Priming and Negative Priming in Violent Video Games

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Abstract

This is a thesis about priming and negative priming in video games. In this context, priming refers to an effect in which processing some concept makes reactions to related concepts easier. Conversely, negative priming refers to an effect in which *ignoring* some concept makes reactions to related concepts more difficult.

The General Aggression Model (GAM) asserts that the depiction of aggression in VVGs leads to the priming of aggression-related concepts. Numerous studies in the literature have seemingly confirmed that this relationship exists.

However, recent research has suggested that these results may be the product of confounding. Experiments in the VVG literature commonly use different commercial off-the-shelf video games as different experimental conditions. Uncontrolled variation in gameplay between these games may lead to the observed priming effects, rather than the presence of aggression-related content.

Additionally, in contrast to the idea that players of VVGs necessarily process in-game concepts, some theorists have suggested that players instead *ignore* in-game concepts. This suggests that negative priming rather than priming might happen in VVGs.

The first series of experiments reported in this thesis show that priming does not happen in video games when known confounds are controlled. These results also suggest that negative priming may occur in these cases. However, the games used in these experiments were not as realistic as many VVGs currently on the market. This raises concerns that these results may not generalise widely. I therefore ran a further three experiments. In these experiments, a variety of different kinds of VVG realism were manipulated and the effects of this realism on priming measured. These experiments suggest that increased realism in VVGs does not lead to increased priming of aggression-related concepts, and therefore that the effects outlined above should generalise to a variety of games regardless of their level of realism.

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Declaration

I declare that the work presented in this thesis is my own. This work has not been submitted for any other award at this or any other institution. If information has been derived from some other source, I confirm that my thesis indicates this. Some of the material in this thesis has been previously published in the following conference paper:

Zendle, D., Cairns, P., Kudenko, D., 2015. Higher Graphical Fidelity Decreases Players' Access to Aggressive Concepts in Violent Video Games, in: Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play. ACM, pp. 241–251.

1 Introduction

1.1 Introduction

Battlefield 1 will be released in October of this year. In this game, players can look forward to “blasting craters in the ground with artillery strikes or ripping apart walls with gunfire” (“Battlefield 1,” 2016). Players of the recent hit *Mafia III* can similarly take part in “brutal takedowns” in which they “mash faces into concrete”(McCaffrey, 2016) . *Call of Duty: Ghosts* is known for its “fierce shootouts” and “guns-blazing combat”(Lowe, 2013). One reviewer of the zombie-themed game *Left 4 Dead* thought that the game contained so much violence that a new player’s kill count would “comfortably hit five figures within a week or two of regular play”(Meer, 2008). Violent video games (VVGs) like the ones described above are extraordinarily popular. At the time of writing this, *Grand Theft Auto V*, the poster-child for violence in video games, has sold over 65 million copies (Makuch, 2016).

Given both the popularity of VVGs and also their controversial content, it is no surprise that there has been considerable concern about what the effects of playing them might be. Academics have suggested links between playing VVGs and a variety of prominent acts of violence, from the killings committed by the ‘Beltway’ sniper (Anderson, 2004), to the attack on the World Trade Center itself (Bushman and Anderson, 2002). In recent years, a single explanation of how playing video games might lead to violent behaviour like this has been gaining increasing amounts of traction in the literature. This explanation is the General Aggression Model (GAM).

Under the GAM, the route from playing a VVG to committing an act of violence is linked to processes of ‘priming’. Priming refers to the idea that when a person processes a specific concept, their reactions to things which are related to that concept are made easier for a short period of time. VVGs, by their nature, contain depictions of aggression. Under the GAM, exposure to this aggression causes the priming of aggression-related concepts (Anderson and Bushman, 2001), which in turn leads to a variety of serious consequences for players of VVGs. In the short term, priming is thought to spread to associated ‘knowledge structures’, such as aggression-related scripts (See Figure 1-1). These “programs for behaviour” (Huesmann, 1988) are then more likely to be used by players of VVGs for a short period of time, leading to temporary increases in violent behaviour.

