, 1996). Indeed, the history of mankind's development of tools saw our species progress from taking small bits of material out of the environment from which to fashion his implements, to radically changing almost every aspect of the world around them, and altering the way modern humans live their lives.

The alpha version of *Minecraft* was first released through an online forum on May 17, 2009 (Persson, TIG Source Forrums, 2009). The initial versions of the game were created entirely by one man working independently - game developer, Markus "Notch" Persson. As paid versions of the game began to bring in substantial revenue, the *Minecraft* development team would expand, but the game's core came from Persson, inspired by an earlier block-based mining game, *Infiniminer* (2009) (Persson, "About the game"). With no advertising budget, the game has spread almost entirely through word-of-mouth (Plunkett, 2011), and, now in full release, the game has sold over 5 million paid copies, and has more than 23 million registered accounts (which allow players to try the game for free, but which excludes many features of the full version of Survival mode) ("Statistics", 2012). These numbers are incredible for any game, let alone an "indie" title begun as a one man project without any substantial marketing. The game's success online has been legendary, due in large part, this author believes, to the massive amount of supernormal stimuli in its design.

Minecraft surreptitiously simulates the environment of the EEA, and embodies many elements of our ancestors technological shift. Upon starting a new game in Survival mode, the player's avatar is dropped into a three-dimensional world constructed entirely out of cubes, depicting a limitless landscape of dynamically generated cliffs, plains, oceans, and trees, in a variety of biomes including temperate forests, deserts, and jungles. Wild animals in a variety of species, including wolves, pigs, and chickens, roam freely. The player starts the game alone, without tools or resources, in a new and limitless world. The player can explore the area around them, climbing mountains and trekking across plains in any direction, and *Minecraft*'s algorithms will procedurally generate new landscapes ahead of the player. One can never reach the end of this world.

The player can collect resources from the environment by clicking and holding on a nearby block. At first, the player has only their bare hands, and so it takes a fair amount of time to break free a block of dirt or wood. Once in the player's possession, these resources can be turned into tools. Harvested wood allows players to create wooden axes, shovels, and pickaxes. These tools allow the player to mine resources more quickly, and allows them to collect more durable resources, such as stone. Stone can be used to craft still faster, more resilient tools, which can then be used to mine rare ores such as iron and gold. Iron and gold must be smelted before being crafted, but can then be used to build even faster and stronger tools, metal

armor, and a variety of more complex tools and devices including buckets, compasses, clocks, mine carts, and even pseudo-electronic circuits. Basic weapons, such as swords and bows, can be constructed as well, and are indispensible for hunting animals, which can be killed for their meat, hide, and feathers.

Weapons in *Minecraft* are also necessary for self defense. Monsters appear in the world at a steady rate in any space that is sufficiently dark. These creatures take a variety of forms, each with their own capabilities, and require different tactics to successfully defeat. However, fire is the best defense of all. With the proper materials, players can craft flaming torches that can be mounted in walls or the ground to provide light, preventing monsters from spawning, and creating areas which they will avoid, if they are not already actively chasing the player. Torches are also a requirement for the player's exploration of the dark underground caves which honeycomb the ground beneath the player's feet. Although the caves are swarming with hostile creatures, spelunking is necessary in order to acquire the rare ores needed to craft better tools and weapons, and to experiment with more advanced technologies. Torches only give light once they have been placed in the world, not while held by the player. Thus, in order to light a section of cave, the player must first charge into the darkness in order to set a torch. This mechanic is thrilling, as it constantly requires the player to charge into the threatening, "predator"-filled unknown.

Darkness is not just found below ground. A square sun and moon travel through the sky, with a full day/night cycle occurring about once every 20 minutes. This means that during the dark night, monsters appear everywhere above ground. Unless they have prepared adequate defenses, players can quickly be overwhelmed and killed if they stay in the open after dark. Because of this, one of the player's first priorities is usually to build a shelter. Initially, these structures are hastily-constructed dirt huts, serving more to keep the player out of sight of predatory monsters than proving any significant defense. However, as the player gains access to more advanced tools and building materials, they are able to create larger stone strongholds capable of holding off more vigorous attacks. Over time, these practical structures can become massive castles - canvases which their creators can use to demonstrate their creativity, or use to boast of their prowess by creating gigantic, complex, and awe-inspiring follies.

