An affordance based model for gameplay

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ABSTRACT
This paper presents a formal model for gameplay based upon the affordances available to the player that are linked to game objects. It has been constructed via an extensive analysis of major first-person games 1998-2008, although it is argued it may extend to all diegetic games. Gameplay can be understood as a network of allowed actions, that can be summarised as a small number of archetypal affordances mediated by a set of parameters that define their functional relationships. As well as the capacity for the model to elucidate the ludic structures of games, it is argued that an affordance based model also provides a means to understand the relationship and role of story and content within a ludological context.

Author Keywords
Affordances, gameplay models, content, ludology, theory.

AFFORDANCES AND GAMEPLAY
Gibson's concept of affordances has been sporadically applied to games for several years now, as a powerful tool for understanding the relationship between player and system. In particular, affordances offer a structured framework for the interplay of interpretation, action and presentation that forms the basis of what Perron has called 'the heuristic cycle of gameplay'. [16]

Put simply, an affordance is an allowed action which can be extracted by a user. Klevjer asserts that an affordance "does not merely describe the conscious act of recognising possibilities of successful interaction... but describes a basic condition for there to be any meaningful visual perceptions at all" [14]. Affordances thus rest upon a fundamental extraction of the functions of the object or environment in question, rather than simply its properties. It is this extraction of available or supported actions that makes affordances such an appealing construct for game researchers. Linderoth & Bennerstedt, for example, argue that "The basic perceptual act for a computer gamer is to pick up affordances in the game environment. She or he sees possibilities for how to interact with the game" [15]. Gee extends this beyond perception, suggesting that affordances link to the epistemological act of play [7]. In all of these cases, the affordance is a quality designed and embedded into a system. What is possible within a game is hardwired into the system as a network of affordances. A similar assertion is made by Calleja [4], Klevjer [14], Pinchbeck [17] and Wilhelmsson [22]. In other words, within a ludic context, an affordance can be described as the functional input/output relationships of an object in the context of the game environment.

However, whilst affordances have been used in games research, what is missing is a formal model taxonimising the types of affordances normally embedded within a system and how these relate to its objects. It is such a model that is proposed here. In order to do so, ludic objects are first categorised according to the states and parameters which define them. This taxonomy has been constructed through an analysis of 35 first person perspective titles released between 1998-2008. In what follows, the acronym FPS is used for brevity, although it should be noted that neither the analysis nor the model is reduced to simply shooters, and includes those games which blur the genre boundaries like Portal [21] Fallout 3 [2] and Pathologic [12].

DEFINING OBJECTS: STATES AND PARAMETERS
To begin with, all ludic objects can be divided into those with one state and those with at least two states. A state is defined as a set of properties that defines the object and its relationship to its context. Objects with only one internal state are those whose affordances only take one form and cannot be altered by gameplay. Multiple state objects, in contrast, are those in which the affordances can be altered, the simplest form of which is being removed from the world. Affordances may change as play occurs; they are defined by a series of parameters (normally integers) which determine how they are enacted. A crate that can be broken, for example, has a parameter that defines the total damage it can take before changing state (whole to broken). In this case, the crate has two states; its affordances are determined by which state it is in, and the state itself is a description of the object's parameters. These states are fixed: so either the state is triggered when the parameters are aligned with this template (such as the depreciating damage counter of the

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crate reaching zero) or by an instantaneous shift in parameters to a predetermined set (a door's parameters, defining affordances like whether one can move through it, see through it, etc, may be fixed to two states – open and closed). As a metaphor, the relationship between affordances, parameters and states can be seen as being like a graphic equalizer. Bass, middle, treble, and so on, may all be independently adjusted on their scale, yielding a different sound. However, the system may also include a number of presets which instantaneously shift all parameters to predefined points on the scale. Thus, if an object is said to have more than one state, it means that the object has at least two predetermined and fixed sets of affordance relationships, whether the parameters defining these may then be also individually manipulated or not.