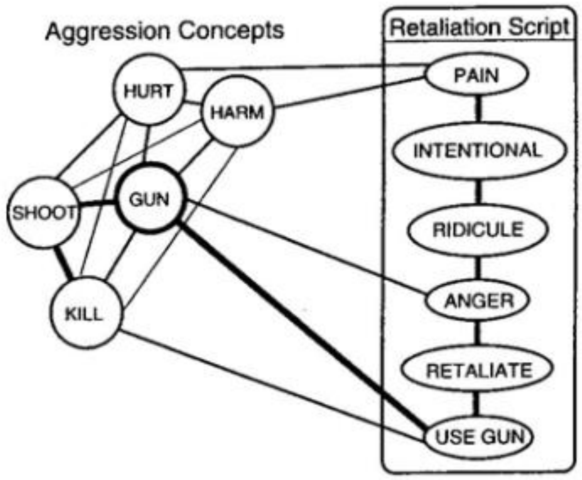

Figure 1-1: The activation of the concept ‘gun’ spreading to a retaliation script, taken from (Anderson and Carnagey, 2004)

However, this is far from the only consequence of priming in VVGs which the GAM suggests. This effect is also thought to indicate that players of VVGs will become more violent in the long term. The reason for this long term change in behaviour is the idea of ‘reinforcement’. Reinforcement refers to the idea that repeatedly priming a concept or knowledge structure causes that same concept or knowledge structure to become easier to prime again over long periods of time (Anderson et al., 2010). According to the GAM, since playing VVGs causes aggression-related concepts and knowledge structures to be primed, *repeatedly* playing VVGs causes these aggression-related concepts and knowledge structures to be reinforced. This process of priming and reinforcement purportedly leads to players of VVGs being chronically more likely to use scripts like the one shown above in Figure 1-1.

According to the GAM the relationship between playing VVGs and behaving aggressively is therefore predicated on the existence of a long a chain of causal links. Players of VVGs are exposed to depictions of aggression. This causes the priming of aggression-related concepts. The repeated priming of these concepts causes aggressive behaviour in the long term. However, it is not clear whether priming actually *happens* in video games. Numerous studies have seemingly provided conclusive evidence that playing VVGs leads to the priming of aggression-related concepts. However, recent research has challenged both the validity of these experiments and the generalizability of the priming effects which they demonstrate. The key reason why these effects have been called into question is to do with experimental control. As Adachi and Willoughby (Adachi and Willoughby, 2011) note, many experimental studies in the VVG literature use an approach in which different games are used as different experimental conditions. For instance, in (Barlett and Rodeheffer, 2009), the effects of violent and non-violent video games are compared by having participants play either *Conflict Desert Storm* (violent) or *Hard Hitter Tennis* (non-violent). Although these games differ greatly in terms of the violent content which they contain, they also differ in other ways. For instance, *Conflict Desert Storm* may be faster paced or more difficult than *Hard Hitter Tennis*. As a consequence, it is unclear whether the results of experiments like the ones outlined above are due to the violent content of the VVGs under test, or whether they might be the product of a third factor such as the difficulty of one of these games. This makes it unclear whether the seemingly definitive priming effects in the VVG literature really are due to in-game violence, or whether they may simply be caused by a lack of experimental control.

Furthermore, recent scholarship in the field of game studies suggests a rationale for why priming may not happen when people play VVGs. This literature suggests that players of games do not process in-game concepts, but rather *ignore* them. As Juul notes in *Half-Real* (Juul, 2011), video games are not just depictions of imaginary events, but also systems in which players engage in competition. Theorists suggest that, in contrast to the viewers of more passive media, "it is common for gamers to lose all interest in the fiction … and to switch their focus onto the rules” (Kirkpatrick, 2011). In other words, whilst the viewer of *Platoon* or *Saving Private Ryan* is necessarily processing aggression-related concepts (e.g. guns, killing, shooting), the player of *Battlefield 1* or *Call of Duty* may be ignoring these concepts in order to focus on winning the game.

This idea that players ignore the concepts depicted in VVGs has important consequences for the effects of VVGs that the GAM predicts. This is because of an effect called *negative priming*. As outlined above, when an individual processes a concept, a priming effect occurs in which that individual’s reactions to related concepts are made easier (facilitated). Conversely, when an individual ignores a concept, an opposite effect occurs in which that individual’s reactions to related concepts are made more difficult (inhibited). This inhibition after ignoring is referred to as “negative priming” (Tipper, 2001). The perspective outlined above implies that negative priming, rather than priming, might happen in video games. If this is the case then playing VVGs would not prime aggression-related concepts. If aggression-related concepts are not primed then, under the GAM at least, long term changes in violent behaviour should not occur for players of VVGs.

Whether or not this priming effect really exists is key to understanding how VVGs might affect their players. If it turns out that priming does not happen in VVGs, then the causal chain proposed by the GAM becomes suspect. After all, if the aggression-related content of VVGs does not prime aggression-related concepts, then the GAM's predictions that priming in VVGs leads to societal harm become difficult to support. Similarly, if it turns out that negative priming rather than priming happens in VVGs, then the mechanisms which the GAM proposes become even harder to support.

