Higher Graphical Fidelity Decreases Players' Access to Aggressive Concepts in Violent Video Games

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ABSTRACT
Several features of violent video games (hence VVGs) may cause gamers to access aggressive concepts during play. Two of these features are graphical fidelity and use of narrative. In particular, the increased graphical fidelity of modern VVGs is widely theorised to cause increased access to aggressive concepts. However, despite this theoretical speculation, there is little empirical evidence of whether these formal features of VVGs actually do influence players to access aggressive concepts during play. Therefore, a 2x2 between-subjects factorial online experiment (N = 710) was employed. This examined the effects of graphical fidelity and narrative content on the extent to which players accessed aggression-related concepts when playing a VVG. Results indicated that the presence of realistic graphics in a video game representing aggression caused players to access aggressive concepts *less* ($p = 0.014$). The presence of narrative content was not found to have a statistically significant effect. Under an influential (though controversial) model of VVG effects known as the General Aggression Model, increased access to aggressive concepts causally contributes to anti-social behaviour by players of VVGs. These findings suggest that even if playing modern VVGs *did* lead to these negative effects, they would not be influenced by the increased graphical fidelity of modern VVGs.

Author Keywords
Games; VVGs; graphical fidelity; narrative content; video game effects; aggression; violent video games; GAM;

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K.8.0. General: Games.

INTRODUCTION
Playing a video game is a more complex experience than just pitting one's skill, speed, and intelligence against the rules of an abstract challenge. As Jesper Juul put it, to play a video game is often "to interact with real rules while imagining a fictional world"[1]: The stimuli that a game produces can represent real concepts to their players as well as the abstract elements of an equation that governs when a game is won or lost. For example, whilst Master Chief from the first-person shooter *Halo* is the agent through which a player takes one of a set of actions in order to maximise his points (rules), he also represents a superhuman soldier committing acts of aggression (fiction).

This tendency of gamers to access real-world concepts during play has led to a strong interest in using 'serious games' to teach players pro-social or otherwise useful behaviours. If players can interpret in-game elements as representing useful real-world concepts, then exposure to these concepts could lead to the development of useful knowledge, and ultimately the learning of useful behaviours.

However, just as pertinently, the ability of video games to influence individuals to access real-world concepts during play has led to fierce debate over their potential *negative* effects. If players can think of their in-game actions as representing real behaviours, then violent video games (hence VVGs) allow their players to imagine that they are committing acts of violence. Under an influential (albeit controversial) model of video game effects called the General Aggression Model (hence GAM), this access to violent concepts is theorised to lead to the development of violence-related knowledge structures; this in turn theoretically leads to players expressing violent behaviours themselves in real life [2].

It is important to note that the validity of the GAM's postulated causal link between the play of VVGs and behavioural change remains subject to extremely heated debate - this is discussed briefly in the following section. We should make clear that in this paper we provide experimental evidence which neither attacks nor defends the GAM's position that VVG play leads to violent behaviour. However, even the harsher sceptics of the GAM admit that it is widely-cited enough to be currently considered the 'default model'[3] of VVG effects, much that they may disagree with it. This dominance motivates a strong interest in discovering the features of VVGs which might cause individuals to access concepts related to the violence represented in a game: Under the GAM, at least, the presence of these features would affect negative

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behavioural change in players – and their absence would influence the prevention of this.

Therefore, in order to investigate how the features of a VVG affect the extent to which a player accesses the violent concepts represented within it, we developed a VVG in Unity3D. We then manipulated two features of this game: Whether it contained narrative content or not, and whether it contained high-fidelity (realistic) graphics or low-fidelity (abstract) graphics. We placed this game online and recorded the extent to which players accessed aggressive concepts during play via an implicit measure.

Our findings suggest that the presence of higher fidelity, more realistic graphics result in players accessing the aggressive concepts represented within a game *less* than the presence of low-fidelity, abstract graphics. This result has important and surprising implications. Primarily, it suggests that some of the current debate regarding the anti-social effects of modern VVGs may need to be reconsidered. The increasing realism of modern games has often been indicted as increasing their negative effects on players by making their violence more lifelike, but our results fly in the face of this theoretical perspective.

BACKGROUND

Anti-Social Video Game Effects

In this section we briefly describe the contemporary debate surrounding the anti-social effects of video games.

