Time and Space in Video Games: A Cognitive-Formalist Approach

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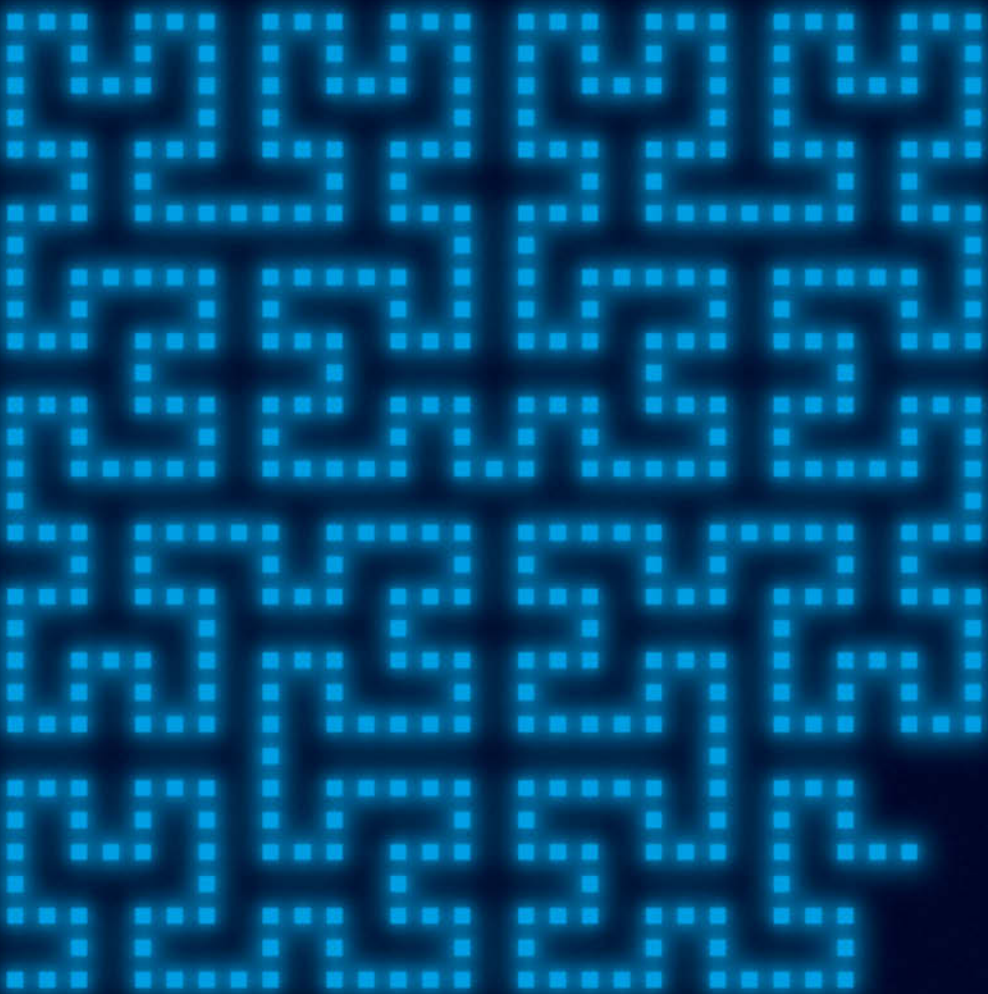

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Federico Alvarez Igarzábal
Time and Space in Video Games

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Introduction

Video games are temporal artifacts. Unlike a photograph or a painting, which display the full amount of the information they carry at any given moment, a video game progressively unfolds in time, like a film or a theater play. In contrast to these last two media, however, which typically show a sequence of events in a pre-established order, video games unfold according to the player's decisions. Therefore, video games are not only temporal artifacts; they are also interactive artifacts in which the action culminates with one of two or more possible outcomes. In this latter sense, the video game is, perhaps unsurprisingly, more akin to sports or other analog games. But the video game is also a potent storytelling medium, which sets it apart from non-digital games or sports and brings it in many ways closer to film or theater.

As the above paragraph suggests, the video game is a complex medium. It shares properties with numerous other media and activities, combining them in novel and captivating ways. The purpose of this study is to further our understanding of the video game by dissecting it into the elements that structure its temporality.

The present work is also largely concerned with the psychology of time perception. Video games are human-made artifacts and, as such, are modeled by human perception and intuition. The same cognitive capacities that have helped us survive throughout the millennia and that we employ in everyday interactions are the ones that shape our cultural products. Examining the cognitive architecture of time perception is thus key to understanding the nature of the medium at the center of this study—for game scholars and developers alike. Game designer Jesse Schell warns those who wish to create games: "You must understand the workings of the human mind or you are designing in the dark" (2008, p. 4). Similarly, a study on the temporality of video games that ignored the mechanisms behind the experience of time would be missing half of the picture.

INTUITIVE BY DESIGN

Evolution has equipped us with a set of cognitive capacities that help us survive in a constantly fluctuating world. Among them, we possess the ability to sense the passage of time. We perceive events, can estimate their duration, and order them in chronological sequence. We can also remember past and anticipate future events. Intuitively, then, we have a notion of what time is. But the term "time" can have different meanings: it can be a coordinate, that is, a label used to locate events; a measure of the duration of events or the gap between them; and a medium in which we move or that flows through us (see Carroll 2010, p. 10).

It could be said that time is the measure of change, that is, of the different states of space. However, there is no absolute reference to measure change. We keep track of time by observing regular changes—the movement of clock handles or the rotation of the earth. However, for space to change *in* time, an external time reference would be needed within which space can change. Otherwise, all we have is that space and its different states, like a tapestry with different patterns. That external reference is, at least so far, nowhere to be found (ibid., pp. 340-342). Whatever the physical reality of time may be, we, as observers, perceive it as flowing in one direction.

The biologist J.B.S. Haldane stated that "the Universe is not only queerer than we suppose, but queerer than we *can* suppose" (1927, p. 286). Solid objects do not have continuous surfaces, but are instead composed of infinitesimal particles and, in between them, mostly empty space; subatomic particles can be in two different states at the same time in what physicists call a quantum superposition; and, according to special relativity, time can elapse faster for one individual than for another if they move at different velocities or are affected by gravitational fields. The more we discover about the universe, the more we realize that our intuitions are not attuned to cope with its profound mysteries. Time is one of humanity's greatest conundrums and its physical nature still puzzles scientist.[1] It is without a doubt one of those phenomena that are "queerer than we

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1 In the book FROM ETERNITY TO HERE, astrophysicist Sean Carroll (2010) explains the arrow of time as a result of the Second Law of Thermodynamics (that is, that entropy can only increase in isolated systems). Entropy was lower in the beginning of the universe and has only increased ever since. That is the reason why we can easily make omelets (higher entropy) from eggs (lower entropy), but not eggs from omelets. Why this is so remains a mystery. The problem is that the laws of physics (as currently understood) are fundamentally reversible, while time is not. This is a contradiction that

can suppose." As Saint Augustine expressed in his Confessions: "What then is time? If no one asks me, I know: if I wish to explain it to one that asketh, I know not" (Augustine and Pussey 2008, p. 332).

Gameworlds,[2] on the other hand, are not half as queer as they could be. Here is a technology that allows us to create mind-boggling virtual worlds. It can transport us to fantastic settings where magic and dragons are real, and to science fiction universes where we can travel through different planetary systems in our galaxy and meet extraterrestrial civilizations. Nonetheless, these worlds often remain very similar to ours in many fundamental ways. The alien species that populate the futuristic cities of science fiction games like MASS EFFECT (BioWare 2007) tend to be markedly anthropomorphic, use spoken language to communicate, experience human emotions, and behave in ways that would be expected from humans. And not only depicted social worlds remain familiar, gameworlds also tend to preserve the same physical characteristics of the real world as we perceive it: Objects are made up of surfaces (sprites or polygons), and their physical behavior features no quantum superpositions or laws of special relativity.[3] By and large, the fictional worlds of video games are slightly modified versions of the world as we intuitively understand it.

There are two main reasons why virtual worlds in video games do not deviate radically from the real world. One is that we would not be able to interact with gameworlds if they defied too many of our intuitions. The other one is that

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scientists have not been able to reconcile yet. Possible answers have been hypothesized, but there is no concrete evidence yet to support them.

2 For the most part, I will use the terms *gamespace* and *gameworld* interchangeably. *Gameworld*, however, will be more often used to reference gamespaces that also represent fictional worlds. TETRIS (Pajitnow 1984), for instance, could be said to have a gamespace but not a gameworld, whereas SUPER MARIO BROS.' (Nintendo 1985) gamespace is also a gameworld where fictional characters live. Nevertheless, a strict differentiation is not necessary in the context of this study.

3 The MIT Game Lab developed the OpenRelativity engine, which simulates the physical phenomena related to special relativity and allows players to perceive them by modulating the speed of light. At very low speeds of light, these phenomena become directly observable. However, this engine has so far been used to develop two small games (both by the MIT Game Lab, one in cooperation with the Boston Museum of Science). Even if it were used in the development of a fully-fledged AAA game, this engine supports the point I am making: Our intuitions are not tuned to understand special relativity. To demonstrate the effects of this theory, the simulation needs to accomplish something that is not possible in real life, namely decrease the speed of light.

those very same intuitions constrain game developers' imaginations, making it exceptionally difficult to imagine what a completely different world would look like. For these reasons, video games offer settings that are in many ways like our world but that differ in just enough aspects to make them look and feel alien, futuristic, or magical, without being impossibly unintuitive.

Those characteristics of games that differ from the usual physical world we inhabit are quite often the elements that make a game fun to play by providing a challenge (traversing a zero-gravity environment) or by serving as practical skills or tools (the ability to teleport). However, most of the other variables remain predictable, allowing players to focus their attention on the salient, unfamiliar aspects of the game. Gameworlds are modified versions of what biologist Richard Dawkins (2005) calls Middle World,[4] that is, a world of a scale somewhere between subatomic particles and astronomical bodies such as galaxies. In this world, the space between atoms is irrelevant and the space between galaxies is an endless black void. Our intuitions evolved in Middle World, and are consequently attuned to the laws of physics as they manifest at this particular scale.

We also evolved in a highly social environment, which led us to develop an intuitive psychology (Wimmer and Perner 1983; Baron-Cohen 1995). It makes sense that extraterrestrial beings in a game have a similar psychology to ours. That makes a game like MASS EFFECT playable, given that an important part of the gameplay involves conversing and negotiating with aliens, which demands that players are capable of anticipating the reactions of the characters they are interacting with.

Naturally, our perception of time has been shaped by the temporal scale of Middle World. Some phenomena occur so slowly that they look static to our eyes and others happen so fast that we are not able to perceive them. A tree does not grow in real-time as we direct our gaze at it, but appears static; light does not travel from a flashlight towards the wall, but it instantaneously projects itself on it. Even our sense of causality (analyzed in chapter 1.3) is driven by assumptions about the behavior of Middle World objects in time and space. A central aspect of this study is to show how our temporal intuitions shape video games.

4 Dawkins introduced the term Middle World in his talk "Queerer than we can suppose: The strangeness of science" (Dawkins 2005), on which the above paragraphs are loosely based.

THE OBJECTS OF STUDY

This study's first object of analysis is the artifact, that is, the medium of the video game. This work scrutinizes the formal aspects of video games that are responsible for their temporality. To this end, I analyze numerous titles, both old and contemporary, across different genres. For this study, direct play of the analyzed games constitutes here a crucial criterion (compare Aarseth 2003). This first-hand experience is often reinforced by the reading of game reviews, guides, and other sources like game Wikis or forum discussions.

The second object of study is the perception of time. Video games are created by humans for humans. Therefore, to understand the temporality (as well as many other aspects) of this medium, it is necessary to understand the intuitions that guide developers and players. To this end, I draw from theories of time perception from the field of cognitive science and aim at providing an overview of relevant aspects of the current scientific understanding of our cognitive architecture. These theories are presented here in a succinct way, with the aim to provide an overview of the features of our temporal perception that are central to a temporal aesthetic of video games. A thorough description of each theory would prove impossible in the scope of this study, since they are based on decades or even centuries of scholarship and scientific research.

This study is *not* concerned with the physical properties of time—a subject that widely exceeds the scope of the present analysis. Logically, the video game's temporal characteristics only exist because there is such a thing as a physical arrow of time. But, within the boundaries of simulated gameworlds, the passage of time is much more malleable than it is in real life. Gametime is reversible, it can be slowed down and sped up, and it can be paused. Many, perhaps most, games make use of these forms of temporal manipulation—though they are seldom included as parts of fictional worlds when games depict them. Thus, even though time in video games is attuned to our Middle World cognitive capacities, it presents some features that distinguish it from real-world time.

Some concepts need to be defined before proceeding, including those in the title. Time and Space in Video Games may sound like an overly ambitious heading, but it is one that is justified by the contents of this study.

Time

Time is treated in this study as a "mental construction" (Pöppel 1997, p. 1). Therefore, to understand temporality in a medium created by human minds for human minds, we need to understand how we *arrive* at time—to paraphrase psychologist Ernst Pöppel (1988, p. 10). Temporal perception is a complex construction that "comprises phenomena, such as simultaneity, successiveness, temporal order, subjective present, anticipation, temporal continuity and duration" (Pöppel 1997, p. 1). All of these aspects of time perception are present in the pages of this study.

The structure of time perception is tripartite: we think in terms of past, present, and future. However, as Saint Augustine said:

> "[N]either things to come nor past are. Nor is it properly said, 'there be three times, past, present, and to come': yet perchance it might be properly said, 'there be three times; a present of things past, a present of things present, and a present of things future.' For these three do exist in some sort, in the soul, but otherwhere do I not see them; present of things past, memory; present of things present, sight; present of things future, expectation." (Augustine and Pussey 2008, p. 338)

In other words, concerning our experience, the present moment is all there is; it is the temporal window in which we think and act. Within this window, we can recall information stored in memory and make conjectures about future events. The past is memory and the future, expectation. The mechanisms that allow us to remember and anticipate events are central to the understanding of video game temporality.

The work of several psychologists informs the pages of this study. Most prominently featured is the research of Marc Wittmann,[5] Ernst Pöppel, Alan Baddeley, Karl Friston, Mihaly Csikszentmihalyi, and Walter Michel. The section on causality (1.3) is primarily informed by a theory of linguist Leonard Talmy.

Both the exploration of cognitive-scientific theories of time perception and the formal analysis of games go in tandem. While some chapters are more focused on player psychology and others on the inspection of formal aspects of video games, the theories explored here were chosen precisely because they have the potential to enlighten our understanding of the temporal structures of video games. For this reason, the reader should not expect a comprehensive summary of the cognitive science of time perception, but rather an exploration of those theories that are most relevant to video games. As an example, circadian rhythms, which synchronize our bodily processes according to outside light conditions and coordinate our sleep cycles, are not included in this thesis. While this system is well-understood by psychologists (see for instance Pöppel 1988, pp.

5 For the sake of full disclosure: Marc Wittmann acted as one of the supervisors of this study.

100-110; Wittmann 2012, pp. 89-92), it is not as relevant to the experience of gaming as the selected theories are.

Finally, by temporal structures I mean any device that permits video game developers to display events and arrange them in succession—from lower-level technical aspects of the medium to higher-level design elements. There are many ways in which developers can sequence events, but many sequences are not necessarily determined by the developer; they are dependent on player choice. In a linear game like SUPER MARIO BROS. (Nintendo 1985), where the levels are structured from left to right, the further to the right an object or enemy is, the later it will be encountered. This game exhibits a fairly predetermined succession of challenges when compared to an open world game like THE ELDER SCROLLS V: SKYRIM (Bethesda Softworks 2011), in which the direction of motion is not fixed, and hence the developer cannot entirely foresee the order in which challenges will be encountered. In SKYRIM, players start the game in a city fairly at the center of the game's vast map and, from there, they can go in virtually any direction they please. Nonetheless, both games possess temporal structures and obey some of the same principles, even though they might manifest themselves in different ways. Section 1.2 introduces these temporal structures and the language that will be used in the subsequent pages of this study.

I will refer to the temporality of video games as *gametime*. While several scholars have scrutinized gametime,[6] the game studies literature is still lacking a broad systematic analysis. Providing such an analysis constitutes a fundamental motivation of the present work. One of the main goals of this study is, then, to

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6 A few examples are Espen Aarseth's APORIA AND EPIPHANY IN DOOM AND THE SPEAKING CLOCK (1998); Mark J.P. Wolf's chapter on time in THE MEDIUM OF THE VIDEO GAME (2002b); Juul's papers, INTRODUCTION TO GAME TIME/TIME TO PLAY (2004) and VARIATIONS OVER TIME (2007), and the section of his book HALF-REAL (2005) based on the former; a few papers and book chapters by Michael Nitsche (2007), Serjoscha Wiemer (2018), and Michael Hitchens (2006); and the efforts of José P. Zagal and Michael Mateas (2007, 2010) of the Game Ontology Project. The anthology TIME TO PLAY: ZEIT UND COMPUTERSPIEL (2016) also compiles a series of texts on the topic (including an earlier version of section 2.2 of the present work). Gametime is also discussed with relation to video game narrative, as in the case of the Henry Jenkins' (2004) GAME DESIGN AS NARRATIVE ARCHITECTURE, and Jan Noel Thon's TRANSMEDIAL NARRATOLOGY AND CONTEMPORARY MEDIA CULTURE (2016). Gundolf S. Freyermuth (2015) analyzes the specific ways in which video games can tell stories in space and time with relation to previous narrative media. All of the above-mentioned sources (among others) have informed the pages of the present work.

conduct a formal analysis of the temporal structures of video games. To this end, I will follow the steps of previous scholars and complement their efforts with the direct observation of video games. This work will expand existing models and provide a detailed and systematic understanding of the temporal structures of video games. Additionally, I will examine these structures through the lens of cognitive-scientific theories of time perception, adding a still absent layer to the current understanding of time in video games: The player's mind.

Time and Space

While the title of this thesis is Time and *Space* in video Games, space is only relevant as it relates to and helps us understand time. In the context of this study, a *gamespace* is a computer-simulated, Cartesian coordinate system that is presented to the player on a screen.[7]

Gamespaces can be seen, but time cannot be perceived directly. As stated above, our minds construct time, but there is no specific organ dedicated to time perception—like eyes sense light or ears sense soundwaves—nor a corresponding mental module that processes temporal information (Wittmann 2009, p. 1955). Our sense of time emerges from our bodily processes. Our minds capture

7 Game scholar Michael Nitsche (2008, 15-16) lists five spatial planes relevant to video games: the rule-based space, the mediated space, the fictional space, the play space, and the social space. The definition presented in this text corresponds to Nitsche's mediated space, that is, space as presented by the visual signals of the computer screen. The way we interpret these signals is also of importance to the construction of time, but these mental processes do not correspond to any of Nitsche's planes. Fictional time, defined as "the space 'imagined' by players from their comprehension of the available images," does overlap with time perception, but it is not an accurate enough description of how we perceive time through the processing of spatial cues. We need not "imagine" space in order to sense it. Many of the cues our minds process from the environment never appear in our conscious experience and are thus not accurately described as "imagined."

Text adventure games do not represent fictional space, but they still present a space where words are organized, and thus also have a space in the sense defined above. The spatiality of the *fictional* world of the game, however, is a mental construction that results from the interpretation of language, and is thus not a direct cue that the game provides. Thus, the temporality of these games responds to spatial properties in two ways: one, words are ordered in space, and we read them in a particular sequence by following certain rules (in English, from left to right and top to bottom); and two, in the mental reconstruction of the fictional space (compare Chatman 1978, pp. 96-97).

environmental and bodily information through different senses and can detect if this information remains constant or if it changes. In the words of psychologist Marc Wittmann: "Ultimately, the notion of time is based on the elementary temporal relation of two events, A and B, which can be judged in their temporal order, 'A occurs before B' or 'A occurs after B'" (Wittmann, 2011, p. 2). Our minds register events and assign them temporal labels, which then allow us to determine if something happened before or after something else. When we arrive at a traffic light and see that it is red (event A), we stop and wait until it changes to green (an expectation). Once it changes to green (event B), we can see it change and at the same time recall that the light was red before (a memory). This mundane sequencing task of the different states of a traffic light is habitually performed by millions of people a day, and it would be impossible without an innate capacity to label events according to the order of occurrence.

Physicist Julian Barbour formulated an analogy to Hans Christian Andersen's tale "The Emperor's New Clothes" that works as a fitting description of how we arrive at time: "Unlike the Emperor dressed in nothing, time is nothing dressed in clothes. I can only describe the clothes" (Barbour 2008, p. 2). While Barbour expressed his claim in the context of an argument about the physical nature of time, it accurately describes how our minds construct time. Our brains have no access to time itself (if there is such a thing), but to indexes that we interpret, mostly subconsciously, to construct the notion of time. The events we perceive in the world are time's clothes. Gamespaces are filled with signals that inform us that time has passed. The movement of objects in these spaces is perhaps the most salient. Video games are, in this sense, temporal garments.

The perception of time is therefore dependent on mental states and the ways these are altered by environmental and bodily signals. Aristotle already remarked in his PHYSICS that "when we experience no changes of consciousness, or, if we do, are not aware of them, no time seems to have passed" (Aristotle 1957, p. 383). In the real world, we know that time is constantly passing. Even if there is no motion around us, our bodily processes are always active. In the simulated worlds of video games, time can be paused, and we become aware of this due to the lack of motion on the screen.

Additionally, it is not only objects in space that change state and move in our sensory fields. We also have the capacity to move in space relative to other objects. When I choose to go somewhere (say, the supermarket), I not only think of the distance between my point of departure (my home) and my destination but also of the time it takes me to cover this distance. According to this information, I will decide if it is best to go by foot, ride my bicycle, or take the tram. Space and time are deeply interwoven in our minds, to the point that we understand time in terms of space. We can think of ourselves as moving through time towards a certain event just like we move through space ("I am nearing the day of the exam"), or of events approaching us ("the day of the exam is approaching"). These are the *ego-moving* and *time-moving* metaphors respectively (see Clark 1973; Lakoff and Johnson 1980; Haspermath 1997). Navigation is a central mechanic in numerous video games and, therefore, a comprehensive analysis of the temporality of video games cannot leave space out of the equation (section 1.2 will look further into this topic).

The relevance of space to video games has certainly not gone unnoticed by games scholars.[8] Space has, in fact, received more attention than time in the game studies literature. What has remained somewhat ignored is the importance of space to the structuring of gametime—a key component of the present study.

Time and Space in Video Games

The final term in the title is that of the medium at the center of the question. The video game is a multifaceted medium that defies a definition in terms of necessary and sufficient conditions. The artifacts grouped under this concept can differ considerably: Some are primarily ludic experiences that have rule systems and give players objectives to achieve within a limited frame of action, like TETRIS (Pajitnow 1984); others are more interested in allowing the player to

8 Janet Murray argued for the importance of space in cyberdrama in her influential book HAMLET ON THE HOLODECK of 1997. Murray enumerated four central characteristics of digital narratives, one of which is that they are spatial (1997, pp. 71-90). Espen Aarseth (2000) focused on space in video games in his article ALLEGORIES OF SPACE. Mark J.P. Wolf dedicated a chapter of his book THE MEDIUM OF THE VIDEO GAME (2002a) to space. Henry Jenkins (2004) introduced the concept of narrative architecture in GAME DESIGN AS NARRATIVE ARCHITECTURE. Clara Fernández-Vara, José Zagal, and Michael Mateas (2005) published a paper on the EVOLUTION OF SPATIAL CONFIGURATIONS IN VIDEO GAMES within their broader Game Ontology Project. The anthology SPACE TIME PLAY. COMPUTER GAMES, ARCHITECTURE AND URBANISM (2007) compiles over 50 essays of several scholars, most of which—despite the word "time" in the title—focus on the topic of video game space. Benjamin Beil analyzes the relation between avatars and space in a chapter of his book AVATARBILDER. ZUR BILDLICHKEIT DES ZEITGENÖSSISCHEN COMPUTERSPIELS (2012). The work of Marc Bonner (2015a, 2015b) analyzes video games in relation to space and architecture. Finally, both Michael Nitsche and Stephan Günzel devoted books to the analysis of space with VIDEO GAME SPACES. IMAGE, PLAY, AND STRUCTURE IN 3D WORLDS (2008) and EGOSHOOTER. DAS RAUMBILD DES COMPUTERSPIELS (2012) respectively.

freely discover worlds with rules but without particular objectives, such as in MINECRAFT (Mojang 2009); a further group of games is concerned with telling a linear story that players need to discover as they advance through a gameworld that opposes almost no resistance, as in the case of DEAR ESTHER (The Chinese Room 2012). Most video games are likely found somewhere in between these broad groups.

Ludwig Wittgenstein (2009) postulated in his PHILOSOPHICAL INVESTIGATIONS that some terms are not defined by a set of essential properties. These are open terms with blurred boundaries, and the objects they refer to present a pattern of overlapping features. There is thus no single essential property that all the objects under this type of concept possess. He calls them *family resemblance terms*. The primary example he uses to illustrate his point is the term "game." The characteristics of artifacts under the term "video game" overlap significantly with those under the term "game," but not entirely (compare Freyermuth 2015, pp. 38-41). Following Wittgenstein's logic, this thesis will treat the concept of "video game" as a family resemblance term.[9]

The definition under which this study will operate is that proposed by philosopher and game scholar Grant Tavinor:

> "X is a videogame if it is an artifact in a visual digital medium, is intended as an object of entertainment, and is intended to provide such entertainment through the employment of one or both of the following modes of engagement: rule and objective gameplay or interactive fiction" (Tavinor 2009, p. 26).

This definition does contain some necessary and sufficient conditions that an artifact needs to possess in order to be considered a video game—namely, to be an artifact (that is, a human-made object) in a visual digital medium intended as an object of entertainment. However, it also includes an either/or clause with properties that are *disjunctively* necessary—the employment of *one or both* modes of engagement: rule and objective play or interactive fiction. That is, for an artifact to be a video game, it needs to be either designed to be played with, or to tell an interactive story, or both.

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9 Freyermuth (2015, pp. 35-38) argues that attempts to define video games systematically (that is, in terms of necessary and sufficient features) have consistently failed. These definitions typically exclude artifacts that could be classified as video games, and are vulnerable to new technological and artistic developments. Instead, Freyermuth provides an insightful historical analysis of the evolution of digital games with relation to analogue games and linear audiovisual media, such as film and television.

Sound is not included in the definition because it is not a necessary condition like visual cues, but it does not follow from this that this study will neglect it (and neither does Tavinor's). While sound plays a secondary role in the present analysis, it is too important to both video games and the psychology of time perception to be overlooked entirely.

Tavinor included the entertainment condition to differentiate the video game from "similar artifacts that have purposes besides entertainment" (Tavinor 2009, p. 28). As examples, Tavinor mentions military and commercial flight training simulators and virtual museums. According to this definition, these are not video games because their main purpose is not to entertain but to train or educate (even though they can still be entertaining). Video games can naturally do more than "just" entertain, but entertainment is a necessary condition for an artifact to be a video game while education or training are not.

A key term in the definition is "interactive." Tavinor places it only next to "fiction," but when saying that a video game "is an artifact in a visual digital medium," he is in a way implying that video games are interactive, given that nowadays digital media are typically so. However, the digital nature of a medium does not necessarily make it interactive (compare Beil 2012, p. 46). Before the advent of interactive computers in the late 50s and early 60s, batch processing was the norm.[10] This type of processing entails running a program with no human interaction. The user feeds the computer the instructions and only receives the results once the machine has completed the computations. Nowadays, batch processing is used in combination with interactive computing—for example, when rendering a video in an editor like Adobe Premiere. Interactive computing enables users to influence programs as they are running. In this sense, all video games are interactive. A way to state this point more explicitly in Tavinor's definition would be to say that "X is a video game if it is an *interactive* artifact in a visual digital medium." Even so, the disjunctive aspect of the definition should remain unaltered—that is, with the adjective "interactive" still modifying "fiction." The fully amended definition would then be: *X is a video game if it is an interactive artifact in a visual digital medium, is intended as an object of entertainment, and is intended to provide such entertainment through the employment of one or both of the following modes of engagement: rule and objective gameplay or interactive fiction.* The term "interactive fiction" is still necessary in that it stresses the interactive nature of the fiction itself. A Blu-ray movie, for example, is an interactive digital artifact intended for entertainment, but its fictional aspect (that is, the movie) is not interactive—it is a linear narra-

10 The seminal video game SPACEWAR! (Russell 1962) was created on one of the first interactive computers, the PDP-1, by a group of students at MIT (Levy 1984, 50-69).

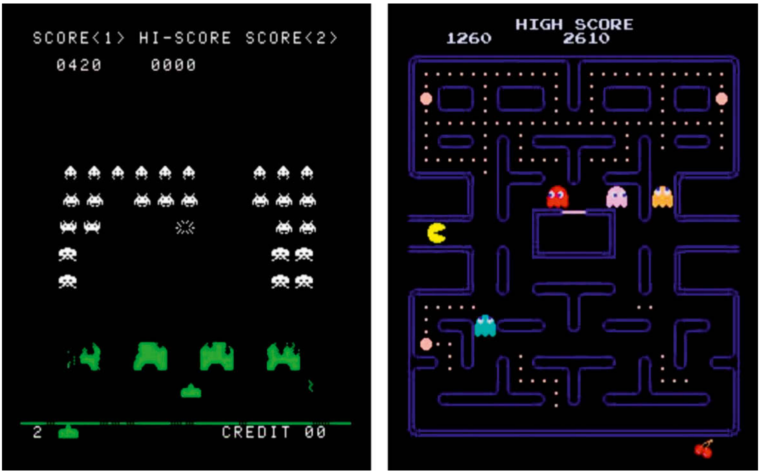
tive that is run by the interactive program (compare Tavinor 2009, p. 32). This precludes Blu-ray movies from being classified as video games.

A further aspect that differentiates video games from other interactive programs is that the latter are typically created to aid the user with an activity and solve problems, while video games pose problems and make tasks intentionally challenging to perform. The word processor I am currently using is meant to aid me with the task of writing, and it is not designed with the purpose to hinder my progress. Ideally, the program would be transparent, allowing me to focus solely on the job at hand and not on deciphering how the program itself works. Similarly, if I press the “add to cart” button on an item’s page on Amazon, I do not want a random number generator determining the likelihood of my success; I want the item to be directly added to my shopping cart, the transaction to run smoothly, and the parcel to show up on time at my doorstep. Video games, on the other hand, are meant to make tasks difficult to accomplish and have indeterminate outcomes. In the words of game designer Greg Costikyan: “games thrive on uncertainty, whereas other interactive entities do their best to minimize it” (Costikyan 2013, p. 15).

Nevertheless, events in video games are not completely uncertain; if they were, it would be impossible to interact with them. They provide what anthropologist Thomas Malaby (2007, p. 96) calls a domain of “contrived contingency.” That is, video games are artifacts designed to generate events and relations between them according to a set of rules. Some events are unchallenging and occur straightforwardly: If the player presses a button, the player character jumps. That is an action that the player would typically want to occur with certainty. But how exactly the jump will be performed (how far or high the player character will jump) can be uncertain and depends on the player’s skill. I will further analyze these topics in sections 1.2, Structuring Gametime, and 2.1, Predictive Thinking in Virtual Space.

The issue with the term “interactivity” is that it manifests on different layers of the medium and other digital media, granting it different meanings depending on where the focus lies. Additionally, the real world is interactive. We interact with other people on a daily basis, and the contents of our own minds constantly interact with each other. The discussion around the term is thus a complex, interdisciplinary hodgepodge (see Beil 2012, pp. 33-54; Neitzel 2012, pp. 80-82). Video games are, on the one hand, interactive in the computer-science sense described above. On the other hand, they also provide visual and auditory information about in-game entities that respond to player input to different degrees.

Figure 1: Space Invaders (left) and Pac-Man (right).



Source: http://www.gamersglobal.de/report/pac-man (accessed February 1, 2018).

The movement of the aliens in Space Invaders (Taito 1978), for instance, follows the same pattern no matter what the player does. Their speed, however, depends on how many invaders remain present on the screen, but it does so according to one fixed rule: The fewer enemies on screen, the faster they move.[11] Other games take player-induced changes into account, like the ghosts in Pac-Man (Iwatani 1980) (the enemies in the game), which track the avatar's location and chase it. If the direction of the action is taken into account, it could be said that the aliens in Space Invaders *react to* and the ghosts in Pac-Man *interact with* the player. Space Invaders is reactive because the actions of the player leave a trace in the gameworld, but the gameworld does not *act back*. In this case, the descending alien block moves in a constant pattern, increases in speed according to one fixed rule, and does not alter its behavior to adapt to the player's actions. In Pac-Man, influence flows in both directions: The player's actions change the game state, but the ghosts change their behavior according to their own objective—namely, kill Pac-Man. More recent games include decision trees or artificial intelligence programs that make their non-player characters (NPCs for short)

11 The acceleration of the aliens' movement in Space Invaders is, curiously, a consequence of processing limitations. The more aliens on screen, the slower the CPU can move them. As the player eliminates aliens, the CPU needs to render fewer of them and, as a result, they move faster. For a detailed technical breakdown see Höltgen 2016 (in German language).

behave in agent-like ways. Their response to the players' behavior is variable and less predictable, forcing players to react in turn. But contemporary games also include entities that simply react to the action of the player character, such as boxes that can be pushed or broken.

Following this train of logic, some game entities react only if the causal chain of events goes in one direction—from the player to the entity. Interaction would take place then only if the causal chain of events zigzags back and forth in at least two directions. "Interaction" is, in this sense, a term that proves useful to speak of agents that influence each other's behavior. In the end, the physical world (including ourselves) could be reduced to a sum of reactions between atoms. Behavior is the result of vastly complex chains of reactions, but it does not make intuitive sense to think of agents in those terms. Instead, we use a shorthand like "behavior" to describe the actions of agents and "interaction" for the mutual influence between two or more agents.

To sum up: If one focuses on the relation between a player and a computer, all video games are interactive. If the focus is on the relation between a player and an in-game entity (disregarding the computer), then there can be interaction or just reaction. In the pages of this monograph, I will mostly refer to video games as "interactive" in the computer-science sense (as opposed to batch processing). The terms of reaction and interaction as one-way or two-way influence will become relevant in different sections, especially in 1.2, Structuring Gametime, and 1.3, Cause, Effect, and Player-Centric Time.

This study concentrates primarily on artifacts that are widely regarded as video games. It is not a search for those video games that handle time in unusual or salient ways, but an effort to analyze the most common aspects of the temporality of the medium. Borderline cases will be taken into consideration, but they can only be identified once a center is defined.

A NOTE ON INTERDISCIPLINARITY

Over a century ago, in his LECTURES ON INTERNAL TIME-CONSCIOUSNESS OF THE YEAR 1905, philosopher Edmund Husserl dismissed psychology for considering it an irrelevant discipline to the phenomenological enterprise (my emphasis):

"Just as a real thing or the real world is not a phenomenological datum, so also world-time, real time, the time of nature in the sense of natural science *including psychology as the natural science of the physical*, is not such a datum" (Husserl 1964, p. 23).

Half a century after Husserl's remark, British scientist and writer C.P. Snow warned of the balkanization of the humanities (back then represented mostly by literary scholars) and the natural sciences (exemplified by physicists) in his lecture THE TWO CULTURES:

> "Literary intellectuals at one pole—at the other scientists […] Between the two a gulf of mutual incomprehension—sometimes (particularly among the young) hostility and dislike, but most of all lack of understanding" (Snow 1961, p. 4).

Nowadays, with disciplines like experimental psychology, neuroscience, and evolutionary biology (and the cognitive sciences in general) providing deep insights into the understanding of the human condition, the humanities cannot afford to look away. The experimental study of the psychology of time—including cognition, neurophysiology, and the mental phenomenon of time[12]—has made so many valuable advances in the past few decades that this thesis will focus predominantly on them as a source of information when it comes to theories of time perception. Some of these advances have even provided evidence for some of Husserl's theories (see for example Lloyd 2012; Wittmann 2011, p. 1). By combining formal analysis of video games with the cognitive science of time perception, the present work attempts to further the consilience of the humanities and the natural sciences.

12 It is important to distinguish between "phenomenology" and a "phenomenon" ("phenomena" in plural). The former refers to the philosophical method of examining human experience started by Edmund Husserl; the latter is a qualitative aspect of subjective experience, such as color, sound, emotion, or duration. It is what things feel and seem like to an observer. Phenomena are studied by phenomenology, but also other disciplines, such as psychology. A phrase like "the phenomenon of time" would then mean how time feels and seems like from a subjective perspective. Phenomena are different to the neurophysiology of time perception, which is concerned with which parts of the brain process information related to time. Even though these two layers are studied by separate disciplines, they are both constituents of time perception, given that phenomena emerge from neurophysiological features. Therefore, both fields should (and do) inform each other. The same applies to any studied aspect of time. We may divide scholarship into disciplines, but the world we study is unitary. The philosophical field of phenomenology is not included in this dissertation, not for being considered irrelevant, but because of scope and time limitations that did not allow me to make an incursion into that literature. For a phenomenological take on the temporality of video games see Grabbe and Rupert-Kruse (2017).

Efforts to bring cognitive sciences into the humanities within the game studies field are already underway, exemplified by the work of Torben Grodal (2003), Andreas Gregersen (2008, 2016) and the anthology edited by game scholars Bernard Perron and Felix Schröter (2016). The present study attempts to contribute to this ongoing effort. Other humanities fields have also served as inspiration for my research: Darwinian literary studies, especially the work by Jonathan Gottschall (2012); cognitive film studies, with scholars like David Bordwell (1989) and the aforementioned Torben Grodal (2009); evolutionary aesthetics, with the work of Dennis Dutton (2009); and philosophy, in particular the work of Daniel Dennett (1991) and Andy Clark (2013, 2015). Additionally, the work of psychologists who have explored topics incumbent to the humanities has also been of great importance. Here the efforts of Steven Pinker (1997, 2003, 2007) and Paul Bloom (2010) stand out as significant influences. Finally, THE GAMER'S BRAIN by Celia Hodent (2018) constitutes a valuable resource that merges psychology and video games from the perspective of user experience design.

An important bridge between the humanities and cognitive science is evolutionary psychology. This discipline studies human psychology through the lens of Darwinian evolutionary theory and has had a profound impact on the work of many of the scholars mentioned above. Applying the principles of natural and sexual selection to the study of human behavior can help explain cultural phenomena in ways that were unthinkable before. The work of Leda Cosmides and John Tooby (1992), the founders of the discipline, is of paramount importance to the epistemological framework of this thesis.

Furthermore, consilience should not only manifest itself in the content of academic research but also in the style and language with which it is presented. This text is written in a reader-friendly way, in clear prose and eschewing unnecessary jargon. In this way, humanist scholars should not have issues with the terms borrowed from cognitive science. In the event that this work might provide insights to psychologists or game designers, I have toned down the humanities' jargon as well. In the cases where specialized terminology is considered helpful or unavoidable, the introduced concepts are duly explained.

STRUCTURE AND CONTENTS OF THE STUDY

The present work is structured in three chapters, which contain three sections each.

The first chapter is entitled Brain Time in Virtual Space. Section 1.1, The State Machine and the Present Moment, discusses the perception of movement and introduces central notions about time perception with a focus on how we experience the passage of time, that is, the "now." The concept of "state machine" is an analogy borrowed from Jesper Juul—who, in turn, took the notion from computer science. It implies that video games are systems that can be arranged in different states at different points in time. This section argues that we construct the temporality of a game by recognizing these states and assigning them temporal labels. Section 1.2, Structuring Gametime, introduces a typology of temporal structures. The goal of this section is to dissect video games into the formal elements and principles that structure their temporality. These will serve as tools for analysis of the temporality of video games and as a language that I will use throughout the remainder of the text. The final section, 1.3, examines our causal intuitions. Games require us to act in ways that yield the results we desire. In order to understand how gameworlds work, we need to engage our sense of causation, which allows us to learn how different entities can affect each other. The perception of causation is rooted in our temporal intuitions, given that it relies on the succession of events, where each event results from a previous one.

The second chapter, Iteration in Virtual Space, is concerned with the role of repetition in gaming. Section 2.1, Predictive Thinking in Virtual Worlds, describes how we become proficient at games through repetition. To explain this, I introduce the notion of the Bayesian brain, which states that the brain estimates the likelihood of an event by combining two sets of data: knowledge stored in memory and the information acquired through the senses during the present moment. The more knowledge we gain by repeating tasks (say, jumping in a platformer[13]), the better we are at predicting the outcomes of events that involve those tasks. Being proficient at predicting states of the environment is crucial for mastering skills. Section 2.2 describes the Groundhog Day Effect, which results from the capacity to reset time in gameworlds by loading previously saved states—a phenomenon that is prevalent in video games. The Groundhog Day Ef-

13 The *platformer* is a game genre where the main mechanic involves jumping from platform to platform. One of the most prominent examples in this genre is SUPER MARIO BROS.

fect is the result of the player traveling back in gametime with knowledge about the future. Since the character is reset with the gameworld, it cannot possess this knowledge. This knowledge gap between the player and the player character can generate issues while telling stories with the medium. The Hybrid Narrator, section 2.3, focuses on how the interactive nature of video games, combined with the iteration that causes the Groundhog Day Effect, complicates the implementation of a narrator. From the combination of retrospective and real-time narration, a hybrid figure arises that seeks to reconcile storytelling with interactivity and constant repetition.

The third and final chapter, Through the Temporal Landscape, examines how the experience of time is not a uniform and constant flow. Temporal perception is akin to traveling through a landscape. We can move faster and slower through it, and it has a perspective that allows us to see forward and backward. The Speed of Time, section 3.1, describes how time passes at different speeds depending on factors like attention and arousal. This section analyzes how video games can modulate our experience of the passage of time. On one extreme, time can appear to pass in slow motion, which is typical of dangerous situations. Games are not hazardous activities, but they implement mechanics that emulate the experience of the slowing down of time. On the other extreme, time can seem to be fast-forwarded. This phenomenon is most discernible in the state of flow that arises when we are deeply focused on an activity—such as playing a video game. Section 3.2, Marshmallows and Bullets, is concerned with the relation between time perception and self-control, a crucial skill to efficiently administer resources. The section analyzes psychological concepts associated with self-control (delay of gratification, temporal discounting, and time perspective) and how they relate to video games in which resource administration is central—paying particular attention to the survival horror genre. Section 3.3, Chekhov's BFG, scrutinizes how games can create expectations through their narrative and mechanics. An analysis of Chekhov's Gun and the difference between "surprise" and "suspense" start this section. Subsequently, these notions are analyzed with regard to game mechanics and accordingly expanded into the medium of the video game.

The entirety of the study is aimed at laying the groundwork for a wide-ranging temporal aesthetics of video games. The first chapter focuses on the perception of the present. The second chapter analyzes the connection between past and future. The third chapter describes how the experience of time (past, present, and future) can be modulated and altered by the relationship between one's goals and the conditions of the environment. These elements, coupled with the work of game scholars and the direct formal analysis of video games, reveal a two-way relation between the medium and time perception: On the one hand, video games are directly shaped by our temporal cognitive architecture. On the other hand, they can modulate our experience and even introduce novel aspects to it—such as resetting time to replay a section of a game.

THE LIMITS OF THE STUDY

Finally, I should point out some constraints of the present study. The main limitation is, ironically enough, time. During the span of a research project such as this one (maybe even a lifetime) there is simply not enough of it to scrutinize the entirety of the literature on time perception. Thus, a selection process was necessary. The extent of our current knowledge of time perception, while still incomplete, vastly exceeds the scope of one single manuscript and would likely span several volumes. As stated above, the theories discussed in these pages have been selected for their capacity to shed light on different aspects of video games. This selection was naturally subject to my own judgment and is not representative of the entirety of the psychology of time perception. Additionally, each of the theories analyzed is highly complex. One research project per theory would likely not suffice to acquire the full extent of the highly specialized knowledge that each of them has to offer. Therefore, this study presents the theories in a succinct way, based on the original studies that support them, but also relying on already summarized accounts—such as review papers and books aimed at non-specialized audiences.

One central preoccupation of this study is to present theories that have an epistemological standing on empirical evidence, and which connect the dots in plausible ways in the context of a naturalist framework. The theories presented here will likely evolve in the future, maybe to the point of becoming different theories entirely, but the empirical evidence they are based on provides solid ground to continue exploring. Some of the approaches discussed in this study are one of many competing frameworks within an area of time perception. Baddeley's working memory model, presented in section 1.1, while accepted by a significant portion of the scientific community, is not the only one available (see Baddeley 2012, pp. 19-22). The pacemaker model described in section 3.1 serves as a heuristic to account for the phenomenon of time dilation, but competing explanations have been put forward (see Wittmann 2009, pp. 1956-1958).

Another characteristic of the theories presented is that they complement each other. The aim was to paint a coherent picture of time perception, which is why I remained within one epistemological framework and did not include theories of, for example, phenomenology—a discipline that has also provided insights into the perception of time, but which can sometimes collide with the models presented above (see Dainton 2017).