Thus, a static, unbreakable crate is defined by a number of parameters: its x, y and z co-ordinates. It may afford cover, or reduction in sightlines, or the ability to adjust the z co-ordinates of an avatar if it can be stood upon. It is a single state object. If the crate in question is breakable, it has two states, controlled by a single parameter: the damage it can take. On taking damage, the integer defining this parameter reduces. When it reaches a certain value (normally zero), a state change is effected. The other parameters defining the object are instantly changed: the corresponding visual representation of the object is replaced with a pile of debris, which no longer affords the ability to adjust the z co-ordinate of the avatar, or the ability to take cover and so on. If the crate can be pushed around by the avatar a new affordance is added. Its other affordances remain constant, although its significance for gameplay may be adjusted by the player taking advantage of these affordances (such as reaching a new area). By moving the crate, the x and y co-ordinates are altered, but the state remains constant; there are no immediate shifts to the defining parameters across the board. This is an entirely distinct process to the state change that happens as a result of reducing the damage-taking parameter to a pre-determined value (zero). In the same way, a light switch has two states: on or off: a single binary parameter determining whether the surrounding area is illuminated or not. In this case, the only parameter shift that can be enacted is linked absolutely to a state change.

Multiple state objects can be divided into those whose use is specifically defined and those that can be manipulated more freely by the player. In other words, a button is tied to an absolute location and function even though the player is free to operate it when they want. This is very different from a Warthog in Halo [3], or the tanks in Crysis [5], that can be used as and when the player determines. A health kit, on the other hand, can only be used in one way, whether it is activated by co-location or added to an inventory.

Another basic division can be made between affordances related to gameplay, and those related to diegesis. This divides those affordances that have the capacity to affect other objects and those that do not, but may still exert influence upon the player's experience. In the former category are objects such as Ladders, Flame Jets, Health Kits, Buttons and Levers, Keycards, Agents and Spawn Points; in the latter Weather, Graffiti, small items such as cups or glasses, PDAs and Journals and Cutscene Triggers.

Finally, in each of these categories there is a scale of significance. For example, barrels may be used as cover in many games, but Half Life 2 [18] greatly increases their significance with its use of the Gravity Gun, turning them into objects to be manipulated extensively in play. Beyond a level of significance, objects become critical, as their affordances will or must always be triggered for play to progress. Keycards that unlock previously inaccessible areas are a generic device of this type, as are the Gravity Pathways and Spirit Walk sections of Prey [11]. By definition, a critically significant diegetic affordance must also be a gameplay object: a code in a journal is not simply a story affordance but renders the journal itself a critical gameplay object. However, we can track a scale of significance in diegetic objects too; textures and posters may not contribute directly to stories or story progression, but act as corroborative detail, supporting the general diegesis. This is in contrast to those objects that explicitly contribute to the story: diaries, journals, audio logs, and so on.

OBJECTS AND AFFORDANCES

Fig 1 demonstrates that the range of objects found in FPS games reduces to a small number of types. This should thus be applied to how the state and parameter make-up of objects mediate the affordances of a game system.

In the 1STATE category, there are two classes of object: static and moving/movable. These objects cannot be altered by the act of play; although in the second class their location can change. Their impact upon gameplay and the avatar is limited to response only. A lava or slime pit will cause a negative health change to an avatar, but it requires the avatar to come into contact with it. There is only one type of static-critical object, the architecture supporting all action in the space, which is perhaps better thought of as the boundaries to the playing area.

Increase in significance → (Generic Gameplay → Critical Gameplay) | Increase in significance → (Corroborative Diegetic → Story Diegetic)

		Generic Gameplay (likely to actively impact on play)	**Critical Gameplay** (will/must always be *triggered*)	**Corroborative Diegetic** (no gameplay or story significance)	**Story Diegetic** (no gameplay, but story information)
1STATE	**Static**	Architecture Lights Unbreaking windows Ladders Static Crates Anomalies (STALKER), lava, slime Flame jets, steam etc		Weather Textures	Posters Graffiti
	Moveable/Moving	Moveable Crates Desks, Furniture (FEAR) Moving architecture (SCARAB – HALO3)	→ May also appear here	Cups, glasses	
>1STATES	**Controlled Trigger** (Finite/Infinite)	Exploding Barrels **Parameter Triggers (health, damage, ammo, guns, items etc)** Breakable Crates + Windows Buttons, levers, valves, dials Spawn point	Keys/Keycards Cascading sequences **Goal triggers (also be Parameter Trigger)** Steam, fire etc (that links to being turned off) Spiritewalks+ gravchutes (PREY) Vehicle bridges (QUAKE)	Light switches, flushing toilets	Cutscene triggers PNPCs
	Multiple Trigger (Finite/Infinite)	Doors, Lifts Vehicles (HALO, FC) Vending Machines (Bioshock)			PDA's Book of Dagon (CTH)
	Independent Object	Agents (Hostile or Non-Hostile)	Bosses PNPCs	Seagulls (HL2) Pigs (Far Cry)	PNPCs