The GAM

By far the most widely-cited model of the anti-social effects of video game play is currently the GAM, or General Aggression Model [4]. This 'default model'[3] of the effects of playing violent video games proposes that the long-term effects of playing violent video games is based on the social learning of behaviour.

Under the GAM, when a player observes aggression in a game, a number of effects occur which lead to short-term increases in aggression: aggression-related knowledge structures are made more accessible, arousal is increased, and an aggressive affective state occurs. More seriously, however, each session of video game play is also theorised to lead to long-term effects through the learning of aggressive behaviours. According to the GAM, when a player observes violent behaviour in a game he or she acquires and develops a variety of knowledge structures related to this behaviour. This learning occurs just as if he or she were observing the represented behaviour in a real-life social context: For example, when an individual plays *Grand Theft Auto V*, the GAM treats this play as an opportunity for learning and developing scripts, schemata and beliefs related to theft and murder.

Long-term increases in aggression are largely ascribed to the observational learning of these aggression-related knowledge structures: As habitual violent video game-play makes knowledge structures related to violence more likely to be activated and applied in real-world contexts [2], it therefore makes violent behaviour more likely to be expressed by a player.

Criticism of the GAM

The past fifteen years have seen the generation of a significant body of evidence supporting the theory of video game effects described above. Indeed, in 2010, one prominent media effects scholar was confident enough to publish a paper entitled "Nailing the coffin shut on doubts that violent video games stimulate aggression" [5]. The short-term effects of playing violent video games which have been typically reported in the literature involve increases in aggressive cognitions (e.g. [6], [7]), hostile feelings (e.g. [8], [9]) and aggressive behaviour (e.g. [10], [11]). Reflecting the GAM's predictions over longer periods of time are a host of widely-reported correlations: Habitual violent video game play has been linked to increases in aggressive cognitions and behaviours, as well as increased hostile expectations [12] [10].

However, recently, fierce debate has broken out within the media effects community regarding the validity of this research. This criticism is extremely diverse, and the issues it involves are varied: They range from issues relating to the validity of instruments used to measure aggressive behaviour, to the reliance of the GAM on correlational evidence of its long-term effects, to several null experimental results, to disconfirmatory studies which demonstrate negative correlations between VVG sales and youth violence (e.g. [13], [3], [14], [15]).

Methodological Issues: Between-Games and Within-Games

It is important to highlight one aspect of this criticism that is of particular relevance to our research. Many studies into the effects of playing violent games may be confounded due to their use of inappropriate games as stimulus materials. Much media effects research adopts a 'between-games' approach. This methodology may be described as one in which an experimenter uses multiple games to represent multiple levels of a single independent variable. Those sceptical of the validity of these experiments claim that the use of multiple games may not afford satisfactory experimental control. Because factors separate from the variable theoretically under manipulation may differ between games, and hence between conditions, it is unclear what causes any observed variation in dependent variables[43] [17]. In contrast to a 'between-games' approach, adherents of a 'within-games' approach advocate utilising only a single game in an experiment, which varies only due to the effect of an experimenter's manipulations. This is the approach which we adopt in this piece of research.

Measuring Access to Concepts

How can we measure the extent to which a player has been accessing violent concepts whilst playing a VVG? Consider that a player has recently played *Call of Duty: Black Ops*,

and we wished to determine the extent to which he or she had been thinking about the violent concepts represented within the game during play. This feature of the player's experience might initially seem extremely problematic to measure: Research in cognitive psychology indicates that the extent to which an individual uses knowledge drawn from some specific source domain (e.g. violence) to process some set of stimuli (e.g. *Call of Duty*) may be an automatic process, operating below the level of conscious recall [18]. In other words, an interested researcher cannot simply ask their participant the extent to which they were thinking about violence whilst playing *Call of Duty* and expect to get a meaningful or valid response in return.

However, a set of measurement procedures are now gaining traction in video game research which provide a solution to this problem. These are implicit measures. So-called because of their ability to gain access to 'implicit' cognitive processes operating below the level of conscious recall, implicit measures are placed in direct contrast to traditional 'explicit' self-report measures, which allow participants to make use of deliberative processes when recording responses [19]. Amongst other non-conscious processes, some of these instruments allow researchers to estimate the strength and recency of the activation of specific concepts in an individual's memory [20]. Using implicit measures, it would therefore be possible to estimate the extent to which a player of *Call of Duty* has recently had concepts related to violence activated in his or her memory. Or, more generally, it would be possible to gain some quantitative estimate of the extent to which a game has caused a player to access the real-world concepts that are represented within that game.

