Gamers' Interactions in Virtual Environments

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Abstract

Video games are developed and designed with gamers in mind. Designers are utilizing principles from both psychology and human factors in order to design meaningful and successful games. Players have strengths, weaknesses, needs, and motivations that need to be both understood and considered with game design. As technology advances, gamers' expectations for their games will not decrease, thus, game designers are challenged to meet and exceed these. This paper briefly outlines relevant psychological and human factors principles that are currently or can be utilized to benefit game design.

Game Start: Introduction

Gamers' have high expectations for their alternate realities, and designers dare not let them down. Designers are constantly challenged with increasing their player base and maintaining it. There are numerous reasons that people are motivated to play or replay games. Some of the most common reasons for gaming include: cognitive challenge, escapism, social networking, or just as a common hobby. Just as McGonigal (2011) articulates, reality is missing something and games fill that gap. This paper discusses psychology and human factors principles and how they can be utilized by game designers to create successful games.

Mind Control: Psychology as a Weapon

The human mind can be both a strength and a weakness. People can pursue through many hardships, but can be easily manipulated or deceived. I am not advocating that designers should utilize psychology to control people, but leveraging psychological principles can help connect the game to its player. The goals and outcomes may differ across games (i.e. commercial vs. training), however, there are elements of psychology that still apply. These areas of psychology have rich literatures, and it is difficult to condense and completely generalize the material. This section briefly describes game relevant psychological concepts and principles, and how they are currently implemented or can be implemented into game design.

Neurological

Dopamine. Multiple studies have shown that the brain releases dopamine during video games. Dopamine is a neurotransmitter that plays a major role in controlling the brain's reward and pleasure centers (Koepp et al., 1998; Mayo, 2007). During experiences of great pleasure, individuals experience a surge of dopamine, and people may feel a heightened mood or sense of motivation. Dopamine can affect future decision making, as it is affected by rewards (discussed later in the *cognitive section*). Dopamine's effects also carry over into memory formation and attention. Thus, dopamine is a powerful chemical that can strongly affect an individual's behavior.

Testosterone. Aside from its role in physical development, health, and sex drive (especially in males), testosterone also plays a part in competitiveness, aggression, and arousal of these types of behaviors (Batrinos, 2012). Some studies suggest that success in games trigger a surge in testosterone, indicating that competition affects testosterone levels of individuals (Oxford et al., 2010). People that tend to be higher in aggression or competitiveness may gravitate towards activities that feed this need (i.e. athletics, video games).

Adrenaline. One of the most commonly known stress hormones is adrenaline. Adrenaline increases heart rate and blood flow to the muscles. Its key function is its involvement in the fight-or-flight response of the body. People can be sensation seekers, which can be commonly known as "adrenaline junkies," and can be more inclined to engage in behaviors that increase their adrenaline (Slanger & Rudestam, 1997).

Fear. Psychologists have categorized fear as one of the basic emotions of humanity. Fear is a response that is elicited from an experience or stimulus that is perceived as a threat or risk. Many physiological symptoms such as increased heart rate, sweating, increased breathing rate, "goosebumps," onset with or as the individual is perceiving feelings of fear. Several areas in the brain are involved with processing and provocation of fear, with the most influential being the amygdala and the hypothalamus (Steimer, 2002). Fear can be conditioned or learned and is very complicated (Figure 1). There is no single modal onset of fear, as perceptions of stimuli may vary from person to person.