Concerning causation, I have chosen to focus on Talmy's theory, since it matches empirical evidence in psychology. Causality as we see it is not "out there," but it relies on assumptions that we make intuitively. Other theories have tried to explain causation as well. The most prominent two were postulated by David Hume (2007) in section VII of AN ENQUIRY CONCERNING HUMAN UNDERSTANDING. The first one states that we learn about causation by observing repeated instances of an event, known as *constant conjunction*. However, the studies conducted by psychologist Albert Michotte (as well as others) showed that we can see causation in single instances. The first time the participants took part in the experiment, they instantly saw a causal relation. The second is the *counterfactual theory* of causation, first formulated by Hume but largely developed by philosopher David Lewis (1973). This theory asserts that the statement "A causes B" is true if the statement "B would not have happened if A had not happened" is true as well. There are several problems with this theory. For instance, events have more than one single cause. If someone lights a match, one could say that the striking of the match caused it to catch fire. But that would overlook other necessary conditions, such as the presence of oxygen, or the absence of wind (Pinker 2007, p. 213). Counterfactual causation requires singling out one cause when in reality every event is the result of a complex contingency. Another problem is known as *overdetermination*, which leads to absurd scenarios such as this one:

> "Consider a firing squad that dispatches the condemned man with perfectly synchronized shots. If the first shooter had not fired, the prisoner would still be dead, so under counterfactual theory his shot didn't cause the death. But the same is true of the second shooter, the third, and so on, with the result that none of them can be said to have caused the prisoner's death" (ibid., pp. 214-215).

There are more issues with the counterfactual theory of causation, but it is still a sophisticated and interesting framework to use in video game analysis, given the capacity of the medium to reset time. Players can change their actions with every iteration to test the different outcomes that can be produced by altering specific variables. In this way, they can engage in counterfactual reasoning. Video games do not solve the problems of the counterfactual theory of causation, but an analysis of the medium through the lens of this theory could still offer valuable insights. To my knowledge, there is still no study that observes video games in this light. I have omitted counterfactual theory from my study in light of said problems and because I chose to focus on human intuition. In that regard, Talmy's model is the most pertinent.

Concerning the analysis of video games, the limitations are twofold. First, just like with the literature on time perception, there is not enough time to observe every game out there.[14] Second, the video game medium evolves at an intense speed, and it proves challenging to keep up with the development of franchises and genres. Nowadays, thousands of video games are released within the span of a research project, with both their technology and design moving forward within this period of time. This study analyzes a wide range of games and game genres, focusing on landmark games (for example SPACE INVADERS, SUPER MARIO BROS., DOOM (id Software 1993), RESIDENT EVIL (Capcom 1996), and HALF-LIFE (Valve Corporation 1998)) and selecting artifacts that can be uncontroversially categorized as video games. At the same time, it keeps an eye on borderline cases that expand the limits of what video games usually do (such as allow the player to rewind time or feature retrospective narrators that react to the player's actions). There is unfortunately still no clear methodology to select a sample of video games in the game studies field, and this dissertation does not constitute an improvement in that regard.

Still, this study sheds light into significant aspects of video games through formal analysis and the presented theories of time perception. All of the formal features of video games discussed here are directly observable in a multiplicity of games, as the examples will show. No feature mentioned in this work is hypothetical or representative of an ideal that video games should strive for. This study is solely based on the description of observable characteristics of video games, and anyone who plays them should be able to see them, too. An additional objective of this analysis is to offer useful insights to game designers, providing them with tools to reflect on how they treat time in their games.

Finally, each aspect analyzed in the following pages could be subject to future examinations that could further expand both the understanding of formal characteristics of video games and of the pertinent theory (or theories) of time perception. It is certainly not the aim of this study to exhaust the possibilities of analysis, but rather to provide a foundation upon which a temporal aesthetics of video games can be built. The cited efforts of game scholars in this regard are of crucial importance, and the account presented here would not exist without them.

14 According to the website Steamspy (2017), 6,912 games were released on Steam in 2017 alone. This number still does not include games that were released for consoles, mobile devices, and those for the PC that are not available on Steam.

Brain Time in Virtual Space

The State Machine and the Present Moment

The perception of time is based on change. Therefore, the first thing a medium needs in order to be time-based is the capacity to change states. Each change of state is an event. The simple act of a pixel altering its color, or its location in space, allows us to perceive the difference between the earlier and the later state, and thus infer that time has passed.

Time is always passing in the real world, but in mediated worlds this is not necessarily the case. Different media represent time in different ways,[1] and these representations can vary from our everyday experience of it. Photographs, for instance, are still images that freeze a particular moment in time. Movement in this medium can be implied, but never actually shown. Thus, a speeding bullet piercing through an apple becomes an image of a bullet floating still next to an apple with two bursting orifices: one right behind the projectile and the other one on the opposite side of the fruit. From this image, we can infer that the bullet came in through one side of the apple and tunneled its way to the other at high speed.

Film offers the capacity to record and display a fragment of time by taking and then projecting sequences of static photographs at fast rates, causing us to perceive one continuous moving image. After the popularization of the moving image through film, television brought it into the living room and, more recently, digital video made it possible for moving images to be transmitted through the Internet into all sorts of devices, some of which can even be carried around in our pockets.

With moving image technologies, the capacity to slow down or speed up the passage of time is afforded, with slow motion and time-lapse techniques respec-

1 For a comparative analysis of the treatment of space and time in film and games (and other audiovisual media) see Wolf 2002b (pp. 77-80) and Freyermuth 2015 (pp. 131-139).

tively. By dilating time, we can see the heaving cheek of a wrestler as it is struck by its opponent's knuckles, or a corn seed slowly bursting into popcorn and rising from the pan into the air in a mist of floating oil drops. Time can also be compressed in order to witness events so slow that they would otherwise appear static. As a result, we can experience the long-drawn growth of a plant in just a few seconds.

Just like film and television, the video game is a member of this family of moving images, and it commonly uses the same display technology as the latter: a screen composed of a matrix of dots called a raster. These come in different forms, from the CRT screens used to play PONG (Atari 1972) in the '70s, to current OLED screens, and can display sequences of frames at high speeds that we perceive as a constant, moving image.

APPARENT MOTION

The moving image is a temporal illusion. It is what psychologists Ramachandran and Anstis call "apparent motion," that is, perceiving an "intermittently visible object as being in continuous motion" (Ramachandran and Anstis 1986, p. 102). Real motion, in contrast, is the perception of continuously moving stimuli in the visual field. A football match watched in a stadium constitutes real motion, whereas the same event watched on TV is in apparent motion. Since movement in video games is apparent, this section focuses exclusively on this perceptual category.

It was commonly believed that we are able to perceive movement from a series of still images thanks to a phenomenon named *persistence of vision*. According to this account, the light irradiating from the screen leaves an impression on our retina that lasts for a few fractions of a second after the source image disappears. The retina is therefore unable to register the changes in light that happen between the moment it gets stimulated by light and the end of this short time frame. This, so the theory goes, is the reason why we do not see the blackness in-between movie frames and the image projected onto the screen seems to be in motion. Persistence of vision approximates what perceptual psychologists call the *flicker fusion threshold*, but it merely solves the problem of why the image on the screen seems continuous instead of being perceived as a blistering slideshow (Anderson and Anderson, 1993, p. 4). The problem arises with the claim that the illusion of movement is a result of persistence of vision, a pervasive misunderstanding in some academic quarters in the previous century, especially in film studies (compare Anderson and Fisher 1978, and Anderson and Anderson 1993).

Back in 1978, Joseph and Barbara Anderson (née Fisher) wrote a paper entitled THE MYTH OF PERSISTENCE OF VISION, in which they rebuked the notion that this phenomenon can "account for the perception of the successive frames of a motion picture as a continuously moving image" (Anderson and Fisher 1978, p. 6). A decade and a half later, they revisited this argument in the aptly-titled paper THE MYTH OF PERSISTENCE OF VISION REVISITED (Anderson and Anderson 1993). The motivation to do so was not to make amendments to the original rationale, but to insist upon it, since the mistaken belief persevered despite their initial efforts to debunk it.

In these papers, Anderson and Anderson point out that the notion of persistence of vision originated from the misrepresentation of an article by the British physician Peter Mark Roget and the assumptions of 19th-century psychologists. Anderson and Anderson also stress that persistence of vision could not possibly account for why we perceive movement. Even without noticing the blanks in-between the frames of a film, we could just as well experience something reminiscent of Marcel Duchamp's "Nude Descending a Staircase," where images from consecutive moments in time would superimpose in overlapping layers (Anderson and Anderson 1993, p. 4). But while we are fully aware that, when watching film or television, we are looking at a series of images in very rapid succession,[2] the illusion overcomes our perception and we only see one continuous image in motion. When Forrest runs, we see him running. When Mario jumps, we see him jumping.

One clear indication that the perception of movement occurs at the level of the brain (and not the retina) is the rare condition known as *akinetopsia* or motion blindness, which appears as a result of a lesion to the visual cortex (Zeki 1991). Those suffering from this ailment in its most extreme form cannot perceive movement. They can see stationary entities, but these vanish from their perception when in motion. It is thus highly implausible that the perception of movement could arise solely as a retinal phenomenon. Movement occurs within the brain. This has been the understanding in psychology since the early 20th century, starting with psychologists like Max Wertheimer (1912), one of the founders of Gestalt psychology.

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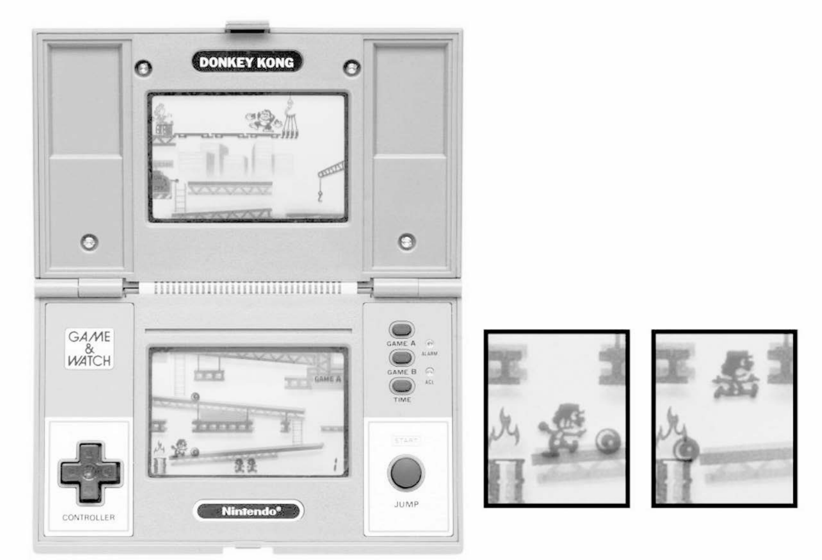
2 There are significant technical differences between how film projectors and television sets (and even between different types of television sets) display images, which are not relevant to the current argument. The important factor in the context of this study is that both technologies work by displaying several frames per second, which enables the perception of apparent motion.

Figure 1.1: DONKEY KONG GAME & WATCH (1982).



Source: http://pica-pic.com/ (accessed June 04, 2019).

Left: The avatar is on the ground, to the bottom-left of the lower screen.
Right: Detail of two frames of the avatar jumping.

Consider for instance electronic handheld games like the GAME & WATCH[3] series released by Nintendo in the 1980s. These are portable consoles with one single game. Their rudimentary LCD screens show a few interactive elements on top of a fixed background. These elements are static black shapes, like paper cut-outs, that represent the avatar and the enemies or obstacles, as seen in figure 1.1. When pressing the jump button, the image of the avatar disappears and one with the same design but in a different pose instantaneously pops up above it. From this, the player can intuitively infer that the avatar has moved, and not that it has disappeared and reappeared a few millimeters higher. A brief moment after the jump, the figure on top vanishes and the one below is displayed once again, implying that gravity pulled the avatar back down to the ground. There is nothing smooth or continuous to this animation, but no effort is needed to perceive

3 Digitalized versions of several electronic handheld games, including some of the GAME & WATCH series, can be found on http://pica-pic.com/ (accessed August 25, 2016).

movement; the illusion simply ensues. On the contrary, an extra effort would need to be exerted to avoid seeing movement.

That this simple technology achieves an illusion of movement already hints at a constitutive feature of the human mind: Our perception is not solely dictated by the bottom-up processing of stimuli, but it also involves the implementation of top-down assumptions about the world (I will explain this in more detail in chapter two, section 2.1). The fact that the GAME & WATCH figures at the top and the bottom possess the same characteristics allows the brain to connect the dots and infer that it is seeing the same character that has changed position. The information captured by the retinas is being processed and interpreted as movement in the brain's visual cortex. If the two figures were a red square and a green triangle, the brain would have more difficulty interpreting the signals as the product of movement.

According to Ramachandran and Anstis (1986, p. 1), the first feature needed to perceive apparent motion is *correspondence*. Players can see the figure jump in DONKEY KONG because it retains its characteristics with only a slight change of pose. The consistency of features allows our visual perceptual system to detect an object and follow it in space.

Correspondence alone, however, is not enough to fully explain the perception of motion. A series of ingenious experiments by Ramachandran and coworkers (Ramachandran and Anstis 1986) have shown that the brain also makes assumptions about how objects in the world behave:

1. "Objects in motion tend to continue their motion along a straight path. The visual system perceives linear motion in preference to perceiving changes in direction" (ibid., p. 105).
2. "Objects are assumed to be rigid; that is, all points on a moving object are assumed to move in synchrony" (ibid., pp. 105-106).
3. "A moving object will progressively cover and uncover portions of a background" (ibid., p. 107).

If all of these conditions are in place, the illusion of movement ensues effortlessly through the mere act of watching. A way to challenge players is to violate these principles, making it harder for them to follow objects in motion.

This capacity of the video game medium to elicit the perception of apparent motion does not differ from what film and television can accomplish. But video games do diverge in one substantial respect from other moving images: They are *interactive*.

THE STATE MACHINE

Game scholar Jesper Juul argues that games are *state machines*, a term he borrows from computer science: "a state machine is a machine that has an *initial state*, accepts a specific amount of *input events*, changes state in response to inputs using a *state transition function* (i.e., rules), and produces outputs using an *output function*" (Juul 2005, pp. 59-61).[4] This notion applies both to analog and digital games. The state machine is thus defined by the rules, which allow for input from players and produce an output that informs them of the current state of the game.

In board or card games, the elements used to play the game keep track of the game state. In chess, these are the board and pieces; in poker, the cards on the table and in each player's hands, and the chips used to place bets. In the case of chess, the whole game state is accessible to both players. In the case of poker, the game state is partly hidden from players, who only have access to the shared information on the table and their own hand (other player's hands and the cards in the deck are hidden parts of the game state).[5] The state machine includes not only the positions of the pieces on the board or the cards and chips, but also the rules that determine what those elements can do at any time in the game. Pawns in chess can only move forward, one square at a time, but capture other pieces diagonally; to get a flush in a game of poker you need five cards of the same suit that do not form a sequence.

In single-player video games, the interaction occurs between a computer and a player. The computer runs a program (the game) that keeps track of its own states. The program informs the player of these states primarily through image and sound. What the player perceives, then, is the state of the mediated gamespace. The player processes this information, chooses a course of action, and provides the inputs required to set the strategy in motion. These inputs are

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4 Programmers might find this analogy disorienting, since finite state machines are one of the programming patterns that can be used to code games (see Nystrom 2014). But the use of "state machine" in this passage shouldn't be taken too literally. Despite this potential confusion, I believe that referring to video games as state machines can be a productive analogy.

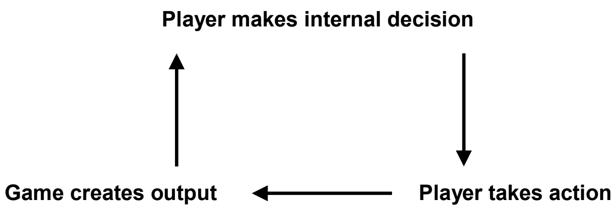
5 Mark J. Thompson distinguished between games of *perfect* and *imperfect* information. Chess does not conceal any information from players and it does not include random mechanics like dice. Therefore, it is what Thompson calls a game of *perfect* information. In poker, on the other hand, players hide their cards from their opponents, which makes it a game of *imperfect* information (Thompson 2000).

commonly made with a controller or mouse and keyboard. The program then updates its state to reflect the incoming information.

While playing a game of TETRIS, the game controls the speed at which the tetrominoes descend and the order in which different pieces appear. The program also keeps score, and draws the image and reproduces the sounds that constitute the game's output. The player can accelerate the pieces' descent, rotate them left and right in 90-degree angles, and can determine their position on the horizontal axis. In more complex games, the variables controlled by both the player and the program itself can be much higher in number.

Game designers Katie Salen and Eric Zimmerman summarize the process of interacting with a game (whether analog or digital) in a concise three-part diagram:

Figure 1.2: Gameplay loop by Salen and Zimmerman.



Source: Salen and Zimmerman 2004, p. 316.

Complex states can arise from this gameplay loop even in games in which players have a minimal range of action—like TETRIS. This is the concept of *emergence* (Schell 2008, pp. 140-143; Salen and Zimmerman 2004, 163-165). With just a simple set of moves, players can participate in the formation of intricate patterns of action and reaction from which new game states emerge. The combination of simple elements can shape the state machine in unexpected ways. Salen and Zimmerman note that "[a] successfully emergent game system will continue to offer new experiences, as players explore the permutations of the system's behavior" (2004, p. 165).

While the computer runs the game, processes player input, and sends output signals with its state-changing peripherals, the player's mind is continually constructing a moving picture of the state of the game. This picture is our conscious experience, which takes place in the window of time we call the present.

THREE MOMENTS IN TIME

The *now* in which we live our lives and play our games is a laborious mental construction. It is not a slice in the constant flow of time, but rather a window that integrates both the proximate future and the immediate past. Husserl called the traces of the past *retention* and the anticipation of future events *protention*. Philosopher Dan Lloyd exemplifies this with the Beatles' song "Hey Jude":

"[Experiences] occur and leave their traces in 'retention,' like a comet's tail. As Paul McCartney lands on 'Jude,' the 'Hey' is retained though no longer sensed. Likewise, as 'Jude' sounds, we anticipate something to follow ('Don't make it bad,' if one knows the song, or something less definite) – this is 'protention'" (Lloyd 2012, p. 696).

Building on a dual taxonomy first proposed by Ernst Pöppel (1997), psychologist Marc Wittmann speaks of three *moments in time* (table 1.1) that constitute our experience of the present: The *functional moment*, the *experienced moment*, and *mental presence* (Wittmann 2011; 2015, pp. 54-62). These perceptual units are nested like a Russian doll of temporal awareness, with their boundaries demarcated by different time frames that span from mere milliseconds to a few minutes.

Table 1.1: The three moments of present experience.

Moment	**Duration**
Functional Moment	Milliseconds 30 ms – 300 ms
Experienced Moment	Few seconds 300 ms up to 3 seconds
Mental Presence	Several seconds up to a few minutes

Source: Wittmann 2015, p. 58.

The Functional Moment

The *functional moment* is the basic building block of our temporal consciousness. It is the level at which the brain discerns if events happen simultaneously or non-simultaneously. At this stage, the brain operates in spans of milliseconds.

Given that the brain needs time to process stimuli, our experience of the present can lag behind the actual occurrence events for hundreds of milliseconds. In addition, different senses operate at different temporal resolutions: Auditory signals function at the highest temporal resolutions, meaning that they are transduced quickly, whereas visual signals require the longest time, and thus operate at the lowest temporal resolution. Acoustic stimuli that are merely two or three milliseconds apart can be perceived as non-simultaneous. For visual signals this gap extends to over ten milliseconds (Pöppel 1988, p. 16; Wittmann 2011, p. 2). Within the "window of simultaneity" (Pöppel 1988, p. 12) stimuli always appear to be concurrent, even if there is an objectively measurable time difference between them. The temporal limit of this window of simultaneity for sound signals is around four-thousands of a second (Pöppel 1988, pp. 18-19). Two clicks, each one millisecond long, played one or two milliseconds apart, would sound simultaneous. In fact, they would seem like one single click—a phenomenon called *click fusion* (Pöppel 1988, p. 11).

As perplexing as it may sound, detecting the non-simultaneity of two events does not necessarily imply that these are perceived in succession. Within particular time frames, it is possible to recognize the non-simultaneity of two events without being able to determine which happened first and which second. If you hear two consecutive clicks, they would need to be around 20 to 40 milliseconds apart for you to be able to tell in which order they were played (Pöppel 1988, p. 19; Pastore and Farrington 1997; Wittmann 2011, p. 2). You would hear that they are non-simultaneous if they were, for instance, ten milliseconds apart. The window of simultaneity varies from sense to sense, but this sequencing threshold of 20 to 40 milliseconds is the same for at least touch, sound, and vision (Pöppel 1988, p. 19). Under the sequencing threshold and over the window of simultaneity, Pöppel speaks of "incomplete subjective simultaneity." Within the window of simultaneity below four milliseconds, we experience "complete subjective simultaneity" (Pöppel 1988, p. 19).

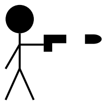
Following Pöppel, the pulse of our temporal consciousness is around 30 milliseconds (on average). In other words, our perception of time is divided into discrete building blocks of a few tens of milliseconds. Below this threshold, we are unable to perceive sequence or duration. To assess the length of any independent stimulus, we would need to clearly determine the point A in time when it started and the point B when it ended—a sequence of events. That is, the stimulus would need to be longer than the window of simultaneity (Wittmann 2011, p. 3). All of this also implies that the seamless flow of our experience of time is a fabrication after the fact.

To ensure that a game's controls feel responsive, it is crucial to provide feedback to player input as close as possible to the window of simultaneity. Jesse Schell maintains that "[g]enerally, it is a good rule of thumb that if your interface does not respond to player input within a tenth of a second, the player is going to feel like something is wrong" (2008, p. 231). Several factors influence the responsiveness of a game, some of which are not under the control of the developer (such as the refresh rate of the screen the player is using). One crucial factor is the frame rate at which a game runs. The reason why gamers tend to obsess with this variable is not so much the smoothness of movement on the screen, but the responsiveness of the game. If a game runs at 30 frames per second, movement will be displayed in increments of 33.3 milliseconds. This is slightly above the average threshold to perceive simultaneity. Even if a game displayed the response on the very next frame after a button press, this frame rate is still dangerously close to the limit where we stop perceiving it as simultaneous. At 60 frames per second, that value descends to 16.6 milliseconds, enabling a response to player input below the threshold where we start to detect sequence.

Mick West, the co-founder of Neversoft Entertainment (TONY HAWK'S PRO SKATER (1999), GUITAR HERO III: LEGENDS OF ROCK (2007)), succinctly explains the challenge of programming a responsive game in a Gamasutra feature (West 2008a). As seen in table 1.2, West demonstrates that at least three frames should elapse from the moment the player presses a button until visual feedback is displayed on-screen. When playing a third-person shooter, for example, if the player presses the shoot button, one frame is missed on the press. In frame two the input is read, the logic state is updated, and the CPU (Central Processing Unit) performs its part of the rendering. In frame three, the GPU (Graphics Processing Unit) renders the state. In frame 4, the new game state is finally displayed, that is, the character shoots.

The game loop is what makes the clock in virtual worlds tick. Each loop will produce a frame, and the faster the loop runs, the more frames per second the game will have. A game running at 30 frames per second will then take 3/30^{ths} (that is, one-tenth) of a second to display feedback. This equals 100 milliseconds, which is considerably over the sequencing threshold of 30 milliseconds. Running at 60 frames per second, the time the game will take to display feedback is of 3/60th (or one-twentieth) of a second, which equals to 50 milliseconds. While this is a substantial improvement, it is still slightly above the threshold.

Table 1.2: The Game Loop.

Input	CPU	GPU	Output
Frame 1 Pressed	Read Input	GPU Rendering	
	Game Logic		
	GPU Logic		
Frame 2 Processed	**Read Input**	GPU Rendering	
	Game Logic		
	GPU Logic		
Frame 3 Rendered	Read Input	**GPU Rendering**	
	Game Logic		
	GPU Logic		
Frame 4 Visible	Read Input	GPU Rendering	
	Game Logic		
	GPU Logic		

Source: West 2008a.

After the player's input, it takes a game at least three frames to create visual feedback.

However, games are perfectly playable at 60 or 30 frames per second.[6] This is because the window of integration for multimodal stimuli (that is, pertaining to more than one sense) is larger than for unimodal stimuli. These integration periods can vary considerably, depending on the length of the stimuli, their frequen-

6 The gaming news website IGN offers a table that compares the resolutions and frame rates of several video games on Xbox One and PlayStation 4 (IGN Xbox One Wiki Guide 2019). Though the data are not necessarily reliable in every case, the table shows that the standard frame rates for both mainstream consoles are 30 and 60 frames per second.

cy, and the senses involved (Wittmann 2011, p. 3). Pressing a button and receiving mediated feedback requires the integration of tactile, visual, and auditory stimuli. The duration of these integration tasks is in the order of hundreds of milliseconds, varying from 100 to 250 depending on the complexity of the stimulus. At best, this should be tested in every individual case. Still, it remains true that, the closer the feedback is to the window of simultaneity, the more responsive controls will feel.

In a follow-up piece, West (2008b) describes how he measured the responsiveness of GRAND THEFT AUTO IV (Rockstar North 2008). The technique he uses is clever and simple: he uses a video camera to record the screen and his hand pressing the button at the same time and then measures the response of the game by counting the frames in the video. That is, if in the video West presses the trigger to fire the handgun at frame one, the frames it takes for the game to display the feedback on the screen will show the delay. In West's measurement, GTA IV exhibits a delay of ten frames or 166 milliseconds.[7] This responsiveness dangerously approaches the upper limits of what our perception can synchronize. We do not perceive this time difference directly, but sense that something is odd instead. West describes this feeling as the game being "laggy" or "sluggish."

The speed at which sound is processed speaks to the importance of auditory feedback in video games. Visual feedback is crucial but, when it comes to quick reactions (as in games of skill), it is imperative to pay attention to acoustic signals. For this very reason, the start of a race is signaled with a gunshot instead of a flash. Even though light reaches the runners sooner than sound, a bang is processed faster than a flash, allowing for a swift, almost involuntary reaction. There is however a limit to how quickly we can react to stimuli. The fastest we can respond to an auditory stimulus is 120 milliseconds (the average is 150 to 200 milliseconds) (Anson 1982). From there, reaction times to auditory stimuli can only go up. For visual stimuli, the reaction limit is of approximately 150 milliseconds (with the average at 250 to 300 milliseconds) (Najenson et al. 1989; Jaskowsky et al. 1990). This difference of 0.05 seconds in reaction speed does not seem like much, but it can have an impact in video games where quick reaction times are key for success, such as fighting games like STREET FIGHTER V (Capcom 2016) or competitive first-person shooters like OVERWATCH (Blizzard Entertainment 2016) (compare Pöppel 1988, pp. 23-32).

7 The refresh rate of the television used can produce a greater delay. West used an LCD TV, which actually added lag, bringing the responsiveness of the game up to 200 ms.

The Experienced Moment

At the next level of our temporal consciousness, the window expands from the 0.03 to 0.3 seconds of the *functional moment* to around three full seconds. This three-second span is what Wittmann calls the *experienced moment*, in which our feeling of *nowness* unfolds. This fact has led Pöppel to express his famed law that "we take life three seconds at a time" (Pöppel 2004).

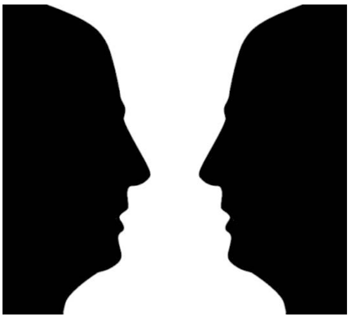
This three-second time window is the longest possible duration of the now, "the temporal limit of consciousness" (Pöppel 1988, p. 49). As author Claudia Hammond puts it: "It is as though every few seconds the brain asks what's new" (Hammond 2012, p. 76). If the context so requires it, the "now" can compress into shorter integration periods. We can even do this actively when focusing on a particular stimulus. Pöppel illustrates this with the example of a metronome: By setting the metronome to 120, one can hear two beats per second. The interval is constant, and each beat sounds exactly the same, but by directing our attention, we can actively bundle the beats into differently sized units—as if we heard "one, two; one, two" or "one, two, three; one, two, three." Here lies one of the main differences between the functional and the experienced moment: in the former, we are passive recipients of stimuli and, in the latter, we acquire some agency as to how the stimuli are perceived (Pöppel 1988, 66; Wittmann 2015, pp. 58-59).

As long as the interval between beats remains around one second, they can be effortlessly integrated into patterns. If the intervals are stretched, there comes a point where it is impossible to keep binding the beats together. At intervals of 2.5 to 3 seconds, the subjective integration of beats into units becomes impossible for most people (Pöppel 1988, pp. 53-54). Beyond this threshold, the interval becomes too long, and it replaces the stimulus (the beat) as the focus of attention (Wittmann 2011, p. 5).

The effects of the three-second present have also been observed in speech and poetry. Spontaneous speech is divided into individual utterances. After each unit of utterance, speakers pause to plan the next one. These units do not surpass the circa three-second limit. The effect is not always observable when reading aloud, because, in that case, the speaker does not need to pause to plan the next utterance. In spontaneous speech, however, the three-second boundary was observed in languages like English, German, Chinese, and Japanese. Children of all ages also speak in units of three seconds. As Pöppel remarks, this is especially notable in children under ten years of age, who speak more slowly than adults but still in three-second units (Pöppel 1988, pp. 71-73). Studies of poetry in several languages (including English, French, Japanese, Latin, and ancient Greek) conducted by Pöppel and poet Frederick Turner have also shown that the majority of poems are structured in three-second verses. Pöppel also notes that the same holds for poetry with longer verses, such as hexameter and pentameter. In these cases, lines are subdivided into three-second utterances when recited. Deviations tend to manifest below three seconds of duration, with the exception of some postmodern poetry, which does go above the limit of the experienced moment (Pöppel 1988, pp. 75-81).[8]

In vision, bi-stable stimuli like the Rubin vase (figure 1.3) or the Necker cube (discussed in section 2.1) provide further evidence of the experienced moment (see Wittmann 2012, pp. 58-59). The Rubin vase (named after psychologist Edgar Rubin) is an ambiguous figure with two possible interpretations: it can be seen either as a white vase on a black background or as two black profiles facing each other on a white background. These two interpretations switch every two to three seconds unless we direct our attention to one of them earlier—in which case the switch can happen faster. However, even when we purposely focus our attention on say, the vase, it is not possible to maintain this interpretation for long, as the brain will change it by itself when the three-second window is over.

Figure 1.3: The Rubin vase.



8 It should be noted that postmodern art is characterized (among other things) by the abandonment of the value of beauty. While beauty standards can and often are culturally defined, many aspects of beauty are related to our cognitive dispositions. Considering the evidence supporting Pöppel's claim that poetry structured in three-second intervals tends to be preferred, it should in fact be expected that postmodern poetry would reject this structure. Thus, postmodern poetry, with verses that surpass the duration of the experienced moment, is still in line with Pöppel's assertions.

Studies have also found evidence for the duration of the experienced moment in tasks involving sensory-motor control. In one of them, participants were presented a sequence of tones that played in intervals from 300 milliseconds up to 4800 milliseconds. Participants then needed to synchronize taps to the rhythm of these sounds. At intervals longer than 2400 milliseconds participants could not follow the timing and synchronization started to break down. The margin of error increased in proportion to the distance between intervals (Mates et al. 1994). A further study analyzed behavioral data collected from different cultures (Europeans, Trobriand Islanders, the Yanomami people, and Kalahari Bushmen). It showed that human short-term, goal-directed behavior is universally segmented in three-second units of movement (Schleidt et al. 1987).

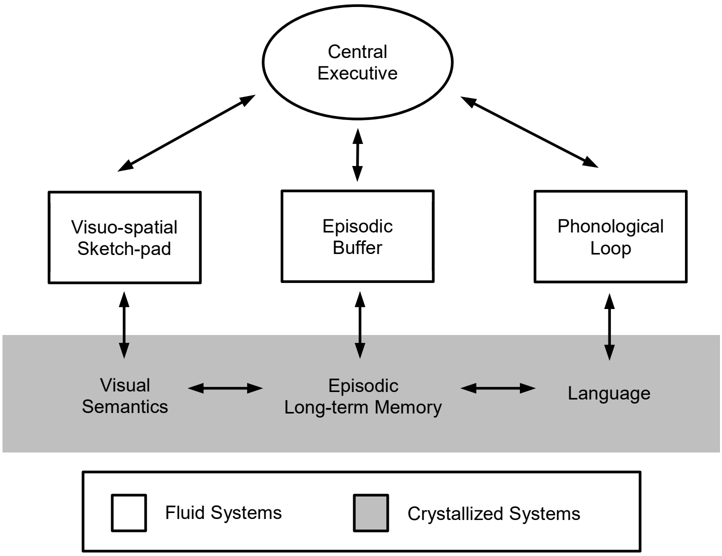
How the experienced moment manifests in video games remains to be examined. It could be hypothesized that player character animations (attacks, jumps, weapon reloads, movement cycles) tend to stay within the three-second time window. While this seems likely, only systematic observation could confirm if it is true. The performance of combos in fighting games could also display these segmentations. For developers, it is essential to keep the duration of the experienced moment in mind when animating and designing game mechanics. While the responsiveness of a game is detected at the range of milliseconds, activities that require synchronization or the integration of events into bundles should remain within this time window for ease of interaction.

Mental Presence

Beyond the limits of the experienced moment lies what Wittmann calls *mental presence*, the third level of our temporal awareness (Wittmann 2011, p. 5). The mechanism operating at this level is working memory, which allows us to retain visuospatial, phonologic, and episodic representations for periods that can exceed the three seconds of the *now*: "An *experienced moment* happens *now*, for a short but extended moment. *Mental presence* encloses a sequence of such moments for the representation of a unified experience of presence" (Wittmann 2011, p. 5). The temporal boundary of mental presence is much fuzzier than those of functional and experienced moments. Our mental representations progressively lose resolution until they are erased from working memory. Some information might be stored in long-term memory for later recollection, but most of the representations vanish eventually. The information kept in working memory can be obtained from sensory data or retrieved from long-term memory. But working memory is not simply a storage space—the term "short-term memory" is used to refer to this particular aspect of working memory (Baddeley 2012, p. 4). It is also a system that can manipulate information.

Starting in the 1960s, psychologist Alan Baddeley has conducted groundbreaking research that led to what is now perhaps the most widely accepted model of working memory (see Baddeley 2003, 2012). This model proposes several components of the system and describes their interactions. In figure 1.4, the top four elements labeled as *fluid systems* represent working memory. These are the *central executive*, the *visuo-spatial sketch-pad*, the *episodic buffer*, and the *phonological loop.*

Figure 1.4: Baddeley's working memory model.



Source: Baddeley 2012, p. 16.

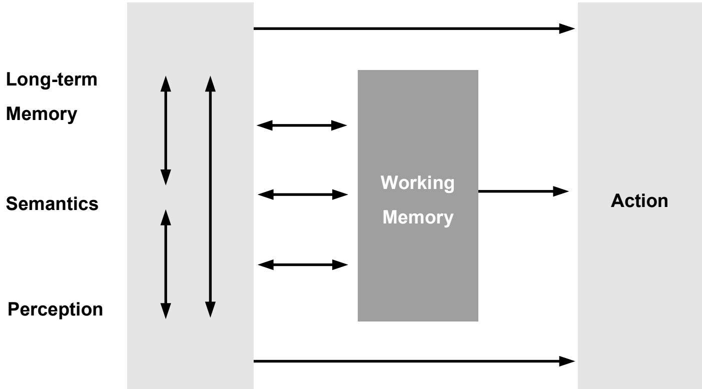
The central executive is our spotlight of attention. It can divide attention between two stimuli, switch tasks, and retrieve information from long-term memory. The visuo-spatial sketch-pad specializes in the storage and processing of visual information (color, shape, movement), and the phonological loop on auditory information (pertaining also to language). The episodic buffer works as storage for information from diverse sources, integrating stimuli into coherent perceptual phenomena. Information like touch, sound, or image is processed in different areas of the brain at different speeds. The episodic buffer creates a unitary representation of events in which all the different stimuli are bound together. The episodic buffer is also capable of binding information creatively, which allows us to fantasize about winged horses and talking snakes. Moreover, it allows us to organize different events in narrative sequences. The combination of the creative and narrative capacities of the episodic buffer enables us to anticipate future events (prediction will be further discussed in chapter 2.1). Baddeley also hypothesizes modules of working memory specialized in smell and touch, but these remain to be studied (see Baddeley 2012).

The grey area in figure 1.4 features elements of long-term memory (the crystallized systems) that interface with the different aspects of working memory. Working memory depends on systems in long-term memory in order to function. The different sets of information stored in these crystallized systems are loaded into working memory and bound together in the episodic buffer. To process language, for example, we save the vocabulary and grammar of the language we speak in long-term memory. This information is then loaded to working memory when conversing or reading. Episodic long-term memory, also referred to as our "narrative self" (Wittmann 2011, p. 5), is the information of past events that provides us with a general story of our lives.

Long-term memory is commonly divided into two main parts according to type of information encoded: *declarative* and *procedural* memory (Cohen and Squire 1980). Declarative knowledge is data-based and can be expressed—names, telephone numbers, email addresses, or a conversation we had with someone. Procedural knowledge is rule-based and related to actions—driving, riding a bicycle, playing the piano, or playing SUPER MARIO BROS.

Our behavior can be influenced by long-term memory either directly or indirectly through working memory (figure 1.5). In the case of runners hearing the starting gun, for example, the bang directly sets them in motion. This reaction can be trained to become instantaneous, almost like a reflex (but not an innate reflex like moving the hand away from a hot stove). In this example, the procedural information in long-term memory on how to perform the start (acquired through training) is associated with the bang to cause action directly. Working memory influences action when making more complex decisions that require deliberation and when an instant reaction is not necessary. Ernst Pöppel talks of *simple reactions* in the first case and *decision reactions* in the second (Pöppel 1988, pp. 23-32). In simple reactions, one stimulus is connected to one response. Decision reactions can vary in complexity and are much more malleable.

Figure 1.5: Baddeley's view of the links between long-term memory and working memory.



Source: Baddeley 2012, p. 18.

A critical aspect of working memory is that it is limited. Imagine playing the fighting game MORTAL KOMBAT X (Netherrealm Studios 2015) for the first time. You select the character Sub-Zero and proceed to play against a friend. In order to use the character to its full potential, you would need to know all of Sub-Zero's basic moves, special moves, combos, and finishing moves. Additionally, each character has three variations, which have different attacks, weapons, or special moves. Sub-Zero has the *Cryomancer*, *Unbreakable*, and *Grandmaster* variations.

Table 1.3 shows the list of button combinations needed to execute Sub-Zero's special moves and *kombo* attacks with the Cryomancer variation. These lists can be accessed from the pause menu during a fight. It would be absurd to try to memorize all the available combinations in your first fight using the character. The more sensible strategy would be to repeat one or two combinations in your head that you could then test during combat against a friend. The only way to learn all of Sub-Zero's moves and combos is through sustained practice.

By repeating commands and probing and exploring the gamespace, players store information in long-term memory, which enables them to produce faster reactions—both simple and decision reactions—than new players. The mastery of a game is thus dependent on the information stored in long-term memory, which enables players to react more rapidly in goal-directed ways.

Table 1.3: List of moves that Sub-Zero can perform in MORTAL KOMBAT X.

Kombo Attacks		**Special Moves**	
Frosty	□, □	*Ice Burst*	⇩⇨ □
Hailstone	□, □, △	*Frost Bomb*	⇩⇨ □ + R2
Permafrost	□, □, ○	*Frost Hammer*	⇩⇨ △
Black Ice	□, △	*Crushing Hammer*	⇩⇨ △ + R2
Straight Slash	⇦ □, △	*Air Frost Hammer*	(Air) ⇩⇨ △
Throat Slice	⇦ □, △, △	*Ice Ball*	⇩⇦ △
Tundra	□, △, ×	*Ice Blast*	⇩⇦ △ + R2
Snow Fall	⇨ □, △	*Slide*	⇨⇦ ○
Quick Slice	□, □, □	*Icy Slide*	⇨⇦ ○ + R2
Cold Punish	△, ○		
Ice Pain	△, ○, △		
Ices Up	⇨ ×, ×		

This table lists Sub-Zero's Cryomancer mode kombos (left) and Special Moves (right). The button combinations are based on the PlayStation 4 version of the game.

The limits of working memory depend on many conditions, which cannot be described within the scope of this work. A useful heuristic is to think of this limit as seven, plus or minus two (Miller 1956). That is the approximate number of pieces of information that a person can maintain in short-term memory. If we try to remember a series of letters, we would experience difficulties with more than seven. To store more pieces of information in working memory, we can rely on a process called *chunking* (ibid.), which allows us to cluster information into groups. Through chunking we can, for instance, reproduce lists of up to seven words, which include many letters each, allowing us to remember more letters than if we were just repeating them individually.

However, the retention of information can be quickly interrupted when other stimuli capture our attention. Video game designers know this quite well, since video games commonly aid players with menus (such as the ones in MORTAL KOMBAT X) and other elements (for example, button prompts) that function as memory aids. Role-playing games, for example, typically have menus where players can review the quests that are open or still pending. In this way, players do not need to rely on memory to recall the objectives or any other information relevant to ongoing or pending quests.

The phenomenon of *immersion* discussed in game studies literature is explained as a consequence of the structure and limited capacity of working memory. Being immersed is, according to Janet Murray, "the sensation of being surrounded by a completely other reality […] that takes over all of our attention, our whole perceptual apparatus" (Murray 1997, p. 98).[9] When playing a video game, working memory is mostly filled with information about the state of the gameworld, and only little information about our body or the environment. Furthermore, the spotlight of attention (the central executive) is directed to the stimuli relevant to the task at hand (playing the game), moving awareness away from irrelevant stimuli. Therefore, we lose awareness of our surroundings and our body, and the feeling of being immersed in the gameworld ensues (section 3.1 will look further into this phenomenon in relation to the state of flow).

The details of our perception of the present are highly complex, and the above lines cannot do them justice. With this overview, I mean to show how games are shaped by the temporal architecture of our minds in relation to the present moment. Understanding these subjacent structures can help scholars better understand video games and developers gain more control over the experiences they wish to create. There is still much more to time perception, as the rest of this study will show. But first, it is important to pay closer attention to the medium. The following section dissects the video game into the basic components that make up its temporality. These elements are arranged into a typology of temporal structures.

9 For an overview of the discussion on immersion in the game studies field (in German language) see Neitzel 2012 (pp. 76-80).

Structuring Gametime

If the perception of time is understood as the perception of change given by a succession of events, structuring gametime entails organizing these events into particular sequences. This section will focus on technical aspects, design features, and general principles that give rise to and structure a video game's temporality. These elements will be classified into three categories: *change of state*, *space-time*, and *conditions*. Each category of this three-part typology contains a number of different features, which altogether constitute a toolkit for the analysis of gametime (table 1.4). This breakdown of the basic temporal elements of video games should be helpful for game scholars, game designers, and anyone who wishes to better understand how events in video games are portrayed and sequenced.

Table 1.4: Typology of temporal structures in video games.

Change of State	**Space-Time**	**Conditions**
Events	*Navigation*	*Time Gauges*
Pace	*Location*	*Turns*
Cycles	*Space-Time Obstacles*	*Progression*
Pause	*Triggers*	*Objectives*
Layers	*Stages*	
Reset		

The first category, *change of state,* focuses on the capacity of computers to simulate moving entities and display them through output peripherals like screens and speakers. The category examines how gametime arises from changes on the audiovisual layer. Each change of state is considered an event, and these can be manipulated by, for example, pausing or rewinding them, or varying their pace.

Space-time, the second category, analyzes the deep connection between space and time. Through the design of space and the placement of entities in it, developers can structure sequences of events and alter the player's experience of time. The final category, *conditions*, describes how time can be structured by limiting and directing the player's behavior within the game. This can be achieved, for example, by setting objectives and applying restrictions such as countdowns.[1]

From the perspective of a game scholar, this typology can be applied to the analysis of any video game's temporality. By playing a game with the three categories and their respective features in mind, it should be possible to observe which features in the game play a role in structuring events.

Game designers can use the typology to think about the temporal structures of the game they wish to design. The numerous features that constitute the typology could be seen as a list of ingredients that can be used and modified in the design of a video game's temporality. In this sense, they are what Salen and Zimmerman call *game design fundamentals,* which "form a system of building blocks that game designers arrange and rearrange in every game they create" (2004, p. 7).

This typology also aims to establish a language for later parts of this study. Consequently, the subsequent sections that lay particular focus on any of the described features will be referenced when pertinent.

Finally, it should be noted that the elements discussed in this section are not regarded as necessary or essential, but rather as recurrent observable properties of video games. This list is crafted to be a comprehensive toolkit for analysis, but it is surely not exhaustive. Even if it were, it would probably not remain that way for long considering the fast-paced evolution of the medium. Thus, this typology is permanently open for revision.

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1 This typology is informed by research conducted by members of the Game Ontology Project (GOP). While there is some overlap between the typology presented here and the GOP, I expand on some of their concepts and introduce new ones. Additionally, the typology has an exclusive focus on time, while the GOP has a more wide-ranging scope. These factors led me to the creation of an expanded and reorganized framework for the analysis of time in video games. The corresponding GOP papers will be duly cited in every case. More information can be found on the project's wiki (Game Ontology Wiki 2015).

A few terms (for example, *events* and *stages*) are borrowed from Chris Crawford's basic components of dramatic universes (Crawford 2003, pp. 264-266). However, the present typology is aimed at describing the temporality of a broad scope of video games, while Crawford's concepts are used specifically in the context of his Erasmatron storytelling engine. Thus, the terms used here differ in meaning and function.