How does this work? Under network models of memory, information is represented as complex clusters of nodes. Whilst the specifics of these models are under constant debate, most theoretical descriptions share some key features: Each node in a network represents a different concept; these nodes are linked together by associational pathways; and these nodes may be activated either by an environmental stimulus. For instance, a node representing 'soldier' might be linked to another representing 'grenade', and another representing 'military', and so on. Whilst some concepts might be more likely to become activated in memory than others (so-called 'chronic accessibility'), they may also be made temporarily more accessible through either environmental stimulus or a mechanism known as 'spreading activation'. If a concept becomes activated in memory, that activation 'spreads' to associated nodes, making it temporarily more likely that they themselves become activated [21]. The recent activation of a concept is thus theorised to make both that concept itself and also associated concepts more easy to access, and therefore also more likely to be used in order to interpret some subsequent stimulus [22]. This effect is exploited by a variety of implicit measures. These measures estimate the accessibility of concepts in memory (and hence, their recent activation) by measuring some aspect of the way in which a participant interprets stimuli related to those concepts.

An example of an implicit measure of the accessibility of a concept is the Word Fragment Completion Task (e.g. [23]). This task is specifically designed to measure the accessibility of aggressive concepts. In this measurement procedure, a participant is presented with a sequence of word fragments (e.g. 'ki__'). The proportion of these fragments which he or she completes with meanings related to a target concept (e.g. 'kill' rather than 'kiss') estimates the accessibility of that concept in memory: We could, for instance, take the example above as a trial related to the accessibility of the concept 'aggression'. A broad variety of these instruments exist for measuring the accessibility of a participant's specific cognitions, as well as other aspects of implicit cognition (e.g. [21]). It is important to note that the majority of these instruments rely on researchers accurately measuring a participant's reaction time in response to some task. In order to garner meaningful results these approaches require extreme precision from an experimenter's equipment, and are therefore difficult to use effectively in many contexts. Furthermore, effect sizes for these instruments in the context of media effects research are typically quite small: a recent meta-analysis of the violent video game research literature places them at $r_{+}=0.25$ for instruments designed to assess the accessibility of aggressive concepts [24].

VVG Features and Access to Violent Concepts

What features of VVGs might influence players to access violent concepts during play? The media effects literature currently contains no over-arching theory to answer this question. However, in *Half-Real*, Jesper Juul suggests a more general taxonomy when he lists a broad variety of ways that games may "cue players into imagining fictional worlds" [1]: They may do this through projecting a world via in-game graphics and sound; through using text and cut-scenes to display dialogue and information; through the enforcement of game rules that cause players to imagine elements of a game differently; through letting players perform actions that make them imagine the game differently; through providing information that surrounds the game itself but is not part of it (such as its box, or a rumour about the game); and even through haptic feedback, such as the use of a 'rumble pack'.

A number of media effects studies have tested the effects of various of these features on the accessibility of players' aggression-related cognitions. Studies have (amongst other things) linked the presence of gore in a violent video game to the increased accessibility of aggression-related concepts [25]; linked the personalisation of player characters in a violent video game to the increased accessibility of aggression-related concepts [26]; and linked the presence of profanity in a violent video game to the increased accessibility of aggression-related concepts [27]. Therefore, we may tentatively say that there is some evidence that

these variables cause players to imagine a fiction whilst playing a violent video game.

However, there is a noted lack of evidence in existence regarding how several of the features identified at the beginning of this section influence this aspect of player experience. More specifically, neither the effects of (1) the fidelity of a game's graphics or (2) whether it contains narrative content are known.

Graphical Fidelity

Player Experience and Graphical Fidelity

In recent decades, video game graphics have progressed from simple abstract shapes to complex and realistically rendered three-dimensional objects [28]. Despite the perceived importance of these increases in graphical fidelity by players (e.g. [29]), very few studies have measured the effects of this variable on player experience in games. Furthermore, those that have done have largely obtained null results. In [30], custom versions of two 2D games were made: One with higher fidelity graphics, and one with lower fidelity graphics. Participants who played a game with higher fidelity graphics experienced higher relatedness, increased immersion and more positive affect than those playing a game with lower fidelity graphics. However, most other research on the effects of graphical fidelity on player experience has been less successful in finding significant effects. In [31], the effects of graphical fidelity on game enjoyment were studied. Participants played one of two identical games on either a Playstation 2 or an Xbox 360 console. The difference in consoles lead to distinct differences in graphical quality: However, no significant differences were found for game enjoyment between conditions. In [32], the effects of visual complexity on the older adult players of a motion-based game was tested. A custom game was created which could feature one of four levels of graphical complexity. However, no significant differences were found for a variety of different measures of player experience.