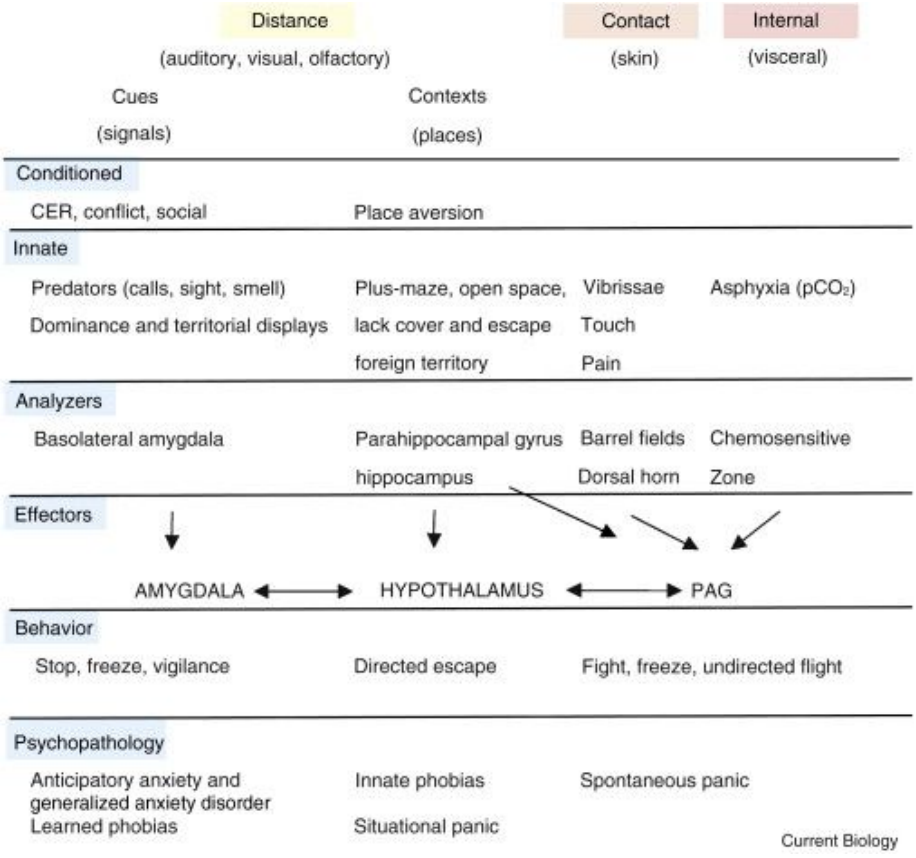

Figure 1. From Adolphs (2013). Fear as a complicated response.

Brain Plasticity. Brain plasticity is the ability of the brain to change in multiple ways: physically, functionally, or chemically. The brain is able to strengthen or rewire its connections due to damage or a need to optimize (perhaps due to training). As people gather more information, learn new skills, make new connections, or challenge themselves cognitively, the brain is tasked with reorganizing this information in a way that benefits the individual. This ability of the brain can affect many other cognitive skills, such as enhanced memory or task switching ("The Neuroscience of Gaming", 2015).

Integration. Without knowing it (or maybe with the help of psychologists), designers are utilizing the influence of neuropsychology to help shape their games. For example, in-game rewards create little surges of dopamine that encourage players to continue playing or to return to the game in order to receive those awards. This effect may also occur through meaningful

character dialogues or random loot acquisition. To foster individual's competitive spirits, some games provide the opportunity to work as a part of a team in order to defeat enemies. These teams may be ad hoc or premade (with friends), which would increase the release of testosterone post-competition. If this behavior fills their competitive itch, players will be more inclined to utilize these modes of gameplay versus solo campaigns or modes. Adding elements such as rankings, leaderboards, and score breakdowns further exaggerate this excretion of testosterone and may further motivate competitive behaviors. Fear and adrenaline are two phenomenon commonly sought in horror or psychological thriller games. Utilizing multiple modalities (i.e. visual and auditory) to elicit a physiological response to which a person would feel fear based on their environment is the goal. Navigating through environments where the fear stimuli aren't necessarily predictable, but the feeling of fear and paranoia lingers enough to create a rush of adrenaline would provide the player with the ultimate experience. Incorporating elements of fantasy and reality help increase the rate and intensity that fear responses are felt. Finally, if the goal of a game is to increase cognitive skills of an individual (i.e. in training scenarios), structuring the game in ways that optimize the learning or skill acquisition can help the brain reorganize. Adding opportunities for deliberate practice, error correction, and well timed feedback will enhance the player's cognitive experience and promote strengthening of connections. The anatomy and functionality of the brain provides several opportunities for game designers to provide game environments that utilize, optimize, and support the brain.