CHANGE OF STATE

This first category, *change of state*, is the necessary foundation for all others. Following Jesper Juul, I have argued in the previous chapter that video games are state machines that possess different moving parts that interact with each other, some controlled by player input and some by the game itself. These moving parts are routines written in the game's code and represented in its audiovisual layer. The capacity of the screen to change state according to what the code dictates allows for a fast and intuitive representation of the changes coded in abstract machine language. As a result, zeroes and ones transform into colorful fictional worlds with running and jumping characters, governed by physical laws much like those in the real world.

Events

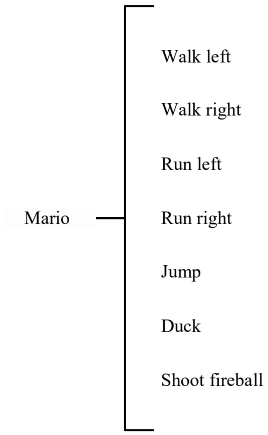
Events are the basic building blocks of a game's temporality. They result from the change of state of an entity in the game and are usually identified with an action, such as walk, run, jump, shoot, or talk.

Entities can act and react in numerous ways. The actions of one entity may elicit a reaction from another (hitting a box might break it), producing a causal chain of events that moves in one direction (character hits box with crowbar, box breaks). Some entities can answer back when acted upon (character one hits character two with crowbar, character two loses hit points and hits character one back), which in turn can produce another reaction in the first part (man two hits back, man one hits back again, and so forth until one falls). The latter is a chain of events that moves in two directions—that is, an interaction in the second sense mentioned in the introduction.

One or more of the entities in the gamespace are usually controlled by player input, while many others are controlled directly by the program itself. It is up to the designer to determine what events the player can prompt with the controller and how the game world will react to these actions.

A list of the events that a player can start in SUPER MARIO BROS., for instance, would look something like in figure 1.6.

Figure 1.6: Events players can start in SUPER MARIO BROS.

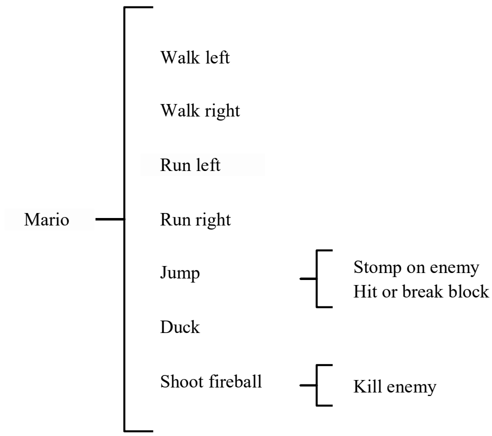


It is a basic skill set, but some events enable the player to perform others that are context-dependent. Jumping, for instance, allows the player to hit blocks above the player character or land on enemies. By hitting brick blocks, the player can break them or extract coins from them, for example. Landing on enemies typically eliminates or incapacitates them, depending on the enemy type.

Therefore, some events are a *direct* effect of the player pressing a button, and others an *indirect* effect, because they require for a direct action to influence a player-independent entity.[2] One could then say that the player can kill enemies in SUPER MARIO BROS., but only by jumping or shooting a fireball first. Jumping and shooting fireballs are *direct events*, and eliminating an opponent is the *indirect event* that can take place as a result (figure 1.7).

2 Jesse Schell distinguishes between "operative" and "resultant actions" (2008, pp. 140-142). These terms are roughly equivalent to the direct and indirect events as defined in this typology.

Figure 1.7: Direct and indirect events in SUPER MARIO BROS.



Pace

Events in video games can take place at different paces. Some games, such as QUAKE (id Software 1996), might require quick reflexes from their players, and others can be comparatively slow-paced and more concerned with strategic thinking, as is SIMCITY (Maxis 2013). Moreover, games themselves can exhibit internal changes of pace. Therefore, pace in a video game can either be *constant* or *variable.*

QUAKE has a *constant pace* because events in the gameworld always occur at the same speed. Conversely, SIMCITY has a *variable pace*, since the player can choose between different rates at which events can unfold.

Game scholars José P. Zagal and Michael Mateas refer to this feature as a part of their *manipulating gameworld time* category in their analysis of gameplay time (2010, p. 856-858). In it, they mention games like MAX PAYNE, where the player can slow down time in order to perform spectacular stunts, such as dodging bullets and aiming and shooting while in the air after performing a jump (this subject will be further analyzed in section 3.1, with relation to time perception in dangerous situations).

Figure 1.8: SIMCITY.

Source: https://www.gameaxis.com/reviews/review-simcity-2013-win/

A city in 2013's SIMCITY. The buttons that control the pace of the game are on the bottom-left corner of the screen.

Cycles

Events in gamespaces are often cyclical. Non-interactive background objects, for example, tend to have looping animations—an effective and resourceful way of displaying constant motion.

Some cyclical events are more than just window dressing and actually play a role in the game mechanics. Non-player characters can move in cycles if they are patrolling an area, for instance. As Mark J.P. Wolf points out, "learning the patterns of behavior and working around them is usually part of the game" (Wolf 2002b, p. 81) Additionally, "[c]ycled action builds player expectation and anticipation" (ibid.).

The most prominent example is perhaps the day/night cycle, which is most common in open-world games. Many of these games feature character skills that only work at night or during the day and, thus, some events can only occur in particular time windows. Day/night cycles are also reliable guides to tell the passage of time in a game, since they are regular occurrences—just like in the real world. For this reason, games with day/night cycles tend to use days (or even weeks) as units of measurement for some events.

Figure 1.9: THE WITCHER 3: WILD HUNT – BLOOD AND WINE.[3]

THE WITCHER 3: WILD HUNT and its two expansions feature day/night cycles that can influence aspects of the gameplay. This screenshot was taken at 10:37 am (in-game time).

BLOOD AND WINE (CD Projekt Red 2016), the second expansion for THE WITCHER 3: WILD HUNT (CD Projekt Red 2015), uses the hours of the day, as well as days and weeks, as a measure of the passage of time. The quest called "Paperchase" requires that the player waits one week in-game before continuing. On a different quest, the Witcher contract "Big Game Hunter," the player is invited to a picnic that will take place the following day at noon in order to celebrate the successful mission. Nevertheless, the player can choose to attend the celebration any day, as long as it is noon, without fear of missing it. Thus, the important datum in this quest is "at noon," a temporal coordinate that repeats itself once every day/night cycle.

3 Unless specified otherwise, game screenshots are of my authorship.

Some multiplayer games with persistent worlds do have events that the player can miss. Zagal and Mateas (2010, p. 852) illustrate this with ANIMAL CROSSING (2002) for the GameCube console:

> "ANIMAL CROSSING contextualizes its fictive time with respect to that of the real world. When the player first starts the game, he or she must enter the current real-world date and time. From that moment, the gameworld tracks time just as a clock in the real world would. The synchronization is such that by not playing on December 25, the player misses all the Christmas day in-game activities."

Christmas events, such as the apparition of Jingle the reindeer (Animal Crossing Wiki 2017), could be missed if the player did not enter the game on December 25. One whole year would have to pass until the repetition of the event.

Pause

Just as the passage of time can be sped up and slowed down in video games, it can also be paused. Typically, the pause function is used in single player games as a tool to take a bathroom break or grab a snack, since it precludes events from occurring while the player is away.[4] *Pause* is part of Zagal and Mateas' *manipulating gameworld time* category: "Temporarily suspending, or pausing, gameworld time (relative to real-world time) is another common temporal manipulation. The idea is that no events occur in the gameworld while gameworld time is paused" (2010, pp. 856-859).

Some games, however, incorporate pauses as part of their gameplay. DISHONORED (Arkane Studios 2012) and its sequel, DISHONORED 2 (Arkane Studios 2016), put the player in control of characters with special powers, such as teleportation and the ability to see enemies through walls. Corvo Attano—the main character in the first game and one of two available characters in the second—has the capacity to stop time around him. This power freezes everything in place while allowing Corvo to walk around enemies as if they were statues—and dispose of them if the player wishes. But this is more of a partial than a full pause, since the game is still running and the player can navigate the environment. Additionally, the player needs to act swiftly before enemies resume their motion, since the gameworld remains static only for a limited period of time.

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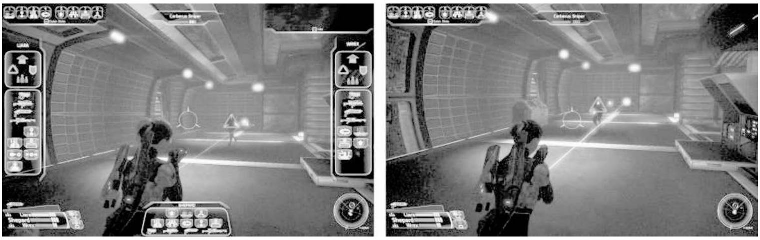
4 Online multiplayer games lack a pause function, since the gameworlds are populated by other players. Especially in cooperative games, where players act in groups, the phrase "going AFK" (away from keyboard) is commonly used to announce a break.

MASS EFFECT allows the player to bring the action to a complete halt in order to strategize during combat sequences (figure 1.10). By pressing and holding a button, players open a menu that allows them to select skills and weapons, and issue commands to teammates. While this menu is open, the fictional gameworld is completely paused. This brings me to the next element in this category.

Figure 1.10: MASS EFFECT.



Left: The menu that allows players to select skills and weapons, and command squadmates. While this menu is open, the action in the three-dimensional gameworld is paused. Right: An instant later, after the menu is closed and the action resumes.

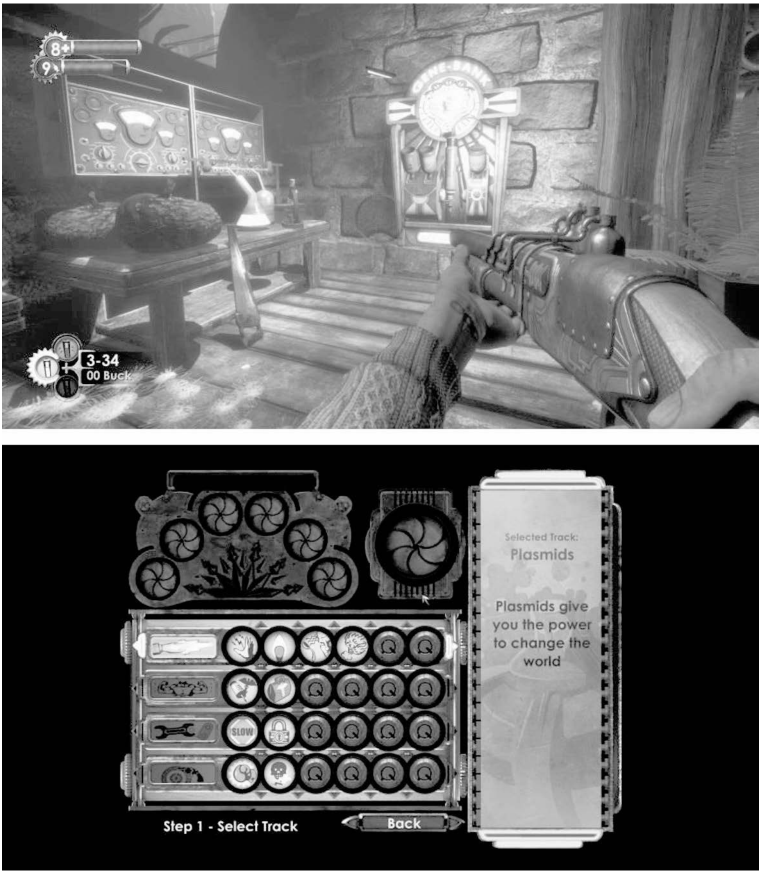
Layers

Interaction with games can happen through overlapping layers, which can have completely different interfaces and events, and unfold at diverse paces. Layers can, for example, be menus that add another aspect to the interaction with the gameworld, such as inventory administration, or the selection of dialogue options.[5] In the above-mentioned MASS EFFECT, while players interact with the menu layer, the layer of the three-dimensional gameworld remains paused, giving them time to make complex decision reactions—to use Pöppel's terminology. Once the layer is closed, action resumes at a normal pace, better suited to simple reactions—though decision reactions still take place.

5 These menus are part of what Jesse Schell calls the virtual interface: "a conceptual layer that exists between the physical input/output and the game world" (2008, p. 224). That is, the physical interface would be constituted by the keyboard and mouse, or the game controller, and the virtual interface by the menus, buttons, and information displays of the game that are not a part of its fictional world.

In BIOSHOCK (2K Boston 2007), for instance, the main layer is the first-person camera view of the three-dimensional world. But the game also has a number of two-dimensional layers (figure 1.11) in the form of menus used to, for instance, upgrade weapons and skills. Additionally, there are menus to select which skills are active, since the player can only have a limited number of active powers at any given time. The decisions made on these menus change the game state and influence which direct events the player character can initiate in the first-person layer.

Figure 1.11: BIOSHOCK REMASTERED (2K Boston 2016).



Top: First-person view. This is the main layer of the game. Bottom: The menu layer used to activate skills.

Events that occur on one layer do not necessarily affect other layers, but layers do tend to influence each other. Other examples of layered interfaces are hacking minigames and character screens that let the player choose which attributes of their character to improve (for an example of a skill tree, see figure 1.20).

Reset

Unlike time in the real world, which runs strictly in one direction, gametime is reversible. All of the events that took place in a game can be undone by starting the game anew, or by saving the game state at particular points in time and then loading them. Players typically load saved states whenever an event occurs that leads to an undesired outcome or impedes further play. To this purpose, numerous games feature "load game" menus or "quick load" keys that load the last saved game state when selected. This action is typically not a part of the fictional world of the video game.

In the early days of gaming, before save states were a common thing, players relied on *lives* and *continues* to keep their progress. In these cases, games allowed players to restart a stage or a stage section at the cost of one of these resources. SUPER MARIO BROS. gives the player three lives at the start of the game. Additional ones can be acquired by collecting green mushrooms or one hundred coins. Each time Mario dies, he loses a life and returns to the beginning of the level. SONIC THE HEDGEHOG (Sonic Team 1991) has checkpoints marked by posts placed in each stage. If Sonic loses a life after activating one of the checkpoints, he does not return to the beginning but spawns at the post. Besides lives, SONIC THE HEDGEHOG features continues, which are also available in limited quantities. After losing all lives, the player can use a continue and start the level from the beginning. Checkpoints do not work in this case. SONIC THE HEDGEHOG is a console game, but continues are also common in arcade games, where they cost players money. By paying again, players are granted a new set of lives and the possibility to maintain their progress (compare Atkins 2007, p. 246).

Some games incorporate the reset function as an in-game event that can be directly performed by the player-character. PRINCE OF PERSIA: THE SANDS OF TIME (Ubisoft Montreal 2003), BRAID (Number None, Inc. 2008), and LIFE IS STRANGE (Dontnod Entertainment 2015), for example, all have characters with the capacity to rewind time. As a result, the reset function becomes a diegetic event that the player can initiate with the press of a single button. The resulting effect is similar to the rewinding of a VHS tape, with past events unfolding again in the opposite direction.

Chapter 2, section 2.2 will expand the reset concept and analyze some of the consequences that it can have for gameplay and storytelling.

SPACE-TIME

Space and time are interconnected in our minds. Psychologist Steven Pinker remarks that this relation manifests in spatial representations of time, such as calendars and hourglasses (Pinker 2007, p. 191). Language also offers a window into the mental connection of space and time in the form of spatial metaphors like "a long/short time," "time goes by fast/slowly," or "time flies." "A long time" is a metaphor of time as distance and "plenty of time" describes time as an amount. A particular point in time can be ahead of us, behind us, or already here. All of these metaphors share a direct relation to space (see Clark 1973, pp. 48-50).

We can also understand time as something moving through us, or as something within which we are moving. When we interpret time as an entity moving past us, we are using the *time-moving metaphor,* which manifests in expressions like "time flew by" or "noon crept upon us" (Hasplemath 1997, p. 59; Lakoff and Johnson 1980, pp. 41-45). If we see time as something through which we move, then the *ego-moving metaphor* is implemented. In such cases, we can say that "we are approaching the end of the year" or "he is going through a rough time" (ibid.). Zagal and Mateas note that research by psychologists Boroditsky, Ramscar, and Frank (2002) has shown that spatial experiences can influence the metaphors that people use. A person moving on an office chair through space is more likely to think of time in terms of the ego-moving metaphor. Someone pulling a chair towards them will tend to think in terms of the time-moving metaphor. "Thus," Zagal and Mateas infer, "the player's experience of time can potentially be manipulated or influenced through game design via tasks that trigger specific forms of metaphoric temporal cognition" (Zagal and Mateas 2010, p. 848).

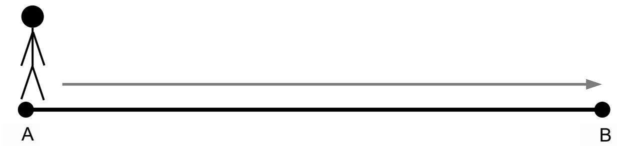
The *tau* and *kappa* effects provide further evidence of the connection of time and space. To produce the tau effect, three flashes of light are shown that are at equal spatial intervals but different temporal intervals. Between the first and second flashes, the temporal interval is shorter than between the second and third. This creates the illusion that the first and second flashes are placed at a shorter distance than the second and third (Helson 1931). The kappa effect occurs when the time intervals between stimuli are constant, but the distances between them vary. The temporal interval seems longer between the flashes that are located further apart, while the inverse is true for flashes that are closer together (Cohen 1955).

Henry Jenkins stated that "[g]ame designers don't simply tell stories; they design worlds and sculpt spaces" (Jenkins 2004, p. 121). Through the sculpting of these spaces, they also determine the temporal sequence of events in their games and influence the player's experience of time. The category of *space-time* analyzes features of video games that pertain to this connection.

Navigation

Navigation is one of the most common actions that players can perform in video games. Given a gamespace (whether two or three-dimensional), any object placed in it at any particular point can navigate by altering its coordinates. Thus, if a character is located at a point A, as seen in figure 1.12, by pressing right on the controller the player can move the character to a point B. The relation between navigation and time lies in the simple fact that, all other things being equal, the farther away point B is from starting point A, the more time it takes to arrive at B.

Figure 1.12: Navigation in a two-dimensional game.



Games that feature a form of navigation resembling the one shown in figure 1.12 are *unidirectional*, since the movement of the player character tends to trace a line in one direction. Pure unidirectional navigation is very rare. One example is the game LINE WOBBLER, which is described by its designer as "a one-dimensional dungeon crawler game with a unique wobble controller made out of a door-stopper spring and a several meters long ultrabright LED strip display" (Robin Baumgarten's Game Experiments n.d.).[6] Platformers like SUPER MARIO BROS. also come close to unidirectional navigation. Even though it is a two-dimensional game in which players can jump, and the levels have platforms placed at different altitudes, the direction of movement takes place predominant-

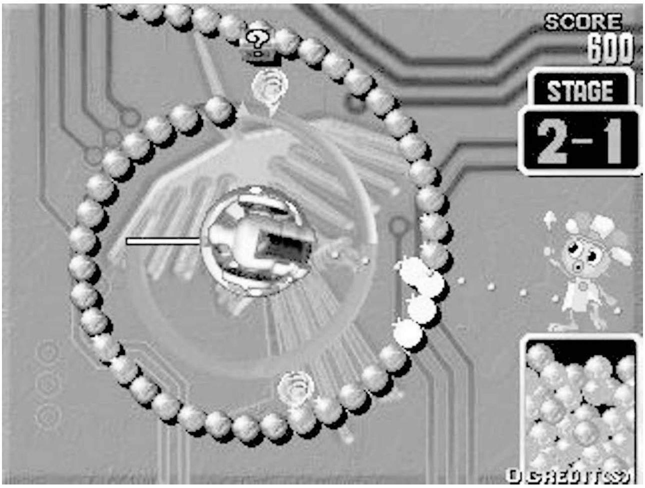
6 LINE WOBBLER can be seen here: http://aipanic.com/projects/wobbler (accessed March 20, 2018).

ly from left to right. The primary objective in the game is to reach the end of each level, which is consistently placed at the furthermost point on the right. This is accentuated by the fact that backtracking in this game is limited by a camera that only pans to the right, blocking access to portions of the level that lie to the left of the frame.

Games feature *multidirectional navigation* when they don't prescribe a direction of movement, but allow the player to choose from one of a variety of available directions. These games might still have an endpoint at a predefined location in the gameworld, but it is largely up to the player to choose how to traverse the world. An early example of multidirectional navigation is PAC-MAN. Games can also feature both types of navigation simultaneously. In chess, for instance, pawns move only forward (normally in a straight line, but diagonally when capturing), whereas the queen can move in eight different directions at any time.

Hence, navigation requires a space and an entity with the capacity to change position in it. Sometimes the space is displayed in its entirety on the screen, such as in SPACE INVADERS or PONG (so-called single-screen games), and the player characters navigate within the frame. In other games, the camera moves together with the player character, like in first and third-person perspective games such as TOMB RAIDER (Core Design 1996) or DOOM (id Software 1993). Finally, the camera and the player-controlled character(s) can also navigate independently, as in real-time strategy games like COMMAND & CONQUER (Westwood 1995).

Figure 1.13: PUZZ LOOP.



Source: https://www.arcade-museum.com/game_detail.php?game_id=9165 (accessed December 1, 2017).

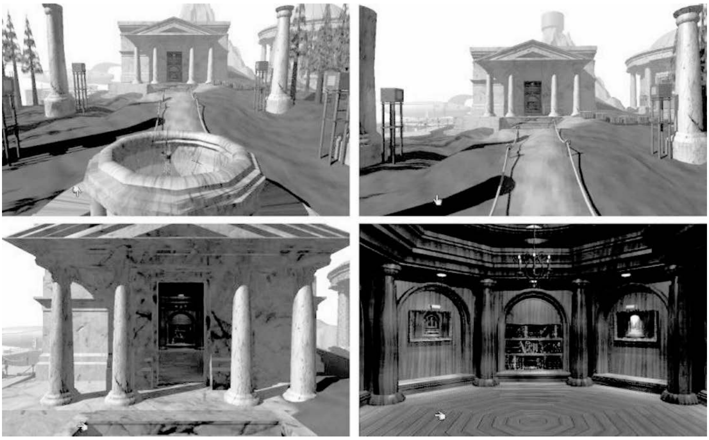
Distinguishing the narrower term *navigation* from the broader *movement* is key. Navigation is a form of movement, but there can be movement without navigation. One example of a video game that features a player character which moves but does not navigate is PUZZ LOOP (Mitchell Corporation, 1998). In it, the player controls a rotating cannon that shoots marbles of different colors (see figure 1.13). The objective of the game is to shoot at a spiraling line of marbles that moves from the edge of the screen towards the center, where the cannon is located. If the line reaches a particular point near the center, the player loses. To prevent this, the marbles can be destroyed if the player hits two or more consecutive ones of the same color with one that shares that color. In this game, the player can move the avatar solely by rotating it, and the camera is static, so navigation with the player character is not possible. Nonetheless, navigation is common in video games, and it has been featured as a central gameplay mechanic by countless titles from very early on.

The seminal video game SPACEWAR! (Russell 1962), for instance, featured spaceships that could navigate a two-dimensional space while firing rockets at each other. Navigation in SPACEWAR! is *continuous* because the space in the game is not segmented and can be traversed in its entirety. To navigate from A to B, the spaceship needs to fly the distance.[7]

Other games feature *discrete navigation*, which means that space is divided into smaller units and the player character moves in increments of one or more of these units. Discrete navigation can thus be counted in amounts of units—for example, the number of squares. This is typical of board games such as Chess or Checkers, both in their analog and digital versions. MYST (1993) is an example of a video game with discrete navigation that was not previously an analog game. In MYST, players navigate the gameworld from a first-person perspective. However, players do not control the character directly, but a mouse cursor instead. By clicking on the image in the direction they want to go, the view of the gameworld is replaced by a new frame that shows the player character's new location or orientation (figure 1.14). Thus, movement in MYST can be tallied in discrete units that could be called *screens* or *frames* (see Wolf 2002b, p. 80).

7 SPACEWAR! also features a hyperspace mechanic that teleports the ship to a random point on the screen. Given the randomness of this feature, it is more useful for dodging rockets than for navigation.

Figure 1.14: MYST: MASTERPIECE EDITION (Cyan Worlds 2009).



This progression of four consecutive screens shows navigation from a courtyard with a fountain into a library. The sequence starts at the top-left and ends on the bottom-right.

Since their early days, game spaces have gradually grown in scale. Some game worlds are now so large that moving from A to B can take upwards of an hour. YouTuber TheyCallMeConnor (2015) uploaded a time-lapse video walking through the most extensive continuous map in THE WITCHER 3: WILD HUNT, from one extreme to the other. He reports having walked for 45 minutes and 30 seconds.[8] Games of this size commonly implement fast travel mechanics—a gamic version of the filmic jump cut that is activated by players whenever they want to jump to another location in space. These mechanics replace continuous spatial navigation with discrete spatial navigation.

In THE WITCHER 3, for example, players need to interact with street signs, which open the map and allow them to jump to any other activated sign. These signs are activated when Geralt, the protagonist, is close to them, so the player needs to travel to each signpost at least once without fast travel.

GRAND THEFT AUTO V (Rockstar 2013) offers a form of fast travel grounded on another form of transportation. If players don't feel like driving, walking, or flying somewhere, they can always call a cab, which costs a small amount of in-

8 In the end of the video, TheyCallMeConnor lists other game maps he has walked through, such as GTA IV's Liberty City (one hour and sixteen minutes), or Fallout New Vegas (one hour and nine minutes).

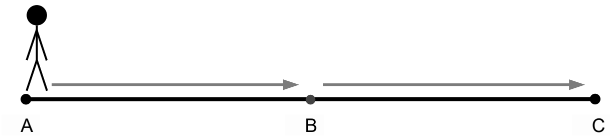
game currency. Taxis can take the player character in real time to its destination, in which case the player can vicariously observe how the car moves through the city. But they also offer the option to spend an additional amount of money to skip the drive and jump to the destination.

Fast travel mechanics usually advance time in the game. Both THE WITCHER 3 and GTA V feature day/night cycles, which move forward in accordance with the covered distance whenever fast travel is used. That is, fast travel is in these cases not only a means to jump in space, but also in time.

Location

With the principle of navigation now established, it follows that the further away an entity is placed from the player character the later it will be encountered. Going back to the scheme introduced above, if the player character starts at a point A in space and walks in a straight line, it will arrive earlier to a point B placed closer to the starting point than to a point C at a greater distance (figure 1.15). By locating objects and characters at different relative distances from the starting point of the game, designers can determine the sequence in which the player will come across them.

Figure 1.15: The principle of location.



All else being equal, the player will reach a point B earlier than a point C if point B is located closer in space to the starting point A.

Video games typically add difficulty to this formula, tying the principle of location to the notion of *progression* that I will describe later under the *conditions* category. The further away a challenge is, the more difficult it will tend to be: Platforms in platformers get smaller and further apart, enemies in *beat 'em ups* become stronger or appear in higher numbers. While a challenging section in a game might be followed by a rather easy one, the difficulty of a game tends to increase as the player progresses.

The items that the player character obtains have a similar transitive relation to space that benefits the player: The further away a weapon or item is, the more powerful it will tend to be. Traditionally, the player character starts a game with a single, relatively ineffective weapon or skill and acquires better ones as the player makes progress. Weapons obtained later in the game tend to do increasingly more damage, which in turn compensates for the increasingly challenging enemies. This characteristic of games will be discussed further in chapter 3.3, Chekhov's BFG.

This type of structure in which the progression of events and difficulty are tied to location in space is the backbone of a vast number of video games, and it is the feature that defines linear games. Think for example of HALF-LIFE (Valve 1998), SONIC THE HEDGEHOG, CRASH BANDICOOT (Naughty Dog 1996), MEDAL OF HONOR: ALLIED ASSAULT (2015, Inc. 2002), or PRINCE OF PERSIA: THE SANDS OF TIME. In all of these games the player's objective is to go from A to B (regardless of the plot) and events will not occur until the player reaches the location in space where they are to take place. Additionally, the further away the player strays from point A, the harder the game becomes.

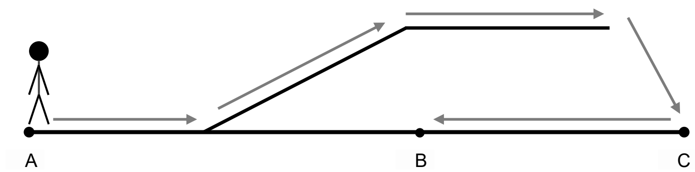
Figure 1.16: PORTAL.

The video game PORTAL (Valve 2007) adds a fascinating ingredient to navigation and the principle of location by allowing players to open gateways that connect remote sections of space. As seen in figure 1.16, the player can walk into the blue portal and come out through the orange one in the background. In this particular puzzle, the player needs to press two red buttons (one of them to the right of the image) within a short time window. But that interval is not long enough to navigate from one button to the other, which forces the player to use portals to shorten the distance between both points, consequently reducing the time it takes to navigate from one to the other.

Space-Time Obstacles

Even in games with unidirectional navigation, space is rarely an empty canvas that allows the player to move in a direct line. Space in games presents obstacles that need to be surmounted for the player character to continue pushing forward. These space-time obstacles make navigation varied and challenging. The fun part of a game is what happens between the starting and the ending points: Shooting monsters, moving from platform to platform, fist fighting, interacting with other players or non-player characters, or simply walking peacefully and enjoying the sights and sounds. Space-time obstacles often break the simple location principle, rendering points in space that are close to the avatar harder to access. Thus, as seen in figure 1.17, a point B close to the starting point A can be accessed later than a point C that is located further away.

Figure 1.17: Location and a space-time obstacle.



A simple change in the design of a level can alter the sequence in which points B and C are encountered. Point B is still closer in space than point C, but further away in time because of the space-time obstacle. From the perspective of the designer, the design of the game space needs to agree with the actions that the player character can perform. In a platformer like SUPER MARIO BROS., for example, where running and jumping are core mechanics, levels consist mostly of pits to jump over and platforms to jump onto. Accordingly, the actions that the player character can perform will shape how players perceive the space. In a game with no jumping mechanics like MASS EFFECT, even a low wall can be a space-time obstacle, so designers use them for different purposes than in SUPER MARIO BROS. Pits and walls in MASS EFFECT are insurmountable barriers that prompt players to look for an alternative way to their destination. In SUPER MARIO BROS. hindrances like these will generally prompt players to try to jump over them.

Often, games let players know that their goal is closer to them in space than it is in time—when an objective is placed behind a locked door that is close to the start of a level and the player needs to search for the key first; or if powerful enemies block access to a particular location to prevent the player from navigating it without advanced skills or weapons. These strategies (explored further under *progression* in the *conditions* category) can be used to generate anticipation and add intrigue to the gameplay experience.

The so-called *metroidvania* games are characterized by this type of design. Metroidvania is a portmanteau of METROID and CASTLEVANIA,[9] the two franchises that helped popularize the genre. These games are characterized by gameworlds with multidirectional navigation and obstacles that require specific skills or weapons to be surmounted. In METROID (Nintendo, 1986), for example, some doors can only be opened by shooting them with a missile. Since the player character is not equipped with a missile launcher in the beginning, players need to explore the gamespace in search for the weapon in order to open these doors.

Triggers

Triggers are entities in the gamespace that respond to the presence of the player character (or other entities) by initiating an event.[10] They can be *visible* or *invisible*.

Visible triggers are represented for instance by buttons, levers, or pressure pads that need to be activated voluntarily by players. In the case of a pressure pad, this is achieved by placing an entity (such as the player character) on top of it; buttons and levers usually require the avatar to be in their area of influence and the player to press a keyboard key or button on the controller. Since they are visible, the player can decide when to activate them and, if they are not an

9 In the case of CASTLEVANIA the term metroidvania refers in particular to CASTLEVANIA: SYMPHONY OF THE NIGHT (Konami Computer Entertainment Tokyo 1997), the first game in the series to feature the multilinear structure characteristic of metroidvania games.

10 The term *trigger* is borrowed from game-engine vernacular, but it is used here in a more general way that eschews specific technical details. The Unreal Engine 4 Documentation, for example, defines them as follows: “Triggers are Actors that are used to cause an event to occur when they are interacted with by some other object in the level. In other words, they are used to trigger events in response to some other action in the level.” (Unreal Engine 4 Documentation 2014-2017). The Valve Developer Community Wiki defines triggers as “entities which respond to the presence of other entities.” (Valve Developer Community Wiki 2016).

integral part of a primary mission or objective, they can also be ignored altogether. Triggers such as these can be used to open doors, call elevators, start machines, or turn lights on and off.

Invisible triggers are areas of influence that react to the player character's presence. They are typically brushes—that is, primitive shapes like cubes, cones, or spheres—that are invisible and intangible, and can thus be placed in levels to sense the player character's presence surreptitiously. Since they do not alert players of their existence in any way, they are used to initiate scripted events that are meant to give life to the gameworld—like a narrative booby trap.

Scripted events are events that are previously orchestrated by the developer and occur whenever a trigger senses the player character's presence. In that way, the gameworld comes to life and events that do not involve the player directly can unfold as in-game action.

The first-person shooter HALF-LIFE was acclaimed for its groundbreaking use of scripted events, among other things, back in 1998.[11] In an early sequence of the game, the player needs to escape a research facility after initiating a multidimensional debacle during an experiment. The corridors of the facility are brought to life by myriad scripted events, such as exploding machinery, falling elevators filled with passengers, and security guards shooting scientists turned into zombies by parasitic creatures called *headcrabs*. All of these events wait for the player to arrive before they start happening. They are initiated by both visible and invisible triggers placed in their vicinity, ensuring that the player does not miss a single moment of the chaotic spectacle.

Following the principle of location, triggers orchestrate the spatiotemporal sequence of events in a game. They also make gametime (especially in single-player games) fundamentally player-centric. I will return to this last point in the next section (1.3).

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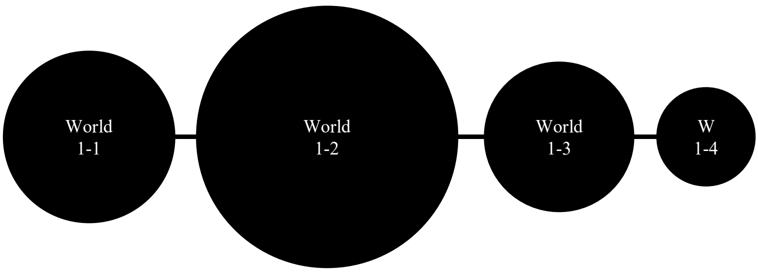
11 Roy Dulin's review of HALF-LIFE for Gamespot states that "[t]here are scripted events in the game. There are opening and closing scenes. But they all occur naturally within the game environment. It may sound simple, but it goes a long way toward helping create a believable world." He later adds that scripted events "bolster the illusion of reality." (Dulin 1998). IGN's review cheers: "The sheer number of hand-scripted events and little scenes keeps the action moving, giving you a reason to keep playing, if only to see what could possibly happen next. I haven't had so much fun playing a game in years. I have not been frightened by a game in years. I have not dreaded corners like I have dreaded corners in this game in years. HALF-LIFE is a superbly ambient game" (IGN 1998).

Stages

Space in video games is often partitioned into disconnected stages. Game scholars Zagal, Fernández-Vara, and Mateas, have dubbed this aspect "spatial segmentation" (Zagal et al. 2008, pp. 181-186). In the sense used here, stages are enclosed gamespaces where events unfold.[12]

Since player characters can only be in one stage at a time, stages are played sequentially. But the order is not always predefined by the game designers. Stages in SUPER MARIO BROS., for example, follow a strictly *linear progression,* which typically signals a gradual difficulty increase from stage to stage in games of skill.[13] Other games, like MEGAMAN (Capcom 1987), allow players to choose stages from a menu and play them in any order. This results in a *multilinear stage progression*—that is, a stage progression that players can structure in several different ways. The final result is naturally always a linear sequence of stages, albeit one configured by player choice.

Figure 1.18: Stage progression in SUPER MARIO BROS.' first world.

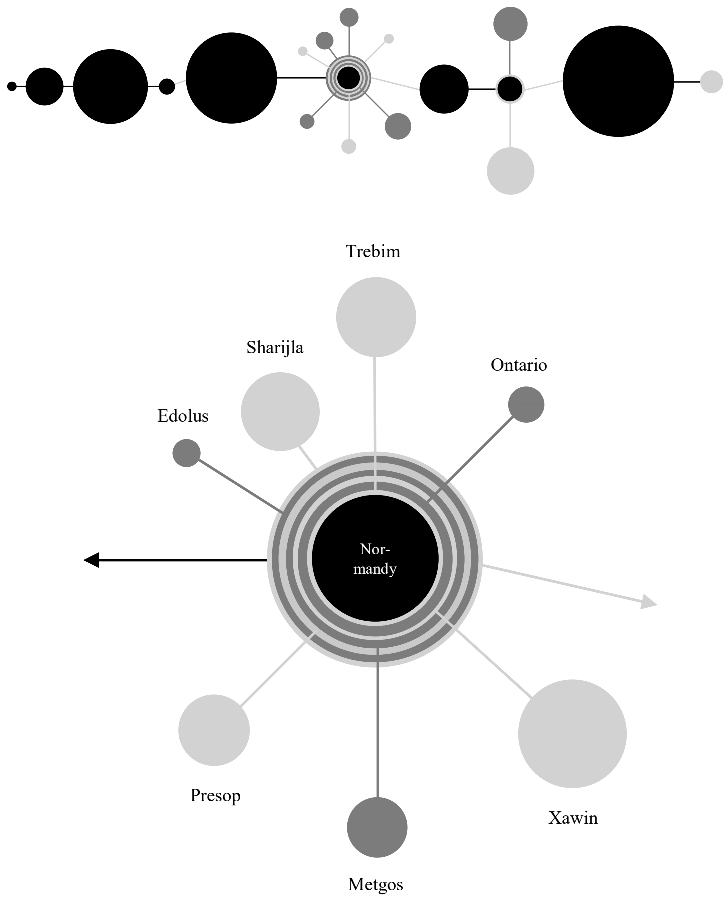


12 Games sometimes label the different spatial segments as *stages*, but several other terms such as *level*, *world*, *zone*, *area*, or *map* have been used with the same meaning. The word "level" is perhaps the most commonly associated with spatial segmentation, but this term can be ambiguous, since it is also used to refer to the levels of a player character (as in "my SKYRIM character is level 15") or to degrees of difficulty, as Zagal, Fernández-Vara, and Mateas have remarked (2008, p. 183). I have chosen the term "stage" for its meanings as both a space where action unfolds and a step in a progression.

13 It should be noted that stages can be skipped in SUPER MARIO BROS. by using secret warp zones. However, the different stages are numbered from 1-1 to 8-4 and can only be skipped in ascendant order. Once on stage 4-1, for example, it is not possible to return to stage 3-4, and the game always starts in stage 1-1 and finishes in stage 8-4.

Figures 1.18 and 1.19 illustrate the stage progression in SUPER MARIO BROS. (*linear progression*) and MASS EFFECT (*multilinear progression)* with data extracted from my personal playthroughs. Stages are depicted as circles whose diameter is proportional to the time it took me to finish them. The progression in SUPER MARIO BROS.' first world, which is made up of four stages, is shown in figure 1.18.

Figure 1.19: Stage progression in MASS EFFECT.



Top: The first ten hours of MASS EFFECT. Bottom: Detail of the radial configuration of secondary missions around the Normandy stage.

Figure 1.19 (top) shows the first ten hours of MASS EFFECT (2007). A few new elements have been added to the representation system in this case: 1) The lines connecting different stages are horizontal when the progression is linear, and diagonal when I could choose between two or more possible stages to play next. 2) Black circles represent main (mandatory) missions, while grey circles represent secondary (optional) missions. 3) MASS EFFECT is characterized by having a recurrent stage, the spaceship Normandy, which functions as a center of operations where players develop relationships with their crew, upgrade armor and weapons, and choose which stage to complete next. The graph represents this peculiarity with the radial configuration seen in the middle of the figure.

Aside from the Normandy, stages in MASS EFFECT are celestial bodies or space stations scattered across the galaxy, to which the player can travel with the spaceship. After completing the main missions in each stage, the player returns to the Normandy. As long as the player visits stages that only include secondary missions and returns to the Normandy, the main story arch does not advance. In figure 1.19 (bottom), the first secondary mission that I chose (Trebim) is located at 12 o'clock, and the progression moves in a clockwise fashion. The circle in the middle represents the Normandy, and its layers in different values of gray show each time I came back to the ship after a secondary mission. Once I chose a new stage with a primary mission, the timeline progresses to the right.

CONDITIONS

So far, the two previous categories have analyzed how video games can change state on their mediated layer and thus represent events—which can be influenced in different ways—and how those events can be structured in time via their organization in space. This third and final category looks at how video games encourage players to pursue specific outcomes and avoid others by setting *conditions*. These conditions constitute the final layer that structures the temporality of video games.

Time Gauges

Time gauges are elements that change state in a regular way and inform the player about the amount of time left within a limited window. These can take the form of clocks, progress bars, or day/night cycles. Time gauges are commonly used to set conditions on gameplay. When a timer runs backward, it informs the player that something will happen when the display reaches zero (see Wolf

2002b, pp. 88-91). SUPER MARIO BROS. is a classic example of the use of countdowns. In this game, players have limited time to navigate through each stage. If the end of the stage is not reached by the time the countdown ends, the player loses a life. The game underscores the final moments of this countdown by doubling the music's tempo, which warns players of Mario's imminent death and increases tension.

The countdown is also featured in escape sequences in which a self-destruct timer of a facility initiates, prompting the player to rush to the exit to avoid being buried alive in the rubble. The Metroid games often feature such escape sequences, one example being the final moments of SUPER METROID. After the player defeats the final boss, Mother Brain, a three-minute countdown starts together with the sounding of an alarm, screen shaking, and explosions. To finish the game, the player needs to reach the exit before the time expires. Sports games like FIFA 17 (EA Canada 2016) structure matches in two half times—just like real-life football but with much shorter default spans. Thus, players have limited time to complete the objective of scoring more goals than the opposing team (Zagal et al. 2008, p. 180). In the game DEAD RISING (Capcom 2006), players need to finish the main campaign in 72 in-game hours, or they will fail.

Another typical use of time gauges is the oxygen bar. Video games with swimming mechanics that allow the player character to dive under water usually feature an indicator that signals the player when the player character is starting to run out of oxygen. These time gauges can take different forms, the most common perhaps being a depleting blue progress bar, as seen in THE WITCHER 3.

Zagal, Fernández-Vara, and Mateas have rightly pointed out that, in cases when there is a time limit to certain events, time acts as a resource, just like ammunition or hit points (2008, pp. 180-181). But time gauges do not need to be countdowns to influence players. Some games reward those players who finish a stage below a particular time with a good grade or with extra points, encouraging players to be fast and efficient. An example is DMC: DEVIL MAY CRY (Ninja Theory 2013), and time trials in racing games such as FORZA MOTORSPORT 7 (Turn 10 Studios 2017).

The above-mentioned day/night cycles are also an example of a time gauge that can have a direct influence on gameplay. Zagal and Mateas (2010, p. 851) exemplify this with the game KNIGHT LORE (Ultimate Play the Game 1984), in which the player character is human during the day and turns into a werewolf at night. As a werewolf, the player character is attacked by non-player characters that would otherwise remain peaceful (Parrish 2007). The player also has a maximum of forty in-game days to finish the game, which entails finding a wizard that can rid the protagonist of his lycantrophy (Computer & Video Games 1985).

Animations can also work as time gauges, a typical case being the reload animation in shooters (see Zagal and Mateas 2010, p. 853). In HALF-LIFE, for example, once the clip of the handgun is depleted, the player needs to press the key assigned to the reload function in order to continue shooting. While reloading, the player character's hands engage in an animation whereby they replace the old clip with a new one. This animation renders the player character unable to attack until the gun is loaded again.

Turns

I have so far treated real-time as the default way in which time passes in games. However, games or game sections can be structured in *turns* when the passage of time takes place in discrete increments (compare Zagal et al. 2008, p. 179). Turns could be seen as the temporal equivalent of discrete navigation.

Turn-based games stand in distinction to real-time games. This classification is most common in strategy games, which can be largely divided into real-time strategy (RTS)—e.g., COMMAND & CONQUER or AGE OF EMPIRES (Ensemble Studios 1997)—and turn-based strategy games—e.g., CIVILIZATION V (Firaxis 2010) or X-COM: APOCALYPSE (Mythos Games 1997). Role-playing games (RPGs) also lend themselves to this classification, since many RPGs (especially early ones) feature turn-based battling systems—DRAGON QUEST (Chunsoft 1986), FINAL FANTASY (Square 1987)—while others feature real-time combat—DIABLO (Blizzard North 1997), BALDUR'S GATE (BioWare 1998).

The archetypal case of turn-based mechanics is when players can only act one at a time. This feature is most common in board games like chess or MONOPOLY (Magie 1932). Since role-playing and strategy are genres that originated as tabletop games, it should come as no surprise that some of their video game counterparts have maintained turn-based systems.[14] When one player is acting, the others wait and observe. Depending on the game, turns can be over either when the active player says so, after a countdown finishes, or once the player has reached the maximum allowed number of events.

Time in turn-based games can also be structured in *rounds*. A *round* is over when all players have used their turn and the first player is up once again. This is common in card games, such as UNO (Robbins 1971). The overarching structure of the round can structure play by allowing for some events to take place before or after each round.