VVGs and Graphical Fidelity

Much relevant media effects research has been conducted into the effects of graphical fidelity in violent video games on aggression-related variables. However, these studies have not been without their problems. For instance, [33] investigated the effects of increased video game realism, including higher-fidelity graphics, on a variety of different measurements. Experimental manipulation of realism was effected by comparing the reactions of participants playing *Doom 1* to participants *Doom 3*. However, no significant results were found for the effects of realism on any aggression-related variables. Similarly, [34] investigated the effects of technological advancement, including higher-fidelity graphics, on a variety of different measures. Experimental manipulation of advancement was effected by comparing the reactions of participants playing an older shooting game (*Zombie Raid*) to participants a newer but similar game (*The House of the Dead 2*). However, no significant results were found for the effects of realism on any aggression-related variables. The null results described above may be explained by the experimenters' use of a 'between-games' paradigm. As detailed earlier in this paper, this approach is common in the media effects literature.

Narrative Content

Narrative content in video games can be delivered through the use of many mechanisms. These range from the presence of simple blocks of text (e.g. [35]) to the use of more sophisticated mechanisms, such as cut-scenes (e.g. [36]) and dialogue trees (e.g. [37]). The presentation of a player's actions as a series of events occurring to fictional characters rather than as a series of strategic decisions has been widely theorised to lead to a plethora of positive consequences. Through contextualising a player's actions as meaningful events that occur within a virtual world, narrative content is theorised to satisfy intrinsic needs, facilitate identification and presence, and increase player enjoyment (e.g. [38], [39]). In contrast to research into graphical fidelity, these assumptions have largely been corroborated by experimental evidence. For example, [40] investigated the effects of pre-game stories on player perception of presence. Some players were shown a short video featuring a background story before playing a game of *Max Payne*, whilst others were not. Players who had been exposed to the pre-game story reported significantly higher levels of presence.

AIMS AND HYPOTHESES

H1: Enhanced graphical fidelity in a VVG will influence players to access violent concepts more during play.

H2: Inserting narrative content into a VVG will influence players to access violent concepts more during play.

METHOD

In order to address these hypotheses, an experiment was undertaken in which several different VVGs were custom-made. In each of these games, a player's task was to drive a car around, hitting and killing as many pedestrians as possible. Some of these games had high-fidelity graphics; others had low fidelity graphics. Some featured text-boxes before play that described a simple narrative in which the player was a violent individual who must move a 'bomb' as far as possible whilst 'killing' as many pedestrians as possible; others only had functional instructions which explained that a player must travel as far as possible in the game whilst colliding with as many moving objects as possible. Screen-shots of the different games are presented below as Figure 1. These games were placed on popular online video game portals. Interested participants elected to take part in the experiment whilst browsing this site, provided informed consent, and then played one of these games. Players' access to aggressive concepts was tested online after play via the Anderson Word Fragment Completion Task, and players were then debriefed via a video presentation integrated into the game.

DESIGN

This was a between-participants design experiment with two independent variables: (1) Narrative content and (2) graphical fidelity and one dependent variable: (1) Access to aggressive concepts. Each IV had two levels: Narrative content could be either present or absent, and graphical fidelity could be either low or high. Therefore, a 2x2 between-participants design was used.

Participants and Setting

This experiment took place online, 'in the field': A game was created in Unity3D and placed online on popular video game portal websites (e.g. kongregate.com, newgrounds.com). Participants were recruited both through the portal itself (i.e. they were browsing on one of these portals and took part out of interest) and via social media (e.g. we set up a Facebook page for the game, accessible here [41], and encouraged participants to share it with their friends via social media).

710 participants took part in the experiment. 619 of these participants were male; 69 were female; and 10 listed their gender as 'Other'. 549 participants were aged 18-24; 89 were 25-29 years old; 49 were 30-34 years old; and only 11 were 35 or older. 479 described themselves as playing games at least once a day; 142 played between this amount and once a week, and 33 played between this amount and once a month.