═══Effects avatar═══ (Generic Gameplay, Critical Gameplay) | ═══Doesn't effect avatar═══ (Corroborative Diegetic, Story Diegetic)

Figure 1: A Taxonomy of gameplay objects

The best example of a corroborative object is a texture, which does not contribute particularly significantly to the player's experience, but remains important to supporting the presented diegesis. Castle Wolfenstein [8] has old stone walls and floor: it looks like a castle. Story objects literally have something to say, they afford an increase in knowledge about the diegesis or push the plot forwards. The first time the player sees the "Who is Atlas?" posters in Bioshock [1], they are directly confronted with a question of whether their guiding PNPC is all he claims; likewise, when, later, they read "Would you kindly?" scrawled across the wall of Ryan's office, there is a direct impact upon the understanding of the story. Thus, the affordances attached to corroborative objects can be seen as epistemological in nature; they support a greater understanding of the diegesis and its stability. Story objects afford a better understanding of the context of the action, and may be specifically attached to ludic information: in other words, they may afford the understanding of what to do next, and how. In both of these cases, there is no reason to distinguish story elements from other gameplay objects. An effective diegesis weaves gameplay and story together through the management and manipulation of the total ludic set. Where story and gameplay are antagonistic, this is not the result of two incompatible forms meeting one another, but a breakdown in the holistic networking of affordance relationships and their presentations through ludic objects. Any object, be it a cutscene, voice-over, piece of architecture, shift in the relationships between other objects, musical cue, power-up, health kit, agent, avatar or game mechanic is fundamentally tied to the underlying network of supported actions embedded within the game system, and this includes the way in which the player interprets the presented activity. After all, interpretation is supported by an affordance – the capacity to enable an interpretation to be drawn. Provided one remembers that any affordance naturally exists along a scale of significance, there is therefore no conceptual division between gameplay and story. Alyx Vance exists as an independent object tied through the environmental set to controlled trigger affordances, and also affords diegetic support, interpretation of the presented events, and a means to contextualise the player's activity.

Movable objects may occur as critical objects, but are more normally found in generic gameplay. There is a wide spread of significance that may be tied to the increasing sophistication and integration of physics engines. There are three normal gameplay functions to this: the first is the deliberate use of movable objects for the player's advantage. A desk may afford the properties of either using it to block off a space, or to climb on. On the other hand, physics is now frequently used in conjunction with artificial intelligence; movable objects make noise, which can be used to attract agents, either deliberately or accidentally. Thus, at one end of the significance scale, we have re-arrangeable furniture as an insignificant feature of gameplay, at the other, crates to be stacked to provide access to new locations. Finally, in the case of Half Life 2's gravity gun the ability to manipulate all movable objects becomes centralized in gameplay. In "We Don't Go To Ravenholm", the use of movable objects largely replaces normal weapons; likewise in Episode 1's "Urban Flight" [19], the gravity gun is used to block Antlion spawn points. Unsurprisingly, given the normal usage of movable objects, it is difficult to find story diegetic objects in this category (although there are, of course, links between some gameplay objects and story – a bomb to be delivered to a location that is not added to an inventory but is represented onscreen at all times, such as Episode 2's [20] Magnusson devices). Movable objects thus expand the affordances of some static objects by placing greater control over how these affordances are used in the hands of the player.