14 Analog predecessors of role-playing and strategy video games are for example DUNGEONS & DRAGONS (Gygax and Arneson 1974) and chess, respectively.

Other turn-based games allow players to act at the same time and instead organize which events can take place at which time. These types of turn-based games are also known as phase-based or WeGo games. In MASTER OF ORION (MicroProse 1993), for example, the player and the AI have one turn to simultaneously make decisions and give orders, followed by an execution turn, in which these orders are carried out.

Progression

Events in video games can evolve according to particular rules, and two types of progression usually work in tandem: *character progression* and *gameworld progression*. Gameworlds tend to develop under the assumption that players get better at the game the more they play. Thus, games of skill scale the level of challenge with tougher enemies, riskier hazards, or harder puzzles. In narrative games, the progression occurs at the level of the plot. But the player character can also develop, acquiring new abilities or items, and improving the ones it already possesses. In strategy games, where players command armies or administer cities rather than control an avatar, progression hinges on building and enhancing structures or units.

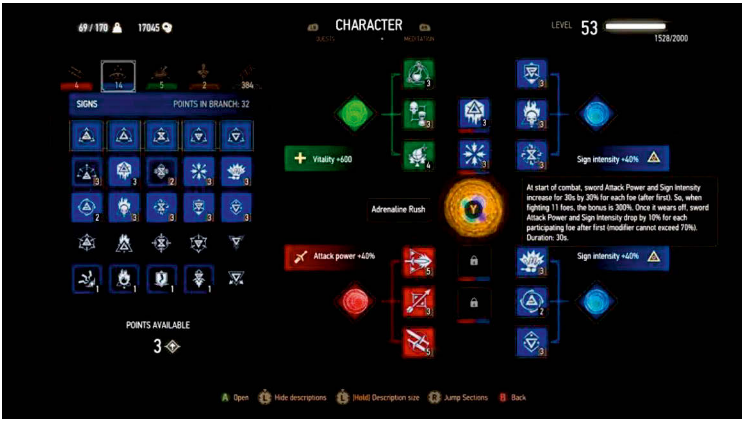
If the player character in a game can jump and acquires an ability to jump greater lengths, the jumping distances in the gameworld will likely increase as well—with higher obstacles or wider chasms, for example. In shooters, acquiring a weapon that makes more damage can be a sign that tougher enemies are coming. Video games can thus influence player expectations in two ways:

- When *gameworld progression* precedes *character progression*: If the player encounters a challenge that the player character is not yet prepared to meet, this signals that there is an item or skill upgrade to be obtained that will help them surmount the obstacle later. Games with *multidirectional* spatial design, such as those in the metroidvania genre discussed above, are structured in this way. In these games, players commonly encounter an obstacle first—such as a locked door or a chasm that is too wide to jump across—and then acquire the tool to overcome it.
- When *character progression* precedes *gameworld progression*: If the player character obtains an overpowered item or skill, the player should expect to encounter a challenge or an enemy that will put this skill or item to the test. DOOM II: HELL ON EARTH (id Software 1994), for example, never presents the player with an encounter that cannot (in theory) be overcome with the weapons that the game has already provided. The BFG9000 (Big Fucking

Gun 9000) is overpowered against most opponents and can dispose of a crowd with a single shot. Once acquired, however, it is advisable to save the BFG's ammunition for later sections that pit the player, for example, aginst a Cyberdemon, which can withstand a few shots of this weapon (just like *location*, this characteristic of games will be further analyzed in chapter 3, section 3.3, "Chekhov's BFG").

Character progression is a defining feature of RPGs, in which characters level up and obtain experience points, enabling the player to activate new skills (figure 1.20). In role playing games, player characters typically start as level one characters and can level up by completing tasks.[15] Character skills are commonly organized in skill trees, meaning that the player can chose to follow different branches, which are specialized in different ability types. In this way, the player could opt to spend experience points on a branch that develops the character's strength, one that unlocks new magical abilities, or one that improves dialogue skills. Gameworlds in RPGs are often open, so that the player can access all or a large part of it from the start. What hinders the player from going anywhere are the challenges present in each part of the gameworld. Typically, challenges in this genre are designed to be met by different skill levels. Thus, enemies in one area might be too tough for a level one character, forcing the player to level up the character before entering.

Figure 1.20: Skill tree in THE WITCHER 3: WILD HUNT – BLOOD AND WINE.



15 The term "level" in this case refers to a property of the player character.

Games can also feature the *regression* of the player character and the gameworld to an earlier state. Regression commonly happens when time is reset after failure, but it can also occur while still moving forward in the game. Some games have weapons with durability, which will break after a certain amount of use, as is the case of THE LEGEND OF ZELDA: BREATH OF THE WILD (Nintendo 2017). The fact that weapons can only be used for limited times puts players at risk of regressing to a previous state with weapons that deal less damage, lest they find a suitable replacement for their current most potent weapon.

Objectives

Video games give the player *objectives*, that is, particular game states that they need to achieve during the playthrough. Objectives can contain events that players have to actualize—for example, killing all enemies in a room or reaching the end of the stage—and events that the player needs to prevent—such as losing all hit points or running out of time. I will call the former *goals* and the latter *restrictions*. Both aspects of an objective need to be realized for said objective to be completed.

In SPACE INVADERS, for example, the objective is to prevent a descending alien block from reaching the ground. To this end, players need to shoot at and destroy the incoming extraterrestrials (goal) and avoid being hit by their lasers (restriction). Once a wave is defeated, a new one arrives. The game repeats this pattern until the player finally loses, given that there is no final alien wave.[16]

Goals in games can be varied. Some require players to collect objects, like the orbs in PAC-MAN. Other games entail defeating waves of enemies, like SPACE INVADERS. Role-playing games are characterized by the objective of upgrading the player-character to the maximum level possible. Adventure games often involve talking to non-player characters and persuading them to act as you desire, such as in THE WOLF AMONG US (Telltale Games 2013). A typical restriction is the death of the player character, which can happen in many different ways—for example, by being shot, or falling into pits or on spikes. Some games require the player character to go unnoticed by its enemies, like in METAL GEAR SOLID (Konami 1998).

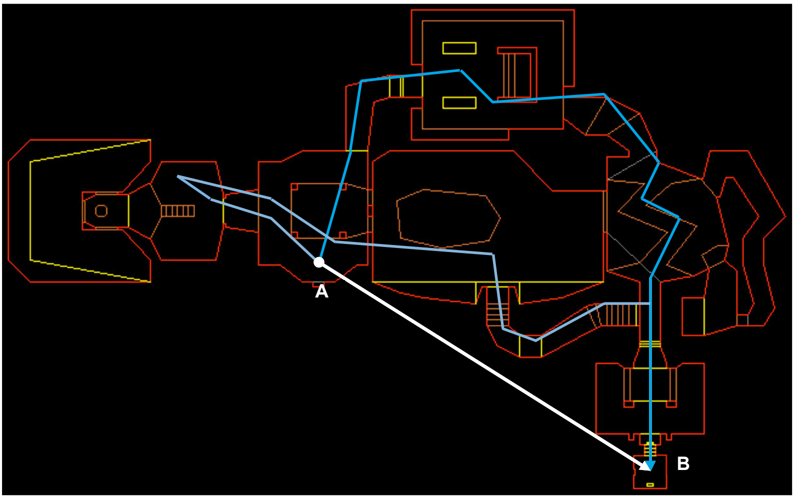
Objectives can also include a combination of several goals and restrictions. To reach the end of a stage (objective) a player might need to acquire a key (goal one) that will allow them to open a door (goal two) that is blocking the way to the exit, all while avoiding enemy attacks (restriction one) and finishing before a

16 This is popularly known as the *doomed player*, since the player is bound to lose sooner or later. The main objective is to get as far as possible in the game.

countdown is over (restriction two). In this way, objectives and goals structure gametime by determining sequences of events.[17]

In many games, going from A to B is an objective itself. When it is prescribed as a game objective, I will call the feature of going from A to B a *goal vector* (see figure 1.21). Goal vectors are displacement vectors that extend from the point where the character spawns in the level, to the point where the level ends. In DOOM, this endpoint is the location of the button that players need to press to finish the level. In SUPER MARIO BROS., the point is the iconic flagpole at the end of most stages or the ax on the far side of the bridges on which the Bowser imposters (and ultimately Bowser himself) stand in castle stages. An example of a game without a goal vector would be PAC-MAN, where stages do not end by reaching a position in space, but by eating all the orbs in the maze.

Figure 1.21: The map of THE ULTIMATE DOOM's (id Software 1995) first level.



Base image source: http://www.classicdoom.com/mapcolor/j1-pc.htm (accessed February 2, 2018).

The white arrow shows a displacement vector from the starting point (A) to the end of the stage (B). That is the goal vector. The blue lines show two possible ways through the map.

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17 Zagal, Fernández-Vara, and Mateas (2008, pp. 187-192) call this "challenge segmentation."

The opposite of a goal vector would be free roaming. NO MAN'S SKY (Hello Games 2016), for instance, has a goal vector that starts at the point where the player spawns for the first time. But this game possesses what is probably the vastest open world so far. According to one of its trailers (No Man's Sky 2016), NO MAN'S SKY offers the player an entire galaxy with 18 quintillion planets to explore. The other end of the goal vector is located at the center of this galaxy. Players, however, can take as much time as they please to reach the center or ignore this instruction entirely and focus solely on free roaming and exploration.

Nevertheless, not all unidirectional games that lack free roaming have goal vectors. A twist on the platformer genre is the *endless runner*, a genre popularized by games like CANABALT (Saltsman 2009), in which the character runs automatically and the player needs to press the jump button (or tap the screen when playing on a touchscreen device) in order to avoid hitting obstacles or falling through gaps. These games feature a camera that moves only in one direction, with the difference that both the frame and the avatar are in constant motion. Space in these games is even more analogous to a timeline than games like SUPER MARIO BROS. The objective in CANABALT and other endless runners is to get as far as possible, not to a particular point in space—just like with SPACE INVADERS, the CANABALT player is doomed to failure at some point. CANABALT prescribes a direction, but not an end goal, thus lacking a goal vector.

While SPACE INVADERS and CANABALT are centered on one objective type, it is common for games to combine more than one. The latest iteration of DOOM (id software 2016), for example, features a combination of goal vectors and areas where the objective is to defeat waves of enemies. Some sections have the player going from A to B, sorting platforming obstacles and killing enemies that stand in the way, but leaving enemies alive in these areas is a possibility. In this case, enemies are placed to impose a restriction (namely, avoid being killed by them). Other sections in DOOM function as small arenas that go into lockdown while demon hordes spawn and attack the player. Once demons stop appearing, the lockdown ends, and the player can proceed to the next section of the stage. In these sealed rooms, enemies are present both to place a restriction (do not get killed) and to set a goal (defeat them all).

Sometimes games also grant freedom to players to set their own goals in order to achieve an objective. DISHONORED, for example, allows players to approach their objectives peacefully while sneaking past guards. The central restriction while choosing this strategy is that the player character should not be detected by enemies patrolling the area. Alternatively, players can completely ignore the restriction of being seen and run into each area guns blazing, unleashing chaos and killing every opponent. The main restriction while playing this way is losing hit points, which leads to the death of the player character. Both strategies can also be mixed to different degrees, allowing for creative playstyles.

One could object that there is no need for the differentiation between goals and restrictions. After all, the restriction of not losing all hit points, for example, could be phrased as the goal of keeping at least one hit point. While this is true, I chose to distinguish these two aspects of objectives because goals are events that happen because of player input, and restrictions can—and often will—occur even if the player remains inactive. Therefore, restrictions relate to the objectives of opposing players or computer-controlled entities.

GOING FORWARD

The typology introduced in this section describes different technical aspects and design features of video games that organize events in sequences. It is aimed at facilitating the analysis of video games in the present study, but also at benefitting the work of other scholars and game designers. In the following pages, the elements of this typology will be the standard vocabulary used to describe the formal aspects of the temporality of video games.

The medium of the video game evolves at an intense speed, and both the hardware and software used to develop and play video games are continually improving. Gaming consoles, for instance, are typically replaced by a newer model twice a decade, allowing games to grow in scale and complexity with each passing year. Independently of technological developments, game developers can also introduce revolutionary design features that change the landscape of gaming. Therefore, as stated at the beginning of this section, a typology such as this one should remain open for future amendments.

Cause, Effect, and Player-Centric Time

Events, I stated in the previous section, are the basic building blocks of a video game's temporality. When starting a new game, players need to learn which *direct events* they can perform and how they are carried out. Do I control a character? If so, what can I make them do (jump, run, fly, punch)? This process involves testing the interface and observing the effects of button presses, mouse clicks, or stick movements. The next step is to discover the *indirect events*. How do direct events affect other entities? And also: How is the player character affected by other entities?

Events do not happen in a vacuum. They are the results of previous events, and are thus chronologically dependent on them. A significant part of the gameplay experience consists in instantiating causal sequences of events that will result in desired outcomes. Understanding these causal concatenations (between interface and gamespace and between entities within the gamespace) is typically a heuristic process; though often manuals, tutorials, and the design of games themselves inform the player as well. Going back to the SUPER MARIO BROS. example of section 1.2, if Mario jumps (direct event) and stomps (indirect event) on a Koopa Trooper (a tortoise-like enemy) by landing on it, the creature will retract into its shell. After the stomp, Mario can run into the shell and propel it forward (indirect event). Any enemies in the path of the hurtling shell will be instantly eliminated (indirect event). Once the shell is off screen, it won't damage any more enemies. If Mario runs behind the shell while keeping it on screen, it will wipe all the enemies out while scoring multiple points—and maybe even granting Mario an extra life. If the player is not careful, however, the sliding shell can ricochet on a surface, such as a warp pipe, and damage or kill Mario as well. While these specific events are characteristic of SUPER MARIO BROS., causal sequences like this one are the backbone of video games.

"WE'RE ALL PUPPETS, LAURIE"

We make sense of the world (whether it is the real or a virtual one) through the perception of causation. We think of our environment as being made up of objects and agents taking part in events that influence each other. And we see ourselves as agents affecting the world and being influenced by it. Events are consequences of other events and, in turn, cause other events to happen. The causal relations we perceive between them help us understand and control our environment. Causation is so central to our everyday experience that it can be disturbing to realize that it is actually an artifice of our perception (Pinker 2007, p. 209).

Dr. Manhattan, a character in the graphic novel WATCHMEN (Moore and Gibbons 1986), perceives time not as flowing in one direction, but as a whole, with his own present, past, and future coexisting. He can also perceive the atomic and subatomic scales, and control matter at will. His human friends, who are trying to change an alarming course of events, count on him as an ally. But, even though Dr. Manhattan possesses the power to influence the world as he pleases, and still retains some human qualities, his godlike perception causes him to lose all interest in human affairs and retreat to the sterile surface of Mars. During a conversation with Laurie, the Silk Spectre, Dr. Manhattan claims: "We're all puppets, Laurie. I'm just a puppet who can see the strings."

In the nineteenth century, astronomer and mathematician Pierre-Simon Laplace (1814/1902, p. 4) eloquently expressed the discrepancy between our causal intuitions and the deterministic picture that physics paints of the universe in a famous thought experiment that came to be known as *Laplace's demon*. Laplace postulated an intelligence so vast and powerful that it would know the position of every particle in the universe and understand all the forces that govern them at any given instant. By processing the information from an instant in time, this intelligence would be able to see the past and the future with the same clarity as it could see the present. Cause and effect would make no sense to this entity, since it would not see events unfolding and objects affecting other objects, but an all-encompassing picture of the spatiotemporal fabric of the universe. While we are busy watching the movie of history unfold, Laplace's demon would have access to the whole film strip simultaneously. Dr. Manhattan is like this demon (but only with access to his personal life history). Losing his sense of causality also makes him lose his sense of purpose. But we are neither Laplace's Demon nor Dr. Manhattan. We are humans that experience time flowing in one direction and the events that unfold in it as the result of previous events. Our actions are oriented towards goals that we see as the potential product of events that we can set in motion. Video games are designed to fulfill these causal intuitions.

CAUSAL ILLUSIONS

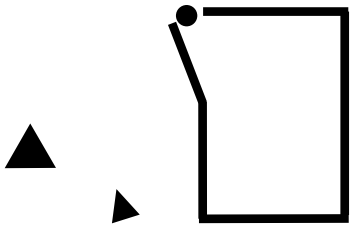
A series of animated gifs circulating online prompt you to blow on your screen after and a five-second countdown. Once the timer reaches zero, one of the versions of this gif cuts to a close-up of Donald Trump with his hair being lightly blown by a gust of wind. If you do as the gif requests and blow on your screen, it *feels* as if you are blowing on Trump's hair.[1] This illusion reveals what is happening under the hood: We don't really observe causation; we see correlations and automatically infer causation. We are so inclined to detect causal relations where there are none that statisticians insistently repeat the mantra that *correlation does not imply causation*.

Psychologist Albert Michotte (1963) conducted studies in the 1940s, which showed that "we *see* causality, just as directly as we see color" (Kahneman 2011, p. 76). These studies upended the widespread assumption that we infer causality from repeated observations of events that goes back to David Hume (2007, section VII). In one experiment, Michotte created an animation in which a square in motion touched a stationary square, and then the second square started to move in the same direction and at the same speed as the first—just like a billiard ball hitting another. Michotte's subjects described what they had just seen as the first square *causing* the second one to move. Just as it plays out for those who blow at Trump's hair gif, Michotte's subjects experienced an illusion of causation. Infants as young as six months old have also been shown to experience this causal illusion and act surprised when the sequence is tampered with (Leslie and Keeble 1987).

In the same decade as Michotte, psychologists Fritz Heider and Mary-Ann Simmel (1944) showed that the perception of *intentional* causality is intuitive, too. They created an animation in which a big triangle, a small triangle, and a circle, move in and around a rectangle (figure 1.22). The way the figures are animated creates the illusion that the big triangle is a bully attacking both the small triangle and the circle in their house, represented by the big square. Our minds effortlessly see this story (or a similar version of it) unfold and we can feel the emotion of the scene, even though it is clearly just a set of geometric shapes moving on the screen.

1 You can try for yourself here: http://popkey.co/m/ajoj0-donald+trump-hair-wind-blow+on+screen (accessed November 18, 2017).

Figure 1.22: Illustration of the Heider-Simmel illusion.



Video games are casual illusions similar to those described above. The difference between video games and Michotte's and Heider and Simmel's illusions is that the former are not just animations; they are systems that can be interacted with. When playing, players are not thinking of electrical signals in the CPU, but in terms of the objects and characters shown on screen. But the "real" action is happening inside the computer or console running the game, not on the screen. The events on the audiovisual layer are epiphenomena crafted to inform players of the game state. Technically, one could play a game (and lose) with the screen and the speakers turned off, since the electrical signals in the computer would continue firing nonetheless.

CAUSATION IN LANGUAGE

Linguist Leonard Talmy (1988) dissected the notion of causality in his analysis of the semantic category of *force dynamics*. This concept of force dynamics involves two entities that exert forces. The focal entity is called the *agonist*, which is influenced by another entity called the *antagonist*. Both entities can have one of two *tendencies*: a tendency toward rest, or a tendency toward motion. The antagonist's tendency commonly opposes the agonist's tendency. Each entity also has a different relative *strength*. The entity with the highest relative strength will determine the *resultant* of the event. In a sentence like *the ball kept rolling because of the wind blowing on it*, the ball is the agonist and it has a tendency toward rest, while the wind is the antagonist and it has a tendency towards motion. The wind is the entity with superior relative strength, which is why it causes the ball to roll.

Figure 1.23 depicts these basic elements.[2] A circle represents the agonist, and its intrinsic tendency is marked by an arrow for movement and a dot for rest. The antagonist is represented by an arrow. If the antagonist is stronger, it is depicted with a plus sign; if it is weaker, it contains a minus sign. Here a basic script: An *agonist tending*, an *antagonist acting*, and the *agonist reacting* (Pinker 2007, p. 222). When combined, these elements and its variables result in four basic force-dynamic patterns.

Figure 1.23: Types of agonist and antagonist.

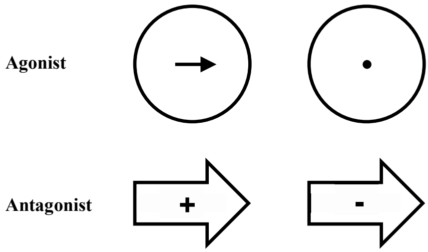


Figure 1.24 shows four different patterns, two of the *causative* type and two of the *despite* type. In both *despite* cases, the agonist retains its initial tendency (to rest on the upper right and to move on the bottom left). In the *causative* cases the resultant is opposed to the agonist's tendency (on the top left the agonist is caused to move, and on the bottom right it is caused to rest) (Talmy 1988, pp. 53-56). It should be noted that the sentences are formulated in an awkward way in order to emphasize that only an event (and not just an object) can cause another event. Normally we would say "the wind blew the ball" instead of "the ball kept rolling because of the wind blowing on it" (Pinker 2007, p. 221).

All of the patterns in figure 1.24 are *steady-state* force-dynamic patterns, given that both the agonist and antagonist are present the whole time. Figure 1.25 shows four new, *shifting* force-dynamic patterns, in which the antagonist either enters or exits the scene (Talmy 1988, pp. 57-58). There are two additional *causative* patterns, which indicate causing (the lamp to topple) and blocking (the fire from burning), and the new *letting* patterns that represent cases in which the antagonist moves out of the way, allowing (the water to flow) and enabling (the particles to settle).

2 The illustrations used in this section are a combination of those used by Talmy (1988) in his original text, and those used by Pinker in THE STUFF OF THOUGHT (2007).

Figure 1.24: Steady-state force-dynamic patterns.

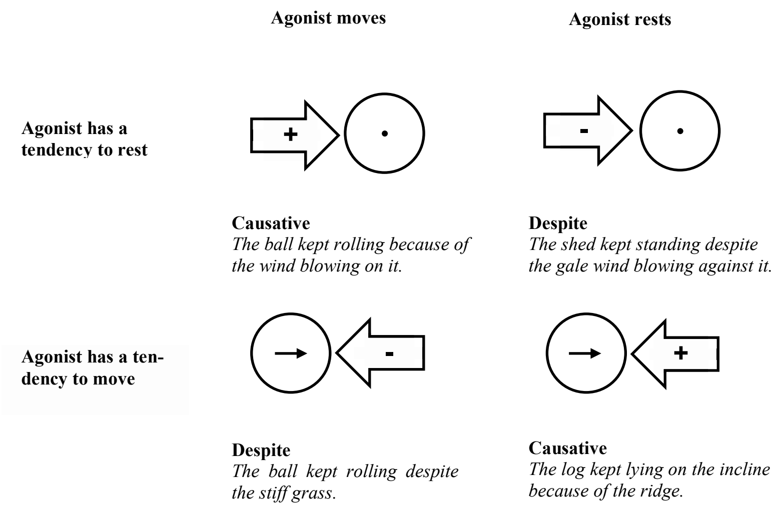
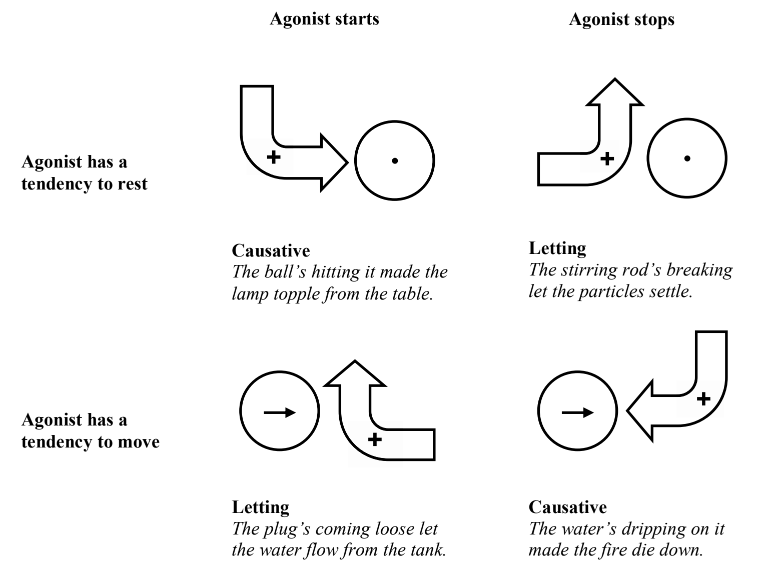
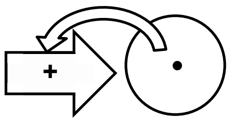


Figure 1.25: Shifting force-dynamic patterns.



A final pattern I wish to describe here is the case where the balance of forces is shifted. Figure 1.26 illustrates one possible scenario in which the agonist starts with higher relative strength than the antagonist, but gradually loses it until the antagonist prevails. The verb "to overcome" is used here, and the curved arrow pointing from the agonist towards the antagonist symbolizes the shift in relative strength.

Figure 1.26: Overcome pattern.



Overcome
The enemy (antagonist) overcame us (agonist) as we stood defending the border.

Steven Pinker notes that this script of an antagonist impinging on (or not impinging and thus "letting") an agonist, "played out in different combinations and outcomes, underlies the meaning of the causal constructions in most, perhaps all, of the world's languages" (Pinker 2007, p. 222). There is reason to believe in the universality of this model, given the parallels between Talmy's analysis and our intuitive understanding of physics, as examined for instance by Andrea diSessa and his notion of *phenomenological primitives* (compare Talmy 1988, p. 91; diSessa 1986), and Phillip Wolff's (2007) experiments based on force dynamics. Talmy's analysis also resembles medieval theories of physics, which postulated an internal *impetus* in objects that led them to be at rest or in motion. Modern physics, on the contrary, can be starkly counterintuitive (Talmy 1988, p. 92), which is not only true for odd quantum mechanics. Talmy's notion of one object exerting a stronger force than the other, as commonsensical as it may seem, is at odds with the well-known principle of physics that if one object exerts a force on another object, the second object will exert an equal and opposite force (that is, equal in intensity, but in the opposite direction) on the first one (ibid).[3]

3 If the two objects have very different mass, then the acceleration will apply mostly to the less massive one. A common example is that if you throw a ball, the ball will fly, but you will not notice that the earth is rotating faster because of it, given that the effect on the earth is negligible. But if you throw a ball forward while on roller blades, you will be launched backwards as the ball soars through the air.

Languages reflect our intuitive understanding of the physical world, acting as a window into the human mind. We interpret the world as made up by entities and not by atoms. We see these entities exerting forces upon each other, as if they had inherent tendencies, and see the object whose tendency prevails as exerting a greater force in the interaction:

> "[S]ome of the most basic force-dynamic concepts—blocking and letting, resistance and overcoming—have no principled counterpart in physics. For their viability, these concepts depend on the ascription of entityhood to a conceptually delimited portion of the spatio-temporal continuum, and on the notion of an entity's having an intrinsic tendency toward motion or rest" (ibid., p. 93).

Video games are systems that allow us to put these intuitions to practice. To be clear, my claim is not that they are deliberately designed to this end (at least not necessarily), but rather that these intuitions guide game designers as well as players, resulting in ludic systems that work in ways that mirror our naive understanding of causation. Tasks in video games typically involve an entity impinging on another entity to produce a result. Game objectives that involve fetching items, killing opponents, or overcoming physical obstacles, can be expressed in terms of force-dynamic patterns.

So far, the examples have focused on inanimate objects, but "language largely extends its concepts of physical force interaction to behavior within the psyche and between psyches" (ibid., p. 94).

FORCE DYNAMICS AND INTUITIVE PSYCHOLOGY

Including an agent in a force-dynamic pattern brings about a few complications. First, even though the construction in English and many other languages can be syntactically simple, as in *"I broke the vase*," an intermediate step can be added to the sequence, that is, the instrument used to perform the action: "*I broke the vase (by hitting it) with a ball*". But many languages, like English, allow mentioning just the agent and the final event, ignoring the intermediate step with the instrument (ibid, p. 60).

Additionally, including an agent adds a subsequent layer to the construct: the agent's volition. When talking about ourselves and others as agents, force dynamics manifests in the notion of the divided self. The sentence "*Susan refrained from playing video games*" refers to Susan's behavior as an internal struggle between two parts of herself: one that wishes to play video games and one that does not. Since the latter part was stronger, she managed to resist the temptation (ibid., p. 69). The semantic configuration of the divided self responds to the logic of force dynamics. One part of the self is the agonist and the other the antagonist, and they have different relative strengths.

The sentence "*I made myself finish the game (even though it was boring)*" emphasizes the divided self, given that it is reflexive: "*I,*" the stronger antagonist, made "*myself,*" the weaker agonist, finish the game. The sentence is also exertive, given that the antagonist is not blocking the agonist, but setting it in motion.

When moving from individuals to interpersonal situations, or interaction with larger social groups, we can also observe force dynamics in action (ibid., p. 75). A person can, for example, *pressure* another person, *restrain* them from, or *push* them to do something. These are not meant as actual physical forces, but metaphors that stand for acts like persuasion, discouragement, or exhortation.

With social groups, we cluster individuals into entities such as peers, a crowd, or the public. Once a number of individuals become a single entity, force dynamics can be easily applied: "*His peers pressured him into smoking*," or "*the crowd brought the singer back out for an encore*."

CAUSATION IN VIDEO GAMES

When considering force dynamics in relation to video games, there are several layers of patterns to take into account: (1) the intra-psychological layer (the player's divided self); (2) player and interface (for example, the player and a controller); (3) interface and computer; (4) player-controlled entity (the avatar) and other in-game entities (sometimes controlled by other players); (5) game (feedback) and player; and (6) player and environment (a quiet living room, a busy arcade, or an e-sports event).

However, when talking about gameplay, the focus can lie on the player as the entity which interacts with other entities inside the gameworld, ignoring both the interface and the avatar. Just as we can say "*I broke the vase*" instead of saying "*I broke the vase (by hitting it) with a ball,*" we can also construct sentences about players causing in-game events such as "*he killed the monster*," or "*she threw a grenade.*"

Of the different layers of agonists and antagonists listed above, it is worth focusing on the fourth: the causal relationship between the player-controlled entity and other in-game entities. The entities that are not controlled by the player include inanimate objects, enemies, and friendly non-player characters. These entities constitute the gameworld.

There are two peculiarities about gametime that should be noted. One is that it can be reset (see section 1.2)—that is, the states of the gamespace can be saved and loaded. This aspect of games will be further analyzed in chapter two, section 2.2. The second peculiarity about gametime—in which the remainder of this section will focus—is that it is in many ways *player-centric*. As I have stated in the previous section (1.2 Structuring Gametime), *triggers* can be scattered throughout the gamespace to initiate events when the player encounters them. Consequently, events in a game often wait for the player in order to happen. It is a convenient technique to tell a story or make a virtual world come to life without resorting to cutscenes or textual exposition. But triggers have a disadvantage: They can make time in games feel artificial.

Returning to the example of HALF-LIFE described in section 1.2 can help illustrate this issue. In the beginning of the game, the player needs to escape the research facility of Black Mesa as it falls apart after an experiment goes awry. In one of the hallways of the complex there is an invisible trigger that, when activated, causes a machine to explode. If the player character dies after traversing said hallway, the player could load a previously saved state and replay that portion of the game. This means that the player will already possess knowledge of the detonation and could thus realize that the machine does not explode until a certain point in the hallway is reached. Therefore, an event that is portrayed as being disconnected from the player's agency is now revealed as caused by the player character's presence. The player can now see the character as the antagonist that brings the machine from a tendency toward rest to a tendency toward action by setting off a trigger. Furthermore, if it were possible to avoid the trigger, the pattern would not be of causing but of letting, as in: "*The player allowed the machine to stay in one piece (by not activating the trigger with the avatar).*" Gametime is player-centric when events do not occur unless the player character is situated at a particular location in the gamespace. One way of improving this strategy of using triggers to initiate scripted events could be to place them at random every time. Thus, the sequence of events would not become as predictable after a few replays of a segment.

Visible triggers can also be a double-edged sword for designers. On many occasions, they initiate missions in games. The trigger might take the form of an icon on the ground, where the mission starts, or a non-player character with whom the player needs to talk to start the mission. Designing missions so that they only start when players wish to is a great way to give them freedom. This type of trigger is frequently used in open world games, where players have access to vast maps with numerous missions and activities, some of which are part of the main story and others which are side stories or simple tasks. The tricky part of this strategy is that the player can choose when events in the main story should resume. Consequently, the possibility of *letting* things occur—whether intentionally or not—is restrained, leading to the problem of *freedom versus urgency*.

Freedom vs. Urgency

THE WITCHER 3: WILD HUNT puts the player in the shoes of Geralt of Rivia within a grim medieval fantasy world. Geralt is a Witcher, a monster hunter for hire. The main story arch of the game has the protagonist searching for Ciri, a woman he raised as his own daughter and who is in mortal danger. Ciri is being pursued by the Wild Hunt, a spectral group of huntsmen who wishes to capture her. Geralt needs to follow Ciri's trail, extract information from people she encountered in her path, and find her before the Wild Hunt does.

Figure 1.27: Ciri (left) and Geralt (right) in THE WITCHER 3: WILD HUNT.

Source: https://forums.cdprojektred.com/forum/en/the-witcher-series/fan-art-aa/62634-ciri-screenshot-thread (accessed February 2, 2018).

Considering that the narrative motivation of the game is an urgent matter, the consistent way to play the game would be to follow the main quests to find Ciri as fast as possible. But THE WITCHER 3 offers players a diverse assortment of side activities and secondary quests to pursue that do not contribute to progress in the main mission. Geralt can destroy monster nests, rescue people in distress, eliminate bandit camps, take part in horse races, and play a card game called Gwent. All of these are short side activities, but Geralt's world also offers plentiful hunting contracts, treasure hunts, and secondary storylines, which commonly require completing several objectives to conclude.

While players can choose to follow only the main storyline, the player is constantly encouraged to take on side missions, especially since some of these quests cannot be played after the main story is over. Thus, the game puts the player in the position of choosing to play in a way that is consistent with the main story (and risk missing content), or ignore Ciri's plight and engage in other activities.

Luckily, the player is never punished for these excursions from Geralt's main quest. For all the urgency that the storytelling conveys, there is no real time pressure to find Ciri, since the main story always waits for Geralt to come back in order to continue. Unless the player activates one of the main quests (by, for instance, talking to a character), time in Ciri's story remains frozen. A scenario in which Geralt *lets* the Wild Hunt capture Ciri because he was distracted by a game of Gwent is never a possibility. In THE WITCHER 3, as in most (probably all) open-world games, gameplay freedom is the enemy of narrative urgency. This is a case of what game designer Clint Hocking (2007) called *ludonarrative dissonance*, that is, a clash between the ludic and the narrative elements of a video game. The main story compels players to act quickly, and the system allows them to take all the time they want.

Henry Jenkins (2004, p. 8) already noted that game designers struggle with the "balancing act" of "trying to determine how much plot will create a compelling framework and how much freedom players can enjoy at a local level without totally derailing the larger narrative trajectory." Freedom to choose what to do can clash with the impact of the narrative. THE WITCHER 3 does not necessarily suffer from this contradiction. It is, after all, a critically acclaimed and commercially successful video game. But game developers need to take these incongruences into account and weigh their costs against their benefits. In striving to perfect the medium as a storytelling tool, designers might need to find solutions to this conundrum.

The illusion of causation is a pervasive one. Players engage with gameworlds by intuitively labeling entities (including the ones they control) as agonists and antagonists, and assigning tendencies to each. This powerful predisposition drives our interaction with video games. The causative, despite, letting, and overcome patterns are the invisible glue that holds reality together, but we are overly prone to perceiving these connections, often seeing agonists and antagonists where there are none (remember the statistician's mantra: *correlation* *doesn't mean causation*). If game developers use triggers to control the occurrence of events, players might detect the causal connections between the character's actions and the events initiated by a trigger, adding undesirable noise to the fictional world.

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This chapter started with an overview of how our minds construct the present moment and the perception of motion. The properties of video games analyzed in the subsequent section (organized in the presented typology) are the raw materials with which our minds construct gametime. Gametime has some special properties that set it apart from physical time: it can be paused, reset, rewound, accelerated, and slowed down. Finally, this chapter introduced the notion of causation. Without a sense of causation, the events that unfold in gameworlds (and in the real world) would be a random collection of occurrences without relation to each other. We chain events through causal patterns that help us make sense of the world and decide on the courses of action that will lead us to our goals.

Through the repetition of actions, the causal relations between events are deeply embedded into the players' minds and become second nature to them. In this way, players can interact with the gamespace without consciously thinking about their actions. Iteration will be the main focus of chapter two. Section 2.1 will explore the mechanism behind the everyday process of learning and automatizing actions through repetition. But gametime takes this learning process one step further, given that it can be reset. Players can, therefore, travel back and forth in gametime and interact with the same game state more than once; a phenomenon that will be analyzed in section 2.2. The present section has described a clash between mechanics and narrative with the problem of freedom vs. urgency. Chapter two will introduce two other sources of friction between gameplay and narrative: a temporal paradox that arises when players reset gametime (section 2.1), and the implementation of voice over narrators in interactive and iterative gameworlds (section 2.3).

Iteration in Virtual Space

Predictive Thinking in Virtual Worlds[1]

Launching a video game for the first time entails stepping into an unfamiliar virtual world. Whether it is a medieval fantasy setting like the Northern Realms of THE WITCHER 3: WILD HUNT, a sprawling modern metropolis such as Los Santos in GRAND THEFT AUTO V, or FALLOUT 4's (Bethesda Softworks 2015) post-apocalyptic rendering of New England, video games exhibit a diverse assortment of scenarios through which players have to learn to navigate by operating their virtual personas.

Not only do players need to learn their way around these settings, they also need to assimilate the mechanics that enable movement and interaction: The actions that the player character can perform and the responsiveness of the controls usually vary from game to game. Besides, the physical laws that govern each virtual environment might differ from the ones we are used to from the real world or other gameworlds.

The adjustment to these properties of the gameworld takes place through a trial-and-error process that Torben Grodal has dubbed the "aesthetic of repetition" (2003, 148):

> "When we arrive to a new city or a new building we slowly learn how to move around, and if we want to learn to drive or bike, we exercise those skills until we have acquired the necessary procedural skills. The video game experience is very much similar to such an everyday experience of learning and controlling by repetitive rehearsal" (ibid.).

1 An earlier version of this section was previously published in the anthology BILDVERSTEHEN. SPIELARTEN UND AUSPRÄGUNGEN DER VERARBEITUNG MULTIMODALER BILDMEDIEN edited by Lars C. Grabbe, Patrick Rupert-Kruse, and Norbert M. Schmitz (Alvarez Igarzábal 2017a).

Thus, players engage in a heuristic process through which they assimilate the design and mechanics of the virtual world until the control of the avatar becomes second nature. Furthermore, someone who is unfamiliar with the particular input device at hand (controller, joystick, mouse and keyboard) would need to learn how to operate it as well. Inexperienced players will typically take their eyes off the screen and look at the controller to locate the button they want to press, or they will lean to one side when they want the character to move in that direction but it is not responding as they expect. Even seasoned players used to a particular input device—mouse and keyboard, for example—might have trouble when switching to a new one—like the Xbox One controller.

The aesthetic of repetition presents itself therefore on two layers: (1) At the level of the physical interface and (2) at the level of the game mechanics. Naturally, the more confident a player is with the first layer, the faster they will be at assimilating the workings of the second.

To some extent, everyone is familiar with the aesthetic of repetition. Steve Baumgart was the winner of what the Rolling Stone magazine claims was the first video game tournament, held in 1972 at the Stanford Artificial Intelligence Lab. The game at the center of the competition was SPACEWAR! In an interview, Baumgart said: "Pretty soon, you don't think about the buttons (…) It's like speed typing – you just look at ships on the screen and make them move where you need them to go" (Baker 2016). But what takes players from needing to pay close attention to the actions they are performing to a state in which they can act without having to "think about the buttons"? A compelling answer to these questions comes from a theory that philosopher Andy Clark (2013) has dubbed *action-oriented predictive processing*, which asserts that the brain is a machine that applies Bayesian statistics to anticipate the state of its surroundings. The theory is principally based on research conducted by neuroscientist Karl Friston (2003, 2005, 2010, 2011, 2012; Friston and Kiebel 2009).

According to this paradigm, the brain creates models of the environment that it matches to incoming sensory information. Should there be an incongruity, the model in the brain is updated accordingly (Clark 2013, p. 182). If the model matches the upstream sensory signal, no update is necessary, so it remains unchanged. Thus, the more experience with a particular activity someone has, the more updated their model of said activity will be, allowing them at some point to operate on autopilot.

Evidence from numerous studies shows that this unifying framework can account for both perception and action. This theory goes beyond the layer of our direct experience into subconscious processes that lie beneath it. After all, a process that is second nature should be expected to be at least partly subconscious in order to be performed without actively paying attention to it. In the words of Clark (2013, p. 197):

"The world, it might be said, does not look as if it is encoded as an intertwined set of probability density distributions! It looks unitary and, on a clear day, unambiguous. But this phenomenology again poses no real challenge. What is on offer, after all, is a story about the brain's way of encoding information about the world. It is not directly a story about how things seem to agents deploying that means of encoding information."

THE BAYESIAN BRAIN

The Bayesian method is one of the two major theories of statistics—the other being classical or frequentist statistics (Romeijn 2016). The basic components of Bayesian statistics are: (1) the priors or prior beliefs—hypotheses based on previous experience; (2) the likelihood—gathered data in the present moment; and (3) the posterior probability—the most likely scenario determined by the information in the two first sets. That is, the priors and the likelihood are fed to a Bayesian estimator, which calculates how likely a particular event is to happen (figure 2.1).[2]

The brain is, within this framework, a Bayesian estimator that possesses models of the world obtained through previous experience or hardwired through evolution (the priors), collects information through the senses (the likelihood), and infers the most likely state of the environment from those two sets of data (the posterior probability). This process results in our experience of the world (compare Clark 2013, Friston 2011, Körding and Wolpert 2006). As Andy Clark remarks:

"[T]he task of the brain, when viewed from a certain distance, can seem impossible: it must discover information about the likely causes of impinging signals without any form of direct access to their source. Thus, consider a black box taking inputs from a complex external world. The box has input and output channels along which signals flow. But all that it "knows", in any direct sense, are the ways its own states (e.g., spike trains) flow and alter. In that (restricted) sense, all the system has direct access to is its own states […] The brain is one such black box" (Clark 2013, p. 183).

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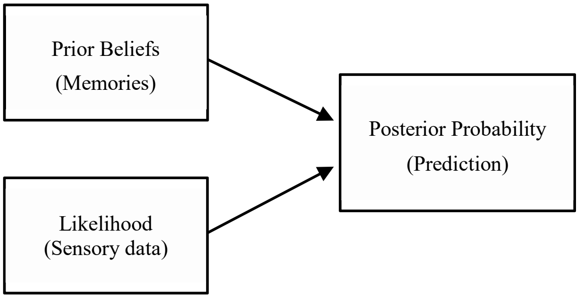
2 Central to this theory is Bayes' theorem, the rule with which the posterior probability can be estimated. Understanding the theorem is not necessary to grasp the logic behind Bayesian inference, so I have chosen to omit it for the sake of clarity.

Figure 2.1: The likelihood and prior beliefs are fed to a Bayesian estimator, which calculates the posterior probability.



From the perspective of the brain, even the body is a part of the external world (Friston 2011, p. 92) and, to complicate things further, the information obtained by the senses (the likelihood) is contaminated by noise (Körding and Wolpert 2006, p. 319). This means that the brain needs to estimate the state of the world and generate reactions to it in a constant state of uncertainty. Through movement, the brain probes the world and updates its priors in the light of the incoming stream of sensory information, generating a feedback loop that integrates perception and motor action into one model.

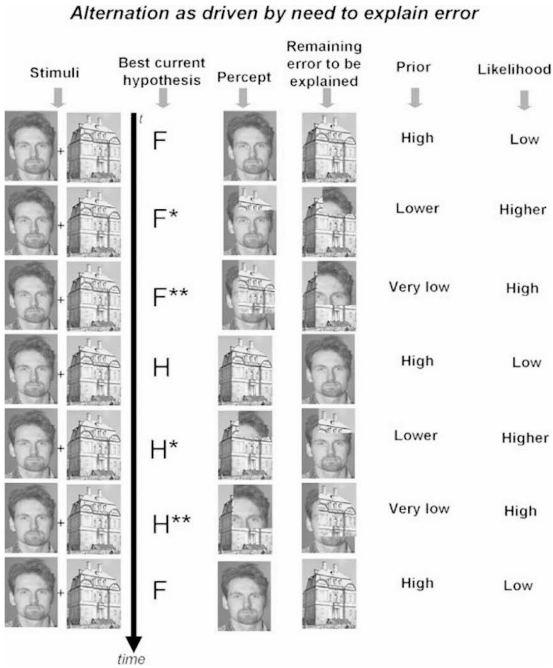
BAYESIAN INFERENCE IN VISUAL PERCEPTION

Cases of Bayesian inference in visual perception can help clarify the theory before moving to examples of motor control. Hohwy, Roepstorff, and Friston (2008) have argued that this Bayesian model is cohesive with diverse studies in binocular rivalry (see Alais and Blake 2005; Leopold and Logothetis 1999; Tong, et al. 2006). This phenomenon occurs when a person is presented with a bi-stable stimulus:

> "If one stimulus is shown to one eye and another stimulus to the other, then subjective experience alternates between them. For example, when an image of a house is presented to one eye and an image of a face to the other, then subjective experience alternates between the house and the face" (Hohwy et al. 2008, p. 687).