As players explore their world and solidify their place in it, they gain access to additional types of resources, and begin to develop more need for a larger variety of resources to pursue larger or loftier projects and goals. New types of resources can also help make the player's survival easier. For example, from the first, the player uses wood gathered from trees to build tools and weapons, initially to craft the entire item, and later just for the handle. As tools are used, they eventually wear and break, and so players will invariably need to forage for trees to provide the wood for their endeavors. When fully harvested, trees also drop saplings, which can be collected

and replanted. If they are replanted on proper surfaces, in arrangements giving them

space to grow and access to sufficient sunlight, the saplings will eventually grow into

full trees. Through experimentation and planning, the player, analogous to his ancient

ancestors, can use foraged saplings to establish a tree farm which could become self

sustainable, with its harvested trees providing both the needed wood and the saplings

necessary to grow the next generation of trees. The same methods can be employed

for a number of other plant types, as well as animals including chickens, pigs, sheep,

and cows, which can each be raised and harvested through the construction of

properly designed structures and enclosures. These methods are particularly

significant as these provide the player with food.

The player avatar has a hunger meter which steadily ticks down over time. If

it becomes entirely empty, the player will take damage and eventually die. At the

start of the game, players are fully dependent on hunter-gatherer strategies for

acquiring their food, and are subject to all of its challenges. The player's starting

point in their virtual *Minecraft* world is picked at random, and as such there is no

guarantee that they will start near an abundant source of food. Most wildly occurring

food sources are easily exhausted, and thus require the player to roam farther above

ground, or delve more deeply into the subterranean caverns in search of food. This is

similar to the patterns of modern hunter-gatherers, who move their base camp

frequently as they somewhat deplete the resources that are nearby and easiest to

gather (Binford, 1980).

While individual play styles may vary, the rapid onset of the monster-filled night, and the need for a static defensive structure often results in players creating a permanent home base not far from their initial starting point. If players become tied to this base, they are more likely to begin to deplete surrounding resources without moving to a new camp, thus hastening their adoption of agriculture to ease the pressures upon them to constantly gather rare resources and food. This outcome of *Minecraft* gameplay likely models the environmental pressures which led most of our own species to adopt an agricultural lifestyle (McClellan & Dorn, 2006).

It is important at this point to note something quite peculiar about *Minecraft*. Most video games include some sort of instruction manual or documentation. Even the simplest free or mobile games typically include a built-in tutorial system or a few instructions explaining the goal of the game, how it works, and what the player is trying to do. *Minecraft* does none of these things. While players might be given a clue in selecting the "Survival" mode of play when first creating their game world, the players are otherwise left to their own devices to figure out what they should be doing. In it's pure form, this is another similarity to the human EEA. There are no tooltips with a collected piece of coal, no popup text to explain that when combined with a stick (made from wooden planks, which themselves are made from blocks of wood harvested from trees) they can be crafted into light-casting torches. Just like in the ancient past, it is only through curiosity and experimentation that players might happen to kill an animal, collect its hide, then develop the proper methods to turn it

into a protective article of clothing. However, most players likely did not

experimentally determine all of the game's crafting recipes themselves. Most players

at some point turned to the game's internet community, which has carefully

documented the details of how each item is made, how different plants and creatures

spawn, and every facet of how the *Minecraft* world works. In the past, ancient

humans would have only been able to share information with the relatively limited

community of other humans in close physical proximity. The massive community

that comprises the internet functions as a supernormal stimuli by making it easier, less

frustrating, and faster for players to utilize their resources, make what they want, and

build their *Minecraft* world. The internet documentation makes it easier for players to

do whatever their instincts already want to do in the *Minecraft* environment.