Cognitive

Attention and Memory. Attention is a cognitive process in which there is selectivity in our perception and behavior. There are limited cognitive resources associated with attention, as we cannot selectively attend to everything in the environment at once. From the attention literature, we can visually track a max of 5 separate moving targets at once (Pylyshyn & Storm, 1988). People are also able to maintain 16 features across four objects in visual working memory (Vogel et al., 2001); features can range from color, size, shape, or elements of an object's identity. During visual search, people are searching for a target within an environment filled with distractor stimuli. There are many reasons why people may struggle with visual search in complex environments (i.e. target-distractor similarity, interference). Endogenous (central) and exogenous (peripheral) cues can be utilized to affect attentional behavior. Endogenous cues symbolically cue the location, but does not actually appear there, versus exogenous cues that appear at the cued location. Areas of the environment where information is sampled from can be considered "channels." Depending on the channel bandwidth (frequency of information change within a channel) may affect an individual's frequency of sampling (or perhaps attending to) the channel. In dynamic environments, people tend to have to divide their attention, which involves splitting attention between multiple sources of information or locations. This is very cognitively draining and can very quickly deteriorate performance. The primary visual attention lobe is an area of the environment where an operator or user should pay the majority of attention. For example, in a first person shooter, the aiming reticle would constitute the PVAL. Glance time is the time it takes for one to shift their attention away from the PVAL then back (Rosielle, 2016).

Operant Conditioning. Operant conditioning involves the modification of behavior using reinforcement and punishments (Skinner, 1963) . Reinforcements are actions or stimuli that are meant to increase the likelihood that a behavior will occur again. Punishments, on the

other hand, are actions or stimuli that are meant to decrease the likelihood that a behavior will occur again. There are two ways of executing reinforcements and punishments (Figure 2): positive (addition of a stimulus or element) and negative (removal of a stimulus or element).

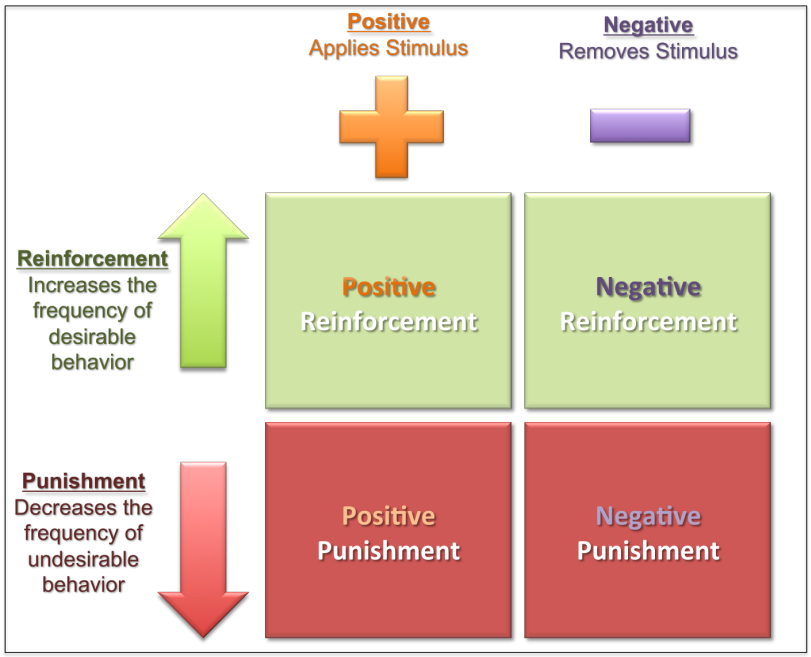

Figure 2. From "Psychlopedia" (n.d.). Reinforcement and Punishment

For reinforcements, there are schedules that can be utilized to manage the frequency of rewards: continuous reinforcement (after every behavior) and partial reinforcement (occurs sometimes). Subtimings of partial reinforcement include: ratio (after a certain number of behaviors) and interval (after a certain period of time) schedules that are either fixed (after a set number of behaviors or time) or variable (after an undetermined number of variables or time). Variable ratio schedules (i.e. slot machines) show the strongest effects and replay values; this demonstrates the powerful effect of people attempting to find patterns.

Decision Making. People make many decisions in everyday life. Sometimes decisions are highly affected by their psychological needs. For example, people may have a strong need for achievement (desire and need to overcome challenges). This can be extremely powerful for manipulating behavior to elicit more grinding and repetitive behaviors (i.e. playing video games) in order to accomplish goals or achievements. People will feel a sense of accomplishing a difficult task, but will not for being too easy. There are several similar cognitive "hacks" that can strongly affect behavior: hedonic adaptation, need for closure, and ego depletion (Rosielle, 2016). Hedonic adaptation involves people being deprived of something making them want it more; when people get it back, they enjoy it more. People have a psychological need for closure, which motivates people to seek experiences and actions that remove ambiguity. One of the most powerful phenomenon, ego depletion, describes how people are unable to resist tempting actions or decisions because they are mentally drained from other tasks. People's decision making can be easily affected by their own psychological needs and desires.