In this case, the subject not only sees either a house or a face, but the perception will shift from one to the other, with combinations of both in between. At first, the subject might only perceive the face. Then, seconds later, the perception will change to part face, part house, until finally only the house will remain visible. This phenomenon will then repeat back and forth indefinitely in intervals of around three seconds—that is, the duration of the experienced moment discussed in chapter one, section 1.1. Figure 2.2 shows a representation of the effect that said bi-stable stimuli have in perception.

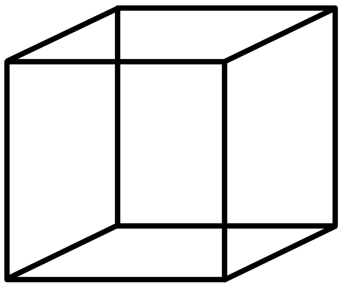
Figure 2.2: Simplified Bayesian scheme for the alternation of stimuli in binocular rivalry.



Source: Hohwy et al. 2008, p. 693.

The reason behind the phenomenon of binocular rivalry is that two different objects (the face and the house) appear to share the same spatiotemporal location and, thus, "[n]o single hypothesis accounts for all the data, so the system alternates between the two semi-stable states" (Clark 2013, p. 185). The incapability of two objects to be at the same time in the same place is a "systemic prior" (ibid.) or hyperprior: "…binocular vision, in primates, rests upon both eyes foveating the same part of visual space. We have therefore learned that the explanation for binocular visual input is unitary" (Hohwy et al. 2008, p. 691). This "failure" of perception caused by an artificial state of affairs in the experimental environment gives us a glimpse behind the curtain that is consistent with the picture of the brain painted by the Bayesian framework. In normal circumstances, objects in the visual field do not share the same place at the same time. So, in the end, the brain settles for the strongest hypothesis, which will be the subject's experience of the world: "What ultimately determines the resulting conscious perception is the best hypothesis: the one that makes the best predictions and that, taking priors into consideration, is consequently assigned the highest posterior probability" (ibid., p. 690).

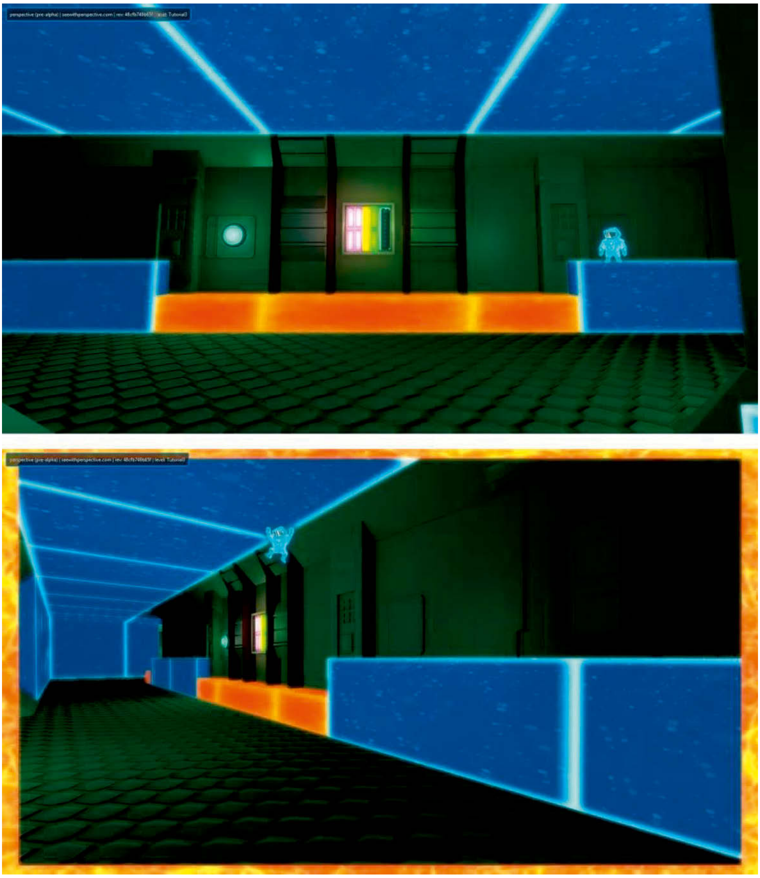
Figure 2.3: The Necker cube.



Hohwy et al. also assert that this explanation applies to bistable stimuli like the Necker cube (ibid., p. 699). In section 1.1, I discussed this type of ambiguous imagery with the example of the Rubin Vase. The Necker cube (figure 2.3) is a two-dimensional figure made up of straight lines arranged in such a way that the brain interprets them as a cube. This cube, however, can be seen from two different perspectives: either from the top, with the front face of the figure leaning to the left, or from the bottom, with the front face to the right. Since actual three-dimensional objects cannot be seen simultaneously from two perspectives, the brain tests both hypotheses by alternating between them (circa every three seconds). Once again, there is no solution to this conundrum, so the brain can only carry on shifting perspectives.

While visual stimuli in video games tend to be congruent—and nothing like the extreme example of the face and the house—, some make use of ambiguous imagery evocative of Escher's famed works "Belvedere" or "Waterfall," or impossible figures like the Penrose triangle (Penrose and Penrose 1958) in order to obfuscate the player's interpretation of the gameworld and, thus, complicate navigation (see Hensel 2015). ECHOCHROME (Sony Computer Entertainment Japan Studio 2008) and PERSPECTIVE (DigiPen 2012) are two examples of this.

Figure 2.4: PERSPECTIVE.



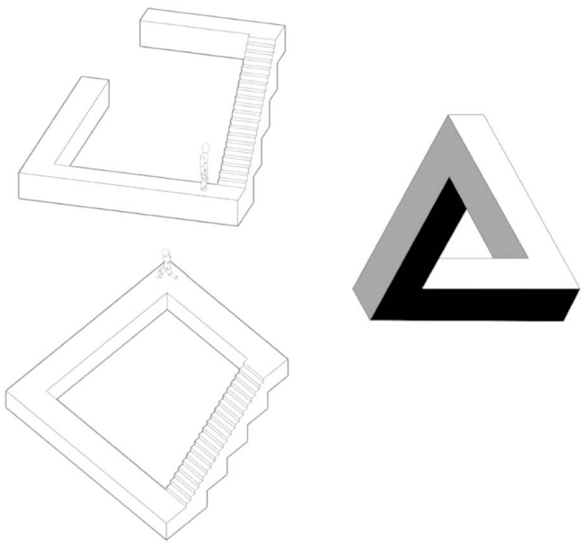
Source: https://www.youtube.com/watch?v=XSS6QBMtfqI (1:06, 1:17).

Top: the blue platforms are too far apart for the player character to jump over the deadly orange platform. Bottom: Moving the camera, and thus changing perspective, brings the blue platforms closer together in the two-dimensional plane, enabling the character to jump across.

Both games combine the logic of a two-dimensional image with a three-dimensional environment, and the player needs to find the most suitable point of view with the camera for the avatar to be able to move from surface to surface. These aesthetic and mechanic elements toy with our systemic priors and make it demanding to determine the avatar's position in relation to platforms and other objects in the world.

In PERSPECTIVE, the player needs to alternate between two discrete play modes: camera movement and platforming. For example, if two platforms are too far away to jump across the gap between them from a side view (as seen in figure 2.4), the camera can be moved to change the angle of the platforms and place them closer together in the two-dimensional plane. This action enables the player-character to make the jump.

Figure 2.5: ECHOCHROME (left) and the Penrose triangle (right).



Source: Left: https://www.youtube.com/watch?v=Pm-4gfJshA8 (accessed June 6, 2019). Right: https://commons.wikimedia.org/wiki/File:Penrose-dreieck.svg (accessed February 9, 2018).

Left: A sequence from ECHOCHROME's tutorial showing the mechanics used to connect platforms through changes in perspective. Right: The Penrose triangle for comparison.

ECHOCHROME (figure 2.5) implements an aesthetic more reminiscent of Penrose's impossible imagery and, in a very similar way to PERSPECTIVE, the player needs to move the camera around to find a suitable arrangement of the platforms that will allow the character to traverse the gamespace. The character, however, is not player controlled, but walks automatically. The challenge for the player is to swiftly move the camera and adjust the perspective according to the needs of the moment so that the character can reach the end of the stage.

The video game examples above show the interrelation between sensory information (visual in this case) and motor action: Placing the camera at a particular angle in PERSPECTIVE might lead a player to believe that the character will be able to jump from one particular platform to another. While performing the action, however, they might realize that the gap between both surfaces is too wide as they see the player character fall through it. This event will bring about an update of the player's prior beliefs, who will subsequently adjust the camera angle. With each challenge, the player will become better at estimating the appropriate distance between two platforms and whether the character is capable of making the jump or not.

BAYESIAN INFERENCE IN MOVEMENT

Imagine an everyday scenario in which you go to the kitchen to get a glass of water. The pitcher is opaque, so you cannot see exactly how much water is in it (the information is incomplete). Since you filled it earlier, you assume it is still full and apply the necessary force to lift a pitcher containing approximately two liters of water. However, your roommate has drunk most of the water without you noticing and did not refill the container. The pitcher will thus offer less resistance than expected, rising surprisingly fast. However, in an instant, you can readjust the applied force to avoid hurling the pitcher into the air.

The curious aspect of this scenario is that you do not need to consciously think about the contents of the pitcher to assume that it is full. The estimation can be, and often is, performed tacitly. If there had been no discordance between your belief and the feedback, you probably would not have noticed the assumption you were making about the weight of the pitcher. But, when the expectations about the environment do not match its actual state, your belief is updated as soon as new information is received and you become aware of your presuppositions.

To put it in slightly more Bayesian terms: You approach the pitcher with a hypothesis about its state that guides your motor actions. When your hand grasps the container and your arm applies force to lift it, a feedback signal moves up the sensory stream. Since this information does not match your model of the world, the feedback is understood as an error signal. This mismatch between hypothesis and incoming sensory information is called *surprisal*—different from *surprise*, which relates to the conscious experience of an unexpected event (Clark 2013, p. 3)—and it causes the model of the environment to be corrected. That is, bottom-up information obtained by the senses is compared to the top-down model of the world and, given that there is a disparity between prediction and sensory information, the model is updated.

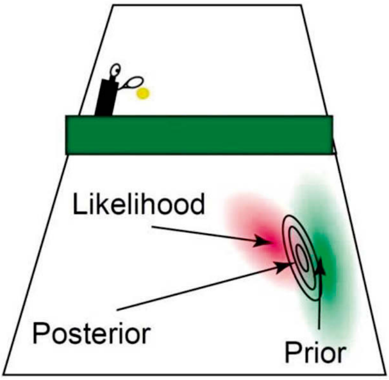
These predictions—such as the one your brain made about the weight of the pitcher—are essential to interact with the world. In the words of Daniel Dennett: "[t]he brain's task is to guide the body it controls through a world of shifting conditions and sudden surprises, so it must gather information from that world and use it swiftly to 'produce future'—to extract anticipations in order to stay one step ahead of disaster" (Dennett 1991, p. 144).

The following example (figure 2.6) by Körding and Wolpert (2006, p. 319) illustrates this notion quite eloquently:

> "[W]hen playing tennis we may want to estimate where the ball will bounce. Because vision does not provide perfect information about the ball's velocity there is uncertainty as to the bounce location. However, if we know about the noise in our sensory system then the sensory input can be used to compute the likelihood […] We can combine this with information that is available over repeated experience of tennis: the position where the ball hits the ground is not uniformly distributed over the court. For example the bounce locations are likely to be concentrated within the confines of the court and the distribution might be highly peaked near the boundary lines where it is most difficult to return the ball."

Figure 2.6 shows three probability distributions: the red gradient indicates the likelihood, the green the prior distribution, and the black ellipses mark where the ball is more likely to bounce, or the posterior probability, as computed by a Bayesian estimator (in this case, the player's brain). I have previously discussed Ernst Pöppel's distinction between simple and decision reactions (section 1.1). In simple reactions, there is one automatic response to one stimulus—I hear a bang, so I start running. These responses can be trained through practice to be faster. Decision reactions are slower but can vary in complexity. In the tennis example described above, the player is met with a decision reaction—determine the speed and direction of the ball, run to a position in the court where the ball can be intercepted, and swing the racket in time to hit the ball in the preferred direction and with the desired strength. The more prior information the player possesses about the game, the faster and more accurate this decision reaction will be.

Figure 2.6: Illustration of tennis example by Körding and Wolpert.



Source: Körding and Wolpert 2006, p. 320.

It is easy to see how this example could translate to a video game like PONG, which is a simplified, virtual version of table tennis. The motor actions that the players would have to execute are different in each case: The tennis player would run towards the alleged landing location of the ball and swing their arm holding the racket accordingly, while the PONG player would move the virtual paddle by means of whatever interface they are using at the moment—such as pressing a key on the keyboard or rotating a knob, as in the case of the original PONG machine. However, both players would estimate the trajectory of the ball with the same sets of data: the current visual information of the ball and their previous experience with the game. But any video game that involves the development of skills rests on the principle of learning through repetition, which relies on the mechanism of action-oriented predictive processing.

COPING WITH UNCERTAINTY

Thomas Malaby defines games as “a semibounded and socially legitimate domain of contrived contingency that generates interpretable outcomes” (Malaby 2007, p. 96). Applied to the specific realm of video games, the domain of contrived contingency is typically a gamespace with entities that behave in different ways and influence each other. The role of the player is to set different variables into motion in pursuit of a particular outcome, usually dictated by the game's objectives. The result of the player's actions is indeterminate, and the challenge of video game design is to strike a satisfactory balance between control and uncertainty within this contingency.

Roger Caillois noted that "[a]n outcome known in advance, with no possibility of error or surprise, clearly leading to an inescapable result, is incompatible with the nature of play" (Caillois 2001, p. 7). As stated in the previous pages, uncertainty is an inescapable fact of life that is not exclusive to play or games. We deal with incomplete and inaccurate information on a daily basis. But, while other systems are designed to reduce uncertainty, games emphasize it. Play theorist Brian Sutton-Smith argues that

> "[a]ll creatures, animal and human, live with some degree of existential angst, and most of them spend some portion of their time attempting to secure themselves from this angst by controlling their circumstances […] We constantly seek to manage the variable contingencies of our lives for success over failure, for life over death. Play itself may be a model of just this everyday existentialism" (Sutton-Smith 1997, p. 228).

Malaby's concept of "contrived contingency" proves fitting in this context. It recognizes games as artifacts in which a scenario with fluctuating variables is orchestrated by a designer for a player to interact with according to certain rules while pursuing particular goals. They emulate the uncertainty of everyday life in a more constrained system and give players the promise of control over this artificial environment.

At first, it is to be expected that the interaction with the gameworld is informed by bottom-up sensory information to a greater degree, since many of the brain's predictions will fail to anticipate the state of the novel virtual scenario. Through interaction with the virtual world, players can update their priors—that is, improve their models of said world—and become better at predicting its states and future events. With time, actions will rely increasingly on top-down models of the environment and less on the incoming sensory stream of data. Given that bottom-up sensory information requires more time to be processed, the better players become at predicting the states of the world, the swifter and more precise their reactions will be. Such is the central mechanism behind the aesthetic of repetition described by Grodal.

In this context, playing video games can be understood as a process of uncertainty reduction through the accumulation of prior knowledge. The accrual of priors leads to increasingly accurate mental models of the virtual environment and, thus, to greater control over it. Therefore, in order to master a game's mechanics, players will perform the same actions repeatedly. Mastering the jump in SUPER MARIO BROS., for instance, entails pressing the jump button again and again in order to assess different variables—for instance, how far or high Mario can jump, or to what extent he can change direction mid-air. Additionally, the player can test how these values are affected by the momentum acquired through running. Most of these repetitions are performed in safe conditions: If a player fails to leap over one of the game's warp pipes because they did not jump high enough, the avatar will often just hit the pipe's side and drop to the ground, losing nothing but a couple of seconds in the process. Players may also simply jump around aimlessly without being motivated by the environment, either as an intentional form of practice or just because they can. The majority of interactions in video games are of this nature. They tend to be less salient than actions that could damage or kill the player character, but they are greater in number and are part of the prior updating process.

Often, however, players need to jump over bottomless pits, spikes, or other hazards that might threaten the life of the player character or diminish valuable resources (e.g., health). In this context, there is one further characteristic of video games that must be taken into account: the capacity of games to reset time.

The Groundhog Day Effect[1]

In the movie GROUNDHOG DAY (Ramis 1993), Bill Murray plays TV weatherman Phil Connors, who is assigned to cover the eponymous celebration in the town of Punxsutawney, Pennsylvania for the fourth year in a row. After reluctantly carrying out his duty, a blizzard forces him to stay one more night in town. On the next morning, as Phil wakes up, he slowly realizes that he is reliving the previous day. That is, he is experiencing Groundhog Day all over again, and he is the only person aware of it. This phenomenon goes on for an extended period of time—exactly how long is not specified—and brings about two main reactions in the character: At first, he appears confused and distressed. Since no action has definite consequences, Phil starts experimenting and engaging in all kinds of reckless and odd behavior. After reaching a point of desperation, he tries to put a halt to the nightmarish loop by driving off a cliff to his death. But he nevertheless wakes up in his hotel bed to relive Groundhog Day all over again. A few suicide attempts later, he finally comes to terms with the situation and starts using it for more constructive purposes: he acquires new skills, such as playing the piano and speaking French, and assists town residents with their problems by employing his capacity of "foresight." In short, Phil Connors first experiences the process as an ordeal, and later as an opportunity.

Time in gameworlds can work in similar ways to GROUNDHOG DAY thanks to the save function, which allows players to store game states and load them whenever they fail or are dissatisfied with the course of events. In this way, time can be reset (see section 1.2) and players return to past game states in order to pursue different outcomes. Janet Murray (1997, pp. 35-36), Espen Aarseth (1999, p. 37), and Mark J. P. Wolf (2002b, p. 80), among others, have already

1 An earlier version of this section was published in the anthology TIME TO PLAY. ZEIT UND COMPUTERSPIEL, edited by Stefan Höltgen and Jan Claas van Treeck (Alvarez Igarzábal 2016).

pointed out the similarity of this process so characteristic of video games to the events portrayed in GROUNDHOG DAY. A few differences between the film in question and the iterations that take place in video games should nevertheless be noted. First, player characters are usually not aware of the recurrence of events, while Bill Murray's character is. In video games, it is the players who are in Phil Connors' position, not their virtual personas. Players are punished with an iteration (and hence a delay of the reward) for losing, but at the same time given the chance to improve their performance by resetting time and erasing the consequences of their mistakes—just like Phil. Additionally, unlike the character in the film, players often exert control over these iterations. While Phil wakes up at the same time on the same day over and over again, players can create new save states as they progress, thus avoiding the tiresome repetition of already overcome sections.

In HALF-LIFE, when players are unsatisfied with a particular outcome—for example, Gordon Freeman (the player character) dies—they can always load a saved game state. This action resets the gameworld to a previous condition and allows the player to try again. Nothing in the world of HALF-LIFE suggests that Gordon Freeman himself can perform this temporal stunt. He is portrayed as a simple human being, with neither superpowers nor technology with the capacity to reverse time. In other words, the save-load mechanic is extra-diegetic—it does not constitute a part of the fictional world that Gordon Freeman inhabits. In order to load a saved game state, players need to either pause the game and go to the *load game* menu where they can select the desired file to load, press the *quick load* key that automatically loads the last quick save, or simply left-click with the mouse or press the key assigned to the *use* function when Gordon Freeman dies. Any of these actions will load an older game state and allow players to repeat the desired segment of the game until reaching a satisfying outcome.

The process of resetting the gametime in a video game to replay segments with knowledge of future events is what I call the Groundhog Day Effect (GDE for short)—a long-established characteristic of single player games. There are two requisites for the GDE to ensue. The first one is that the player must lose progress. The second is that the game needs to return to a previous state. While these two aspects might seem like the same, the loss of progress does not always entail returning to a previous state. In games with procedurally generated content in which the player never encounters the same level twice, progress is lost forever and the GDE cannot take place. In some games, the world does not go back to a previous state when the player fails and there is no loss of progress. In SPACE INVADERS, for instance, when the player loses a life, the game resumes from the very moment the player character died, without erasing any of the progress made thus far. Hence, the first prerequisite for the effect to happen is not met in this case. The GDE does occur when the player starts the game from the beginning a second time. Additionally, returning to a previous state does not necessarily entail losing progress. In the beginning of HORIZON ZERO DAWN (Guerilla Games 2017), the main character, Aloy, is in her childhood. After a few missions, the game fast forwards to Aloy's late teens and the game narrative remains in this stage of her life until the end. If, hypothetically, the game offered flashback missions where the narrative returned to Aloy's childhood, then the game would go back to a previous state, but it would be incorrect to say that the player had lost progress. The player would still be progressing in the game, while playing at an earlier state. These passages could, for example, serve to inform the story.

This process adds a curious aspect to action-oriented predictive processing (discussed in the previous section), since the player's model of the gameworld can be updated with very precise information. When learning to ride a bicycle, the repetition of actions helps learners acquire prior knowledge on how the vehicle works, but they will know little about what is waiting around the corner the next time they go out for a ride. In games, players can know what is hiding around the corner, its location, if it is moving, at what speed, and in what direction. This knowledge can help optimize navigation and resource management to a degree impossible to achieve in equivalent real-life scenarios.

Especially in games in which iterations have no cost whatsoever, aside from the temporary loss of progress (there are no lives or continues to worry about), the mere mindless repetition of actions can be expected to lead to precise and efficient decision making. In turn, games can up the stakes and be challenging in ways that could prove extremely frustrating without the aid of constant iterations. A game like CUPHEAD (Studio MDHR 2017), for instance, offers a jarring level of difficulty that needs to be counteracted through insistent repetition.[2]

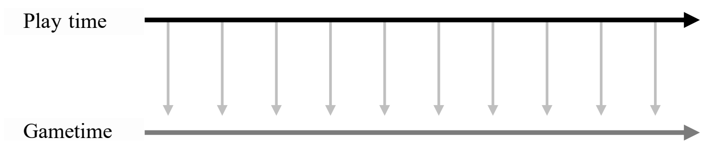
2 CUPHEAD'S difficulty caused much stir online at the time of its release, as a quick google search for the terms "CUPHEAD difficulty" can show. Some saw it as a positive trait, while others wished that the game would have been easier. Game journalist Mitch Wallace (2017), for example, praised CUPHEAD in a Forbes article, while warning players of its difficulty. Laura Dale (2017) from Kotaku UK described the game's difficulty as "infuriating."

THE GROUNDHOG DAY EFFECT IN JESPER JUUL'S TIME MAPPING

In his paper INTRODUCTION TO GAME TIME / TIME TO PLAY (2004), Jesper Juul introduced the concept of time mapping, which he further discussed in his book HALF-REAL (2005). Juul argues that video games are real and fictional at the same time—hence the book's title—and presents a model that accordingly distinguishes between *gametime*[3] and *play time*. In Juul's words: "Play time denotes the time span taken to play a game," while gametime is "the time of the events in the game world" (2005, p. 142).

As players interact with the gamespace, their actions project onto it by, for example, turning a mouse click into a gunshot or a key press into forward motion. Juul illustrates this projection as seen in figure 2.7. The top and bottom arrows represent play time and gametime respectively, and the arrows pointing down in between represent the projection.

Figure 2.7: Jesper Juul's time mapping.



Source: Juul 2005, p. 143.

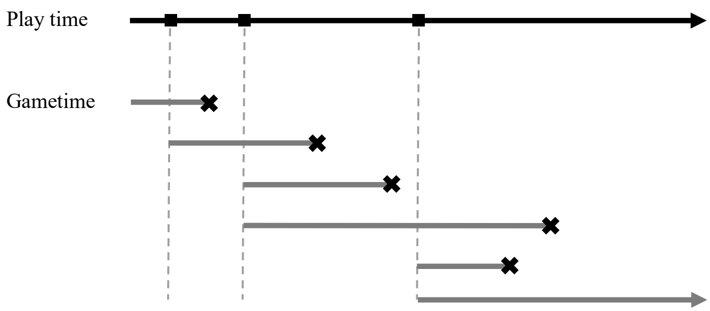
As explained by Juul, in a game like QUAKE III ARENA (id Software 1999), one second of play time is equal to one second of gametime. That is, time inside the fictional world is running at the same speed as in the real world. Other games, like SIMCITY 4 (Maxis 2003), present a different type of projection. In this case, one year of gametime may go by in just two minutes of play time (Juul 2005, pp. 143-145). But, since the GDE can occur regardless of this difference in projection ratio, its implications are irrelevant to this section.

3 In the paper INTRODUCTION TO GAME TIME / TIME TO PLAY*,* Juul uses the terms *event time* and *play time*. In HALF-REAL he replaced the term *event time* with *fictional time*. Other scholars have used the terms *game progress time* (Hitchens 2006, pp. 46-47) and *gameworld time* (Zagal and Mateas 2007, p. 518). For the sake of coherence, I will use the term *gametime* instead of Juul's terminology.

Juul extends his model in order to include cutscenes and loading time. Subsequently, Hitchens (2006), Nitsche (2007), and Tychsen and Hitchens (2009) expanded it even further. While most other elements described by Juul and his contemporaries fall outside of the scope of this analysis, there is one observation made by Hitchens, Tychsen, and Nitsche that will be further developed here to illustrate the Groundhog Day Effect. They stress the fact that gametime can be reset and update Juul's model accordingly. While the play time follows its customary linear fashion—as dictated by the laws of physics—the gametime makes occasional backward jumps every time the game is interrupted to reload a previously saved state. I will follow this extension of the model and take it a step further.

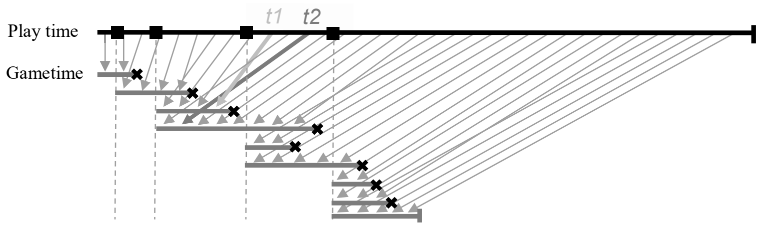
To illustrate the GDE (figure 2.8), I have added points to the play time that represent the moments when the player saved the game state (the black squares). From each of these points, a dotted line descends that indicates its correspondent point on the gametime. I have also broken the gametime into several segments. These breaks occur every time the game is interrupted (marked with an X) and a previous save state is loaded—either because the player lost and is thus forced to reload in order to continue playing, or they are just motivated to repeat a segment of the game in an attempt to obtain different results. Figure 2.8 shows a partial view of a hypothetical playthrough. Both timelines end in arrows, indicating that the playthrough continues.

Figure 2.8: The Groundhog Day Effect.



Since the player travels back in gametime, the segments of the broken timeline overlap to different extents. The projection of the actions performed in the play time takes the form shown in figure 2.9. As the play time advances uninterrupted, the gametime zigzags back and forth. Figure 2.9 depicts a complete hypothetical playthrough with the projection arrows now emphasizing the temporal displacement. Notice how the projection arrow labeled *t2* starts later in play time than the projection arrow labeled *t1*, but has an effect on an earlier moment of the gametime—albeit on a different segment.

Figure 2.9: Projection and Groundhog Day Effect.



The GDE is a direct consequence of this process of trial and error that is central to gameplay, combined with the capacity of computers to faithfully store and retrieve information. Furthermore, the punishment of failure by means of the death of the character is a common feature that increases the frequency in which save and load states are used. While a save state can be loaded to easily amend mistakes that are not as final, the demise of the player character is nonetheless a common and typically irreparable mistake.

The save state guarantees that players will not completely lose the progress they have made and eventually reach the end of the game—provided they keep trying—without having to start over from the very beginning every time they lose. Before the days of save states, reaching the end of a game was hardly to be expected. In fact, early in video game history games usually tended to increase in difficulty until the player eventually lost—the aforementioned doomed player. Emblematic games like TETRIS, BREAKOUT (Atari 1976), and SPACE INVADERS illustrate this point. These games had no intended ending, just a succession of ever-harder levels.[4] Losing all the progress and starting over from level one was

4 Many of these games have what is popularly known as a *kill screen*. These are dead ends that result from programming oversights or errors (see Giant Bomb n.d.), and come about when a player reaches a stage so high that the developers did not take it into consideration. PAC-MAN is perhaps the best known example. A bug caused it to draw stage 256 with one half of the screen visible and the other constituted by a series of random numbers, symbols, and letters, rendering it impossible to finish. This earned it the moniker “split screen.” Nevertheless, as is typically the case with kill

an intrinsic part of playing games. Granted, some games featured checkpoints, lives, and even continues. But finishing a game was not the most common goal in the early days of gaming, while getting better at them by reaching higher scores and levels each time likely was.

Nonetheless, along with the increase of computer processing power and storage capacity came the possibility to save and load game states, while games themselves were also able to progressively grow in size and complexity. It is not the same to restart SPACE INVADERS from the beginning—where the mechanics remain essentially the same in every stage and there is no progressing plot nor an ending—than to restart MASS EFFECT—a game in which the decisions made have an impact on the progressing storyline, and RPG elements allow the player to customize the characters and arsenal in ways that affect the gameplay. The progress made in MASS EFFECT is not only a testament of skill. It also requires a high level of emotional and analytical investment in a complex storyline with compelling characters over several hours of gameplay that players would not be willing to erase so easily.[5]

A TEMPORAL PARADOX

The Groundhog Day Effect adds a new feature to Grodal's aesthetic of repetition (analyzed in the previous section) by allowing players to erase all traces of failure from the game state: If the player falls off a virtual bicycle and hurts a knee, loading a previous game state will do away with the injury and allow them to try again unblemished. But there is yet another twist that comes along with this temporal exploit. As players make progress in games with fictional worlds and characters by going back and forth in gametime, "[n]ot only does the event time return to an earlier state but the time reversal means that players interact with a certain game state knowing its immediate future conditions" (Nitsche 2007, p. 148). The player character, however, cannot possibly know what these future conditions are, since its fictional memory was erased with the player's progress. This discordant access to knowledge between the player and the player character produces a temporal paradox. Events that lay in the future for the play-

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screens, reaching it demanded a level of skill only achieved by a minority of players. A comprehensive description of stage 256 can be found online, in chapter five of Jamey Pittman's Gamasutra feature THE PAC-MAN DOSSIER (Pittman 2009, p. 8).

5 According to howlongtobeat.com the average MASS EFFECT playthrough lasts around 18 hours (HowLongToBeat n.d.).

er character are, in contrast, past events that are about to repeat—and not necessarily for the first time—from the player's perspective.

Figure 2.10: Fight against Gozu in SHADOW WARRIOR.

Source: https://steamcommunity.com/sharedfiles/filedetails/?id=596130639 (accessed February 2, 2018).

In SHADOW WARRIOR (Flying Wild Hog 2013) the player controls Lo Wang, an assassin who allies with an ancient demon, Hoji, in the search for a legendary sword. At the start of the first boss fight against a demon called Gozu, Wang impatiently asks Hoji: "How am I supposed to defeat him?" Hoji, who speaks in Wang's head and only seldom materializes, replies that he has to shoot at glowing cracks in the enemy's armor—the glow incidentally works as a visual aid, making Hoji's advice somewhat redundant. Once the player shoots at one of the cracked armor plates for a moment, it opens exposing a crystal on the demon's body. Hoji then instructs Wang to destroy that crystal. After shooting at it for a while, the crystal explodes. The same process has to be carried out with four other armor plates and their respective crystals. If the player character dies, the fight starts again from the onset. This time the player will know where to shoot, but the dialogue will play unaltered nonetheless—even though the player character might be firing directly at the right spot already. Hoji does not seem surprised at all by this, nor confused by the fact that Wang asks what to do while confidently doing the right thing. He just tells Wang to do what he is already doing: shoot at the glowing cracks in Gozu's armor. This could have been avoided with different lines of dialogue. Wang, for instance, could stay silent and Hoji could say something like “that’s right, shoot the glowing cracks in his armor” once players do so, given that conspicuous visual cues are assisting them anyway.

SHADOW WARRIOR’s example stands out because of the characters’ remarks, but video games are teeming with similar situations. Every time the player resets the gametime and comes back with updated knowledge and slightly improved skills, enemies and NPCs typically behave in the same way and utter the same things at the player character without realizing that it possesses information that it could not possibly have. From Hoji’s perspective, Wang should be nothing short of a psychic, but he acts as if nothing out of the ordinary were happening. Programming an AI with expectations about the player character would be a curious way of dealing with the paradox, but it would just make it manifest instead of effacing it—aside from the fact that it would be a daunting task. There is nonetheless at least one game in which special kinds of enemies recognize the player character when he comes back from the dead: MIDDLE-EARTH: SHADOW OF MORDOR (Monolith Productions 2014). However, this game has additional features that deserve closer attention, so I will return to it later.

SOLUTIONS TO THE PARADOX

Through the analysis of several video games, I have come across different mechanics that address the paradoxical relation between player and player-character behavior. In what follows, I will examine these particular mechanics by classifying them in five different categories:

1. *Respawn*: the act of spawning (and respawning) is integrated into the fictional world, avoiding the need to load saved game states.
2. *Death becomes the game:* the death of the player character changes a variable in the game state instead of interrupting it.
3. *Rewind*: The act of resetting the gametime is integrated into the fictional world.
4. *Player character briefing:* Player characters are given information about the game state that eliminates the knowledge gap between them and the player.
5. *Deal with it:* The consequences of actions are irreversible.

Respawn

Spawn points are predetermined locations in the game world where the player character can appear (spawn) at the start of a match or level and reappear (respawn) after death during said match or level without loading a previous save state. Player character spawn points are common in multiplayer gaming, where saving and loading game states is not an option. When playing a round of free-for-all in CALL OF DUTY: MODERN WARFARE 3 (Infinity Ward 2011), for instance, the spawn points allow players to instantly get back in the action after being taken down by an opponent. Nonetheless, player-character spawn points are also a feature of many single-player games.

Whether in single or multiplayer games, spawn points are most commonly extra-diegetic: avatars normally pop into existence in predetermined locations without any fictional explanation needed. Sometimes, however, these spawn points can be diegetic, that is, spaces or objects in the gameworld that integrate the act of spawning and respawning into the fictional world. SYSTEM SHOCK 2 (Irrational Games/Looking Glass Studios 1999) introduced contraptions called Quantum Bio-Reconstruction Machines that were later reimagined as Vita-Chambers (figure 2.11) in its spiritual successor, BIOSHOCK. These machines reconstruct the player's avatar automatically after it dies. The same happens in BORDERLANDS (*Gearbox Software* 2009) and its sequels, where the New-U Stations are said to store the characters' DNA in order to reconstruct their bodies when they die. Hospitals in the GRAND THEFT AUTO (GTA) series, from GTA III (DMA Design 2002) onwards, have a similar function. Every time the health meter depletes, the player character respawns in front of a hospital. In GTA, however, hospitals only solve the paradox if the player dies while free roaming. During a mission, if the player character loses its health completely, the game either automatically loads a checkpoint inside the same mission or sends the player to a hospital, which means restarting the mission from the beginning.

In the case of the Quantum Bio-Reconstruction Machine the GDE disappears, since the game state is not reset, but the paradox remains. These machines need to be activated by the player character and, in doing so, the state of the character *at the moment of activation* is saved into its memory. When the player character dies later, a past version of it is reconstructed, which lacks the knowledge acquired after the machine was activated. The Vita-Chambers, on the other hand, do not need to be activated and, thus, they do not save a particular state of the player character. In BIOSHOCK the character is reconstructed as it was at the moment of his death by the nearest machine. The New-U Stations solve the paradox as well, since, when the player character dies in BORDER-

LANDS, its body gets visibly deconstructed and reconstructed again (alive, of course) next to the last machine that was activated.

Figure 2.11: A Vita-Chamber in BIOSHOCK REMASTERED.

ASSASSIN'S CREED (Ubisoft Montreal 2007) fits into this category as well, but with a particularity. In this title, the player interacts with a fictional simulation inside the game. ASSASSIN'S CREED starts in the fictional present day, where the player controls Desmond, the descendant of a long lineage of assassins. In this world, memories are stored in genetic information that is then transferred through the generations. This information is nonetheless inaccessible to the carriers unless they connect to a piece of equipment called the Animus. When Desmond interfaces with the machine, he can relive the memories of his ancestor Altaïr (and others as the series progresses) as three-dimensional simulations. If the player fails to achieve the objective while in the Animus, the memory is desynchronized and the simulation starts again. Since Desmond does not actively remember what happened in Altaïr's life, he is as oblivious of his ancestor's fate as the player, but the respawn mechanic is made diegetic, given that the player is interacting with a meta-simulation.

Death Becomes the Game

In LEGACY OF KAIN: SOUL REAVER (Crystal Dynamics 1999) and SOUL REAVER 2 (Crystal Dynamics 2001), death does not represent the end for the player character but merely a passage to another plane of existence.

In both games, the player controls Raziel, a vampire with the capacity to shift between the material and the spectral planes. Each realm has different characteristics, which must be exploited by the player in order to solve puzzles and move forward in the game. While in the material plane, the physics resemble very much that of the real world and Raziel can interact normally with objects such as weapons or doors. In the immaterial plane, these objects are not interactive. Instead, Raziel can, for example, phase through gates that block his way, or walk on the beds of water bodies as he does on dry land.

Figure 2.12: SOUL REAVER.

Top: A location in the material realm. Bottom: The same location in the spectral realm. The most noticeable differences are the colder color palette and the distortion of space, manifested in the columns in the background.

The player can freely switch to the spectral realm at any time, but it is also accessed when Raziel's health bar depletes—that is, when he "dies." When in the spectral plane, his health gauge slowly regenerates. The material realm, in contrast, can only be accessed through specific portals when Raziel's health is full. Health can be restored by killing and absorbing the souls of enemies in both planes. By means of this plane-shifting mechanic, the GDE does not occur and, thus, there is no paradox.

It should be noted that Raziel can die in the spectral plane as well. In the first entry of the series, death as a specter makes Raziel respawn in the Underworld, where the Elder God resides and the game begins. Progress made thus far by the player remains unaltered, and so the paradox still does not take place. In SOUL REAVER 2, however, when Raziel dies in the spectral plane, the game restarts from a checkpoint, which causes the GDE—and hence the paradox. Additionally, in both games players can also save and load game states, bringing about the GDE and the paradox as well.

Rewind

In PRINCE OF PERSIA: THE SANDS OF TIME, the Prince has the ability to reverse time with the power of the titular sands (see Atkins 2007, pp. 243-244). Thanks to this mechanic, the player can undo certain actions with the press of a button. This game is a 3D platformer, which means that most of the game's challenges involve moving and jumping across platforms in the x, y, and z axes of the game's Cartesian space. The Prince—the game's protagonist—performs acrobatic moves utilizing walls, flag poles, columns, and other features of each level's architecture to access hard-to-reach areas. If players miss a jump, all they need to do is press a key and time will run in reverse—just like pressing the rewind button of a VCR. When the player releases the button or the specified limit is reached—the rewind cannot go on indefinitely—time in the game starts running forward again. Since the Prince triggers this ability himself with a magic dagger charged with the Sands of Time, the paradox is not present in this game as long as the rewind feature is used. In this case, resetting gametime is a diegetic process.

Nevertheless, the player has only a limited number of charges in the dagger. Each one of those charges allows the player to rewind time once. When all charges are exhausted, the player has to load a previous save state to continue playing. Loading a save state even when having one or more charges is also an option. When doing so, the paradox should reappear. However, a further characteristic of this game prevents the paradox from occurring, which will be discussed in the next category.

Figure 2.13: BRAID.

Top: The player character has fallen into a pit. Bottom: By pressing a button, the player can rewind time and return to the moment before falling.

BRAID is a 2D platformer that introduces the same mechanic but with an explicitly lyrical intent: The rewinding of gametime stands as a metaphor for repentance. More than a narrative, BRAID presents the player with a series of reflections about romance and the irreversibility of time in the form of text, followed by levels with puzzles that can only be solved by means of the rewind mechanic—it is not just a trick that the player can make use of when dying. In BRAID not all of the objects in the gameworld are always affected by the rewinding, and in other instances the mechanic produces (quite literal) shadows of past actions that can open doors or kill enemies in the present, making puzzles even more challenging.

Players can rewind as many times as they wish and there is no game over state, which eliminates the paradox almost completely. The only case in which the paradox could be considered to occur is if the player starts a new game. Even though the game ends exactly where it started, suggesting that the events loop, the pieces of jigsaw puzzles that the player gathered through the game remain collected. If the player starts a new game from scratch, the puzzle pieces need to be gathered again. The ending of PRINCE OF PERSIA produces a similar loop, since the prince uses the dagger to completely reverse the events of the game, erasing everything the player has done. However, the final boss fight—that takes place after the last radical rewind—changes the course of time and, consequently, the events of the game never occur. Hence, restarting the game would in principle cause the paradox to take place—but, as stated above, another feature of the game prevents this from happening.

Another game that uses the rewind mechanic is LIFE IS STRANGE, an episodic graphic adventure. In this interactive story, the player assumes the role of Max, a teenage girl who, after witnessing a tragic incident at her school, realizes that she has the power to reverse time when she spontaneously does so to undo the consequences of said accident. The player interacts with the world by navigating with the protagonist and pressing contextual keys to use objects and talk to NPCs. Dialogues have different options the player can choose from, which take the conversation in different directions. The rewind mechanic is not always available, and Max can only use it for a limited amount of time. Every time an event can have an impact in the gameworld, the game informs the player with an icon. When this icon appears, the player can go back in time and choose a different course of action. When Max learns valuable information in a conversation, another icon appears on the screen and signals that the player can go back in time and use this newly acquired knowledge, which is subsequently added to the dialogue options. In one scene, Max is trying to prove to her friend Chloe that she possesses the power to rewind time by telling her what she has in her pockets. At first, neither Max nor the player know the correct answers, a fact that is represented with a set of false dialogue options that render the task impossible to accomplish. After the first failed attempt, Chloe empties her pockets and shows Max that she was wrong, which gives the protagonist (and the player) the chance to memorize each object in detail. At this point, the player can rewind until before the challenge started and tell Chloe exactly what she is carrying. The correct dialogue options now appear among a few false ones, making it still possible to fail, but the scene can be repeated until all the right answers are selected. Therefore, LIFE IS STRANGE integrates the resetting of gametime in the gameworld, avoiding the knowledge gap between player and player character.

LIFE IS STRANGE still allows players to reload the last saved checkpoint and also replay chapters at will (apart from the fact that the game can be completely restarted), which causes the paradox to occur. Still, players can play through the entire game only using the diegetic rewind mechanic, and thus avoid the paradox altogether.

Figure 2.14: LIFE IS STRANGE.

The moment when Max (left) tells Chloe (right) what she is carrying in her pockets.

Player Character Briefing

BATMAN: ARKHAM ASYLUM (Rocksteady 2009) features the Detective Mode. With it, Batman (and the player) can examine the nearby area by seeing through walls. This mechanic also provides crucial information about the enemies, such as how many there are, which of them are armed, and in what psychological condition they find themselves (if they are nervous or calm); it also highlights points of interest in the gamespace, like vents to crawl through or weak walls that can be shattered (see figure 2.15). In this way, both the player and the character acquire knowledge about the state of the gameworld without needing to engage in a process of trial and error. Additionally, a map overview accessed by both Batman and the player details the level design. Through these features, little information is left (some hidden collectibles remain out of sight) that the player could acquire through means of the GDE. However, this solution only works if, when Batman dies and the player restarts from a checkpoint, the Detective Mode is activated. If the player abstains from using it, the paradox appears.

Figure 2.15: BATMAN: ARKHAM ASYLUM.

Top: A level in the challenge mode with the Detective Mode on.
Bottom: The same level a moment later, with the Detective Mode off.

Several other games with stealth mechanics, like DISHONORED or BIOSHOCK INFINITE: BURIAL AT SEA – EPISODE TWO (Irrational Games 2014), have systems similar to the Detective Mode, allowing the characters to see enemies through walls. But these games do not brief players as thoroughly as BATMAN: ARKHAM ASYLUM—both lack an in-game map, for instance. ASSASSIN'S CREED resembles the Batman game as well, in that it includes a map and the Eagle Vision mechanic that allows players to spot NPCs behind walls and detect which are hostile or the objective of an assassination.

PRINCE OF PERSIA: THE SANDS OF TIME, as we have seen, introduces a diegetic rewind mechanic that effaces the paradox as long as the player uses it. This mechanic is, however, not entirely necessary. When the player needs or decides to load a checkpoint instead, the paradox should in principle appear. But the whole game— except for the final boss fight—is, in fact, a story told by the prince. This means that every successful attempt by the player at solving a puzzle or fighting an enemy is constructed as a retelling of actions that the protagonist has already performed. Occasionally, a voice-over of the prince is heard, fulfilling his role of omniscient narrator. If the prince dies, he says "No, no, no, that's not the way it happened. Shall I start again?"—or a variation of that phrase. Furthermore, when saving the game state at one of the checkpoints, the prince exclaims "Done! I'll start from here next time." The fact that the player is playing a retelling of events erases the paradox almost completely. The character is not exactly "briefed" in PRINCE OF PERSIA, but the effect is the same: the knowledge gap between player and player character produced by the GDE is countered by a plot device that gives the character more information (the topic of narration in video games will be discussed in the next section, The Hybrid Narrator).

The paradox is nevertheless not completely erased, because the final boss fight takes place after the narrated events. Restarting this fight is the only action in the game that produces the paradox.