Objects with more than one state (>1STATE) are divided into three categories: controlled triggers objects (CTOs), free trigger objects (FTOs) and independents (including agents and avatars)

The majority of objects in FPS environments are CTOs; they are the devices that control the gameplay and diegetic experience. Simply put, a CTO is one that can only be utilized in a defined way and normally just once. Exploding barrels change state when their predetermined parameter trigger is activated: they effect a negative parameter shift on the environment and objects around them and are then removed from play. Buttons, levers, valves and gears are used to initiate embedded sequences and cannot be drawn upon in any other way. Fire and steam jets are on until turned off; cutscene triggers push plot forwards and then revert to inactivity. Toilets may be flushed and taps turned on and off, but there is no extension of this basic affordance set and frequently no ramifications to the act. Often, what are touted as gameplay features are simply variations on this object type with a diegetic dressing: Prey's spirit walk sequences and gravity-bending walkways are simply CTOs, as are Bioshock's vending machines. In all cases, the system controls the allowed inputs and the corresponding outputs and, as should be clear from the above, this follows for diegetic objects as much as gameplay ones. There are two special subclasses to this set: goal triggers and parameter upgrades (discussed later). Goal triggers force a non-returnable shift to a new environmental state, whether

that means a break for level load, or a permanent alteration to the environment and system state. Examples of the latter include the release of the Flood in Halo, or a factional shift in S.T.A.L.K.E.R. [9]. Goal triggers make repeated use of an environment possible as they shift the input-output channels of the environment whilst leaving it apparently unchanged either visually or in terms of generic gameplay. These kinds of triggers frequently serve a double-purpose as critical story diegetic objects or, to put it another way, goal triggers are often encased within a strong diegetic device. In all of these cases, the affordances of CTOs are system defined and normally specific: these objects have affordances that *do* something as much as they *enable* something.

FTOs are much less common. They are limited to objects such as free use vehicles, lifts and doors. The latter are often actually CTOs, but occasionally a greater degree of player control is allowed: in Call of Cthulhu: Dark Corners of the Earth [10], some doors can be bolted as well as closed, and the decision to bolt a door, leave it open or close it can have a highly significant impact on gameplay. In Halo, the player has a high degree of freedom in terms of when they can use a vehicle; they can make a choice between Warthog and Ghost, and can use these in the exterior locations more or less how they like (though the game limits their use to exterior environments, thus bottlenecking gameplay). Affordances attached to this small set of objects thus normally focus upon mediating other affordances in the ludic space. In terms of diegetic objects, those that can be repeatedly referred to fall into this category, such as audio logs and emails. Some parameter upgrade objects are effectively FTOs, such as sniper scopes, and these, like other triggers, may be finite in usage.

Finally, the set of independent objects basically comprises of those multiple state objects with a fixed-state artificial intelligence system attached to them: agents and in-game NPCs. Although they certainly have the capacity to affect the avatar, they will navigate the environment on their own and do not always require an input to be triggered. This is best illustrated by those games which allow inter-factional conflict, where it is possible to simply observe the agents interacting with one another independently of player activity. As with the other categories, however, we can still grade independent objects according to their primary roles in gameplay and diegesis, and their significance to either. For example, a boss or sub-boss such as Robert Marsh in Call of Cthulhu, or Sergeant Kelly in Doom 3 [13] is a critical independent object, as there is no way to avoid them and engaging with them is essential to progression. Some persistent NPCs also fall into this category, such as Alyx Vance General populations are less significant in these terms, as it is not always necessary to interact with them in order to progress and there are occasional independent agents that play no significant role in gameplay or story such as Far Cry's pigs [6]. Both of these may be seen as corroborating the diegesis, and supplying an additional point of interest for inquisitive players. In terms of story diegetic classification, it should be noted that not all NPCs are independent objects at all. Cortana, though critical to Halo's diegesis, does not exist in the game as anything other than a series of audio files and cutscenes triggered from the avatar's position in the environment and relative to goal triggers. Essentially, the game's most important NPC is actually a string of story-diegetic CTOs.

Every single object existing in an FPS environment can be placed into this taxonomy, from NPCs to buildings, barrels and health kits. It is thus evident that despite the great experiential range of FPS worlds, the functional architecture of the environment is vastly simpler than its diegetic overlay. We can now classify the types of affordance these objects enable in a similar way.