1.2 Research Questions

As outlined above, priming is of central importance to the GAM. However, a lack of control in much of the VVG literature makes the nature of this effect unclear. It may be the case that exposure to aggression-related content in VVGs leads to the priming of aggression-related concepts. It may alternatively be the case that the repeated observation of priming in the VVG literature is a false positive caused by systematic confounding. Complicating this picture further is evidence from the game studies community. This literature suggests that playing video games might lead to negative priming rather than priming. This thesis therefore helps to answer the following research questions:

- Does priming happen in VVGs?
- Does negative priming happen in VVGs?
- Does negative priming happen even if VVGs are played for only short periods of time?
- How do the features of VVGs influence priming?
    - Does the level of realism (graphical or behaviour) make a difference to whether these priming effects occur?
    - Does the narrative context of play make a difference to whether priming effects occur?

1.3 Methodology

There are three key points to be made about the experimental methodology which I used to answer these research questions. The first of these points is that throughout all of the experiments presented in this thesis I used specific and bespoke games as stimulus materials. As noted earlier, much of the VVG literature may be confounded due to a lack of experimental control. This lack of control is caused by the use of different video games as different experimental conditions. In order to avoid this issue, in each experiment within this thesis I custom-built a bespoke video game myself. I then manipulated these games so that only the specific feature which was of relevance to the hypothesis of an experiment would vary between that experiment's conditions.

A second important methodological consideration which I made was the use of online experimentation. In the majority of experiments presented in this thesis, I placed the bespoke games which I had made online and had gamers take part in my experiments over the internet, rather than in the laboratory. This way of running experiments enabled the use of large and representative samples of gamers. Overall, 3948 participants took part in the online experiments described in this thesis, of which 2835 played video games at least once a week. These sample sizes not only allowed the detection of very small effect sizes, but their representative nature also suggest that the results of this thesis apply to real players of VVGs.

However, there is a final important point to make about the methodology used in these experiments. This point relates to the use of VVGs as stimulus materials. Three experiments in this thesis investigated whether the aggression-related content of VVGs caused the priming of aggression-related concepts. However, none of these experiments used VVGs as stimulus materials. They instead used video games which featured a variety of *other* concepts, and tested whether playing these games primed *these* concepts. The results of these experiments were then generalised to the priming (and negative priming) of aggression-related concepts by the aggression-related content of VVGs. I used this approach in order to guard against false negatives in my results in as stringent a way as possible. Under the GAM, the priming of aggression-related concepts is influenced by a player's affect and arousal. Crucially, when it comes to VVGs, these factors are likely to vary between players as well as between conditions. For instance, one player may find a game of *Tetris* frustrating, whilst another may not. These between-participants differences should increase variance within experimental conditions when it comes to the priming of aggression-related concepts. They therefore seem likely to lead to small effect sizes when it comes to measuring this priming.

In order to avoid situations in which I failed to observe a real effect due to these small effect sizes, I therefore did not use VVGs to test for the presence of priming or negative priming. Instead, I tried to use games which featured concepts that seemed less likely to lead to substantial differences in affect and arousal than the presence of violence. The selection of these specific concepts (such as animals and vehicles) was further motivated by the need to ensure that the theme of each experimental condition's game fits that game's mechanics. Furthermore, in later studies in the thesis in which I *did* use VVGs as stimulus materials, I always made sure to use very large sample sizes which, as noted above, allow the detection of effects with very small sizes.

1.4 Outline of the Research

In order to answer the research questions outline above, I conducted a series of six experiments. In the first set of these experiments (Experiments 1-3), I investigated whether priming still happened in video games when known methodological confounds were removed from experiments, or whether negative priming might instead happen in these cases. In the second set of these experiments (Experiments 4-6), I conducted further studies to look into whether the results of Experiments 1-3 generalised to more realistic VVGs.

In Experiment 1 I created a bespoke run and gun game. This game was reskinned so that it formed two different conditions. In one condition, the player took on the role of a soldier who sprayed a steady stream of bullets at oncoming enemies. In the other condition, the player took on the role of a baker who sprayed a steady stream of icing at oncoming cupcakes. Participants were tested after play for the priming (or negative priming) of both cake-related and soldier-related concepts. The results of this experiment were inconclusive. They suggested that neither priming nor negative priming had occurred. However, it was unclear whether this null result reflected a genuine lack of priming, or whether it might be the product of interference from the genre of game which was used, which was a run and gun game. After all, in this experiment I was looking for the priming of soldier-related concepts – however, it seemed as though these concepts might be primed by both conditions of the run and *gun* game, regardless of their 'skin'.