Deal with It

Game developer Quantic Dream strongly emphasizes the decision-making part of gameplay in HEAVY RAIN (Quantic Dream 2010). The game does not have a save-load mechanic, so the choices made will impact the storyline in ways that are only reversible by restarting full chapters or the whole game. David Cage, the game's lead designer and screenwriter, has expressed the motivation behind this design choice on more than one occasion. In the second portion of a two-part interview with G4TV in 2009, prior to the release of HEAVY RAIN, Cage confessed that he "would like people to play it once," because "that's life. Life you can only play once" (Berghammer 2009). And he continued:

"I would like people to have this experience that way, but the game allows you play [*sic!*] as many times as you want, of course, and I'm fine with that, but the right way to enjoy HEAVY RAIN is really to make one thing because it's going to be your story. It's going to be unique to you. It's really the story you decided to write, and that will be a different story from someone else. And, again, I think playing it several times is also a way to kill the magic of it" (ibid.).

Three years later, Cage reiterated this argument in an interview with Videogamer (Kelly 2012), while discussing BEYOND: TWO SOULS (Quantic Dream 2013) and in 2016 he did it once again, this time talking to Gamespot (Cage 2016) about his game DETROIT: BECOME HUMAN (Quantic Dream 2018).

Cage's games have branching storylines with different possible endings that rely on decisions made by the player to move forward. His goal is to create narratives that deeply engage the player by means of interaction. Each scene presents players with a series of choices, some of which can have a significant impact on the story's outcome. Thus, players are not vicarious observers of someone else's life, but share responsibility for the consequences of each decision made by the characters. Cage's games allow players to replay chapters directly after finishing them, but the games never present the player with a game over screen or any sort of clear failure condition. The story simply pushes forward according to the decisions that the player makes. Additionally, the consequences of these choices are not always readily noticeable, so it is not necessarily clear what effect a decision made in one chapter might have on subsequent ones.

Cage's bet is that players become so invested in the characters and story that restarting a full chapter (or the complete game)—and thus losing a significant amount of progress—will be less desirable than to follow the events until their conclusion. For these stories to have a strong impact on players, it makes sense to discourage them from facing the GDE.

Some characters can die in predetermined parts of the plot in Quantic Dream's games. This tends to happen close to the conclusion of the narrative as part of one of the many end states of these games. Being so story and character-driven, they do not let their protagonists die early in the game—since it would be irreversible. But there are other games that apply the feature of permanent death from early on.

Figure 2.16: A father-son moment in Quantic Dream's HEAVY RAIN.

Source: http://www.gamersglobal.de/screens/10992 (accessed February 2, 2018).

Permadeath—shorthand for permanent death—is the most punishing solution to the paradox. In DIABLO III (Blizzard Entertainment, 2012) this is an optional feature present only on hardcore mode. When playing on this mode, the save and load functions are only implemented so that players can resume their game where they left it the last time. When the player character dies, however, it is final. Player characters are created at the start of DIABLO III, so, if the game is restarted, the player needs to create a new one. Several games implement this mechanic, and there is even a whole category of games known as *roguelike*, named after the game ROGUE (Toy and Wichman 1980), that has permadeath as one of its defining characteristics.[6] Irreversible death and other features make playing these games a highly challenging task.

Nevertheless, permadeath alone does not solve the paradox completely. If you die in a game and have to start again from square one, and the entire game remains unchanged, then the paradox persists. Roguelike games have another characteristic that, together with permadeath, erases all traces of the GDE and the paradox: procedural generation of the gamespace. With this method, stages

6 There is no actual consensus on a definition of *roguelike*, but the Berlin Interpretation created at the Roguelike Development Conference 2008 is a useful approximation (RogueBasin 2013). Among numerous other features, the definition states that roguelike games need random environment generation, permadeath, turn-based gameplay, and grid-based gameworlds. Following this definition, the three games listed above are not roguelikes. Terms like *hybrid roguelikes* or *roguelike-likes* have been coined to classify games that utilize some elements of the roguelike genre.

are not predesigned by the developer by hand, but by algorithms that autonomously create the level for the player in a quasi-random manner. Procedural content generation makes it impossible to memorize the level design in order to master the game. Games like DON'T STARVE (Klei Entertainment 2013), THE BINDING OF ISAAC: REBIRTH (Nicalis 2014), or SPELUNKY (Mossmouth 2008), while not considered roguelikes per se, include both procedurally-generated stages and permadeath as an inescapable feature of the gameplay. In these games, neither the player nor the character know what is going to happen in each new playthrough. The design of the level, including the amount and locations of enemies and resources, is unknown every time the player restarts a game. But the player does acquire some knowledge of general mechanics, types and behavior of enemies, and uses of items that the character should forget after death. Since each new game is started with the same character, the paradox is only solved partially.

Permadeath with procedural level generation is a definitive solution to the paradox in cases where a new character is created with every new game. The second time players play a game like BIOSHOCK or HEAVY RAIN, they know exactly what to expect. In contrast, dying in ROGUE means losing all progress and starting the game from square one with a new character on a completely unknown map. The only issue with this solution is that it is not well-suited for storytelling in a traditional sense. If a designer wishes to tell a story with fixed characters, locations, and a predetermined succession of events (even if it features different branches and endings), they need more control of the design of the game (at least for the time being).

"ONCE WASN'T ENOUGH FOR YOU, EH? WELL, TWICE IS FINE BY ME!"[7]

MIDDLE-EARTH: SHADOW OF MORDOR is an interesting collage of four of the above-described categories. The game starts as Talion's (the main player character) family is slain. Talion is murdered as well, but he becomes possessed by the spirit of the elf Celebrimbor. So, the protagonist lingers in the world of the living

7 The title is one of the several phrases that Uruk captains and warchiefs utter when they encounter the player character again after killing him in the video game MIDDLE-EARTH: SHADOW OF MORDOR.

in a state that is neither alive nor dead, sharing his body with another conscious being.[8]

Since Talion becomes Celebrimbor's vessel, the player can switch between them at will. While the player spends most of their time as Talion, shifting to the spectral form of Celebrimbor activates a number of valuable special abilities. This alliance between an elf's spirit and the body of an undead man is the plot device—and mechanic—that provides most of the solutions to the paradox.

There are two main ways to shift to Celebrimbor: one involves the simple press of a button. This action switches between characters every time it is performed. The second way entails pressing and holding the button that aims the bow, a weapon that only Celebrimbor can wield. Once the button is released, the character switches back to Talion. When using Celebrimbor, the appearance of the world changes. The player character's surroundings dissolve into a deep-blue darkness, a spectral wind begins to blow, and living creatures become colored silhouettes that can be seen through walls (while the shapes are usually blue, the tint can vary in enemies according to type). Wraith Vision, as it is called, resembles the Detective Mode in BATMAN: ARKHAM ASYLUM or the Eagle Vision in ASSASSIN'S CREED. This mechanic introduces the first solution to the paradox: *player character briefing*.

Furthermore, since Talion is technically not alive, he cannot die. Thus *Death becomes the game* is not just an occasional aspect of SHADOW OF MORDOR, but it spans across its whole duration. There is nonetheless a health bar that depletes as Talion takes damage. When it empties, Talion and Celebrimbor respawn at the top of Forge Towers that are scattered throughout the gameworld, but the game state does not return to a previous condition. Even though the nature of the towers remains largely unclear, the elf's spirit appears to be tied to them. This connection is suggested by their ghostly appearance (the towers glow and have a light-blue tint, just like Celebrimbor) and the fact that they can only be seen standing out amidst the darkness in Wraith Vision, i.e. through the eyes of Celebrimbor. They only materialize for Talion when standing close to them but, otherwise, all the player can see is ruins. In short, these towers perform the function of diegetic spawn points, just like the Vita-Chambers in BIOSHOCK or the New-U stations in BORDERLANDS. Forge Towers need to be activated by Celebrimbor. Once this is done, the player characters will respawn in the nearest one—not in the one that was activated last. *Respawn* is thus added to the list of solutions featured in the game.

8 While the details are somewhat more intricate than that, I shall largely omit them for the sake of brevity.

The fourth and last category that SHADOW OF MORDOR contains is *deal with it*. The game introduces an original mechanic called the Nemesis System that keeps track of the ranks in the army of Uruks—the most common enemy in the game. Uruks have three ranks: soldier, captain, and warchief. One of the game's layers (see section 1.2) allows players to see a diagram of the Uruk ranks. This information can be used in different ways across the game's missions. Players can dominate a captain and send him to fight against another captain or a warchief, or they can eliminate him themselves. When captains and warchiefs are disposed of, however, a lower ranking Uruk can take their place. In this way, players never lack nemeses to fight against. When captains or warchiefs eliminate Talion, they level up and become stronger. Since SHADOW OF MORDOR lacks a load-game menu or any function that permits players to go back in gametime, the only way to remedy this failure is to confront the now tougher Uruk once again and take revenge. As mentioned earlier in the text, captains and warchiefs will remember Talion. If the player confronts a captain or warchief Uruk for a second time after being killed by him, the enemy will react surprised at Talion's comeback with expressions like "And here I thought that you were already dead and rotting," or "Once wasn't enough for you, eh? Well, twice is fine by me!"

Figure 2.17: MIDDLE EARTH: SHADOW OF MORDOR – LORD OF THE HUNT (Monolith Productions 2014).

The start of a new confrontation against an Uruk Warchief, Zugor Beast Butcher, after losing against him more than once. The subtitle reads "Have you lose [sic!] count of how many times I've killed you? Let me remind you!"

LATHER, RINSE, REPEAT

The aesthetic of repetition so common in video games has not escaped the sight of game scholars. Players learn to interact with video games through trial-and-error processes, just as they would with real-world activities. The Groundhog Day Effect adds a new element to an otherwise everyday heuristic process, allowing players to reset the gametime and thus undo the consequences of unsuccessful efforts. In games with fictional characters, this process generates a gap between the knowledge acquired by the player from previous attempts, and the player character's knowledge, which is reset along with every other element in the gameworld every time the player loads a saved state. This, in turn, creates a paradoxical relation between the behavior of the player and the player character.

Nevertheless, the analysis of several video games has shown that there are mechanics and plot devices that help avoid the knowledge gap between player and character. Their implementation was likely motivated by reasons other than an interest in solving the paradox—such as increasing the replay value or the difficulty of the game—and, therefore, they sometimes address only part of the issue. However, there are cases where the paradox is completely avoided. Games like MIDDLE EARTH: SHADOW OF MORDOR and LEGACY OF KAIN: SOUL REAVER achieve this by turning death into a gamestate. On the other hand, PRINCE OF PERSIA: THE SANDS OF TIME and LIFE IS STRANGE apply mechanics that integrate the resetting of time in the gameworld and eliminate the paradox at the same time. The combination of permadeath, procedural content generation, and character creation seems to be the most effective way to avoid the paradox; but this is (at least presently) not the best means for storytelling. It cannot go without saying that there might be more solutions that have not been discussed here and, surely, many new ones could be designed and implemented in the future. These could be the subject of subsequent studies.

In the context of game development, a game designer that wishes to tell a compelling story and create believable characters might want to take the paradox into account. These solutions may help them set the focus more effectively on narrative and character development, consequently enhancing the player's experience.

A further problem that arises when telling stories in video games with the GDE involves the figure of the narrator. The following section will look into this figure and how it is shaped by the temporal iterations of video games.

The Hybrid Narrator

It was a clear day in the Mushroom Kingdom. A stubby plumber with a big black mustache sprinted through an open field. He had no time to enjoy the sights: the helpless princess had to be rescued from the claws of her evil kidnapper. The knight in overalls raced ahead, swiftly eluding hazardous obstacles and prevailing over every enemy that tried to impede his march. Just after bravely stomping on a menacing tortoise, despite his finest efforts, a miscalculated jump led the working-class hero to the bottom of a pit where he died instantly.

It was a clear day in the Mushroom Kingdom. A stubby plumber with a big black mustache sprinted through an open field. He had no time to enjoy the sights: the helpless princess had to be rescued from the claws of her evil kidnapper. The knight in overalls raced ahead, swiftly eluding hazardous obstacles and prevailing over every enemy that tried to impede his march. Just after bravely stomping on a menacing tortoise, he successfully leaped over a pit that could have led him to a tragic death, had he not calculated the jump with the utmost precision.

The above paragraphs narrate a hypothetical scene from SUPER MARIO BROS. Players probe their way through the virtual world by means of the common trial-and-error learning process that often leads the virtual character to its death. Following the Groundhog-Day-Effect logic in the scene described above, the repetition of the paragraph could go on and on for pages undergoing only slight changes—depending on how often the player character dies and how many lives the player has at their disposal. This example intends to illustrate—in an admittedly ludicrous way—the problems with of one of the main elements of narrative in the video game medium: *the verbal narrator*.[1]

1 I will use the notion of *verbal narrator* to speak of a storyteller who uses language, whether it is written or spoken. The intricate academic discussion surrounding the narrator exceeds the scope of this argument and this section will not delve into it in detail.

THE RETROSPECTIVE NARRATOR

Traditionally speaking, the narrator is a voice that tells a story[2] to an audience. I will refer to the narrator that is already familiar with the recounted events from beginning to end as the *retrospective narrator* (compare Ryan 1993, p. 1).[3] In literature, the retrospective narrator seems to be indissociable from the notion of narrative. Take, for instance, the definition of narrative by the renowned literary scholar Gerald Prince: "the recounting (as product and process, object and act, structure and structuration) of one or more real or fictitious events communicated by one, two or several (more or less overt) narrators to one, two or several (more or less overt) narratees" (in Eskelinen 2001). According to this definition, the absence of a narrator would entail the absence of a narration.[4]

In the realm of film, the relation between narrative and narrator acquires a new level of complexity that challenges Prince's definition. This medium does not require a narrative voice to describe the action; it displays it directly in front of the spectator in the form of a moving image. As Kuhn and Schmitt have argued:

> "Though almost all feature films abound in storytelling capacities and thus belong to a predominantly narrative medium, their specific mode of plurimedial presentation and their peculiar blending of temporal and spatial elements set them apart from forms of narrative that are principally language-based" (Kuhn and Schmitt, 2014).

Thus, narration in film arises from the combination of different elements that result in the final audiovisual experience, such as the camera, editing, sound, and the mise-en-scène (compare ibid.; Thon 2016, p. 143). This assertion implies either that there can be narrative without a narrator, or that film has another kind

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Jan-Noel Thon's TRANSMEDIA NARRATOLOGY AND CONTEMPORARY MEDIA CULTURE (Thon 2016) offers a thorough account of this discussion with regard to film, comics, and video games.

2 In this particular section, I am interested in "story" or "narrative" in the traditional sense of "the presentation of a number of events" (Juul 2005, p. 156). I will use both terms interchangeably.

3 A retrospective narrator does not need to employ the past tense. Narration in the present tense is "a disguised form of retrospective narration" (Ryan 1993, p. 1) if it is authored with a predefined ending in mind.

4 This line of argument can be traced back to book three of Plato's REPUBLIC (2013) and his distinction between imitation and narration.

of retrospective narrator, different from the one found in literature: one that shows the story instead of telling it (compare Arsenault 2006, p. 52; Thon 2016, p. 143).[5] Nevertheless, the verbal narrator is far from absent in film. In the early, silent years, its role was assigned to intertitles, and a vast number of films since the introduction of sound make use of a voice-over narrator.

The characteristics of gametime complicate matters even further for the verbal retrospective narrator (compare Thon 2016, p. 207). The storytelling during gameplay portions is generally carried out without the aid of a verbal narrator, and it is instead performed with other elements of the medium—some of which can be found in film as well—, such as the camera, sound and level design, and the mise-en-scène (compare Jenkins 2004, p. 123). The retrospective narrator, if featured at all, is commonly relegated to non-gameplay portions. Cutscenes and text passages can easily make use of a verbal narrator, just like film or literature. But, during gameplay, the action emerges in real time as the player interacts with the gameworld. In this way, the present tense of gameplay and the past tense of narration are safely kept apart. In the words of game designer Chris Crawford:

> "The story itself is noninteractive, and the game itself lacks dramatic content. You interact with the nonnarrative game, then see some non-interactive story, then interact some more with the game, then see more story, and if you alternate between the two fast enough, it becomes an 'interactive story'—right?" (Crawford 2003, p. 260).

Additionally, the constant iteration produced by the Groundhog Day Effect provides another layer of complexity. A narration repeating over and over with every iteration of a particular segment (just like the two paragraphs that open this section) would run the risk of rapidly becoming irritating. Thus, one could argue that gameplay is incompatible with the retrospective narrator—though this is not necessarily the case.

The retrospective narrator appears in video games outside of gameplay portions in different ways. THE WITCHER 3: WILD HUNT, for example, recaps the main plot points in the form of 2D animations every time the player launches the game. These animations are narrated in voice-over by Dandelion, a bard who is a friend of the protagonist, Geralt of Rivia. The game also shows the player short 2D animations after several quests, with voice-over narration by Geralt himself, reflecting on the foregone events. These animations can differ according to the decisions made by the player during each quest. A final way in which THE

5 Film critic Seymour Chatman, for instance, has called it the *cinematic narrator* (in Thon 2016, p. 143), while film scholar André Gaudreault speaks of a *monstrator* (one who shows) instead of a *narrator* (one who tells) (in Arsenault 2006, p. 52).

WITCHER 3 introduces the voice of a retrospective narrator is in the multitude of texts that are available to the player. Some of them are found in the quests menu and recap the events of already played missions, which proves especially useful when resuming a quest that has been put on hold and whose details might have been somewhat obscured by the passage of time—considering the limits of working memory described in chapter one, section 1.1. The voice narrating these texts is, once again, that of Dandelion. Other texts with narrators include diaries, letters, and books that provide information on the history and legends of Geralt's world. All of these texts refer to the events they describe in the past tense, but never are the events of the game narrated as they occur. Hence, there are two temporalities in THE WITCHER 3: the present tense of gameplay and in-game cutscenes, and the past tense of the recounted events in 2D animations and texts.

Some video games include retrospective, voice-over narration during gameplay that does not directly address the action happening on screen. THOMAS WAS ALONE (Bithell 2012) is an example of this. The narration runs while the player interacts with the game world, providing information about the character's feelings, thoughts, and motivations, while leaving the description of the space and the action to the interactive moving image. Remedy's QUANTUM BREAK (Remedy Entertainment 2016) and ALAN WAKE (Remedy Entertainment 2010) are further examples of retrospective, voice-over narration in video games. In each case, the gameplay is framed by the narration as a reconstruction of past events.

THE REAL-TIME NARRATOR

Real-time verbal narration (as opposed to retrospective narration) is usually called "commentary" (compare Ryan 1993, pp. 148-150). When watching a football (soccer) match on television or listening to it on the radio, the event is narrated to the spectators as it is happening. Take this radio commentary that ESPN's Jorge Ramos shared on his Twitter account (@ESPN_JorgeRamos, May 6, 2015):

"Jordi Alba steals the ball and starts the counter-attack. Jordi takes it. He crosses the half-way line. Messi wants the ball. Everyone gives it to him because he can solve almost anything. Messi cannot get through. Now Boateng has it. Second recovery by Rakitić. He's heading toward the center spot. Gives it to Dani Alves. Back to Rakitić. Passes it back to Piqué. Now to Busquets. Gives the ball to Rakitić. Rakitić gives it to Messi. Messi wants to get into the 18-yard box. This can get messy. He's in! Goooooal! Oh my God! I'm leaving! There's nothing else to see here! Ladies and gentlemen, we are turning everything off! Close the radio! Close the network! End football!"[6]

As Marie-Laure Ryan argues, live sports broadcasting is primarily a form of chronicle, since it is "mainly interested in the *what* of the game" and "the primary task of the announcer is to report everything that happens on the field as soon as it happens" (Ryan 1993, pp. 141).

What distinguishes retrospective from real-time narration is the time elapsed between the narration and the narrated event. Real-time narration occurs *during* the narrated event, while it still has an open ending; retrospective narration takes place *after* the narrated event has already finished. Retrospective narrators have thus greater control over the plot, since they already possess all the pieces of the story before they start to tell it. Retrospective narrators can, for instance, omit irrelevant information or swap the order of the events—for example, by telling the ending first (compare ibid., pp. 148-150). Real-time narrators do not know how the narration is going to end, and cannot influence the pacing or the order of events. As Ryan puts it, in real-time narration "[t]he relation between the duration of the narrated and the duration of the narration is rarely comfortable: there is usually either too much or too little time for language to capture the action live" (ibid. p. 141). Hence, a sense of urgency is typical in the production of real-time narration, due to the need to keep up with the succession of events.

Yet sports commentary is not a mere description of events. It is also embellished speech aimed at enhancing the drama of a match. A study by Bryant and coworkers (1977) examined the commentary of several American football matches in different networks. They classified the different sentences in three categories: descriptive, dramatic, or humorous. As the researchers report:

"From the 6 games analyzed, a total of 5728 sentences were coded, or an average of about 955 sentences per game. Of these, an average of 690 per game, or about 72 percent were

6 Transcription of the Spanish original: "Roba Jordi Alba y se viene la contra. La lleva Jordi. Atención, cruza la linea ecuatorial. La pide Messi. Todos se la dan a él porque el soluciona casi todo. Allí Messi no puede. Ahora con Boateng. Segunda pelota que recupera Rakitić. Encaró hacia el medio. La vuelve a tocar con Dani Alves. Devuelve para Rakitić. Atrás para Piqué. De primera para Busquets. Juega para Rakitić, Rakitić para Messi. Messi se va a meter al area. Puede armar lío. ¡Se metió! ¡Golaaaaazo, por Dios! ¡Me levanto y me voy, no hay más nada para ver! ¡Damas y caballeros apagamos todo! ¡Qué se cierre la radio! ¡Qué se cierre la cadena! ¡Qué no haya más fútbol!" The audio can be heard at https://soundcloud.com/polanco-4/gol-barza-2-0-bayern (accessed March 8, 2018).

classified as descriptive. For the remaining commentary, approximately 27 percent, or an average of 251 sentences per game, were recorded as serious dramatic sentences, while the remaining 1 percent, or 14 sentences per game, were classified as humorous" (Bryant et al. 1977, p. 144).

Thus, while the majority of the sentences were descriptive, a significant percentage of the commentary (more than a quarter) was dramatic.

Real-time narrators can also tell retrospective stories relevant to the narrated event. Sports commentators might talk about past matches between the contesting teams, or the history between two particular players. These stories have a particular function: to increase the tension produced by the drama developing on the court. In fact, another study by Bryant showed that the enjoyment of a match increases substantially if the commentators portray the relationship between the opposing players as hostile (Bryant et al. 1982). "Classic" confrontations (for example, Real Madrid vs. Barcelona) are particularly appealing to audiences because of the long history of rivalry between the opposing teams (ibid. p. 109). But this does not detract from the fact that the real-time narrator is reacting to events without knowledge of what the outcome will be. These retrospective portions extend the duration of the story towards the past mainly to exploit the open-ended nature of the current confrontation. In an actual retrospective narration, the ending can influence the recounting of events.

There are different instances within video game culture where live commentators narrate what the spectator sees on the screen—just like in sports matches—such as E-sports broadcasts and *let's play* videos. Sports video games, on the other hand, feature simulated commentary. The commentary in series like FIFA or MADDEN NFL consists of audio snippets that are pre-recorded by professional commentators. An algorithm then stitches these fragments together as the player plays.

One of the first games to include commentary was NFL SPORTS TALK FOOTBALL '93 (Blue Sky Software 1992), for the Sega Mega Drive. The commentary in this game was robotic and repetitive, but quite the novelty for its time. Games like ROCK & ROLL RACING (Blizzard Entertainment 1993) ("Rip is about to blow!") or NBA JAM (Midway 1993) ("He's on fire!") included highly formulaic, sporadic commentary as well. The popularization of the CD-ROM as a console and PC-gaming format appears to have facilitated a drastic jump in the quality of video game commentary. Game series that previously featured no or very little commentary suddenly had far richer and better-quality commentary in their 1997 iterations (along with the new implementation of 3D engines)—for example, FIFA 97 (EA Canada 1996), MADDEN NFL 97 (EA Tiburon 1996), or NHL 97 (EA Canada 1996).[7]

Before the release of the 2017 installment of the MADDEN NFL franchise (EA Tiburon 2016), part of the game's advertising campaign mentioned an overhaul of the commentary system with a new team of announcers and the ambition "to do something that had never been done in the commentary space before" (EA SPORTS 2016). A piece on Vice Sports of July 2016 asked hyperbolically: "Can Madden 17 save sports commentary in video games?" (Porter 2016). Reviews of the game have been largely positive,[8] but the critics' verdict concerning the new commentary appears to be somewhat mixed.[9] Nonetheless, while it can still be repetitive and at moments limited to one-liners, simulated commentary has certainly come a long way since its early days in cartridge consoles.

For the most part, real-time narration is constituted by a live chronicle of events that are out of the narrator's control. Whether a computer algorithm selecting pertinent audio samples from a library or a real-life person, the real-time narrator needs to react to the events happening on the field or court and report them while enhancing the drama.

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7 I hasten to add that the "CD-ROM revolution," as labeled by Tristan Donovan in his book REPLAY (2010, pp. 237-247), started much earlier than 1997. According to Donovan, Sony released the first CD music player in 1982 and the format caught the attention of game developers from early on. PC gaming made use of the CD-ROM in the early nineties with titles like THE 7TH GUEST (1993) or STAR WARS: REBEL ASSAULT (1993), which kindled the popularity of the PC as a gaming medium, Donovan argues. During this time, the main gaming consoles were the cartridge-based Sega Genesis and the Super NES (Panasonic's 3DO console already made use of the CD-ROM in 1993, but it could not compete against Sega's and Nintendo's popularity). By looking at the evolution of sport games, it would appear that until 1997 most of them were developed with the limitations of consoles in mind. It seems reasonable to infer that, once the Sony PlayStation and the Sega Saturn were released in the mid-nineties and popularized the CD-ROM as a console format, sports game developers could start exploiting its increased storage capacity, thus enhancing the graphics and sound in their titles.

8 The game has an average score of 83/100 on Metacritic, both for the PlayStation 4 and the Xbox One versions (Metacritic 2016).

9 For example, IGN's Dustin Toms (2016) reported being "not convinced," while Destructoid's Chris Carter praised it for being "vastly improved with strings of new dialogue that provide coherent and relevant thoughts" and added that "it's taken a step further with update patches that add in relevant happenings from week to week" (Carter 2016).

So far, I have shown that both the retrospective and the real-time narrator are present in video games, even though they tend not to mix. Still, on some rare occasions, they do, giving rise to what I call the hybrid narrator.[10]

THE HYBRID NARRATOR

Developers and scholars have previously scrutinized narration in video games (see for instance Crawford 2003, Jenkins 2004, Arsenault 2006, and Thon 2016), but there is a form of narrator that has not yet been explicitly addressed. The hybrid narrator, as I will hereafter call it, is an amalgamation of the real-time and the retrospective narrator. This voice knows and tells the game's story retrospectively from start to finish, while at the same time commenting in real time on the player's actions.

Games commonly tell stories with fixed beginnings and endings while leaving enough leeway for the player to make decisions that have no effect on the final outcome. Mario will always find Princess Peach at the end of SUPER MARIO BROS. Many decisions along the journey from A to B are up to the player, but the events that take place before A (the kidnapping of the princess) and after B (the princess finally being in the eighth castle) are outside of the player's jurisdiction. In Jenkin's (2005, p. 8) words, "The introduction needs to establish the character's goals or explain the basic conflict; the conclusion needs to show the successful completion of those goals or the final defeat of the antagonist." What happens in between can differ within a certain range of parameters that the player can influence in real time.

Because of this blending of time frames, games tend to lack a verbal narrator and, those that feature one, generally restrict its presence to non-gameplay sections such as cutscenes. Conversely, games with commentators usually do not feature retrospective narrators, since they emulate sports broadcasting and do not tell a pre-written story. The hybrid narrator works both ways: On the one hand, this figure possesses a retrospective aspect conceived by the designer as an indispensable part of the narrative. On the other hand, this narrator also features a real-time aspect that—while it is also pre-written and thus to some extent predictable—needs to be triggered by gameplay events to emerge and is not critical for the story to develop. The hybrid narrator is the embodiment of the hybrid

10 The hybrid narrator discussed here should not be confused with the notion of hybrid narrative, which can be used to refer to the combination of different points of view or different writing styles in one text.

temporal nature of video games, yet it is rather the exception than the rule. In what follows, I will analyze three games that feature hybrid narrators: PRINCE OF PERSIA: THE SANDS OF TIME, THE STANLEY PARABLE, and BASTION.

Prince of Persia: The Sands of Time

The hybrid narrator featured in PRINCE OF PERSIA: THE SANDS OF TIME is not particularly well executed, which makes it an interesting place to start. In this game, the eponymous protagonist tells the story of how he partook in an invasion of a Maharaja palace led by his own father, king Sharaman. The game starts with a cutscene narrated in voice-over by the prince. Once the cutscene concludes, the player takes control of the character and plays through a section that introduces basic mechanics—like movement, jumping, climbing, and sword fighting. After the first few challenges are over, the prince resumes the narration during gameplay (always in voice-over; it is not the avatar on screen who is speaking). The prince's narration does not comment on what happens on screen, but explains his own motivations and provides context for the action. But, a few minutes into the game, something peculiar happens: The game pauses automatically and a menu opens with the text "Do you want to save?" displayed on the screen, to which the player needs to answer by clicking on "yes" or "no." At the same time, the prince's voice asks "Shall I continue my story from here the next time we're interrupted?"

Unless the player character dies during the (quite easy) tutorial section, this is the first hint that the narrator in PRINCE OF PERSIA: THE SANDS OF TIME is not a typical retrospective narrator (compare Atkins 2007, pp. 247-248). With this question, the prince's voice trespasses from the realm of the narration into the realm of the mechanics. But notice the awkwardness of the question. Why would anyone ask that? If you are telling a story and are interrupted, you normally resume from where you left. If your interlocutor forgot important details of your tale, then you could recap those; but you wouldn't stop to ask if you should start from a particular point just in case you are interrupted *while* you are telling the story. Once the player is finished saving the game, the prince says: "Done. I'll start the story from here next time."

Another instance in which the narrator crosses the boundary between narrative and mechanics is when the player character dies. Whenever this happens, the narrating prince utters "No, no, no. That's not what happened. May I start again?" This case is perhaps even stranger than the previous one. The prince seems to imply he mistakenly told the listener that he died when he actually did not. These two cases (the save game menu and the comments when dying) are particularly salient because of their awkward implementation and recurrence throughout the game.

Figure 2.18: PRINCE OF PERSIA: THE SANDS OF TIME.

PRINCE OF PERSIA: THE SANDS OF TIME, though not without flaws, is an early and laudable effort to implement a hybrid narrator in a video game. One might consider that the prince's narration has been written with a somewhat amusing intent, but the game's overall dramatic tone does not quite support this decision.

The Stanley Parable

THE STANLEY PARABLE[11] makes use of the hybrid narrative voice with grace and wit, wryly underscoring the problems that can afflict the hybrid narrator. While PRINCE OF PERSIA: THE SANDS OF TIME divides its focus between gameplay and storytelling, THE STANLEY PARABLE has a straightforward narrative intent. The player's role is limited to walking around an office building and occasionally in-

11 THE STANLEY PARABLE was first released as a modification of HALF-LIFE 2 (Valve 2004) in 2011. In 2013 a standalone version was released with some changes, such as new narrative paths and improved graphics. This analysis is based on the standalone version.

teracting with buttons or doors while an omnipresent voice-over narrator tells "the story of a man named Stanley."

In the opening cutscene, the narrator introduces Stanley, a content office worker whose daily routine consists of pressing buttons on a keyboard by following prompts as they appear on a screen. "And then one day," the narrator states, "something very peculiar happened. Something that would forever change Stanley. Something he would never quite forget." After sitting at his desk for the good part of an hour, he had received no orders, nor had seen any coworkers. "Something was very clearly wrong," continues the narrator: "Shocked, frozen solid, Stanley found himself unable to move for the longest time. But as he came to his wits and regained his senses he got up from his desk and stepped out of his office."

At this point, the player gains control of Stanley from a first-person perspective. The player needs to move around the building and, as far as the narrative motivation goes, figure out why everyone has disappeared. As the player inspects the surroundings, the narrator provides information about Stanley's thoughts and a first objective: "Stanley decided to go to the meeting room. Perhaps he had simply missed a memo."

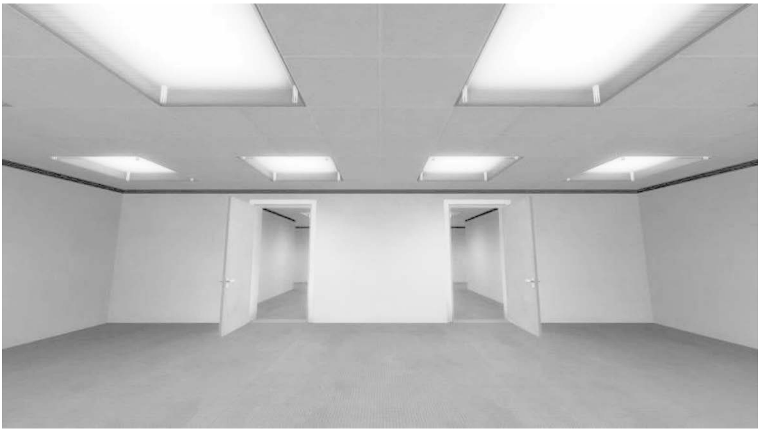
If the player tries to interact with the objects (computers, desk drawers, cabinets) in one of the first rooms, the narrator promptly reveals his hybrid nature[12]: "Stanley went around touching every little thing in the office, but it didn't make a single difference, nor did it advance the story in any way." Even if the player's actions trigger this remark, the game might seem to develop in a linear fashion at first, with few possibilities for interaction. The first minute or so consists of a series of corridors and rooms filled with jejune props such as cubicles, computers, and file drawers that do not react to the player's prompts—aside from computer screens that turn off when clicked on. This situation changes soon enough when the player walks into a room with two open doors on the opposite end: "When Stanley came to a set of two open doors, he entered the door on his left," declares the narrator (see figure 2.19).

If the player chooses to enter the door on the left, the narrator continues his tale undisturbed. Other forking paths appear on the way but, as long as the player follows instructions, the narrator maintains a retrospective point of view. If the player chooses to go right, however, the narrator starts to become uneasy: "This was not the correct way to the meeting room, and Stanley knew it perfectly well. Perhaps he wanted to stop by the employee lounge first, just to admire it." The

12 "The Stanley Parable Announcer Pack" for DOTA 2 (Valve 2013) replaces the game's default announcer with THE STANLEY PARABLE'S narrator (Dota 2 Wiki 2017). Here he embraces the role of a straightforward commentator.

hallway leads directly to a dull common area with some chairs, coffee, and a soda vending machine. If the player lingers in this room, the narrator grows impatient: "Yes, really, really worth it being here in the room. A room so utterly captivating that even though all your coworkers have mysteriously vanished here you sit looking at these chairs and some paintings. Really worth it."

Figure 2.19: THE STANLEY PARABLE.



"He entered the door on his left."

When the player finally decides to exit the room, the narrator tries to send Stanley in the direction the story demands ("But at last he had enough of the amazing room and took the first door on his left to get back to business"). But the more the player ignores the narrator's directives, the more frustrated he grows. Soon he starts criticizing Stanley and even addressing him directly in the second person, imploring him to cooperate: "Look, Stanley, I think perhaps we've gotten off on the wrong foot here. I'm not your enemy. Really. I'm not. I realize that investing your trust in someone else can be difficult, but the fact is that the story has been about nothing but you all this time."

The narrator's frustration and frequent sarcasm are enhanced by his temperate British accent and correct diction, which complete a humorous arrangement that drives the player to search for the many possible ways in which the storyteller can be caused to derail. This branching structure can culminate in several possible endings with different tones and subjects[13]: One reflects on free will, one on insanity, and another on art, to name a few. Above all, THE STANLEY PARABLE provides a facetious commentary on the nature of games and the tension between narrative and mechanics, between guided storytelling and player freedom.

Bastion

The final example, BASTION, does not seek to strike the humorous note of THE STANLEY PARABLE. Instead, it presents the earnest story of a city struck by a catastrophe, the Calamity, which killed most of its inhabitants. The player controls a character, referred to as "The Kid" by the narrator, from an isometric perspective. His task is at first to reach the titular bastion and reactivate a device in it by collecting the cores (magic crystals) that power it. The player later learns that this device, called the monument, has the power to turn back time. At the end of the game, the player can choose to fly away from the city and start anew somewhere else, or go back in time to try to prevent the Calamity.

Rucks, a character that The Kid meets in the bastion, narrates the game.[14] At the very start of the game, accompanying the image of The Kid resting among the floating ruins of what seems to be his home, Rucks says: "Proper stories are supposed to start at the beginning. Ain't so simple with this one." This observation, combined with the knowledge of the bastion's time-bending capabilities revealed later, suggests that this is not the first time that the Calamity has taken place and that The Kid has already used the bastion to go back in time at least once. Rucks seems to be telling the story with knowledge of this repetition.

Once the narrator finishes his brief introduction, The Kid lies asleep, motionless until the player presses a button. When this happens, the narrator comments: "He gets up." Here the narrator is providing a direct commentary on the action happening on screen as the player causes it. In contrast to THE STANLEY PARABLE and PRINCE OF PERSIA: THE SANDS OF TIME, the narrator in BASTION tells the story in the present tense, which makes his role of commentator more evident. However, the game's narration is depicted as retrospective, disguising the com-

13 According to THE STANLEY PARABLE Wiki there are 19 possible endings (The Stanley Parable Wiki 2018).

14 BASTION'S writer Greg Kasavin has written about his creative process in his blog. He calls the narrator in BASTION a real-time narrator, even though his function exceeds that of a typical commentator: "Its purpose is to deliver story and exposition, and to build atmosphere, investment, and immersion in close partnership with the gameplay" (Kasavin 2010).

mentary as part of the story. That is, the gameplay is portrayed as being caused by the verbal narration, although it is often the other way around (compare Thon 2016, p. 216). After all, Rucks states from the very beginning that he is telling a story—albeit not a "proper" one—and later provides further cues that he is telling the story from a point in the future.[15]

Figure 2.20: BASTION.

"Kid just rages for a while."

The narration is often triggered by unavoidable actions—such as waking up at the beginning, or finding the first weapon in the game, a hammer (to which the narrator says: "Finds his lifelong friend"). Still, other parts of the narration are activated by certain noncompulsory actions. After defeating the first enemy in the game, if the player stays in the area and starts smashing props with the hammer, this triggers the commentary "Kid just rages for a while" (figure 2.20), which would not be heard if the player proceeded to the next area directly after defeating the enemy. In addition, if The Kid falls to his death, Rucks can deny this happened ("And then he falls to his death. I'm just fooling!"), just like in PRINCE OF PERSIA: THE SANDS OF TIME, or utter a passing remark ("Can't be too careful these days").

The narrator in BASTION also provides information about the main character's inner world and the game's mechanics, as in the previous examples. The

15 After The Kid finds the first core to power the bastion's monument, for example, Rucks says: "I still remember the look in his face after that one."

phrase "Kid's worked up quite a thirst by now, so that fountain looks real inviting" realizes both functions, because it points the player towards a fountain in the game world that can be used to drink water and heal the character.

Rucks performs his hybrid role of commentator and storyteller, just like the other two described narrators, but this is made seamless through lines that never address the narratee directly. In THE SANDS OF TIME, the prince talks directly to an unknown listener when saying that he will continue to tell his story from the point where the game is saved, or acts confused every time the player character dies and says that he will start over because "that's not what happened." As argued above, this is highly unusual behavior for a storyteller. Additionally, it can lead players to think that the prince is breaking the fourth wall by addressing them, since only in the end players learn that the prince is telling the story to the Maharaja's daughter, Farah. For these reasons, the dissonance between story (past) and gameplay (present) becomes evident. BASTION does a much better job at concealing the tension between retrospective and real-time narration. THE STANLEY PARABLE, on the other hand, makes this disconnect conspicuous and exploits it to comedic effect.

FINDING A BALANCE

Juul once said that "it is impossible to influence something that has already happened," which means that "*you cannot have interactivity and narration at the same time*" (Juul 2001). But video games can grant players the capacity to affect some variables within a particular story, which can nonetheless still be a fixed sequence of events with a predetermined ending. In this sense, interactivity and narration do happen at the same time, and it is from this mixture that the hybrid narrator emerged.

Retrospective narration can usually provide a much more selective reconstruction of events and leave irrelevant information out. Real-time narration monitors the action as it happens and often comments on events that are not essential to the overall narrative ("Kid just rages for a while"). As Ryan points out, "the broadcast displays what the retrospective narrative eliminates: what does not fit into a game-story" (1993, pp. 141-142). In a retrospective narrative, the narrator can also condense actions in broader concepts. If a character prepares a meal, the retrospective narrator could just say "he cooked dinner." A real-time narrator, however, does not have that luxury and needs to either describe the cooking process step by step, spend that time providing additional information that might complement the narrative, or remain silent while the action unfolds.

The retrospective narrator can also adopt an omniscient perspective that is normally out of bounds for a real-time narrator. The hybrid narrator makes this whole range of options available, which developers could use at their discretion.

A final point that should be made concerns iteration, and specifically the Groundhog Day Effect. Repeating a game section or an action that prompts the narrator (falling from a ledge) can lead to the recurrence of the narrator's lines, which can risk a loss of immersion. Greg Kasavin, BASTION'S writer, made a clear point about this issue:

> "[N]othing sucks the momentum out of the game's narrative like a repeated line. […] So we drew a line in the sand: No repeats in the game, not unless you replay the game from the start or restart a scenario from scratch (and even then we mix up the narration)" (Kasavin 2010).

To this end, "BASTION uses about three thousand predetermined 'pieces' of verbal narration, represented in spoken as well as written form, that are triggered by a variety of player actions" (Thon 2016, p. 215). Both PRINCE OF PERSIA: THE SANDS OF TIME and THE STANLEY PARABLE deal with this issue in similar ways. In the former, the prince can utter one of several different lines when then the player character dies, while THE STANLEY PARABLE'S narrator does not start to tell the story all over again with every iteration, thus omitting lines that he has already delivered. While the reappearance of lines cannot be entirely avoided, these strategies help elude frequent repetition that might risk breaking the spell of immersion.

Surely enough, the hybrid narrator can lead to disruptive cases of ludonarrative dissonance. Yet, if implemented with care, it has the potential to deliver suitable narration by merging the retrospective and real-time points of view in one single voice, simultaneously addressing the narrative and interactive properties of the video game medium.

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Our interaction with video games is marked by iteration. This chapter has explored how we learn through repetition, and how that experience is enhanced by the capacity to reset gametime. Additionally, two further areas of friction between mechanics and storytelling were uncovered: The temporal paradox caused by the Groundhog Day Effect, and the difficulties of implementing verbal narrators.

Chapter three will treat the experience of time as analogous to traveling through a landscape. Understood as a landscape, time can be said to have a perspective. We can focus on what lies ahead of us (future), behind us (past), or immediately around us (present). We can also travel through the temporal landscape at different speeds. Some moments seem to last forever, and others are over before we know it. While gametime allows us to travel in two directions, our travels through the temporal landscape take place exclusively in one direction. The final chapter of this study will show that our relation to the temporal landscape holds a significant role when we play video games.

Through the Temporal Landscape

The Speed of Time

We travel through the temporal landscape on a one-way street, with an inexorable push towards the future (compare Clark 1973, p. 50). Just like when driving on a highway, we may speak of ourselves traveling through the landscape, or the landscape moving around us by means of the ego-moving and time-moving metaphors respectively (described in chapter one, section 1.1). But, while we are forced to drive in one direction, we are not restricted to a constant speed. These variations in the speed of temporal travel are, to be clear, unrelated to the *actual* passage of physical time, or to the change of pace characteristic of some videogame worlds (see section 1.2). It is our *experience* of the speed of time that is constantly changing.

One of the most familiar situations in which time seems to slow down its pace is in waiting rooms. While waiting for a doctor's appointment, for instance, we tend to focus our attention on the passage of time itself. As a result, our experience of time dilates, making the distance between now and the expected appointment seem excruciatingly long (Wittmann 2015, p. 13)—which elicits a feeling of boredom or impatience.

William James (1866, p. 392) stated that we feel bored when "we grow attentive to the passage of time itself." But what does that exactly mean? As stated in the beginning of this study, there is no organ that senses time in the way eyes sense light or ears sense sound. A prevalent theory states that the mind has a pacemaker that starts counting pulses whenever we direct our attention to the passage of time (see Wittmann 2009). These pulses accumulate, producing an estimation of how much time has elapsed. According to this model, focusing solely on the passage of time would generate a higher number of pulses than, for instance, performing timing tasks that involve external information. The accumulation of more pulses creates the illusion that a moment is longer than it actually is. As the idiom goes: a watched pot never boils. However, there is no evidence for a part of the brain that performs this function. Marc Wittmann has hypothesized that these pulses are our bodily signals. Then, the expression of "growing attentive to the passage of time" would refer to our bodily experience: "During waiting times I become self-aware and experience myself and my body more intensely"[1] (ibid., p. 1961). Becoming attentive of our own body, known in psychological jargon as *interoception*, slows down our experience of the passage of time.

On the other end, when focused on external or *exteroceptive* information, we lose self-awareness and the passage of time accelerates (Pöppel 1988, p. 83; Wittmann 2015, p. 13). Our bodily pacemaker is not engaged and we lose track of time. This phenomenon is commonly associated with a feeling of pleasantness (Craig 2009, pp. 1938-1939). Therefore, the speed at which we travel through the temporal landscape is contingent on what we are doing and where we direct our attention—inward or outward.