MAPPING THE AFFORDANCES OF FPS GAMES

Constraining and enabling movement and perception are the basic affordances of any object with a physical presence in the environment: all architectures and props afford the actions of navigating around the space (and may be co-opted for cover, although this can be seen as using the affordances relative to another agent strategically, thus part of the same basic affordance). Constraining movement is a vital part of controlling experiential gameplay, so it is not as a simple as blocking a player; indeed walls and doors should be thought of as devices which enable gameplay to be meaningful and enjoyable because they do some of the work of exploration for the player. These constraints also apply to agents and PNPCs.

An affordance that yields a change to the environmental parameters means a shift in the entire set of objects, which may be an alteration to physics or, more commonly, the removal of an object, or objects. When a crate is broken, or a barrel destroyed, or an agent killed, it makes sense to consider these removals as changes to the overall state of the environment, as well as individual parameter shifts, as once activated, the object ceases to have any states at all (being removed). Spawn triggers are also environment parameter shifts as they add objects to the environmental set; however, it is the first type of environmental parameter

shift that is of real importance. Understanding that the final operation of any finite-parameter affordance is a change to the environmental set in the form of the removal of one object provides evidence for an underlying principle of FPS play: that as play progresses, the environment set simplifies. Spawn points may increase the number of objects in the environment temporarily, but otherwise, play is the process of an inevitable decrease in the number of objects, and number of affordance activations left in each finite state object. The core action of FPS games – shooting at things – is thus tied to a general, ongoing set of alterations to the environment set and this outcome is linked to many of the objects found in the environment.

Thus, any object that can be interacted with (in other words, that has a supported action or input/output relationship attached to it) yields a parameter change, that may or may not result in a state change. When a barrel is pushed, the parameters defining its co-ordinates alter; when it is shot at, its damage parameter reduces and may force a state change. Changing an object's parameters, with the important subset of changing its location, represents the fundamental activity of gameplay – the manipulation of objects, according to a set of predetermined rules, by the player.

In terms of CTOs that afford a parameter shift to the avatar, such as a health kit, therefore, it should be noted that at least two affordances are triggered simultaneously – a change to the object's parameters and a change to the avatar's parameters. If the object in question has reached the end of a depreciating use count parameter, a third affordance is also effected – change to the environment set. Thus, in the case of a single-use health kit, if the affordance is activated, there is a parameter shift to the avatar's damage-taking capacity and a change to the environmental set (health kit is removed from play). Likewise, a health kit in S.T.A.L.K.E.R. is not immediately activated but adds to the avatar the capacity to heal itself an additional number of times, but it is removed from the environment. It might even be suggested, therefore, there is no object state change when a kit is picked up, instead there is a parameter shift to the avatar and a reduction in the environmental set.

There are thus two types of shifts to object parameter that can be attached to any given object: the capacity to shift its own parameters and the capacity to shift another object's parameters (including independent objects, or agents). Finally, the capacity of change the parameters of the avatar as a special case should be distinguished.

An exploding barrel can thus be described as a >1STATE movable object with the following affordances: Change Own Location (it can be moved around), Change Own Parameters (takes damage then explodes with a state change), Change Object's Parameters (when it explodes it inflicts damage), Change Avatar's Parameters (in the same way) and Change Environment (when it explodes, it is removed from play). As a CTO, the last three of these are tied to the state change. A static, unbreakable crate (1STATE, Static) that cannot be climbed upon is linked to only one affordance: it constrains movement and perception. A light switch (1STATE, Controlled) is linked to two: Change Own Parameters (a binary integer state change) and Change Environment (by altering the local illumination). A Warthog (>1STATE, Free) is linked to may be used to Change the Avatar's Parameters (for moving and shooting), Change Own Parameters (it can be occupied or not, it can flip over), and Change Object Parameter (agents may enter it and also have their parameters shifted). It also constrains movement and perception to a limited extent (you can't move through a Warthog, or see through it very well). Finally, a Covenant Brute (>1STATE, independent) can Change its own parameters (move around, take damage, shift into different states as dictated by contextual AI), change other object's parameters (shooting at things) and, of course, change the avatar's parameters in the same way, Its constraint over movement and perception is relatively negligible compared to most static objects (and would not normally be expected as a gameplay function).