The Anderson Word Fragment Completion Task (introduced in the section below) is a widely-used implicit measure of the accessibility of an individual's aggression-related cognitions. This was used as an estimate of access to aggression-related concepts. Measurement using this instrument does not rely on millisecond precision in recording a participant's reactions, and therefore is appropriate for use in an online experiment, in which one cannot guarantee particular features of any participant's hardware.

Games

A game was made which sought to emulate the violence contained in recent video games such as *Grand Theft Auto V*: A participant would play the role of a violent driver, whose goal was to travel as far as possible, whilst hitting as many pedestrians as possible.

Figure 1. Abstract and Realistic Graphics.

This game was implemented in Unity3D, which was used because of both its ability to rapidly prototype complex 3D virtual environments and because of its ability to be easily deployed to the web. Our first independent variable (graphical fidelity) was manipulated by making versions of this game which solely differed in their graphical quality: In one level of this variable, graphics were of low fidelity (hence referred to as the 'abstract graphics condition') and in the other they were of high fidelity (hence referred to as the 'realistic graphics condition'). Screen-shots of this manipulations are depicted above as Figure 1. Our second independent variable (narrative content) was manipulated by the inclusion of text-boxes filled with content before play. In one level of this variable, participants were presented with simple, functional instructions before playing the game (hence referred to as 'narrative content absent condition'). In the other, they were presented with a violent narrative before play (hence referred to as 'narrative content present condition').

Measures

As mentioned above, we assessed the activation of aggressive concepts in memory through measuring the post-play accessibility of participants' aggression-related

cognitions. This was accomplished via the Anderson Word Fragment Completion Task. This task has been used in a broad range of different media effects studies (e.g. [42]) and has been demonstrated to be a valid measure of the accessibility of aggression-related cognitions (e.g. [43]). It works like so: When a participant's aggression-related cognitions are more accessible, they are assumed to be more likely to be used when interpreting a neutral or otherwise ambivalent stimulus. Therefore, given a word fragment that could be completed in one of several ways (e.g. 'ki__' could be completed to make 'kiss', 'king', or 'kill'), an individual whose aggression-related cognitions are more accessible is more likely to complete this word fragment with an aggression-related meaning (i.e. 'kill') than an individual whose aggression-related cognitions are less accessible. The Anderson Word Fragment Completion Task consists of a series of 98 words, half of which may be completed to form aggression-related meanings. A participant is given some set period of time to complete as many of these fragments as possible (in our case, 3 minutes). The number of fragments that a participant completes with aggressive meanings out of the number of fragments that they complete in total is taken to estimate the accessibility of their aggressive cognitions.

Procedure

Upon electing to take part in the experiment, participants were taken to an informed consent screen. If they agreed to take part, they would be exposed to one of two text-boxes. One of these contained simple functional instructions for playing a game. The second text-box contained a piece of narrative. Following exposure to text-boxes, players played a driving game for two minutes. The game consisted of driving a car as far as possible whilst hitting as many pedestrians as possible in two minutes. This game was rendered using either abstract or realistic graphics. Following this stage of the experiment, the Anderson Word Fragment Completion Task was administered to participants, and they were then debriefed via a short video presentation.

Ethical Considerations

Given the potentially upsetting nature of this piece of research, several steps were taken to ensure that it was carried out as safely as possible. Firstly, the violence depicted in the game was deliberately mild: No blood or gore was present, in contrast to other games which may be found on the portals to which the game was uploaded. Secondly, before playing the game, participants were explicitly warned that they might be exposed to violent content. Thirdly, mechanisms were put in place within the game which barred from play participants who entered their age as under 18.

RESULTS

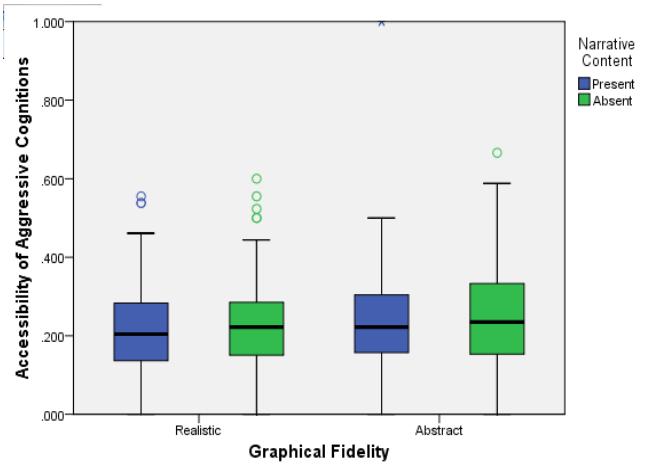

Figure 2: The accessibility of aggressive cognitions by treatment.