A further factor that can intensify the role of attention is the level of arousal elicited by the perceived stimulus (Craig 2009, Wittmann 2015). When an intense emotion overcomes us, we become more attentive to our bodily processes. The experience of fear, awe, anger, bliss, or sexual attraction, directs our attention to strong internal sensations and slows down the passage of time. For a brief moment, it might even seem to stop.

A final differentiation is in place here. We can judge the duration of an event both *prospectively* and *retrospectively*. This difference between prospective and retrospective judgments of duration can elicit contradictory impressions of the same moment. While in the waiting room, the temporal landscape between now and a future event (the doctor's examination) becomes rather empty and we come to be expectant of the next salient event. In this case, we are judging duration *prospectively*. We can only estimate time prospectively for short periods. For durations that exceed mental presence (the limits of working memory), the judgment of duration is either a mix of prospective and retrospective estimations, or purely retrospective.

When judging duration *retrospectively* (remembering the time in the waiting room), we might recall the feeling of boredom and the apparent dilation of time, but we will likely underestimate the time we actually spent waiting. And the inverse is true with enjoyment and the compression of time. Right after a vacation in a foreign country, for example, we may have the impression that two weeks went by in a heartbeat because we were not paying attention to the passage of time during those days. That is, we made no prospective judgments of duration. Retrospectively, however, it can seem like we spent two months instead of two weeks on vacation given that those two weeks provided us with unusual quantities of novel information.

1 My translation from the original German.

Retrospective judgments of duration rely on the available quantities of information from the remembered moment. That is, if our memory of an event is more detailed than usual, we will retrospectively overestimate its duration. Events with new information seem longer than events with known information. Moreover, emotionally saturated events will also seem longer retrospectively. Strong emotions make us process more interoceptive and exteroceptive information. Therefore, the higher the level of arousal, the longer we will tend to judge any period of time (Wittmann 2015, p. 22).

These phenomena also explain why time goes by faster as we get older. At a very young age, even the most trivial things are new pieces of information that will catch our attention. Additionally, childhood is more emotionally saturated than adulthood. These factors make a year for a child seem to last longer than for an adult. In adulthood there is less new information in the environment, lives tend to get structured in routines, and subjective experience loses some of the intense emotional coloring of childhood. All of this contributes to the acceleration of our journey through time as we age.

MEDIATED SPEED OF TIME

A study conducted by psychologist Olga Pollatos and coworkers (2014) exposed two groups of participants to three different movie clips, each of them 40 seconds long. The clips were scenes from THE BLAIR WITCH PROJECT (Myrick and Sánchez 1999), ICE AGE 3: DAWN OF THE DINOSAURS (Saldanha 2009), and a documentary describing a German city. The first film was chosen to elicit the negative emotion of fear, the second to amuse the participants, and the third for its emotionally neutral content. Additionally, one group of participants was asked to focus on interoceptive states and the other on exteroceptive stimuli while watching the clips. After viewing, the participants had to estimate the duration of each video retrospectively. The study showed that arousal had a significant impact in the estimation of duration. The fear condition produced the longest duration estimates, the neutral condition only slight underestimations, and the amusement condition the shortest duration estimates.

Moreover, the emotional effects were on average more pronounced in those participants who focused on their interoceptive states. They overestimated the duration of the fear condition clip (over 44.4 seconds) in relation to the other two estimates, and they starkly underestimated the duration of the clip in the amusement condition (27.4 seconds). In the neutral condition, both groups underestimated the duration of the clip with only slight differences (the interoceptive group: 35.2 seconds, the exteroceptive group: 33.2 seconds). This study provides evidence that film can influence our time perception. There is no equivalent study for video games at the moment, but it would be reasonable to hypothesize similar results if such an experiment were carried out.

The experience of time moving fast is well-known by video game players (Wood et al. 2007).[2] When immersed in a game—especially games of skill—, players often lose track of time. Even within a gaming session the speed of time fluctuates. Salient moments like the jolt of encountering a menacing enemy, or the frustration of losing a tense fight, can slow down the passage of time. Even positively-laden events might make time slow down if they are intense.

THE LAST OF US (Naughty Dog 2013) is a third-person video game with shooting and stealth mechanics. The game puts the player in the shoes of Joel, a man living in a world destroyed by a fungal infection that turns people into voracious zombie-like monsters. Joel, who lost his daughter twenty years earlier during the fungus outbreak, must now bring a teenage girl, Ellie, to an underground group called the Fireflies. This task signals the start of a long and perilous journey that brings Joel and Ellie into conflict with both human and non-human adversaries. During their time together, the characters develop a caring father-daughter relationship. Towards the end of the game, with a long series of death-defying events already behind them, Ellie and Joel find themselves in a quiet, abandoned bus station in Salt Lake City. All of a sudden, Ellie runs off as if surprised by something. The player—controlling Joel—needs to follow her and find out what caught her attention. Given the constant threat in THE LAST OF US' merciless world, the player is probably alarmed by Ellie's behavior. After a short pursuit, however, it is revealed that Ellie is chasing after a group of giraffes (which apparently escaped from the Zoo after the infection). The revealing moment is oddly awe-inspiring.

Standing on the second floor of the overgrown building, in a room with no outer wall, Ellie and Joel encounter one of the giraffes feeding on the vines that cover up what remains of the structure. It is a peaceful and touching moment. Ellie, a child forced into adulthood by a tragedy-ridden world, is suddenly bursting with childlike enthusiasm. It is a moment that lingers in the memories of those who play the game.[3]

2 As an anecdotal note: Whenever I commented to someone that I am writing my PhD thesis on the topic of time in video games, the most common remark that followed was something along the lines of "so you mean like when you are playing video games and hours seem to pass by in minutes?"

3 IGN's Lucy O'Brien asked if the giraffe scene was "the most important moment in The Last of Us" (O'Brien 2013). Kirk Hamilton of Kotaku called it "the emotional

Figure 3.1: THE LAST OF US REMASTERED (Naughty Dog 2014).

Source: https://www.gamer83.de/the-last-of-us/screenshots/ (accessed January 31, 2018).

Ellie (left) and Joel (right) pet a giraffe.

PREDICTIVE PROCESSING AND THE SPEED OF TIME

The way time speeds up and slows down can be understood in terms of predictive processing. As seen in chapter two, section 2.1., the mind creates top-down models of the world. These models are compared to impinging bottom-up sensory signals and, if there is no mismatch, the mind continues relying on the predictions. Since these models are based on prior knowledge about the environment that we have stored in memory, the more priors we have, the better we are at predicting the state of the environment.

Operating on the base of predictions is a pleasant experience. It is metabolically cheap, it is fast, and it allows us to move around with ease in autopilot. Bottom-up information is more expensive and slower to process, which is why we tend to prefer our predictions as long as they are good enough. Whenever there is a discrepancy between predictions and sensory information (the phenomenon called *surprisal*), we become aware of the bottom-up stimuli. Attention is, in this sense, an error signal. A highly unpredictable environment with con-

peak of the game" (Hamilton 2013). The website CONTROL500 referred to it as an "iconic scene" (CONTROL500 n.d.).

stant error signals is more demanding than one with familiar places and people, which is why we tend to prefer the latter. However, an environment that is completely predictable—like a doctor's waiting room—can prove utterly tedious. We naturally seek some level of unpredictability; a level that is not exhausting, but still challenging enough to keep our attention away from the passage of time.

In the context of the predictive processing framework, growing attentive to the passage of time can also be interpreted as an error signal. As long as we are engaged by occurrences in the environment, we remain inattentive to time. Time entering our attention is a sign that the temporal landscape has become dull, pushing us to find an activity to get busy with.[4]

Emotionally arousing events usually provide us with a surge of interoceptive and exteroceptive information, making time slow down in our experience. Prospectively, increased speeds in information processing make our experience of time decelerate. Retrospectively, the feeling persists because we store this information in memory, likely due to its adaptive value. Positive, intense emotions,

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4 A possible reason for this could be in our deep past. In our evolutionary history, this experience could have led us to engage in activities with adaptive value. While this is only speculation, it seems reasonable that those individuals with a tendency not to squander their time should have had a better chance at spreading their genes. It does not follow from this that we should then be only interested by activities that are obviously productive (especially not in the modern world). Many activities, such as playing, which seem on the surface as wasteful, are always taking over our free time and even stealing time from activities that are more important for survival, such as working for a wage. There are a few arguments that support this seemingly contradictory claim. Firstly, we do not live in the environment in which we evolved. Our instincts are tuned to life in the Pleistocene African savannah, not to contemporary life. Secondly, one should distinguish between the proximate and ultimate causes of a behavior (see Scott-Phillips et al. 2011). The proximate cause might be because it is fun or pleasurable for the individual. The ultimate cause can be adaptive, meaning that said experience of fun or pleasure would have evolved because it motivated behavior that contributed to spreading the individual's ancestor's genes in the Pleistocene environment in which humans evolved. Thus, fun is a proximate cause to play, but the ultimate cause might be improving motor skills or strengthening social bonds. Another aspect that should be taken into account is that behavior can also be a byproduct of another, adaptive behavior. Playing video games is fun even though sitting for hours on a chair staring at a screen can be a health risk and it detracts from other productive activities. But we did not evolve in an environment with video games, just as we did not evolve in an environment with cheesecake, but both are (at least in some ways) enhanced versions of play and food of our ancestor's environment.

such as love, can signal significant events and people related to reproduction and kin selection. Life-threatening situations, such as a car crash, provide us with a collection of potentially life-saving priors. Exhilarating activities such as extreme sports or amusement park rides usually emulate danger—albeit in controlled, relatively safe environments. Therefore, these can also make time slow down (see Arstila 2012).

BULLET TIME AND THE EXPERIENCE OF DANGEROUS SITUATIONS

The first detailed reports of the experience of life-threatening situations date back to the nineteenth century. Albert Heim, a geology professor in Zurich, driven by curiosity about the final experience of climbers who fall to their deaths, interviewed the lucky survivors of potentially fatal falls in the Alps. Heim later published these accounts in the 1892 Yearbook of the Swiss Alpine Club under the title "Notizen über den Tod durch Absturz." The text was translated in 1972 by University of Iowa psychiatrists Russell Noyes and Roy Kletti with the title "Remarks on Fatal Falls" (see also Arstila 2012). Heim writes: "In nearly 95 percent of the victims there occurred, independent of the degree of their education, thoroughly similar phenomena, experienced with only slight differences" (Noyes and Kletti 1972, p. 46). And he continues with this captivating description of the experience (my emphasis):

> "[N]o grief was felt, nor was there paralyzing fright of the sort that can happen in instances of lesser danger (e.g. outbreak of fire). There was no anxiety, no trace of despair, no pain; but rather calm seriousness, profound acceptance, and a dominant mental quickness and sense of surety. *Mental activity became enormous, rising to a hundred-fold velocity or intensity. The relationships of events and their probable outcomes were overviewed with objective clarity.* No confusion entered at all. *Time became greatly expanded.* The individual acted with lightning-quickness in accord with accurate judgment of his situation. In many cases there followed a sudden review of the individual's entire past; and finally the person falling often heard beautiful music and fell in a superbly blue heaven containing roseate cloudlets. Then consciousness was painlessly extinguished, usually at the moment of impact, and the impact was, at the most, heard but never painfully felt. Apparently hearing is the last of the senses to be extinguished" (Noyes and Kletti 1972, p. 47).

Further studies by Noyes and Kletti (1976, 1977) essentially support Heim's account. In their 1976 and 1977 surveys, the most commonly reported aspects of the experience of life-threatening situations were "increased speed of thoughts" accompanied by purposeful and quick reaction and "increased attention and alertness," and "an apparent slow down of external time," which for some was so intense that they reported that "time stood still."

The philosopher Valtteri Arstila (2012, p. 2) summarizes the experience of time in dangerous situations in six key features:

1. The feeling of external time expanding and slowing down to a great extent.
2. Dominant mental quickness as demonstrated by the increased speed of thoughts.
3. There is often an altered sense of the duration of the event lasting longer than it actually does.
4. If possible, in the event in question, people often act fast and purposefully.
5. In the latter case, their attention is also altered and narrowly focused on the issues relevant for survival.
6. Unusually sharp vision or hearing.

Points one ("the feeling of external time expanding") and three ("an altered sense of duration") might require further clarification, given that they appear so similar. The first feature refers to the subjective experience of time passing slowly. The third feature is concerned with the estimation of the duration of the moment. Regardless of the connection between the experience of time going slowly or fast and the estimation of its duration, these are separate phenomena (ibid., p. 3).

According to Arstila, the two main factors that trigger this experience are "the belief in imminent death" and "that the event is surprising" (ibid., p. 2). Individuals who experienced a dangerous event but did not believe that it was life-threatening do not report experiencing time in slow motion as often as those who believed their lives were in real danger (65 percent versus 80 percent respectively). Surprise is perhaps an even more important factor, since "hospital patients facing a threatening situation due to their illness do not report an increased speed of thoughts and altered attention" (ibid.).

Video games cannot elicit this experience, given that they are safe activities. Even if the player character's life is threatened in the game, players are sitting securely in front of a screen. Nevertheless, slow motion in video games is often used to *represent* this psychological state of emergency. This effect is commonly known as *bullet time*, and it was popularized in the video game medium by MAX PAYNE (Remedy Entertainment 2001).[5]

MAX PAYNE is a third-person shooter inspired by hard-boiled fiction.[6] It gets its name from its protagonist, a DEA agent who is undercover in the Punchinello Mafia family, responsible for the trafficking of a designer drug named Valkyr in New York City. Three years before the events of the game, a group of junkies high on the drug broke into Max Payne's home and murdered his wife and baby daughter (compare Max Payne Wiki 2019). The tale of MAX PAYNE is one of bloody revenge. The player leads Payne armed to the teeth through three acts of carnage, leaving a trail of mobster corpses behind.

Figure 3.2: Max Payne soars through the air in bullet time.

5 The bullet time effect is also well-known in film, perhaps most prominently used in THE MATRIX (Lana and Lilly Wachowsky, 1999).

6 According to the Encyclopædia Brittanica, hard-boiled fiction is "a tough, unsentimental style of American crime writing that brought a new tone of earthy realism or naturalism to the field of detective fiction" that emerged in 1929, which "used graphic sex and violence, vivid but often sordid urban backgrounds, and fast-paced, slangy dialogue" (Encyclopædia Brittanica 2018).

The mechanics of the game are typical for a third-person shooter: move the character, point the gun, and shoot at your enemies. In addition, MAX PAYNE has a signature move. By the press of a button, the player can trigger the bullet time mode, which decreases the pace of the game. The mobster's screams deepen and stretch like bubblegum and bullets visibly whoosh through the air. Max's aiming, however, remains comparatively faster than the rest of the gameworld, allowing the player to dispose of a group of enemies with relative ease and panache. Nonetheless, this slow-motion mode cannot be used indefinitely. An hourglass icon on the bottom left of the screen (see figure 3.2) depletes as time passes. The meter progressively refills as the player kills enemies.

Since MAX PAYNE'S implementation of slow-motion mechanics in 2001, numerous games have replicated the effect in one way or another. A few examples are F.E.A.R. (2005), CALL OF JUAREZ (2006), VANQUISH (2010), and GRAND THEFT AUTO V (2013). In the sci-fi third-person shooter VANQUISH, the protagonist Sam Gideon dons a sophisticated battle armor called the Augmented Reaction Suit (ARS), which, among other things, can enhance his perception. PlatinumGame's blog describes this *AR Mode* in a way reminiscent of the phenomena related to time perception in dangerous situations:

> "Activate AR mode [*sic!*] to speed up Sam's perception, making enemies around him seem slower. AR Mode can be used during any of your regular maneuvers – dodging, vaulting and boosting – to allow you to aim with precision" (PlatinumGames 2017).

This ability is a bullet time mode just like MAX PAYNE'S, but with one addition: The AR Mode also activates automatically whenever the player character's health drops to dangerously low levels, giving the player a final chance to find cover or dispose of threats before the gauge reaches zero. It is in this last scenario that the AR mode resembles somewhat more closely the real experience of slow motion as an automatic phenomenon triggered by near-death experiences. Still, video games are far from implementing a realistic version of the experience of time in dangerous situations. In most cases, it is framed as an ability of the player character (enemies seem to lack it), and it is activated either manually by the player or automatically in very specific scenarios, instead of in every life-threatening event.

On the other end of the experience of the passage of time is the feeling of time speeding up, which is most noticeable when in a state of *flow*. Unlike the extreme slowing down of time in dangerous situations, the speeding up of time is an experience that video games can certainly elicit in players (Wood et al. 2007).

FLOW

Flow is the opposite of that are-we-there-yet feeling we experience when the passage of time enters our awareness. First systematically studied by psychologist Mihaly Csikszentmihalyi, who also coined its name, flow is what we experience when we get so focused on an activity that we lose awareness of time, our self-consciousness, and our surroundings. As Wittmann (2012, p. 78) notes, "after work or play in flow comes to a conclusion one is surprised that it is already nighttime (or daytime again)."[7] One might only then notice a feeling of hunger or the need to go to the restroom that was lurking in the background during the work or play session. Flow is a state that we deeply enjoy.

Csikszentmihalyi's studies showed that this experience is a common denominator of many activities that, on the surface, might seem worlds apart: "Apparently the way a long-distance swimmer felt when crossing the English Channel was almost identical to the way a chess player felt during a tournament or a climber progressing up a difficult rock face" (Csikszentmihalyi 1990, p. 48). Furthermore, the experience of enjoyment of an activity is described in the same way regardless of age, gender, culture, or socioeconomic status. Flow is characterized by eight components:

> "First, the experience usually occurs when we confront tasks we have a chance of completing. Second, we must be able to concentrate on what we are doing. Third and fourth, the concentration is usually possible because the task undertaken has clear goals and provides immediate feedback. Fifth, one acts with a deep but effortless involvement that removes from awareness the worries and frustrations from everyday life. Sixth, enjoyable experiences allow people to exercise a sense of control over their actions. Seventh, concern for the self disappears, yet paradoxically the sense of self emerges stronger after the flow experience is over. Finally, the sense of the duration of time is altered; hours pass by in minutes, and minutes can stretch out to seem like hours" (Csikszentmihalyi 1990, p. 49).

The reader that is experienced with video games might have noticed how these eight points can perfectly fit the description of a gameplay session. Salen and Zimmerman note that "[i]n each of the eight components of the flow activity Csikszentmihalyi mentions, there are clear parallels with games" (2004, p. 338). Let us revisit them one by one: (1) Video games are typically designed to be tasks that players have a chance to complete. Some games—for example, CUP-

7 My translation from the original German.

HEAD—demand more skill from their players than others—for example JOURNEY (Thatgamecompany 2012)—, but games are usually designed to be finished.[8] (2) Whether playing at an arcade or at home in our living room, games demand our full attention. To play a video game, we need to be able to concentrate. (3) Games commonly state clear goals. Those games or game passages where goals are not clear tend to be frustrating. (4) Actions performed in video games should provide immediate feedback in order for players to know how they are performing and whether they need to adjust their behavior. (5) A deep and effortless involvement is not necessarily achieved while starting a new game. However, after overcoming the learning curve, players can lose themselves easily while taking on the game's challenges. As argued in section 2.1, games are designed for us to engage in a process of uncertainty reduction, which allows us to (6) exercise control over our actions and environment. (7) The feeling of immersion is directly connected to this point. Recall section 1.1, where I stated that we feel immersed while playing video games because the spotlight of attention is directed at the gameworld and we lose self-awareness (together with the awareness of our surroundings). After an experience of flow, however, the self reemerges stronger, enhanced by new knowledge, skills, and a sense of accomplishment. (8) Finally, while playing video games, it is easy to lose track of time and hours might feel like minutes—the most common report concerning time in a state of flow. However, while retrospectively it seems like hours flew by, specific moments that require an extra dose of focus might still dilate in consciousness during the experience.

The sense of selflessness mentioned in the seventh feature of the flow experience implies that, while in a state of flow, we are not aware that we are a self, separated from the environment. The self is, after all, a mental construction that requires that the focus of attention is directed inwards. While absorbed by an activity during a state of flow, the self becomes blurry and the boundaries of this mental construction expand: "When a person invests all her psychic energy into an interaction – whether it is with another person, a boat, a mountain, or a piece of music – she in effect becomes part of a system of action greater than what the individual self had been before" (ibid. p. 65). Nothing supernatural is happening here; it is the effect of the mind focusing all of its attention on the interaction between the body and the environment, and suspending the sense of the self as a separate entity from the surroundings. This phenomenon of losing the sense of self produced by deep focus on an activity likely contributes to the feeling of immersion that is so characteristic of video games.

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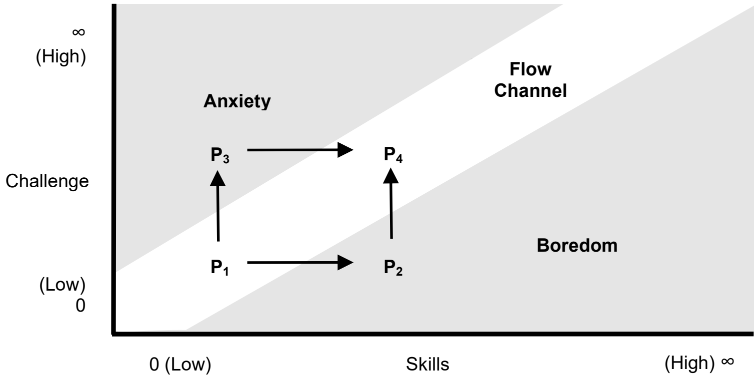
8 Even games without an ending, such as SPACE INVADERS, are structured as a series of tasks (that is, objectives and stages) that can be completed.

Naturally, not every gameplay session is just like the one described above. Sometimes a game is poorly designed, exasperatingly hard, or insipidly easy. But anyone who has enjoyed a video game will likely recognize the above paragraph as something familiar. The state of flow is a sweet spot at which we arrive whenever the challenge we face is high enough that it is not boring, but not too high to become frustrating. Right in the middle there is a space, the *flow channel*, where the state of flow can be achieved (see figure 3.3).

Figure 3.3: The flow channel.



Source: Csikszentmihalyi 1990, p. 74.

In terms of predictive thinking, we are in a state of flow when an activity presents us with an adequate level of uncertainty and new information in order to remain interesting, but we have sufficient prior knowledge to act in a purposeful and controlled way. However, for an activity such as a game to *remain* interesting, it needs to meet the constantly evolving skill level of the player—recall the *progression* feature, part of the *conditions* category in the typology of temporal structures (section 1.2). The *flow channel* arises from an activity that effectively escalates the difficulty of the challenge as the skill level of the person performing it increases. If the challenge is much higher than their skill level, players become anxious. If, on the other hand, their skill level is higher than the challenge, players experience boredom. Tasks start feeling like chores, demanding time but little effort to complete. In this state, players start paying attention to the passage of time once again and might hope that the game (or the current mission) will be over soon.

But no gameplay experience is characterized by a constant state of flow. As shown in figure 3.3, a player (P_1) starts with little skill, and the game provides almost no challenge. Since the level of challenge is adequate to the player's skill level, the player enjoys the game. In time, the player will become better at the game (P_2) and can enter a state of boredom if the game does not dial up the challenge. On the other hand, if the game becomes more challenging before the player's skill level increases (P_3), the player will become anxious. At this point, the player needs to keep practicing so as to re-enter a state of flow (P_4). The Groundhog Day Effect is often involved in this process, since players can keep repeating a sequence that is too challenging until their skills improve, enabling them to overcome the obstacle.

These fluctuations between flow, boredom, and anxiety are likely inevitable. According to Jesse Schell, this instability might even be desirable:

> "[t]his cycle of 'tense and release, tense and release' seems to be inherent to human enjoyment. Too much tension, and we wear out. Too much relaxation, and we grow bored. When we fluctuate between the two, we enjoy both excitement and relaxation, and this oscillation also provides both the pleasure of variety, and the pleasure of anticipation" (Schell 2008, p. 122).

Jesse Schell also argues that this "tense and release" cycle can occur within the flow channel and does not necessarily need to break the flow experience (ibid.). While this might be true, the interruption of the flow experience is not always an undesirable outcome. A state of flow could be the reward that players seek while playing game portions that can make them feel anxious or bored—as long as these sections do not overstay their welcome. In this sense, video games reward players not only for their success after the completion of objectives, but also for their perseverance by providing them with a pleasurable flow experience.

To be conducive to flow, an activity needs to have rules and clear goals, provide frequent feedback, require the learning of skills, and be as distinct from everyday existence as possible (Csikszentmihalyi 1990, p. 72). These are all common features of video games. In single-player video games, progression (discussed in chapter one, section 1.2) is crucial for keeping players in the flow channel. Games need to increase their difficulty as the player advances, or else they risk becoming tedious. To this end, games use different strategies: Enemies gradually move faster, do more and take less damage, and come in greater numbers; puzzles gradually become more elaborate; platforming sections demand increasing precision in greater jumping distances. Many games also offer different levels of difficulty (for instance easy, medium, and hard) to allow entry to inexperienced players and provide a challenge to the more seasoned ones (compare

Schell 2008, pp. 118-123 and pp. 177-178; Salen and Zimmerman 2004, pp. 350-352).

One other way in which designers can improve the chances of players attaining a state of flow is giving them the freedom to choose what to do—and when to do it—beyond the core mechanics of the game. To accomplish this developers can, for example, include skills or items that are not entirely necessary, but add depth to the game once the core mechanics have been learned. In this way, the designer grants some control to the player, who can decide when to increase the challenge by learning how to perform new actions. Role-playing games are good examples of this type of design in which players have a wide range of skills and items they can choose from. By acquiring experience points, a player can spend them to unlock a new skill or increase the effectiveness of one that is already in use. A new ability—for example, an offensive power that allows the player character to shoot fireballs—typically has a learning curve, and might put players at a slight disadvantage compared to older skills that they have already mastered. However, if this newly acquired skill is more powerful than previous ones, players will benefit from mastering it. Introducing interesting and useful new mechanics adds an element of risk, but it motivates players to experiment. As long as players do not feel safe enough to experiment with the new skill, they can continue to use the familiar ones, giving them some control over their flow experience.

We move through the temporal landscape at varying speeds according to where we direct our attention and how emotionally aroused we are. Video games, like any other activity, can contribute to the acceleration and deceleration of the subjective passage of time. In the next section, I will discuss *time perspective*—another feature of the temporal landscape. Time perspective is closely tied to our capacity to engage in self-control, a skill vital to player success in many video games.

Marshmallows and Bullets[1]

A few years ago, a commercial for the Kinder Surprise chocolate egg aired on German television. In it, a girl sits at an empty table in a room otherwise devoid of furniture or decoration, with the exception of a flip chart. A young woman hands the girl a chocolate egg and gives the following instructions: “This surprise egg is for you and, if you don’t open it until I come back, you’ll get a second one.” As the woman speaks, the viewer sees several takes of different children, showing that the pretend experiment was conducted many times with different “subjects.” This ad produced by the German advertising agency Zum Goldenen Hirschen is called DER NEUGIER-TEST (The Curiosity Test) (Zum Goldenen Hirschen n.d.). The Kinder Surprise eggs are known for hiding a trinket inside—the surprise—that kids obtain when they eat the chocolate. The commercial continues as it offers the viewer a manifold display of anxious behavior: one youngster stares at the egg with a furrowed brow; another shakes it near her ear and looks at the camera with innocent eyes; a third hides under the table, comes back up slowly, takes a short peek at the egg, and immediately hides under the table again; a fourth one grabs her head and gives the camera an uneasy look. In the end, as expected, they cave to temptation and sink their teeth into the delicious treat. The commercial ends with the slogan “Na, Neugierig?”—which roughly translates to “well, curious?”—displayed in colorful font. What the question seems to imply is that the kids opened the candy and ate it to find out what kind of toy was hiding inside, emphasizing the Kinder egg “surprise” instead of the fact that kids love chocolate—or almost any food rich in sugar and fats. While curiosity might have enhanced the appeal of the chocolate

1 An earlier version of this section was published in the anthology CLASH OF REALITIES 2015/16. ON THE ART, TECHNOLOGY, AND THEORY OF DIGITAL GAMES (Alvarez Igarzábal 2017b).

egg, any type of candy—with or without a surprise—would have likely done the trick.

In fact, marshmallows accomplished the very same feat a few decades ago. DER NEUGIER-TEST was actually mimicking a famed longitudinal study started by psychologist Walter Mischel and coworkers in the late 1960s and early 1970s known as the Marshmallow Test (Mischel et al. 1970; 1972; 1988; 1989), which spanned for many decades with several different measurements.

The experiment proceeded in a very similar way to the commercial. The children sat alone at a table in a room and one of the researchers gave them a treat with almost the same guidelines: the children had the choice to either eat the treat right away, or to wait for the adult to come back without eating it, in which case they would get a second one. In some cases, these treats were marshmallows, hence the name of the study. But the children could, in fact, choose one of several options, including marshmallows, cookies, or pretzels (Mischel et al. 1970, p. 332; 1972, p. 207; 2014, p. 17). They could also call the researcher back by ringing a bell, which would also deny them the possibility of a second treat. The experiment was carried out (with variations) over the course of several years with over 500 children ages four and five. While the researcher was away, the kids were either directly observed or filmed. Once again, just like in the commercial, the kids used different strategies to pass the time and resist eating the treat that was handed to them. But here is where the similarities between the streamlined portrayal of the commercial and the results of impartial scientific practice start to wane: while some kids ate the treat right away or at some point before the researcher came back, others were able to accomplish the task at hand and received the promised reward. That is, some kids could delay the pleasure produced by eating a marshmallow (or cookie or pretzel) and tolerate the unpleasant feeling produced by this postponement in favor of a future, superior benefit. What Mischel and his colleagues were studying was self-control. They wanted to understand how it works and how it manifests in behavior.

The tests with preschoolers were just the first stage of Mischel's long-term study. A dozen years later around one hundred of the 500 children who took part in the experiment were tested again. This time, the researchers looked at their performance in school and asked their parents to judge their child's social and academic skills. The researchers discovered that the children who performed best in the Marshmallow Test tended to perform better in school and earned a more positive judgment of their skills from their parents. These results showed that the Marshmallow Test could, to some degree, predict a child's success in school and their social environment later in life (Mischel et al. 1988; Mischel 2014, pp. 23-24).

It should be noted, as Wittmann (2012, p. 15) points out in his assessment of the experiment, that a look at the original data shows that the connection between the early test results and the later adolescent performance in school and social life is at best moderate. Several other factors also contribute to the development of social and academic skills. Nonetheless, Wittmann continues, the correlation stands: the kids who waited longer for the adult to come back with the second marshmallow were more likely to perform better in school and their social lives in adolescence. The ability to voluntarily postpone gratification in favor of a better, deferred reward is therefore a key aptitude for goal-oriented decision making.

To better understand these results, it helps to think again of time as a landscape. Not only can we travel through it at different speeds, but we can also look ahead and behind us. Thus, time can be said to have perspective. Zimbardo and Boyd, following Kurt Lewin (1951), have defined time perspective (TP) as follows:

> "TP is the often nonconscious process whereby the continual flow of personal and social experiences are assigned to temporal categories, or time frames, that help to give order, coherence, and meaning to those events […] Between the abstract, psychological constructions of prior past and anticipated future events lies the concrete, empirically centered representation of the present" (Zimbardo and Boyd 1999, p. 1271).

Time perspective is, simply put, the process of organizing the continual flow of life into three temporal frames: past, present, and future. Of those three categories, two are top-down, *off-line* constructions of events—the remembered past and the conjectured future—and one is (partly) bottom-up, *online* sensory perception—our awareness of the present status of the environment. But our attention is not always evenly distributed between these three temporal categories. Some might emphasize the future over the present and the past, or the past over the present and the future. These temporal biases have a significant impact on our decision-making process (ibid., p. 1272). The more future-oriented one person is, the better they will be at self-control. Present-oriented minds will rather seize the moment without giving future consequences too much thought. Past-oriented people tend to revert to bygone days, surrendering to nostalgic tendencies.

Present-oriented decision making is what psychologists also call temporal myopia (Wittmann 2012, p. 16). We all have temporal myopia to some degree, since, all other things being equal, we would rather obtain a particular benefit right now (say, 50 dollars) than at some point in the future. We would even take a slightly smaller benefit now (45 dollars) than a slightly larger one in the future (50 dollars), as shown by a study conducted by Gregory Madden (2003). The future is muddled with uncertainty, so anything that lays further ahead in time is consistently devalued. Temporal myopia can thus be measured with *delay discounting* tasks such as those used by Madden, showing that the value of a particular good decreases with relation to the time it takes to obtain it.

Several other follow-up experiments in the longitudinal Marshmallow study were conducted. In 2002 and 2003, for instance, a study showed that "longer delay of gratification at age 4 years was associated with a lower BMI [body mass index] 3 decades later" (Schlam et al. 2013). Another follow-up experiment was conducted in 2011 in which 59 of the subjects—now in their forties—were tested (Casey et al. 2011). The subjects sat this time in front of a computer screen which displayed a sequence of photographic portraits. Depending on the characteristics of the facial expression displayed on the monitor, the subjects had to either press a button as fast as possible or do nothing. Each image remained very briefly on screen, giving the subjects little time to react. Previous studies had shown that we tend to react more readily in emotionally loaded situations than in emotionally neutral ones (Ochsner and Gross 2005; Sanfey 2007; Heatherton and Wagner 2011). So, when the subjects were asked to react to neutral facial expressions with the press of a button and not to react to happy faces, those who had failed to obtain the second marshmallow the first time around forty years earlier were now more likely to press the button when a happy face showed up, even though they were asked not to. This study linked the capacity to suppress impulsive reactions to brain areas located in the frontal cortex (Wittmann 2012, p. 30).

A vast number of video games relate to Mischel's findings. Video game genres could even be categorized in terms of how they engage with our temporal perspective, and one might speculate that the preference for a particular genre relates to the temporal frame a person tends to prioritize. While some games emphasize fast reflexes and are thus more attuned with a present-oriented mindset, others focus heavily on careful planning and resource management. Success in a strategy game like COMMAND & CONQUER or CIVILIZATION V, for example, depends largely on the players' capacity to spend or save resources and command units with long-term goals in mind. Decisions made early in the game can have a strong impact on what happens in the following hours. Games like DOOM or CUPHEAD, on the other hand, demand fast and precise reactions from the player, and, though some foresight is nonetheless required, long-term planning is not as important.

Other games exploit our temporal myopia for monetary gain. In CANDY CRUSH SAGA (King 2012), a mobile match-three puzzle game, the player has five lives, each of which is lost every time the player fails a level. Once all lives are lost, the player can purchase more (with actual money), wait half an hour for one life to replenish, or ask a friend for one over Facebook. Additionally, if a level is too hard, the player can buy a Booster to make it easier and remain in a state of flow. CANDY CRUSH SAGA speculates with the players' boredom and anxiety, offering a way out of those undesirable experiences through spending.

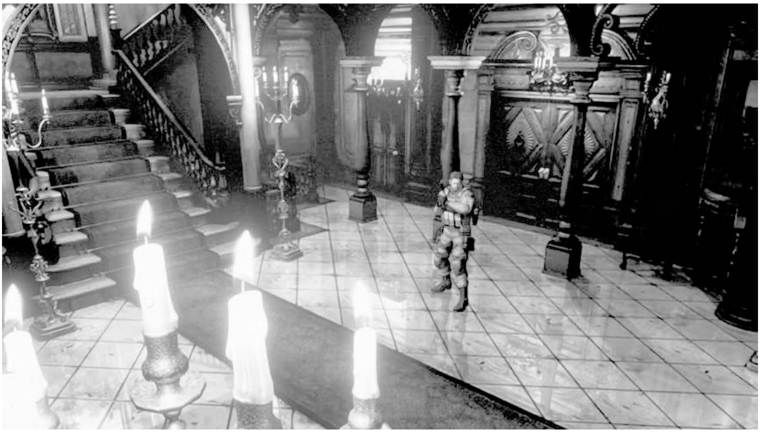
The genre known as *survival horror* is of particular interest in this context, since it focuses specifically on overcoming temporal myopia through the mechanics. This genre is well known for featuring vulnerable protagonists that have to survive in an unsettling and hostile environment with very limited resources. In what follows I will show how the psychological notions of time perspective, temporal myopia, and delay discounting are reflected in the RESIDENT EVIL HD REMASTER (Capcom 2015). This game is the latest version of RESIDENT EVIL (Capcom 1996), one of the titles that defined the genre in the mid-1990s and which is now popularly regarded as a survival horror classic.[2]

RESIDENT EVIL: THE MECHANICS THAT DEFINED SURVIVAL HORROR

The game begins as the S.T.A.R.S. (Special Tactics and Rescue Squad) Alpha team is searching for the Bravo team, which disappeared during the investigation of a series of gruesome murders that took place in Raccoon City, where victims were savagely slain and eaten by groups of people. After finding the remains of the missing party's crashed helicopter along with a Bravo team corpse, the Alpha team is attacked by a pack of decaying dogs, who take down one of the teammates. The survivors run towards a mansion for shelter as they see their chopper take off, abandoning them in the murky woods. This sequence is shown to the player as an introductory cutscene.

2 In fact, RESIDENT EVIL was the first game to use the term *survival horror* (Fahs 2009, p. 4). At the beginning of the game, a screen greets players with the text "Enter the Survival Horror."

Figure 3.4: RESIDENT EVIL HD REMASTER.



Chris Redfield in the main hall of the mansion.

As far as horror settings go, the abandoned mansion is quite the cliché, but it provides the game with a fitting somber atmosphere. Once inside the mansion, the player takes control of one of two available characters, Jill Valentine or Chris Redfield—the choice is made before starting a new game. Choosing whether to play as Jill or Chris doesn't change the story significantly. When choosing Jill, for instance, Chris disappears on the way to the mansion, and the player character is together with another teammate, Barry Burton. Selecting Chris introduces a surviving Bravo team member, Rebecca Chambers, and Jill and Barry go missing. Albert Wesker, a third teammate, is alive and well with both protagonists. The next step for the remainder of the Alpha team is to explore the mansion and to find a way to escape.

Most importantly, each character possesses individual traits: while Jill has lower health (she can die faster) and deals less damage than Chris, she has a bigger inventory and can thus carry around more items at the same time. The characters also obtain different tools and weapons—for example, while Chris receives a flamethrower at a later point in the game, Jill obtains a grenade launcher. These and other differences make playing the game with each of the characters a slightly different experience, but it remains true in both cases that the game is punishingly difficult. The choice of character is not so much a matter of difficulty as of desired playstyle.

Once the game starts, the player soon finds out that the house is infested with ravenous zombies. While these enemies move slowly and alert the player of their presence with growls and groans, the game's mechanics—in combination with the ominous setting—manage to make the encounters challenging and frightening.

RESIDENT EVIL has fixed camera angles from which the player observes the action. Once the player character moves to the edge of the frame, the game switches to a subsequent camera angle, revealing space that previously remained unseen (see figure 3.5). Since camera angles are predetermined, the player never knows for sure where the character will stand next in relation to the frame, which makes movement planning more challenging than with an over-the-shoulder, player-controlled camera (for a comparison see figure 3.6). While the current angle might be a bottom-up view, the next one could place the camera above the avatar and on the opposite side of the room. Additionally, fixed camera angles can conceal information by leaving it off-camera or by hiding it on the backside of objects.

In addition to its fixed camera angles, the original RESIDENT EVIL used what is popularly known as *tank controls* for the movement of the avatar. With this control scheme, the player makes the character move forward in the direction it is facing at that moment by pressing up, and backward by pressing down. To rotate the avatar in order to change direction the player needs to press left or right. The 2015 remaster lets players choose between the early control scheme and a more intuitive alternative. These new movement controls eliminate the need to rotate the player. The direction in which the character moves will directly correspond to the direction pressed on the controller: Up moves the character upward in the frame or away from the camera, down downwards or towards the camera, right to the right side of the frame, and left to the left side. The character will move forward in the indicated direction and automatically rotate if needed.

Figure 3.5: Camera.

Top: Chris Redfield walks towards the camera in RESIDENT EVIL HD REMASTER. *Bottom: Once the character reaches the edge of the frame, the game switches to a camera with the opposite angle, now displaying the character from behind*

Figure 3.6: Aiming.

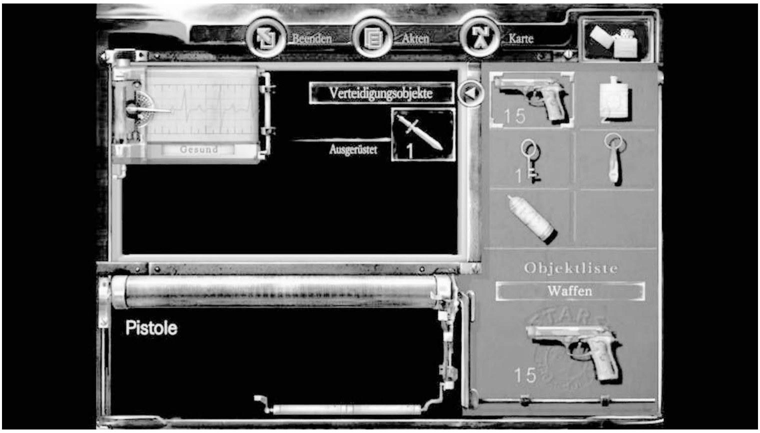
Top: Aiming the gun at a zombie with the over-the-shoulder camera in Resident Evil 4 Ultimate HD Edition (Capcom 2014). Bottom: Aiming in Resident Evil HD Remaster with a fixed camera.

The game further complicates character movement by implementing a constrained shooting system that does not allow the character to walk while aiming a weapon. In order to shoot, the player has to press and hold the button assigned to aiming so that the character lifts the weapon. Once in this stance, the player can shoot with the press of a second button. To aim the gun up or down, left or right, the player has to use the same keys assigned to movement. These buttons will now either rotate the avatar (pressing left or right) or pivot its arms up or down (pressing up and down)—aiming the shotgun up and firing it point-blank at a zombie, for example, is likely to take it down with a single headshot. Thus, players can only approach encounters with a binary fight-or-flight strategy, but never do both at the same time—it is impossible to shoot while retreating, for instance. If the player chooses to fire, they commit to a particular position in space as long as they continue aiming the weapon. If the player chooses to run away, the character becomes defenseless. Moreover, when the player character's health drops significantly, the character will start limping, which makes it even more vulnerable to enemy attack.

The player characters in RESIDENT EVIL are weak compared to their resilient enemies. But, as if this aspect would not render the game challenging enough, if a player manages to neutralize all zombies in a room, they need to burn their bodies, or they will otherwise come back as the faster and more resilient Crimson Heads. To this end, the player needs to carry around a lighter (which Jill has to find but Chris carries from the beginning) and a fuel canteen. The latter has limited uses and needs to be refilled periodically.

RESIDENT EVIL is not about running through corridors guns blazing, as is the case in DOOM or other action shooters; it is about knowing when to fight and when to flee. Another feature that makes the game particularly challenging is that the player can only save the game at predefined locations scattered around the house. These are signified by typewriters, which are usually inside safe rooms where the player is free from harm—a fact underscored by a soothing tune that plays when inside these rooms. When the player interacts with a typewriter, the save menu opens. But the player needs an ink ribbon to save, a resource that is always in limited supply. Thus, even the act of saving your game requires careful consideration. For this reason, dying in RESIDENT EVIL tends to be more punishing than in games with frequent checkpoints or in which the player can save at will, as it is more likely that the player will lose valuable progress.

Figure 3.7: Chris Redfield's inventory with five out of six slots occupied.



The saving mechanics lead me to the final point of this game analysis: resource management. Not only the ink ribbons, but every other resource in Resident Evil is scarce. The player never has a surplus of bullets or medicinal items. Every shot fired counts, and every missed shot leaves a bitter aftertaste. Even when the player somehow manages to obtain several weapons and their respective ammunition, both Jill and Chris have limited inventories (Jill has eight slots, and Chris six). The player has to choose what objects to carry around at any given time and the rest has to be stored in item boxes found in safe rooms—weapons occupy one inventory slot, extra ammunition can be stored in a second one. Typically, there is not much space left in the inventory for ammunition and weapons, since the player needs to carry keys, puzzle items, medicinal herbs, the lighter (if the player chose Jill) and the fuel canteen, while leaving one or two slots free in case they find something useful. Inventory management under these conditions is by no means an easy task.

THE AESTHETICS OF SELF-CONTROL

In the disquieting rooms and corridors of the abandoned mansion, the fear produced by the approaching undead might lead to a careless reaction that could waste an unnecessary amount of ammo. To avoid impulsive squander, the player can choose to attack lone zombies with the knife, a clumsy and ineffective weapon that takes one inventory slot but has the advantage of not requiring ammunition. In this way, bullets are saved for situations where the player faces two or more zombies at once, or more potent enemies. Another possible strategy is to simply run past the slow-moving zombies when the room gives the player enough leeway.

These approaches might supplant the feeling of relative safety provided by a firearm with an unnerving sense of danger. Using the knife has the disadvantage of being a very ineffective melee weapon and, since the zombies attack exclusively at close range, anything short of flawless timing can give them a good chance to strike. Running past enemies might also get the player character dangerously close to them—and, depending on the situation, they can even follow the player character into different rooms. A gun, on the other hand, disposes of the zombies while keeping them at bay. Nevertheless, the advantage of using the knife or evading enemies is clear: the player can move ahead without having used a single bullet, which could prove valuable for future (and possibly more challenging) encounters.