I therefore conducted a second experiment in order to clarify what might be responsible for the null result described above. In Experiment 2, two versions of a bespoke maze game were made. This game was again reskinned so that it formed two different conditions. In one condition, the game was vehicle-themed. Players took on the role of a car looking for a garage whilst avoiding trucks. In the other condition, the game was instead animal-themed. Players took on the role of a mouse looking for their mouse hole whilst avoiding cats.

Results not only indicated an absence of priming, but also showed a clear negative priming effect.

I conducted a final experiment to discover if the negative priming effect seen in Experiment 2 happens even if people only play a game for a short period of time. In Experiment 3, a bespoke game was again custom made. In this case, the game was a vehicle-themed infinite runner game. However, due to the small effect sizes observed in previous experiments I decided to run this experiment online in order to obtain a large sample size (n=460). Results indicated that negative priming occurs even if participants play a game for only 20 seconds. However, no priming (or negative priming) effect was seen for participants who played the game for 120 seconds. This suggests that whilst negative priming may occur in VVGs, it is both a small and delicate effect.

These results strongly suggested that priming does not happen in video games when confounding factors are properly accounted for. However, the games used in the experiments described above all had a relatively low degree of realism. Realism appears frequently in the VVG literature as a feature of modern games which might lead to significantly higher levels of priming. It therefore seemed incautious to generalise the results of these experiments to VVGs as a whole without first understanding what the effects of realism on priming were. Experiments 4-6 therefore investigated the influence of realism on priming.

Realism is as a game's ability "to mimic things that exist, or events that have happened in real life" (Malliet, 2006). For example, graphical realism refers to the ability of video games to visually resemble real people, places and things. High levels of graphical realism can be achieved in a video game via a variety of techniques. For instance, 3D models which are built from large numbers of polygons are thought to present "more realistic or organic" (Tavinor, 2009) forms than their 'low-poly' cousins. However, graphical realism is not the only form of video game realism. Behavioural realism is a term which refers to the ability of the things in a video game to *behave like* things in the real world. Again, this can be achieved via a variety of techniques. For instance, the use of 'ragdoll physics' in a game can make in-game entities appear to realistically move according to physical laws (Schell, 2014). Contrastingly, the implementation of sophisticated AI techniques can allow characters in a video game to behave in a similar way to their real-world counterparts (Adams and Rollings, 2007).

In Experiment 4, a bespoke violent driving game was made. This game was manipulated so that it featured two different levels of graphical realism. In one version of the game, the graphics were detailed and lifelike. In the other, they were simple and block-like. The results of a large online experiment (n=710) indicated that greater graphical realism led to *less* priming of aggression-related concepts, rather than more. This result showed that this form of realism would not disrupt the existence of the effects seen in Experiment 1-3 in more graphically realistic VVGs.

Experiment 5 investigated whether a different type of realism might increase priming in VVGs. A bespoke first-person shooter (FPS) game was made, and then manipulated so that it formed two different experimental conditions. In one of these conditions, a physics engine gave enemies physically realistic deaths. In the other condition, these deaths were instead animated via pre-recorded animation sequences. The results of a large online experiment (n=898) indicated that this kind of realism did not increase the priming of aggression-related concepts in VVGs.

Experiment 6 was a final online experiment which investigated the effects of behavioural realism on priming in VVGs. In this game, two versions of a bespoke FPS game were again created. In one condition non-player character (NPC) enemies used realistic squad-based tactics, whilst in the other condition they used less realistic, simpler behaviours. Results of a large online experiment (n=1880) indicated that more realistic NPC tactics may lead to marginally *less* priming of aggression-related concepts in VVGs, but they certainly do not lead to *more*.

1.5 Scope

There are two key points to make about the scope of this thesis. The first, and most important, is that it does not investigate whether playing a VVG leads to aggressive behaviour in general. It instead investigates whether playing a VVG leads to aggressive behaviour *according to the mechanisms proposed by the GAM*. Whilst it may seem subtle, this distinction is crucial. The research outlined in this thesis suggests that priming does not occur in VVGs. This evidence effectively dismantles many of the mechanisms which the GAM proposes lead to aggressive behaviour amongst VVG players. In other words, these results cast doubt on the possibility that playing VVGs leads to aggressive behaviour via the mechanisms that the GAM proposes. However, they do not necessarily cast doubt on the possibility that playing VVGs leads to aggressive behaviour *via some other mechanism*. This possibility lies outside the scope of the thesis, and is only treated incidentally here.