The scores for the word fragment completion task can be seen above as Figure 2. Means and standard deviations for each treatment are presented below.

Narrative Content	Graphical Fidelity	Mean	Std. Dev.	N
Present	Realistic	.215	.118	164
	Abstract	.237	.135	197
	Total	.227	.128	361
Absent	Realistic	.224	.115	187
	Abstract	.249	.132	162
	Total	.236	.124	349
Total	Realistic	.220	.117	351
	Abstract	.242	.134	359
	Total	.231	.126	710

The effects of graphical fidelity on the accessibility of aggressive cognitions was tested via a 2x2 ANOVA, with graphical fidelity (abstract, realistic) and narrative content (present, absent) as between-subjects factors. Results indicated that there was a statistically significant main effect of graphical fidelity on the accessibility of players aggression-related cognitions, $F(1,706) = 6.018$, $p = 0.014$, $\eta_p^2 = 0.008$. This might seem to confirm **H1**. However, surprisingly, results indicated that this relationship was in the opposite direction to the one hypothesised: Playing a violent video game with *lower*-fidelity graphics caused significant greater accessibility of aggressive concepts ($M = 0.242$, $SD = 0.134$) when placed in comparison to playing a violent video game with *higher*-fidelity graphics ($M = 0.220$, $SD = 0.117$). These results remained significant even when outliers were removed, $F(1,693) = 7.424$, $p = 0.007$, $\eta_p^2 = 0.011$.

There was no statistically significant main effect observed for the presence of narrative content, $F(1,706) = 1.253$, $p > 0.263$, $\eta_p^2 = 0.002$. There was no statistically significant interaction between the factors, $F(1,706) = 0.33$, $p > 0.855$, $\eta_p^2 < 0.001$. Thus we cannot reject the null hypothesis regarding **H2**.

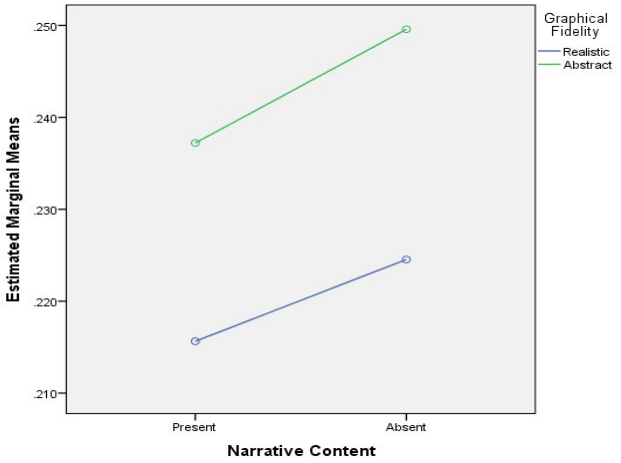

Figure 3: Estimated marginal mean scores on the Word Fragment Completion Task

Further Statistics

Further statistics were computed to determine if in-game player behaviour might be responsible for this unexpected result regarding **H1**. We were concerned that players of a game with more realistic graphics might avoid killing pedestrians, thereby leading to reduced depictions of violence in-game, and the consequent surprising results which we observed. The number of kills that a player made in-game was positively correlated with the accessibility of that player's aggressive cognitions, $r(708) = 0.139$, $p<0.01$. Furthermore, a 2x2 ANOVA, with graphical fidelity (abstract, realistic) and narrative content (present, absent) as between-subjects factors and number of kills as dependent variable revealed a significant effect of graphical fidelity on the number of kills a player made in game, $F(1,706) = 7.312$, $p = 0.007$, $\eta_p^2 = 0.01$. However, this relationship indicated that players in a game with realistic graphics killed significantly *more* NPCs ($M = 26.12$, $SD = 15.52$) than players in a game with abstract graphics ($M = 23.04$, $SD = 14.65$), rather than less. Therefore, this aspect of player behaviour in game could not have been responsible for the observed effects. As a final note, it is important to note that all the statistical tests carried out above were two-tailed for the maximum possible rigour.