Finally, there are the two diegetic affordances. Corroborative objects- those that are not explicitly linked to story development but support the general semantic presentation afford a stable diegesis and reinforce expectations and assumptions about this. The entrails twisting through Mars City are often attached to walls and floors (1STATE, Static, Constrains Movement and Perception) but they also support the idea of a Hell-invaded base and assist in maintaining the general ambience. On the other hand, many of Bioshock's audiotapes not only supply this affordance, but also directly afford a greater degree of knowledge about the story – they afford increases and decreases in plot complexity and player understanding. The affordances attached to types of objects can be summarised as follows:

Pertaining to the environment set (I.e. the environment and everything in it)	Constrain/Enable Perception and Movement [C/E] Change Environmental Parameters [CEP]
Pertaining to the object itself (an internal affordance)	Change Own Parameters [COwnP] Change Own location [COwnL]
Pertaining to another object(s) in the environment (including the avatar)	Change Object's Parameters [COP] Change Avatar's Parameters [CAP]
Pertaining to the diegesis (without gameplay function)	Support Diegesis [SD] Manage plot complexity and transparency [STORY]

Figure 2: Summary of affordance types

All of the affordances available to, or through, environmental objects across the classifications reduce to a basic set of six gameplay affordances and two diegetic affordances. In the case of environmental objects, whether they are single or multiple state, these affordances are for the most part controlled, specific and predetermined. In the case of two special classes of object however, there is a much greater degree of complexity in how these affordances are mediated and enacted. Agents and avatars should thus be considered in more detail.

AGENTS AND AVATARS

Agent refers to those objects in the environment with some form of artificial intelligence attached to them that exercises self-contained control over the application of the affordances available to them. The concept of state being defined here enables a simplified understanding of independent objects to be established: it can be understood that what is actually created is a set of input-output relationships with the environment, mediated by a series of parameters.

In this definition of states, a parameter is a mediating variable, affecting the affordance relationships inherent in an environment set. As an example, one very simple state system existing for all agents comprises of ALIVE and DEAD. Each of these states has a pre-determined set of affordance relationships with the environment set, which control movement, perception, reaction to events, and so on. This corresponds to a single sliding scale which determines the state: a health bar, represented by an integer value decreasing every time the agent is affected by a COP action with a negative health parameter specification. At a certain integer level – normally zero – the agent state changes from ALIVE to DEAD and its affordance relationships immediately shift to the second, predefined, set. However, within ALIVE, each defined affordance relationship may have at least one mediating variable attached to it, from speed of movement to likelihood of firing at any other given object.

An independent object has two special affordances that make it unique. The first is the capacity to perceive the environment set, mediated by a set of parameters that create the illusion of sensory information; the second is the capacity to select an output from a set given this input information (giving rise to the illusion of reasoned action). Thus unlike a controlled trigger, which has a vastly reduced or singular input-output system, or one which is fundamentally predetermined and locked to a specific context; agents are capable of determining, to an extent, how this system operates. Note that this does not require a great deal of complexity, as the options and parameters within the self-determined system can be extremely simple. Further, the actual affordances underlying the outputs fit without issue into the gameplay affordances here COL (applied to the agent itself); COP (normally by attempting to impose a negative parameter shift upon its health). Every action an independent object may carry out fits these basic gameplay affordances, from team communication and social behaviour (COP) to projected mood states, as noted above. This is not to denigrate the complexity of game AI, but it is nevertheless important to understand that the experiential complexity is without doubt greater than the structural complexity, and approaching the issue from the perspective of affordances makes this extremely clear.

By defining an agent's behavioural and action responses in terms of affordance relationships, it becomes clear that when an agent behaves differently, what is really occurring is a shift to the mediating variables by which it selects or conducts actions or, in the case of a state change, makes a jump to a predetermined set of parameter-mediations. Just as a negative change to an agent's health integer may alter parameters that mediate its PERCEIVE and SELECT affordances, it may affect its direct capacity to undertake or exploit gameplay affordances. A heavily damaged agent may also be constrained in movement; it may have a causal relationship between the parameters mediating its health and the parameters mediating its movement. These causal relationships can be extended to other gameplay affordances, including COP, and these may also be directly shifted by such affordances being initiated by another object in the environmental set. If agents picking up Quad Damage upgrades is enabled within the system, then co-locating with such an object changes the parameters by

which the agent utilizes these two affordances by increasing the negative health parameter shift caused by an accurate hit. Running over a health kit likewise alters the parameters of the health integer, with potential knock-on effects to the parameter structures described elsewhere in the state.