Taken as a whole, *Minecraft* presents a vast array of similarities to the

Pleistocene environment and the human EEA, including the game's initial emphasis

on hunting and gathering for obtaining plant and animal resources; the requirement

throughout that players explore their environment in order to obtain necessary

minerals and ore; the deprecation of these resources in areas close to the player's base

structure, pushing them towards new technology, revised strategies, or migration to a

new area; game mechanics which strongly encourage the formation of a shelter for

defense from predators and for use as a home base; the appearance of nocturnal

predators who can be kept at bay with fire; predators' occupation of cave systems;

exploration and habitation of caves as aided by torches; larger bodies of water which

serve as barriers to the player, but which can be navigated by intrepid players in small

watercraft; open-ended gameplay and lack of instructions or explicit goals; discovery

of craftable items by experimentation; tool production, with tools that improve with

the use of advanced and more difficult to obtain materials, and the constant need to

replace worn-out tools by creating new ones; the ability to manipulate every aspect of

the game world, enhancing the player's view of the world as one large tool and

allowing him to modify, shape, and improve it as he might a tool, sculpting the

environment to fit his needs, just as ancient humans did to their world, sparking the

beginnings of agriculture, civilization, and the modern world. In addition, the game

also features such behaviors as the cooking of meat, which increases the amount of

satiation given by the in-game item, just as real world cooking causes meat to become

easier to chew and digest; the use of fire for cooking, illumination, and protection;

and the ability to domesticate wolves (and as of a recent update, cats) which will then

follow the player and aid them in attacking monsters, not dissimilar from ancient

man's taming of wolves to aid in hunting and defense.

Beyond their similarity to the ancient EEA, many features of *Minecraft*

actually represent supernormal stimuli by presenting even more appealing versions of

these stimuli to players. These include the ease with which complex, difficult, and

labor intensive tasks can be completed quickly, easily, and with just a click of a

button such as harvesting plants, slaughtering animals, mining stone and ore, creating

tools and weapons, and constructing large buildings. This cannot be overstated - the

game depicts a huge number of tasks that players might have undertaken in the EEA at great costs of time and energy. In *Minecraft*, the player can do all of these things, reaping the benefit of fulfilling the call of his instincts to hunt, gather, explore and build, without paying the high costs he would have had to in the ancient past or even today in the modern world. The player avatar possesses almost limitless endurance, allowing them to run, jump, mine, and build all day without rest, and requiring just a bit of food. While day and night cycles occur, and different climates exist in the game, there are no seasons within the game, meaning that once one knows how to plant and grow a crop, they will be able to at all times. The processes needed to grow crops or cause animals to multiply, and the instructions for how to use these resources to construct tools and other objects can be found listed on the internet, rather than having to be discovered by the player. This collection of information is not part of the game - rather, this database evolved alongside the game, and because of *Minecraft*'s unique development process, made it moot for a recipe system to be incorporated into the game by the developers. This interaction would seem to qualify the internet recipe database as a supernormal contribution to *Minecraft*. Further, these virtual crops grow much faster in the game then they actual crops do in the real world, and it is easier and faster to multiply animals. All of the difficulties of these challenges which our species has evolved to feel rewarded for completing are vastly reduced, leaving players with little barrier to collecting those rewards in the form of feelings of satisfaction and accomplishment.

Even the stimuli in the world designed to induce negative reactions from the player are perfect examples of how supernormal stimuli can be used in video games. Aside from hunger, the player's greatest danger is darkness, making it difficult for him to see, and from whence dangerous monster spawn. At night above ground, the entire world becomes too dangerous for players who are not fully aware and armed. Even then it is easy for them to attract a horde of enemies and become overwhelmed. It is far safer for them to hole up and construct a shelter, protected by fire and light, than to engage the wilds of the night. This primeval fear of the dark runs deep even in our modern psyches, and makes exploring the dark depths of *Minecraft*'s cave systems a hair-raising task, never failing to engage, and requiring the player's full attention to prevent the player from falling victim to a monster. The game also builds upon our instinctual fears in the design of its predatory enemies, which include undead zombies (a threatening and mobile corpse, which is sure to trigger fear and disgust from survival instincts seeking to keep us away from the potential illness spread by human remains and the threat responsible for creating those remains) and giant spiders (with fear protecting humans from their venomous bite). In fact, a quote from *Minecraft*'s creator, Markus Persson, gives particular insight into the design of his monsters: "As for the spiders.. I suffer from mild arachnophobia and remember the giant spiders in Eye of the Beholder as being one of the scariest enemies in a role-playing game. I'm not sure why I keep exposing myself to them as enemies in my games.." (Persson, "Community heroes: Notch, for Minecraft", 2010). Persson

acknowledges the effect spiders have on him, their use as enemies in other games, and that in spite of, or perhaps because of, this fear he frequently includes them as enemies in his games. When considered in terms of our species innate aversion to arachnids, this statement seems even more indicative of supernormal stimuli being at work.