Even while using the handgun, impulsive reactions might lead to imprecise firing and wasteful use of ammunition, especially given RESIDENT EVIL'S quirky controls and disorienting camera angles. In the mansion's narrow spaces, it is important to keep a steady hand. If the player senses that a rushed reaction could lead to a misfire, then fleeing and finding a better stance from which to attack is the best strategy. Just like the test subjects who pressed the button when a "forbidden" happy face flashed on the screen, impulsive players might start shooting before thinking. Zombies are slow but tough and taking them down requires several rounds from a magazine with a limited capacity. If a firearm is emptied and the approaching Zombie has not yet fallen, the player will need to reload the gun to continue firing, provided they are carrying extra ammunition. Reloading is performed through an animation that makes the character vulnerable to attack—this can be avoided by reloading in the inventory screen.

RESIDENT EVIL is a constant tradeoff between distress and safety—or at least a relative feeling of security. Since games tend to increase in difficulty with time (and this one is no exception), saving ammunition for later challenges is crucial. Temporal myopia can be a serious disadvantage in this type of game, and future-oriented players will likely have a better chance at succeeding than more present-oriented ones. Choosing the stressful and riskier strategy in the present might contribute to a safer stance in the future. From this perspective, RESIDENT EVIL is a virtual *bullet test*, where ammunition is to players what marshmallows were to the children in Mischel's study. The gratification in the case of the marshmallow is the pleasure of eating it. In the case of the bullet, it is the feeling of safety gained by firing it. The delay of gratification is in both cases an exercise in self-control.

Playing the Player

As we play games, they, in turn, play with our cognitive capacities. Looking at the work of psychologists like Walter Mischel not only reveals a part of the human psyche that has a crucial function in our interaction with video games, it can also be useful to understand how exactly game design can hijack our cognitive systems and influence our behavior.

The survival horror genre poses a concrete challenge in psychological terms. The settings and mechanics are expressly designed to elicit fear in players: the ominous rooms of the desolate mansion in RESIDENT EVIL are teeming with lurking threats that can quickly end the player character's life, and the shortage of resources combined with constrained movement and shooting mechanics elicit a constant sense of helplessness. The player's mental hazard detectors are thus easily agitated, to the point that they can get startled by false alarms, like the shadows cast by a candle's flickering light—not to mention the justified scares, like zombies unexpectedly breaking in through windows. Players are thus prone to react impulsively and to lose focus of long-term goals. A successful player needs to maintain a future-oriented perspective in spite of the myriad unsettling stimuli that pullulate throughout the mansion.

Nevertheless, players are not invariably bound by their cognitive proclivities. In one of the instances of their Marshmallow Test, Mischel and his team encouraged some of the kids to use different strategies that could distract them from the reward (Mischel et al. 1972). These strategies had a dramatic impact on the amount of time that children were able to wait. Some were instructed, for instance, to think of something fun while waiting, others of something sad, and others about the reward. Thinking about something fun proved to be a very successful strategy compared to thinking about something sad or focusing on the reward. Those kids in the "think fun" group had a mean waiting time of over 13 minutes, while the "think sad" group waited for a mean of five minutes and the "think reward" for just four. This experiment shows that, though temporal biases are somewhat predefined dispositions, they are not absolutely determinant factors of behavior. By modulating their states of mind, the participants could significantly improve (or impair) their performance in the test.

An alternative strategy that the researchers instructed the children to apply was to imagine that the marshmallow on the table was only a picture of a marshmallow by adding an imaginary frame around it (Mischel et al. 1989). Children who did so delayed gratification for almost 18 minutes. Curiously, a group of kids who participated in the experiment with an actual picture of a marshmallow instead of the real thing waited for the same amount of time as the ones who imagined that it was a picture. Yet another group, which was given a picture but instructed to imagine a real marshmallow, waited for less than 6 minutes (all values being averages). These results demonstrate that the mental representation of the object has a significant impact in decision making. Granted, a kid's imagination is normally more powerful than that of a teenager or an adult, but there is a way in which this still applies after infancy.

The philosopher Tamar Szabó Gendler distinguishes between the notions of *belief* and *alief*. Belief is that which we rationally understand as true, while alief is that to which we react in spite of disbelieving it. Among other examples, Gendler mentions the experiments conducted by Paul Rozin which showed that adults "are reluctant to drink from a glass of juice in which a completely sterilized dead cockroach has been stirred, hesitant to wear a laundered shirt that has been previously worn by someone they dislike, and loath to eat soup from a brand-new bedpan" (Gendler 2008, pp. 635-636). Every grownup person in their right mind knows that a new bedpan is a completely innocuous food vessel. However, the mental associations produced by its originally intended use as an in-bed toilet make the sheer thought of eating out of it revolting. Something similar happens with fiction. When playing RESIDENT EVIL, we believe that it is a game and that everything we see is ultimately just zeroes and ones inside our computer, but we alieve that we are alone in a zombie-infested mansion. If players focus on their beliefs instead of their aliefs by reminding themselves that it is just a game, it will become easier not to fall into a present-oriented mindset—just like the children who looked at the picture of the marshmallow keeping in mind that it is just a picture.

In an early version of the experiment, Mischel wanted to find out if children could wait longer while the reward was in the room or when it was not present. He found out that "the presence of the rewards serves to increase the magnitude of the frustration effect and hence decreases delay of gratification by making the waiting period more difficult" (Mischel and Ebbesen 1970, p. 337). That is, the very presence of the reward made it more tempting. Applying this logic to RESIDENT EVIL, the best thing for players to do in order to save a particular resource is to simply store it in the item box. If players carry the handgun around, it will be harder to limit themselves to using the knife and avoiding zombies. Leaving the gun in the chest might seem like the commonsensical thing to do; after all, you cannot use what you do not have. But, following the experiment, one could even predict that the allure of the gun would decrease as well, and the player would focus more effectively on the available options instead. It would be reasonable to expect a player to be more efficient at using the knife in this condition than if the easier option of relying on a gun were readily accessible.

The capacity to resist short-term gratification in favor of later benefits is certainly not just central to psychological experiments and video games. It is a conundrum we face whenever we decide to go on a diet, stop smoking, start exercising, or study for an exam instead of playing video games, to name a few examples. RESIDENT EVIL takes this familiar experience and overemphasizes it through the interplay between its audiovisual presentation and its mechanics: While the environment is designed to elicit impulsive behavior, the mechanics require players to be thrifty and carefully plan their actions. The discomforting effect produced by these conflicting stimuli embodies what could be called an *aesthetic of self-control*.

The notion of players voluntarily engaging in activities that conduce them to engage in self-control evokes an ancient philosophical question: Why do we enjoy cultural products and activities that emulate situations that we would normally find unpleasant? Psychologist Paul Rozin has studied this phenomenon, which he has dubbed *benign masochism*. In Rozin's words, benign masochism

> "refers to enjoying initially negative experiences that the body (brain) falsely interprets as threatening. This realization that the body has been fooled, and that there is no real danger, leads to pleasure derived from 'mind over body.' This can also be framed as a type of mastery" (Rozin et al. 2013, p. 439).

One thing seems clear: The self-control tests of the survival horror genre are a cherished form of entertainment. RESIDENT EVIL'S success is evidenced by its two remakes, several sequels and spinoffs, and the transmedia extensions like films and comics that it has spawned since its first appearance twenty years ago.

The temporal landscape's perspective directly relates to the psychology of self-control. While driving through the temporal landscape we can focus on the rearview mirror (the past), on the landscape immediately around us (the present), or on the road ahead (the future). While we can direct our attention to the different parts of the landscape, the environment and our internal predispositions can condition us to prioritize a specific time frame over the others. Video games, as this section has shown, can alter our relation to the temporal landscape and incorporate time perspective and self-control as part of the gameplay. The next section will focus on time perspective in connection to how video games generate expectations, that is, how they create possible futures in the player's mind.

Chekhov's BFG

The '90s classic video game DOOM II: HELL ON EARTH incrementally arms players with an arsenal that they need to put to good use in order to plow through the hordes of demons and zombies standing in their way. At the start of the game, players wield a handgun and later acquire a shotgun, then a double-barreled shotgun, a chaingun, a rocket launcher, and a plasma rifle. Two melee weapons are also part of the roster: a chainsaw and the player character's bare fists. The weapons can differ in several respects, including damage, range, rate of fire, and type (and availability) of ammunition.

DOOM II's final and most powerful weapon is the BFG9000. BFG stands for Big Fucking Gun, a fitting name for a massive metal cannon that fires oversized plasma orbs. After shooting the orb, the weapon additionally emits an invisible cone of 40 tracer rays that deal further damage (DOOM Wiki 2018). This gun can wipe out several of DOOM II's enemies with one single shot.

Enter the Cyberdemon—a towering, horned, goat-legged monster with cybernetic enhancements. According to data provided by the DOOM Wiki, two or three shots of the handgun are commonly required to take down the Trooper (Doom Wiki 2016), DOOM II'S weakest enemy with twenty hit points. In contrast, around 388 gunshots are necessary to take down the Cyberdemon, the game's toughest enemy with four thousand hit points (ibid.). The first battle against a Cyberdemon occurs late in the game (stage 20 of 30), so the player will likely have the whole arsenal at their disposal.[1] But, even with a powerful weap-

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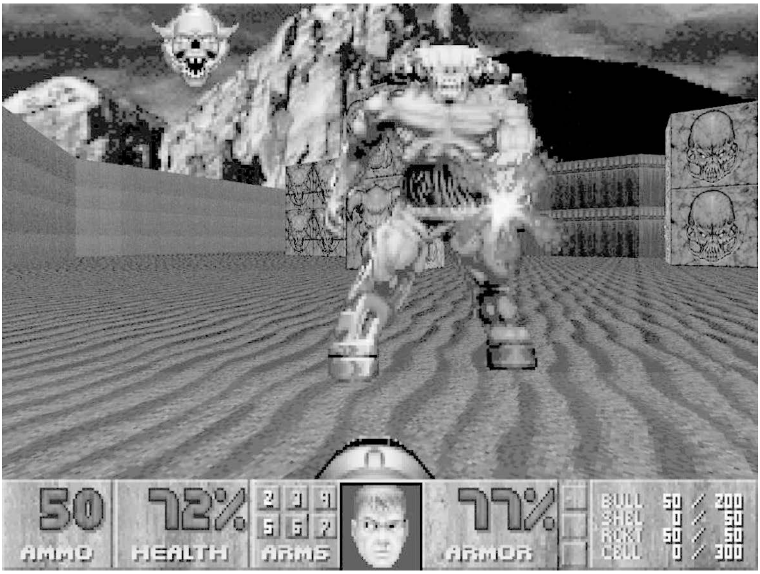
1 To be precise, the Cyberdemon does appear in one relatively early stage in the first third of the game—map number eight, called "Tricks and Traps." However, two factors make this encounter more of an intellectual puzzle than a battle: First, the monster is located in a room with several Barons of Hell (smaller goat-legged monsters). These are all facing the Cyberdemon, which is standing opposite to the entrance, looking back at them. When the player character walks in, the Cyberdemon detects it and

on like the rocket launcher, 45 direct hits are required to take down the behemoth. With the plasma rifle, which deals less damage but has a much higher rate of fire, the monster needs to be hit around 180 times.

Figure 3.8: The Cyberdemon in the original DOOM.



Source: http://doom.wikia.com/wiki/Cyberdemon (accessed January 24, 2018).

A blast of the BFG9000, which can dispose of several enemies at once, is not enough to defeat a Cyberdemon, who can withstand up to three *direct* shots from the weapon. The BFG does have a few limitations, which make it challenging to land a direct shot on the monster while dodging the missile barrage that it constantly hurls at the player. First, its firing rate is extremely slow. From the moment the fire button is pressed until the weapon fires, almost one second elapses.

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starts firing, damaging the Barons, who start attacking back. Thus, the player only needs to use the Barons as cover and let them take care of the giant beast. The second factor that facilitates this encounter is the presence of potent power-ups in the room: one Soul Sphere that grants the player an additional 100% of health, and an Invulnerability Sphere (or more, depending on the difficulty level), which renders the player-character invincible for 30 seconds. Playing these cards correctly renders the encounter rather unchallenging. Additionally, the BFG9000 can be acquired in this stage for the first time, albeit in a secret area.

Second, ammunition for this weapon is in limited supply, and it is shared with the plasma rifle. It consumes forty plasma cells per blast, of which the player can carry 300 (600 with a backpack). Thus, the player can shoot the weapon a maximum of seven times (15 with a backpack) before it runs out of ammunition. Once the plasma cells are expended, the plasma rifle is rendered useless as well. Therefore, as argued in the previous chapter, it is clever to save the plasma cells for challenging sections.

Following the principle of location and the linear stage structure described in section 1.2., difficulty in DOOM II gradually increases as the player advances through the gameworld. The game's progression is thus closely tied to the organization of objects in space and the linear sequence of stages. Correspondingly, the player character acquires more powerful weapons as time passes and more distance is covered. In multilinear games, players might encounter a challenge early on that requires better skills or abilities than those they possess, forcing them to explore other paths in search of the means to meet the challenge. In a linear game such as DOOM II, players obtain the tools to meet future, more demanding challenges in advance. In terms of the typology introduced in section 1.2: *character progression* antecedes *gameworld progression*. Once the player receives a weapon of such great power, an expectation is placed. The BFG9000 is an omen of things to come.

CHEKHOV'S GUN

The nineteenth-century Russian writer Anton Chekhov left a vast collection of letters behind after his death. Among everyday matters, his views on political issues, and comments on his main occupation as a physician, his epistolary exchanges include writing advice to friends and colleagues (Chekhov 2004). One of these pieces of advice came to be known as *Chekhov's gun*. In a letter of 1889 he wrote the following comment (my emphasis):

"I've read your farce. It's wonderfully written, but the structure is unbearably bad […] Dasha's first monologue is completely superfluous and stands out like a sore thumb. It might have been functional had you decided to give Dasha more than a minor role, in which case it would have had some relation to the rest of the play […] *One must never place a loaded rifle on the stage if it isn't going to go off. It's wrong to make promises you don't mean to keep*" (in Goldberg 1976, p. 163).

Chekhov's maxim is related to the literary device of foreshadowing (that is, elements in a story that hint at events to come), since the gun in question generates expectations, but it is rather an admonition of the inclusion of unnecessary elements in a story. All elements in a tale need to fulfill a narrative purpose or be removed. The gun stands for any salient object or event that might capture the audience's attention and generate expectations about the fictional world—in the above quote, it is a monologue that gives a minor character too much relevance. If these expectations are not satisfied in any way, the event or object that produces them ought to be left out of the story. However, Chekhov's advice should not be taken too literally. A table in a dining room need not fulfill any other purpose other than being a prop, since it is expected to be there—the absence of a table in a dining room would be more salient than the table itself. A gun, on the other hand, is an instrument that can be used to take someone's life, so it commonly attracts attention and signals the potential for death—or a character's intention to kill—, which is likely why Chekhov used one as an analogy.

Chekhov's gun can be applied to video games in two ways. The first one is, naturally, in narrative. While telling a story with the medium of the video game, this piece of advice is as useful as it is for theater, literature, or film. The second way pertains to game mechanics. *Chekhov's BFG* would then state that if you give a player a gun, then you need to give them a reason to fire it. Each ability or weapon acquired by the player character should be mirrored by a suitable challenge in the gameworld: For every BFG9000 there should be a Cyberdemon.

Unbalanced mechanics can make games too easy or unfairly hard and disrupt the sense of flow that an actual challenge can elicit (see section 3.1). They can thus lead to boredom or anxiety. But they can also lead to the disappointment produced by unfulfilled expectations.

VISIONS OF THE FUTURE

Expectations are events that are likely to occur from the perspective of an observer; they are the possible futures that players work with when they plan ahead. As argued in section 2.1, games are characterized by having uncertain outcomes, typically leading to two primary scenarios: player success or player failure. Players typically expect different possible outcomes from a situation and try to act in ways that will narrow the range of possible results to those that they consider desirable.

Jesse Schell (2008, pp. 26-27) and Salen and Zimmerman (2004, pp. 165-166) argue that surprise is a central component of games. From a simple set of events that can occur on screen, a large number of combinations of events can *emerge*. Predicting which events will emerge is crucial for success, but not always possible. Through *emergence*, surprises commonly ensue. But the term "surprise," while correct, can be imprecise. After all, it is actually easy to design a surprise. Just make something completely unexpected happen, and players will certainly be surprised, since they could not anticipate it. When playing SUPER MARIO BROS., if I press the jump button and Mario suddenly explodes, I will be surprised. But that does not seem like a recommendable design feature. Some things in the gameworld need to remain constant, while others can change in expected or unexpected ways. The question is: How far should events in a game stray from the player's expectations? Introducing the concept of *suspense* in contrast to a *surprise* can help with the answer.

Time is the ingredient that marks the difference between an event being a mere surprise and a suspenseful development. The German writer and philosopher Gotthold Ephraim Lessing reflected on this distinction in the dramatic notes he wrote between 1767 and 1769:

> "By means of secrecy a poet effects a short surprise, but in what enduring disquietude could he have maintained us if he had made no secret about it! Whoever is struck down in a moment, I can only pity for a moment. But how if I expect the blow, how if I see the storm brewing and threatening for some time about my head or his?" (Lessing 1890, p. 377).

In other words, if the story lets the audience know in advance that an event might occur, it creates suspense. A player or reader includes it as a part of their model of the world and comes to expect it. From that moment, all events are interpreted in association with this expectation. If, instead, the event happens abruptly, without warning, it is a surprise. Surprises force players or readers to hastily readjust their mental model to include this new event and make sense of it. Lessing makes his general preference for suspense clear when he states that "for one instance where it is useful to conceal from the spectator an important event until it has taken place there are ten and more where interest demands the very contrary" (ibid.). A sudden surprise is a fleeting experience, and it might come across as gratuitous or a mere shock effect in the context of storytelling. Suspense, on the other hand, opens the possibility for future events from an early moment and takes the audience for a ride with one or more possible destinations. The delight of a well-crafted story lies partly in the interplay between the audience's predictions and the unfolding of events.

Over a 150 years later, filmmakers Alfred Hitchcock and François Truffaut echoed Lessing's thoughts in a famed conversation.[2] Truffaut defined suspense as "the stretching out of anticipation" (Truffaut 1984, p. 72). Hitchcock illustrated the distinction between *suspense* and *surprise* with the following example:

> "We are now having a very innocent little chat. Let us suppose that there is a bomb underneath this table between us. Nothing happens, and then all of a sudden, 'Boom!' There is an explosion. The public is *surprised*, but prior to this surprise, it has seen an absolutely ordinary scene, of no special consequence. Now, let us take a *suspense* situation. The bomb is underneath the table and the public *knows* it, probably because they have seen the anarchist place it there. The public is *aware* that the bomb is going to explode at one o'clock, and there is a clock in the decor. The public can see that it is a quarter to one. In these conditions this innocuous conversation becomes fascinating because the public is participating in the scene. The audience is longing to warn the characters on the screen: 'You shouldn't be talking about such trivial matters. There's a bomb beneath you and it's about to explode!'
> In the first case we have given the public fifteen seconds of *surprise* at the moment of the explosion. In the second case we have provided them with fifteen minutes of *suspense*" (ibid., p. 73).

In linear, non-interactive media like film or literature, audiences can try to predict the flow of events that are out of their hands. Either Hitchcock's characters will notice the bomb or not. If they find it, they might either defuse it, run away from it, or still be caught in the explosion. Audiences that possess knowledge ignored by characters need to wait and see if events will unfold in the way they expect them (or want them) to. Expectations in linear media take the form of the question: "what are the characters going to do next?" In video games, this question can still shape expectations, but players additionally ask "what am I going to (have to) do next?"

The relation between player and character knowledge works differently in video games. Section 2.2, The Groundhog Day Effect, analyzed how players can act with knowledge that the player character does not have. If players know that there is a bomb under a table, they will control the player character differently and do whatever they can to avoid being caught in an explosion. Hitchcock's brand of suspense, which relies on an asymmetrical knowledge relation between viewer and character, is thus a futile exercise at the level of the mechanics. But suspense is certainly achievable in games. If the player is informed of the bomb

2 The connection between Hitchcock's and Lessing's musings was noted by film scholar David Bordwell (2013).

under the table in a video game, then the suspense would arise from the player's own capacity to deal with the situation—not by wondering whether the characters will notice the bomb or not.

Schell (2008, p. 27) illustrates the importance of surprise with a study conducted by psychologist Gregory S. Berns and coworkers (2001). In this study, participants were delivered water or juice into their mouths through tubes, while their brains were scanned via functional magnetic resonance imaging. Some participants received water and juice at regular and others at irregular—and thus unpredictable—intervals. The study revealed that those participants that received the stimuli at irregular intervals experienced more pleasure than those who could predict if water or juice was coming next. Thus, Schell argues, surprise can enhance enjoyment. But the participants knew that they would receive either juice or water. There was no condition in which they could suddenly be delivered vodka without previous warning. The outcome was always within the range of the participant's expectations, and it never subverted them. Thus, by differentiating surprise from suspense, the conclusion should be that suspense enhanced enjoyment in this experiment, and not surprise.

FALSE EXPECTATIONS

In video games, players commonly control a player character who can equip different items. Players need to figure out what events these items can initiate and what effects these events have in different contexts. Sometimes the use of an item is patent because it is a digital counterpart of a real-world object. If a player finds a gun in a gameworld that is portrayed as having very similar characteristics to the real world, then there is little need to ask what the object is for. In CALL OF DUTY: MODERN WARFARE 3, the use of weapons is straightforward. Practice is needed to learn the exact way each firearm works, but their purpose is clear: They shoot bullets, which are used to take down enemies. In the case of the BFG9000, it is clear that it is a weapon, but the player needs to fire it at least once in order to understand its capabilities.

Other times, when the use of an item is less obvious, games give instructions through text or other forms of exposition. The video game PORTAL, for instance, puts players in the shoes of Chell, a woman in charge of testing a portal gun in an experimenting facility. The first minutes of the game are designed to progressively teach new players how the game's main mechanic works and introduce them to the logic of test chambers. During the first section, players are guided by an artificial intelligence called GLaDOS (Genetic Lifeform and Disk Operating

System). However, before giving players a fully-functioning portal gun, the game walks them through a couple of easy puzzles where orange portals are opened by the AI on specifically marked walls. Only after a few puzzles, the player encounters the portal gun rotating on a pedestal, automatically shooting blue portals. Blue portals connect to orange portals, and there can only be one of each open simultaneously. At this point, the player can pick up the portal gun and start shooting blue portals. Orange portals, however, are still opened by GLaDOS. The following puzzles teach the player the complexities of manipulating portals in different test environments, but only by having them open one of the two portals. After learning how to work with pressure-sensitive buttons, companion cubes, energy pellets, and moving scaffolds, the player obtains a new portal gun that shoots both blue and orange portals.

Figure 3.9: PORTAL.

One of the game's early test chambers. The yellow orb at the center of the image traveled from the spherical contraption that fired it to the left of the screen, through the blue portal on the right, to come out from the orange portal on the floor. The orb will hit the light-emitting device on the ceiling, activating the moving platform located in the background.

In yet other cases, games leave players in the dark as to what the function of an entity is or what effects it can have on other entities. MINECRAFT, for example, is an intricate game that tells players remarkably little about how to play it. The game's survival mode primarily consists of garnering resources and surviving in a vast procedurally-generated world. Players need to obtain raw materials to create tools, build shelters, cook food, and craft weapons to fight the game's monsters. There is no main objective other than staying alive and exploring the enormous gameworld. The game also has a complex system of crafting that starts with the creation of a set of items (swords, axes, chests, doors, ladders) with basic materials (wood, stone) and gradually advances until the player can mine and use more valuable and durable resources (iron, diamond) that allow for the crafting of more powerful tools. But MINECRAFT does not tell the player how to create these items or garner resources, or even what items can be crafted and to what ends. Players need to either find out by themselves or resort to the numerous online sources of information, such as the official MINECRAFT Wiki (2018), which contains a compendium of knowledge garnered by the game's community.

There is another truth to creative work: rules are made to be broken. Once a medium's conventions are established, subverting them can yield interesting results. For all its obscurity, MINECRAFT is a game that makes sense once its logic is learned. It has a clear progression, stable rules, and every element plays a function in the system. Other games are not so systemically coherent. The expectations generated by a game's progression can lead to false assumptions, and even some entities might be placed just to confuse or mislead players.

The RESIDENT EVIL HD REMASTER analyzed in the previous chapter gives players a handgun and a combat knife as starting weapons. Both are weak weapons that do not deal much damage to enemies and, especially in the case of the knife, can prove challenging to use. Later in the game, players can acquire a shotgun. This weapon is more powerful than the initial two and can take out zombies efficiently. The problem with RESIDENT EVIL is that it is not always clear which enemies one should engage and which not. Zombies can be defeated, but sometimes it is best to run past them and save the ammunition. Boss fights usually require eliminating the enemy with gunfire, but this is not always the case. The first of two encounters against Yawn, a giant snake, can be ignored entirely. With Chris, the player can enter the room where the snake is located, pick up an important item, and then head back out again. With Jill, the player can get help from a non-player character, which will shoot at the snake until it leaves. Only in the second fight against Yawn players need to fire at it until it is defeated. Shooting Yawn during the first encounter is an exercise in wastefulness, but the game does not inform the player of this. Thus, players might be tempted to waste shotgun shells on the snake to no effect. Shooting at Yawn will make it leave, but at the cost of resources that could have been saved for later.

At a later point in the game, the player will come across a character called Lisa Trevor. She is a victim of experiments that have left her highly deformed and attacks the player character every time she gets a chance. Lisa's attacks are slow but powerful. There are three encounters with Lisa in total, and she can only be defeated in the last one. During the first two, the player should simply avoid Lisa, given that she is completely impervious to attacks. Once again, the game does not inform the player of Lisa's invulnerability. In the first encounter, players might squander shotgun shells, as they did with Yawn. Ammunition does not damage Lisa, but shots can make her recoil. During the third and final encounter, the player can fire at her until she falls off the platform on which the fight takes place. But an attentive player would notice that there are four boulders on every corner of the platform. The boulders connect to chains, which are attached to a stone grave on the other end, where Lisa's mother is buried. Dropping all the rocks off the platform reveals the remains, a sight that overwhelms Lisa, who grabs her mother's skull and drops off the edge of the platform. Lisa can thus be beaten without spending a single round of ammunition.

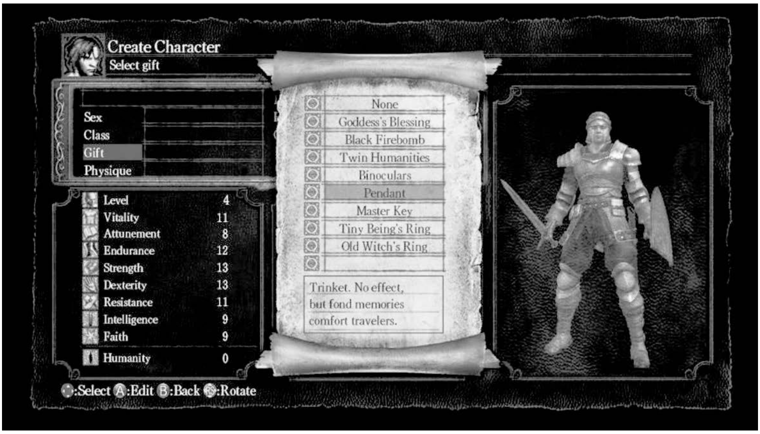
Figure 3.10: RESIDENT EVIL HD REMASTER.

Lisa Trevor approaches Chris Redfield.

Red herrings are devices used in storytelling to misdirect the audience. They are typical of crime or mystery stories. For example, an innocent character might become the suspect of murder if they come back from the woods with a shovel and mud on their boots after the disappearance of another character. Both Lisa Trevor and the first encounter with Yawn are *mechanical* red herrings. The encounters can be entirely avoided, but players might still fire at the threatening monstrosities with everything they have, losing valuable resources that would be useful in other encounters. Players might be prone to thinking that Lisa and Yawn are the Cyberdemons to their shotgun.

A further example of misdirection in video games is DARK SOULS (From Software 2011), a decidedly challenging action role-playing game. As RPGs usually do, it starts with a character-creation screen. Here, players can equip a gift to start out with. These gifts vary from very useful items, such as a key that opens closed doors, to not-so-useful items, like a pair of binoculars. One of the gifts is a mysterious pendant, whose description reads: "Trinket. No effect, but fond memories comfort travelers." This item was the object of much speculation among DARK SOULS enthusiasts, who spent considerable amounts of time and energy in trying to elucidate its real function.

Figure 3.11: DARK SOULS.



The menu in the character creation screen where the gift can be selected. The option "Pendant" is highlighted.

According to the game news site IGN, DARK SOULS' creator Hidetaka Miyazaki fueled this intrigue in an interview with the Japanese site Famitsu, where he stated that he either plays the game with the pendant or nothing (Stanton 2012). Later, in an interview with Game Informer, when asked about the pendant, he exhorted players to look for answers: "I cannot tell you here how you use the item. I still want people to try investigating the meaning of the item. Please find it out on your own!" (Kollar 2011). Players tested several theories, always to no avail, and shared their attempts on venues like Reddit (2011). Finally, in conversation with IGN, Miyazaki confessed that the pendant was actually a prank, and that it had no special function whatsoever (Stanton 2012).

DARK SOULS is famous for its extreme difficulty.[3] Mastering the game requires a significant amount of practice and patience. The mechanics, much like in MINECRAFT, are not clear to beginners. The workings of the game need to be uncovered through painstaking trial and error or by consulting online sources, such as Wikis and video tutorials.[4] Furthermore, the history of DARK SOULS' stunning medieval-fantasy world is shrouded in mystery, and its different locales hide countless secrets, inviting constant exploration. The story of the game needs to be pieced together from snippets of information that are scattered throughout the intricate architecture of its castles, crypts, and churches. Taking these facts into account, it is understandable that players expected the pendant to possess some secret use or meaning. Miyazaki may have anticipated as much when including this mysterious item in the game and locating it in a menu where players can choose from a variety of useful items.

Both DARK SOULS' pendant and RESIDENT EVIL'S unbeatable encounters with Yawn and Lisa Trevor transgress the principle of Chekhov's BFG. If the player expects certain items to have a particular function within a game's system, they will look for signs that confirm these expectations. DARK SOULS includes a mysterious but useless item in a world teeming with secrets to uncover. RESIDENT EVIL gives players a powerful weapon in a world where resources are scarce, only to slyly confront them with enemies that cannot be defeated. DARK SOULS' pendant is a practical joke that led players to take unnecessary risks and squander their time in the search for a meaning that was never there. In the case of RESIDENT EVIL, the red herrings are designed in a way that can trick the player into wasting valuable resources. Both are challenging games in which the obscurity of the mechanics contributes to their steep difficulty. They create false expectations, like mirages on the temporal landscape, which misdirect players into making the game even harder for themselves.

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As chapter three has shown, video games take different approaches to the temporal landscape. Genres like strategy or survival horror require players to maintain a future-oriented time perspective in order to succeed. Action games, like

3 The Guardian, for example, listed DARK SOULS under "the 25 hardest video games of all time" (Stanton and Freeman 2016). IGN editors included it among "the hardest games we've ever played" (IGN 2014).

4 See for example the DARK SOULS REMASTERED Wiki (2018).

platformers or first-person shooters, demand a more present-oriented perspective. Privileging one time frame over the others has an impact on the players' behavior and their experience of time. Video games can also make players move faster through the landscape by eliciting the state of flow, the phenomenon that explains why hours go by like minutes while playing. While video games can somewhat slow down the player's experience of time (recall the giraffes in THE LAST OF US), the most extreme cases of slow-motion perception are out of bounds for them—these cases only occur during sudden, life-threatening situations. Video games, as safe activities, can only simulate these experiences (in a rudimentary way, at least so far), as exemplified by the bullet time mechanics popularized by MAX PAYNE. Towards the landscape's horizon lie the players' expectations, which influence the paths players choose as they approach the future. This final section has argued that expectations are a key ingredient in the generation of suspense, which contributes to our enjoyment of video games (and numerous other forms of entertainment). But expectations are a double-edged sword, since game designers can use them to point players in the wrong direction and increase a game's challenge.

Conclusion

This study has examined the manifestation of two ancient human preoccupations in the contemporary media landscape: time and play. Play, like any other activity, unfolds in time. For the act and cultural artifacts of play to be fully understood, it is crucial to elucidate the mechanisms of time perception. Only a few decades ago, interactive computers entered the scene and, with them, the medium of the video game was born—which gave way to a novel mixture of games and storytelling. The capacities of computers to simulate systems and display interactive moving images were rapidly assimilated as means for the creation of games that could not exist in the physical world (think of SPACEWAR! or TETRIS) and fictional worlds in which players themselves can act as protagonists.

Our sense of time has shaped these new cultural artifacts and given rise to gametime: a simulation of time as it behaves in the Middle World in which our perception evolved, but with some characteristics of its own—it can be paused, reset, reversed, slowed down, and accelerated. Gametime, as this study has shown, relates to time perception in two ways. On the one hand, it conforms to the limitations of the human cognitive apparatus. Accordingly, gametime is neither too fast nor too slow, and it does not follow the laws of relativity or quantum mechanics, but the laws of physics as they manifest at the scale our minds can perceive. On the other hand, gametime can behave in ways that enhance and manipulate our experience of time, offering a new set of possibilities.

In light of this duality, I examined gametime from two complementary angles: the formal analysis of video games and the cognitive science of time perception. By bringing together these perspectives, the above pages have shown how time perception shapes the medium of the video game, and how the medium can, in turn, manipulate our perception of time.

Formal analysis has helped uncover the basic constituents of video games that determine their temporality. Drawing from work on gametime by game studies scholars as well as my own observations, the typology of temporal structures (section 1.2) divided gametime into its fundamental components. Three different aspects of gametime were classified in three categories: how events unfold on the mediated layer (change of state), how they are arranged in the gamespace (space-time), and how they are delimited by systemic boundaries (conditions). Some of these features of gametime were scrutinized in more detail in subsequent sections, uncovering three main points of friction. First, I discussed the use of triggers, which leads to player-centric gametime. Events can clash with our causal intuitions if they are portrayed as independent of the player character's presence yet rely on their proximity to unfold. In the case of open world games, triggers provide players with the freedom to explore while the story waits for them to resume. This elicits the problem of freedom vs. urgency. Second, I addressed a temporal paradox brought about by the Groundhog Day Effect, which occurs whenever players go back in gametime and replay a segment of a game with knowledge of the 'future.' This leads to a knowledge gap between player and player character. Some possible solutions were described, though most of them address the problem only partially. Third, I discussed the issues that can arise with the implementation of verbal narrators. In a medium where players can make decisions that affect the unfolding of events, the implementation of a narrator can be a challenging task. I have argued that a hybrid narrator emerges from the combination of retrospective and real-time narration, which fits the blending of play and storytelling.

Throughout a significant part of this study, I have analyzed the temporal characteristics of video games through the lens of time perception, as understood by the field of cognitive science. Theories put forward by experimental psychologists, neuroscientists, linguists, and philosophers have been of the utmost importance to this study. The concept of apparent motion explained how the experience of a moving image arises from the rapid succession of frames—a fundamental aspect of gametime. The construction of the present moment addressed the properties and limitations of our experience of time—limitations that shape the design of video games. The mental connection between space and time—illustrated by language (for example, the ego-moving and time-moving metaphors) and spatial representations of time (calendars, hourglasses)—was the basis for the space-time category in the typology of temporal structures, which analyzed how gametime can be organized through the gamespace.

But our minds do not just process raw information that the senses gather from the environment. They also rely on assumptions to extract meaning from the world, as in the case of causation. Video games tap into the mechanisms that govern our sense of causation, described by the theory of force dynamics. The events that take place in gamespaces are structured by causal relations that players must elucidate in order to reach their goals. The freedom vs. urgency problem is a mismatch between our causal intuitions and the fact that events in open world games typically do not unfold unless players explicitly initiate them by actively starting quests. The theory of action-oriented predictive processing showed how Grodal's aesthetic of repetition works at the mental level by combining prior knowledge with sensory information to create a model of the world. The accumulation of prior knowledge allows players to act on the basis of models and rely less on incoming sensory signals, which allows for faster and more precise reactions. The mechanics and aesthetics of bullet time were also examined through studies on the experience of time in life-threatening situations.

This study has also demonstrated that video games can affect time perception. They can accelerate or decelerate the passage of time, and influence the temporal frame (past, present, or future) in which players focus their actions, which impacts player behavior. The deeply engaging state of flow explained why hours can fly by while playing video games. The psychology of self-control, based on our experience of time, was shown to be a central component of many video game genres—especially those which involve the administration of limited resources, such as survival horror. I have also argued that setting expectations influences the player's behavior and experience of the game. These expectations can be used to create suspense, as well as misdirect and challenge players.

All of these aspects have expounded the many ways in which gametime contributes to the captivating interactive experiences that have players fixed to the screen for hours on end. Therefore, to fully comprehend the medium of the video game, it is of paramount importance to analyze it through the lens of time perception.

THE TIME WE WANT

With the capacity to create interactive worlds, we also have an opportunity to shape them in ways that please us. Our cognitive apparatus constrains our cultural artifacts, but our creative imagination and technological prowess take us to fictional worlds where the rules of Middle World can be twisted and turned in creative ways.

In this fashion, gametime behaves less like a tyrant and more like a genie who can make our wishes come true. Would you like death not to be final? Granted. Do you want to fast forward through this boring sequence? Sure thing. Is this experience too overwhelming? Pause time and reflect. Are you not ready to face a particular challenge? Take your time and start it whenever you feel prepared.

The malleability of gametime grants game designers and storytellers fascinating new tools to work with. At the same time, it constitutes a profound challenge for those who wish to create cohesive fictional worlds and make players feel responsible for their actions. In this context, perhaps the most significant victim is the genre of tragedy. After all, tragedy rests on the inexorability of the passage of time. Events, as they transpire, must be deeply lamentable and final. Jesse Schell expressed his worries on this issue in a talk at the Game Developer Conference (GDC) in 2013. He stated that

> "[tragedy is] not really a thing for us [game designers]. If we're doing an interactive Romeo and Juliet, what happens? Oh, my God, she died! Well, let me go back to the checkpoint, we're gonna fix that up (…) I'm not saying doing tragedy is impossible in video games. It's just hard" (Schell 2013).[1]

The power to bend time comes at a high price if it deprives the medium of one of the most memorable forms of art—the one epitomized by the works of Sophocles and Shakespeare. The section on the Groundhog Day Effect explored a possible solution in which games like HEAVY RAIN do not allow players to reset the timeline—the *deal with it* category. Nevertheless, even this workaround cannot stop players from starting a game anew or watching gameplay videos of alternative endings.

Games can also combine linear storytelling with interactive gameplay, funneling the player's actions into one single ending through narrative segments—such as cutscenes. Some, like Schell or Crawford, argue that the medium is not being used at its full narrative potential in these cases. In their eyes, this approach does not constitute a solution to the problem, but it is rather a part of it. It might be the case that video games will not be able to solve this issue. Perhaps they should simply embrace the malleability of gametime—making the most of what sets video games apart from other media.

Whatever happens, the future ahead of us offers promising avenues of exploration that could take gametime in novel, fascinating directions. If there is one conclusion from this study for game scholars and designers alike, it is that time perception is a constituent aspect of our interaction with video games. Our experience of time is malleable but dependent on a constrained cognitive apparatus that is constantly making assumptions about the world. Understanding how we

1 See also Schell 2008, p. 269-270.

arrive at time is crucial to appreciate the present and shape the future of gametime.

Our ability to predict future events is too limited to tell us exactly what new developments the medium of the video game will bring about. For this, we have no choice but to wait and see. Only (real) time will tell.

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ASSASSIN’S CREED (CA 2007, Ubisoft Montreal/Ubisoft)

BALDUR’S GATE (CA 1998, BioWare/Interplay Entertainment)

BATMAN: ARKHAM ASYLUM (GB 2009, Rocksteady/Eidos Interactive)

BEYOND: TWO SOULS (FR 2013, Quantic Dream/Sony Computer Entertainment)

BIOSHOCK (US 2007, 2K Boston/2K Games)

BIOSHOCK INFINITE: BURIAL AT SEA – EPISODE TWO (US 2014, Irrational Games/2K Games)

BIOSHOCK REMASTERED (US 2016, 2K Boston/2K)

BORDERLANDS (US 2009, Gearbox Software/2K Games)

BRAID (US 2008, Number None, Inc./Number None, Inc.)
BREAKOUT (US 1976, Atari, Inc./Atari, Inc.)
CALL OF DUTY: MODERN WARFARE 3 (US 2011, Infinity Ward/Activision)
CALL OF JUAREZ (PL 2006, Techland/Ubisoft)
CANABALT (US 2009, Adam Saltsman/Semi-Secret Software)
CANDY CRUSH SAGA (GB 2012, King/Activision)
CASTLEVANIA: SYMPHONY OF THE NIGHT (JP 1997, Konami Computer Entertainment Tokyo/Konami)
CIVILIZATION V (US 2010, Firaxis/2K Games)
COMMAND & CONQUER (US 1995, Westwood/Virgin Interactive Entertainment)
CRASH BANDICOOT (US 1996, Naughty Dog/Sony Computer Entertainment)
CUPHEAD (CA 2017, Studio MDHR/Studio MDHR)
DARK SOULS (JP 2011, FromSoftware/FromSoftware)
DEAD RISING (JP 2006, Capcom Production Studio 1/Capcom)
DEAR ESTHER (GB 2012, The Chinese Room/ The Chinese Room)
DIABLO (US 1997, Blizzard North/Ubisoft Entertainment)
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DISHONORED (FR 2012, Arkane Studios/Bethesda Softworks)
DISHONORED 2 (FR 2016, Arkane Studios/Bethesda Softworks)
DMC: DEVIL MAY CRY (GB 2013, Ninja Theory/Capcom)
DONKEY KONG GAME & WATCH (JP 1982, Nintendo EAD/Nintendo)
DON'T STARVE (CA 2013, Klei Entertainment/Klei Entertainment)
DOOM (US 1993, id Software/GT Interactive)
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DOTA 2 (US 2013, Valve Corporation/Valve Corporation)
DRAGON QUEST (JP 1986, Chunsoft/Nintendo)
DUNGEONS & DRAGONS (US 1974, Gygax and Arneson/Wizards of the Coast)
ECHOCHROME (JP 2008, Sony Interactive Entertainment/Sony Interactive Entertainment)
FALLOUT 4 (US 2015, Bethesda Game Studios/Bethesda Softworks)
F.E.A.R. (US 2005, Monolith Productions/Vivendi Universal)
FIFA 17 (CA 2017, EA Canada/EA Sports)
FIFA 97 (CA 1996, EA Canada/EA Sports)
FINAL FANTASY (JP 1987, Square/Nintendo)
FORZA MOTORSPORT 7 (US 2017, Turn 10 Studios/Microsoft Studios)
GRAND THEFT AUTO III (GB 2001, DMA Design/Rockstar Games)
GRAND THEFT AUTO: VICE CITY (GB 2002, Rockstar North/Rockstar Games)

GRAND THEFT AUTO: SAN ANDREAS (GB 2004, Rockstar North/Rockstar Games)
GRAND THEFT AUTO IV (GB 2008, Rockstar North/Rockstar Games)
GRAND THEFT AUTO V (GB 2013, Rockstar North/Rockstar Games)
GUITAR HERO III: LEGENDS OF ROCK (US 2007, Neversoft/Activision)
HALF-LIFE (US 1998, Valve Corporation/Sierra Entertainment)
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HEAVY RAIN (FR 2010, Quantic Dream/Sony Computer Entertainment)
HORIZON ZERO DAWN (NL 2017, Guerilla Games/Sony Interactive Entertainment)
JOURNEY (US 2012, Thatgamecompany/Sony Interactive Entertainment)
KNIGHT LORE (US 1984, Ultimate Play the Game/Ultimate Play the Game)
LEGACY OF KAIN: SOUL REAVER (US 1999, Crystal Dynamics/Eidos Interactive)
LIFE IS STRANGE (FR 2015, Dontnod Entertainment/Square Enix)
MADDEN NFL 97 (US 1996, EA Tiburon/EA Sports)
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MASS EFFECT (CA 2007, BioWare/Microsoft Game Studios)
MASTER OF ORION (US 1993, Simtex/MicroProse)
MAX PAYNE (FI 2001, Remedy Entertainment/Rockstar Games)
MEDAL OF HONOR: ALLIED ASSAULT (US 2002, 2015 Inc./EA Games)
MEGAMAN (JP 1987, Capcom/Capcom)
METAL GEAR SOLID (JP 1998, Konami Computer Entertainment Japan/Konami)
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MINECRAFT (SE 2009, Mojang/Mojang)
MONOPOLY (US 1935, Elisabeth Magie/Hasbro)
MORTAL KOMBAT X (US 2015, Netherrealm Studios/ Warner Bros. Interactive Entertainment)
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OVERWATCH (US 2016, Blizzard Entertainment/Blizzard Entertainment)
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PORTAL (US 2007, Valve Corporation/Valve Corporation)

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QUAKE (US 1996, id Software/GT Interactive)

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QUANTUM BREAK (FI 2016, Remedy Entertainment/Microsoft Studios)

RESIDENT EVIL (JP 1996, Capcom/Capcom)

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SIMCITY (US 2013, Maxis/Electronic Arts)

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