Discussion

These results surprisingly contradict our first experimental hypothesis (**H1**): Greater levels of graphical fidelity led to the significantly *lower* accessibility of aggression-related cognitions following the play of a violent video game. In other words, participants who played a game with low-fidelity graphics accessed concepts related to that game's violent content *more* than those who played the game with high-fidelity graphics. This result is extremely unexpected – to the best of our knowledge it is entirely unprecedented in the empirical literature. It is therefore wise to consider various alternative explanations that may account for this effect before beginning its interpretation.

If this research were being carried out using a 'between-games' paradigm (i.e. different games representing different treatments), it might be possible that this result was confounded. However, as detailed above, great care was taken to custom-build experimental conditions which differed only according the game feature under test. This explanation for the observed results thus seems unlikely.

We were concerned that our manipulation of video game features could have lead to player behaviour differing in some way, and this difference might in turn have led to the observed variation in player experience. This explanation, however, seems unlikely. Inferential statistics indicated that there *was* a significant ($p<0.01$) correlation between the number of kills that players made whilst playing the game and the accessibility of their aggression-related cognitions. However, statistics also indicated that *players of the game with high-fidelity graphics killed significantly more pedestrians than players of the game with low-fidelity graphics* ($p=0.007$): In other words, this aspect of player behaviour could not be responsible for the observed effect, except for perhaps obscuring its true magnitude.

The observed effect size in this study is small, with only 0.8% of the variance in player experience being accounted for by our experimental manipulation ($\eta_p^2=0.008$). This is consonant with the small effect sizes which characterise the use of this and similar instruments in media effects research. Meta-analysis of the field places effect sizes at $r_+=0.25$ for instruments designed to assess the accessibility of aggressive cognitions [24]. Our η_p^2 of 0.008 is equivalent to $r=0.089$, or an effect about a third of the size of the ones typically observed within the literature. When one considers that these effects are usually the product of studies comparing the effects of a violent game to a non-violent game rather than the manipulation of one feature within a single violent game, our observed effect size seems in keeping with the literature.

If it is unlikely that an error in experimental design accounts for our results, then what does? As covered earlier in this paper, very little is known about how graphical fidelity impacts the experiences which players have with video games. Indeed, many studies which have set out to test some hypothesis about this feature have failed to reject their null hypotheses. This result, therefore, does not contradict a large body of empirical evidence. However, it is nonetheless unexpected, and perhaps unintuitive: Why would lowering the fidelity of a VVG's graphics make players access the violent concepts underlying their game-

play more rather than less? Surely looking more like the real world would make players think more about the violent content of a game rather than less. However, non-empirical evidence from a broad variety of sources suggests that, when it comes to access to concepts, a simple picture of 'more fidelity being more effective' may not be entirely correct. Will Wright, designer of *The Sims*, stated over a decade ago that abstraction in video games was the key to keeping a player's mind engaged whilst playing: By stripping a game of inessential features, players are forced to collaborate with the game in order to make a meaningful experience – this is one of the reasons why characters in *The Sims* speak in a "chirpy, invented language" rather than canned dialogue [44]. Similarly, research in multimedia learning has found that abstract visualisations of target concepts can facilitate the learning of those concepts more effectively than realistic visualisations of them [45]. Likewise, in [46], cartoonist and comics theorist Scott McCloud suggests that less realistic and more "iconic" representations of entities in comic books cue readers to think about the concepts that lie behind the representation itself, rather than the specific image shown on the page. Therefore, whilst it may be too early to make any conjectures regarding the mechanisms which lie behind the observed effects, several intriguing possibilities exist which may explain them.

The results in regard to our second experimental hypothesis (**H2**) were not statistically significant. This result may be explained by ineffectual experimental manipulation on our behalf. Narrative content was represented by a text-box filled with a short story, presented to the player before play. Whilst in the past many video games have delivered narrative content through similar mechanisms, this technique has rapidly fallen from favour in recent years [47]. Given this, it may well be the case that players in conditions where narrative was supposedly present 'skipped' reading what was in the text-box, thereby rendering our manipulation effectively absent. The lack of a significant result may therefore be due to the fact that our manipulation was not appropriate: Our hypothesis might have been better served, for instance, if the narrative content was presented through a cut-scene. It is worth noting because of our experimental method, we are entirely unable to determine whether this was the case or not. When we decided to run this experiment online 'in the wild', we were aware that we were sacrificing a significant proportion of our ability to control and closely monitor experimental participants in exchange for theoretically increased ecological validity. In a laboratory setting we could have easily observed whether players were 'skipping' text boxes and corrected this element of the experimental design. However, in this context we are still unable to determine whether this was the case. This lack of control and observation is certainly a drawback of using an online methodology in which large numbers of players are anonymously 'crowd-sourced'. To some extent the observation aspect of this problem may potentially be remedied with the application of data logging and analytics techniques to online experiments (for instance, automatically recording and timestamping all player interactions with a game), but it appears that both online and laboratory experiments will continue to have their own distinct and complementary advantages for the foreseeable future.