Similarly, when a player selects a weapon from a list, what is really happening is that the parameters by which they can apply the gameplay affordance COP is altered, using the mediating factors of range, accuracy, local damage, splash damage and so on. This affordance is normally locked to a decreasing integer (an ammunition count), so that with each shot, the integer is decreased until it reaches a point where that particular configuration of mediating variables is no longer usable. For this reason, we should consider jumping between weapons as state changes (as several depreciating counts are attached to a predetermined set of mediating factors, 'describing' each individual weapon). Thinking in this way, picking up an ammo clip can be seen as a parameter upgrade – it increases the otherwise decreasing ammunition integer. A new weapon or ability can be understood then as an CAP, in the form of the addition of a new state, as it defines a new predetermined set mediating variables for applying this affordance. Finally items such as health kits may be seen as either environmental CTOs yielding a parameter shift or general parameter upgrades that afford the avatar a capacity to cause a parameter shift in itself, at any point. As well as this, we can note that alongside these forms of parameter upgrade objects, there are more permanent upgrades, as with new weapons, that create new states. This discussion naturally leads to a consideration of avatars in more detail.

The list of what it is that avatars actually do in games, is in fact very short, with a larger number of mediating parameters most of which are locked into specific states. For instance, walking, crawling, running and even swimming are all states within the basic affordance of moving. Running increases the speed of movement whilst normally leaving other mediating variables unchanged. It often also changes the parameters of the avatar's presence in the environment (by making more noise, it effectively alters other agents' perception of the environmental set). Crouching reduces speed and noise and drops the avatar's presence visually along the vertical axis; jumping temporarily shifts the avatar along the z-axis. All of these really fall under COwnL and in some cases (swimming, sneaking, running) COwnP. Changing weapons, applying health kits or using any item such as a sniper scope, can also all be classified under the pre-existing COwnP.

Interacting with the environment can thus be seen as triggering affordances, and avatars have the capacity to do this in one of two ways. In the case of co-location, the affordance is best thought of as a controlled trigger item. Some controlled triggers also require *use* buttons, but in these cases, the same basic affordance is applied: COP. Any kind of shooting, including grenades and melee are applications of COP, mediated by range, accuracy, damage, etc. Reading journals and audio logs are COP to trigger SD or STORY. As with objects, the real complexity and experience of gameplay comes from the mediation of parameters, through which a complex subjective experience can be created. For example, choosing to switch from pistol to rocket launcher in a combat sequence may cause a series of representational shifts, but in reality, all that has happened is the parameters mediating the affordance of COP have been adjusted. There is no actual change of object, just a state change shift in the avatar.

It can therefore be argued that gameplay can be understood as a network of affordance relationships existing between objects in an environment, and that both the types of object and types of affordances they have the capacity for are relatively small in number. All activity in a ludic space can be reduced to a small number of affordances, enacting mediated parameter shifts in other objects and this includes the activity of agents, and even the avatar.

CONCLUSION

Affordances are an extremely powerful tool for understanding gameplay and, what is more, it appears possible to formally taxonimise both the range of affordances normally present in gameplay and the object types these affordances are embedded within. A number of interesting points emerge from this process. Firstly, that the actually structural range of both affordances and objects is small – the entirety of gameplay can be reduced to a simple set. What creates the diverse experiential flavour of gameplay is the design and application of mediating variables to this set. Secondly, that it is easy to see gameplay and story as being rooted in the same conceptual base, thus addressing some of the historical concerns over how the two constructs operate together. Thirdly, that the underlying ludic structure of the genre examined here (first person games) can be described simply using this formal model of affordances. Whether the affordance and object set presented here extrapolates robustly to other genres of diegetic gaming is an open question: we would argue it certainly holds up to initial observation and its capacity to

describe what are commonly termed 'cross-over' first-person titles such as Call of Cthulhu, Fallout 3 and Pathologic suggest this is the case. The fact that it appears both possible and beneficial to address the gap between Juul's real rules and fictional worlds with such a simple conceptual model and offer a real means of understanding how mechanism and diegesis interweave suggests that this model may be of significant interest and use for games researchers regardless of their genre or approach.

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