Integration. The described cognitive concepts are some of the most well utilized ones in current game design. For example, utilizing what we know about the restrictions of visual attention and working memory, designers are able to adjust the amount of information available to the player in the interface at once. If people are required to accomplish a task that is outside of their cognitive abilities, they are typically provided with some additional aid in the form of other humans, augmented "powers" of attention, or NPCs. Using both endogenous and exogenous cues to help the player navigate the environment and attend to important areas of the environment helps promote expertise and skill acquisition. Most people are familiar with the concept of reinforcements and punishments, even if not by these names. Designers take advantage of the variable ratio schedule of rewards, especially in loot or other similar reward schemes. Combining the biological effects of rewards and the human tendency to seek patterns in environments, designers are able to maintain their players with these reward systems. By not providing gamers with all of the content and information immediately, it stimulates players' desire to continue playing to remove the uncertainty. Content rotation is another method that is currently being used to affect decision making, as it depletes player's from certain experiences so they can enjoy them more the next time it is available. Finally, by structuring games based on achievements, it allows players who have high need for achievement to challenge themselves to accomplish everything "possible" in the game.

Social and Emotional

Failure. Contrary to popular belief, failure is not always bad. Failure, the lack of success, can contribute to learning, skill acquisition, and increased competency (Ravaja et al., 2005). Utilizing failure to learn from mistakes provides people with an avenue to succeed in upcoming attempts. This process helps strengthen connections between elements of knowledge or skill acquisition and processing, thus, strengthening the memory and increasing expertise. People will feel much more competent after failures when they finally do succeed, as they will see the failures as stepping stones to success. One of the most critical parts of utilizing failure is the content and onset of feedback. If people do not receive "useful" feedback, they may not see the "positives" of their failure and may never learn from their mistakes or will give up. People will enjoy the process of persevering, as it is a measure of their mental strength.

Flow. Flow is a state of consciousness in which there is a deep minded, and positive focus on the current task being performed (Csikszentmihalyi, 1990; 1997). There are several factors that describe the experience: 1. Intense and focused concentration on the present moment, 2. merging of action and awareness, 3. loss of reflective self consciousness, 4. sense of agency over the situation or activity, 5. temporal distortion, and 6. experience is intrinsically rewarding (Nakamura and Csikszentmihalyi, 2014). In order to achieve flow, people need to have some level of expertise and must be partaking in a task that has a level of challenge that is close to one's level of expertise (Figure 3).