  Minecraft also presents supernormal stimuli in its handling of the number of players in the game. In single-player mode, there is only the one player, and thus there is no competition for resources, no disputed over sharing, and no conflict over the best locations to build base camps. The potential for strife between humans is avoided, allowing one human complete control over his virtual world (or even multiple worlds, if the player so chooses). This option is always available to the player, however, online multiplayer modes, while reintroducing the potential of conflict with others, also means that that there is opportunity for the already existing advantages given by the game can be further leveraged into massive and wondrous cooperative adventures and undertakings. Further, if a player or group of players does create something impressive, multiplayer mode ensures that many other individuals will be able to see and admire it, all from the comfort of their own homes. The status and recognition garnered in this way would not have been as accessible to our ancient ancestors, whose achievements could only be recognized by those physically present or nearby, thus, marking this as another supernormal stimulus.

Finally, perhaps *Minecraft*'s greatest supernormal stimulus is its deceptively simple block-based environment. By building its world entirely from identical-size blocks, the world is simplified, making it easier for players to take it apart and rearrange it in ways that suit their needs and desires. Especially when placed in reference nearby the game's many other constructed tools and objects, it encourages the player to make an analogy between these tools and the whole virtual world. In the same way that players shape tools for their needs, they become empowered to shape the world to their needs. The Paleolithic landscape of the game can become rapidly transformed into one filled with architecture and gadgets designed by the player for their enjoyment, or to make their adventure through Survival mode faster and easier. The gameplay of *Minecraft* seems to appeal to the same instincts our ancient ancestors' evolved to make this leap, propelling their transition from the hunter-gatherer lifestyle into agriculture and onward into the construction of settlements, towns, cities, and the interconnected urban landscapes of the modern world. *Minecraft*'s greatest supernormal stimulus would appear to be that it allows players to not just make this leap themselves, but that it actually encourages it, removing the unpleasant bits, the complexity, the eons, and hardship our ancestors endured to make this change, and leaving behind for us the adventure, the magic, and the wonder, not simply of discovering a new world, but of building one of our very own.

Conclusion - Designing Supernormal Stimuli

As this analysis would seem to indicate, humanity's evolutionary history has possibly played a large role in sculpting the modern video game landscape. Many of today's most popular games appear to function as powerful supernormal stimuli by providing players with supercharged instinctual experiences and feeding into our evolutionary needs. FPSs' links to hunting and projectile weaponry, MMORPGs' densely layered status hierarchies, and *Minecraft*'s revolutionary super-simulation of the human EEA compellingly correlate as simulations of stimuli and conditions found in the environments of our ancient ancestors. Yet these games seem to do more than simply replicate these stimuli; they look as if they augment and exaggerate them, creating artificial triggers that are far more appealing to our evolved instincts than any found in nature, appearing to elevate these games from mere recreations to enthralling supernormal stimuli.

This likely has contributed to the ability of designers to craft many remarkably engaging, pleasurable, and satisfying gameplay experiences. Despite this, the possible link between ancient human environments and modern fun does not appear to be widely acknowledged. Aside from the occasional offhand comment, it is not a subject of wide discussion in the game design community. The potential of applying evolutionary psychology to transform games into supernormal stimuli should be recognized as a powerful tool. The subjects of humans' innate instincts for play appear to have inspired countless video game varieties, however, many more stand to

be mined from this rich creative vein. By identifying the activities humans have been selected to find rewarding in the EEA, game designers will likely be able to transform these activities into new games, and perhaps even lay the foundations for entire new genres of play.

Further, the effort to create better virtual game experiences stands to have significant positive effects on humanity as a whole. By experimenting with the design of idealized virtual worlds and systems, humans may be able to uncover new ways in which humans can enjoy their behaviors and interactions. Many of these insights could be exported to the real world, and applied to offline versions of human work and play. In this way, games stand to serve as valuable test beds for new ways to improve the modern human environment, and the future of the way our species experiences the world.

The history of video games appears to be filled with examples of supernormal stimuli, and if evolutionary thought is adopted more widely by the game designers of today, the games of the future promise to be ripe with many more.

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