As outlined earlier, previous experimentation regarding the effects of graphical fidelity on aggression-related variables have often led to null results. Why did our results differ so radically from those previously observed? It may have been due to the large sample sizes we used (p=710), which enabled us to find significant effects even when effect sizes were small. Or it may have been our use of a within-games methodology with a strong manipulation of our independent variable: As documented earlier in this paper, previous research into the effects of graphical fidelity on aggression-related measures in games has used a 'between-games' approach. It is worth pointing out here, however, that a 'within-games' approach also has its disadvantages. Whilst we would strongly argue that this approach prevents the confounds symptomatic of the traditional 'between-games' approach, it also prevented us from including an entirely non-violent 'control' condition. A control might have allowed us to draw further and bolder conclusions from our results, which we were unable to. However, we would argue that to create a non-violent version 'within' the game presented above would have required extensive changes to the game itself, and potentially confounded our result entirely: The validity of this experiment rests on making precise experimental manipulations through the alteration of specific VVG features.

The Consequences of these Results

We have discussed how we may have arrived at our results – now, what are their consequences? Primarily, this experiment is of immediate importance to the study of the effects of VVGs. Both academic and media sources alike have questioned whether recent radical increases in the fidelity of game graphics might be accompanied by similar increases in those games' negative effects (e.g. [48] [33]). However, attempts to discover whether such a causal link exists have been unsuccessful. More specifically, experiments have repeatedly returned null results regarding the effects of graphical fidelity on accessibility of participants aggression-related thoughts. As outlined earlier in this paper, graphical fidelity is of particular interest to media effects theorists as it accounts for a large proportion of the theoretically predicted anti-social effects of VVG play. In contrast to this, our study returned a significant (p=0.018) but small (η_p^2=0.008) effect between conditions demonstrating that high-fidelity graphics *decreased* the accessibility of participants aggression-related cognitions following play.

Does this result matter in the real world? We would argue that it does. However, due to the large number of participants in this study, we have obtained an unusual combination of small effect size and high significance. Therefore, it is important not to approach the practical interpretation of our results naively. Two related points should be carefully made here:

1. Because the observed η_p^2 is so small, we cannot confidently state that there is much practical significance in the *size* of the difference between conditions.
2. However, because the observed p-value is low, we can state with high confidence both that there *is* a difference between conditions, and the directionality of that difference. Usually, this would not be enough to give a result practical significance. However, we would argue that this is a special case: **The directionality of this difference is counter-intuitive, and therefore this result bears strong practical significance.**

In other words, whilst (1) any statements which we might make about the *extent* to which players of VVGs with low-fidelity graphics accessed aggressive concepts would be weak, (2) our statement that players of VVGs with high-fidelity graphics access aggressive concepts less is important *despite this*, because it runs counter to currently accepted theories of how VVG effects work. It is commonly held that greater graphical fidelity should increase access to aggressive concepts in VVGs. Because we have high confidence that this feature instead *decreases access,* our result falsifies a commonly-held theory about how VVG effects work. It therefore bears real importance – despite the fact that we're unsure of the interestingness of this effect's *size*.

CONCLUSIONS AND FUTURE WORK

In this paper, the presented results indicated that higher fidelity graphics in a violent video game led to decreased access to aggressive concepts. This result suggests that even if playing violent video games *did* lead violent behaviour, the increased graphical fidelity of modern violent video games may not necessarily contribute to this effect.

Whilst the observed effect size was small, the result is counter-intuitive and thus bears practical significance: Part of the current debate regarding the negative effects of increasingly realistic violence in video games may need to be reconsidered.

This result was observed in an online experiment utilising large numbers of crowd-sourced players. Further work should be undertaken in order to address whether this interesting result can be successfully replicated in a controlled laboratory setting, and investigate any alteration of effect sizes which may be caused by this change in experimental setting.

Future work will focus on determining whether the effect observed above generalises to other contexts. Furthermore, we will attempt to discover any other formal features of VVGs which cause players to access aggressive concepts.

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