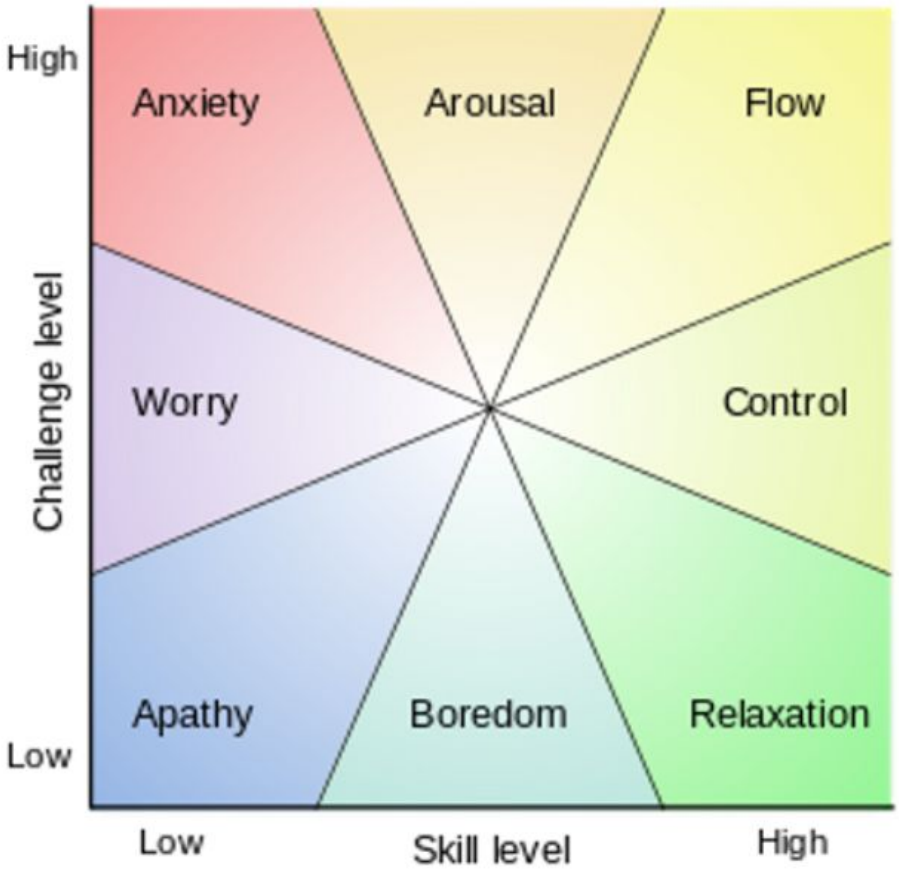

Figure 3. From Csikszentmihalyi (1997). A view of Flow

Integration. Games that consider social and emotional elements tend to provide players with more meaningful and beneficial experiences. For games that focus on learning or skill training, this is especially important. Challenging players promotes interactivity and immersion with the system and the world, while failure deepens learning and increases feelings of competency upon success. Incorporating proper frequency and onset of feedback optimizes the learning process, and maintains players' favor of the game. The balance of failure and flow is key to developing a holistic game experience and to increase the chance of replayability.

Consolidating Your Defenses: Core Human Factors Principles and Considerations

Nielson's Heuristics. Nielson developed 10 general heuristics for user interface design based on his previous research on usability problems. The 10 heuristics include: 1. Visibility of system status (keeping users informed and feedback), 2. Match between system and the real world (use familiar language and use logical organization), 3. User control and freedom (allow users to backtrack), 4. Consistency and standards (maintain concept and action consistency), 5. Error prevention (design prevents or reduces error), 6. Recognition rather than recall (minimize cognitive load), 7. Flexibility and efficiency of use (optimize for expert and novice performance), 8. Aesthetic and minimalist design (maintain simple aesthetics and remove

irrelevant info), 9. Help users recognize, diagnose, and recover from errors (communicate errors and solutions clearly), and 10. Help and documentation (make information search easy).

Jill Gerhardt-Powals's Cognitive Engineering Principles. Gerhardt-Powals, J. (1996) pulled 10 design principles based on cognitive psychology and engineering literatures. She found strong correlations between performance and integration of these principles. The 10 principles are: 1. Automate unwanted workload (eliminate unnecessary tasks), 2. Reduce uncertainty (clear display communication), 3. Fuse data (chunk lower level data), 4. Present new information with meaningful aids to interpretation (utilize similar and clear frameworks), 5. Use names that are conceptually related to function (use context relevant labels), 6. Group data in consistent and meaningful ways (logically and conceptually group data), 7. Limit data driven tasks (reduce tasks that require integrating new data), 8. Include only needed information on the display (remove irrelevant information), 9. Provide multiple coding of data (functions should have multiple "codes" and be customizable), and 10. Practice redundancy (include repetitive rounds of information). These principles have been shown to optimize performance, reaction time, accuracy, and workload, compared to displays that do not consider these principles.

General Human Factors Principles. In general, the field encourages some basic principles to help optimize design (Dix, 2009). For example, in screen design and layout, it is important that the grouping of items is consistent with both the natural or contextual logic and that related items should be visually together. Decorative aesthetics should help emphasize the relevant groupings, while alignment and white space can help define the space of the groupings and prevent information overloading. Utilizing multiple modalities (using multiple human communication channels→ i.e. vision and auditory) can help promote dual processing and efficient output. Some systems allow for and benefit from users entering into a flow state, thus, the system space should encourage this immersion. For systems that have a wide user base, it can be critical to design with accessibility options or considerations in mind (i.e. visual, hearing, physical impairments).

Continue?: Summary

Video games provide unique experiences, not only for the gamers, but also for designers. There are neurological, cognitive, social and emotional concepts from psychology, and heuristics and principles from human factors that can help inform game design. Designers can provide environments for gamers that stimulate players biologically, challenge players cognitively, and immerse players socially and emotionally. These environments should be structures strategically in order to encourage the most effective and meaningful navigation for players. Some of these concepts might serve as core game mechanics, and others may be used to direct tutorials or adjust general gameplay. Effective use of these concepts will result in better games, however, uninformed integration can lead to a loss of players or significant backlash from the community. Game on, designers!

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