The second key point to be made regarding scope is that this research deals with whether playing video games leads to priming. It does not answer, or attempt to answer, any questions about the effects of priming itself. Some scholars assert that an effect can happen in which the priming of aggression-related concepts *directly leads to aggressive behaviour*. However, this link between effects recorded on pen-and-paper measures and actual violent acts is not without controversy. Whether the priming of aggression-related concepts leads to actual aggression or does not is not germane to this thesis. Again, priming's relevance here lies not in its social importance in general, but its social importance *as part of the mechanisms proposed by the GAM*.

1.6 Contributions

Experiments 1-3 focused on the first and second of the research questions outlined earlier in this introduction: Determining whether priming happens in VVGs when methodological problems common in the VVG literature are absent, and investigating whether negative priming might happen instead. In contrast to the majority of the VVG literature, these studies employed tight experimental controls which ensured that only the concepts depicted within a game varied between experimental conditions. These experiments showed that it is extremely unlikely that the aggression-related content of VVGs causes the priming of aggression-related concepts. This result suggests that a lack of experimental control in the VVG literature may be responsible for the widespread reporting of the priming effects of VVGs. In addition to this, they also suggested that negative priming occurs in VVGs. However, the results of these experiments indicated that the effect size associated with negative priming in VVGs was likely to be very small, and suggested that negative priming was a delicate effect which was sensitive to even small changes in experimental design.

Experiments 4-6 focused on the third of the research questions outlined above: Investigating whether the lack of priming seen in previous experiments generalised to the more realistic VVGs which are currently on the market. These experiments suggested that greater realism in VVGs should not lead to greater amounts of priming. Instead they suggest that, if anything, the increased realism of modern VVGs may lead to *less* priming.

The implications of these contributions are severe for proponents of the GAM. The GAM proposes a series of conceptual links which form a chain of cause-and-effect between playing a VVG, being primed by the aggression depicted within this game, and committing acts of violence. These results suggest that this priming does not occur in VVGs, and that this lack of an effect generalises to even the more realistic VVGs currently on the market. Since priming does not occur in VVGs, the causal chain outlined above is broken.

The experiments presented here look at priming, and not aggressive behaviour. Their results therefore cannot directly suggest whether or not playing VVGs leads to aggressive behaviour. However, these results do strongly suggest that VVGs do not lead to priming, and hence do not lead to aggressive behaviour *in the way that the GAM predicts*. Further work is therefore needed to determine alternative mechanisms which might explain both how (and if) playing violent video games leads to proposed antisocial effects in the literature.

2 Literature Review

2.1 Introduction

This is a thesis about priming and negative priming in violent video games (VVGs). This literature review therefore begins by providing a general overview of priming and negative priming in the context of cognitive psychology. It describes both what these effects are, and how they can be measured. The review then moves on to describe how priming is theoretically seen to fit into the effects of VVGs. In order to do this, it focuses on the GAM, or General Aggression Model. This model proposes both that playing violent games leads to violent behaviour, and that the priming of aggression-related concepts plays a large role in causing this behaviour. Finally, the literature review concludes by describing how the features of VVGs are thought to influence the priming effects of VVGs. This section places a particular emphasis on the proposed effects of VVG realism on their players, and the different techniques which can be used to make a VVG more realistic.

2.2 Priming

Priming is of central importance to this thesis. In its most general sense, this flexible term is used to refer to any situation in which exposure to some stimulus influences a person's response to a subsequent stimulus (Sternberg, 2005). There are a variety of different scenarios which might fit this description, and there are consequently a variety of different kinds of priming which are described in the literature.

For instance, repetition priming refers to situations in which being exposed to a specific stimulus causes subsequent reactions to that *same* specific stimulus to become easier (Eysenck and Keane, 2013). For instance, categorising a specific image of a basketball might lead to individuals being faster at subsequently categorising that same image if its presentation were repeated.

Similarly, perceptual priming refers to a situation in which being exposed to a stimulus changes a person's reactions to subsequent stimuli with similar "visual, auditory, or tactile form"(Craighead and Nemeroff, 2002). For example, categorising an image of a basketball might lead an individual to later be faster at categorising an image of the earth, or of an eye. Whilst these things may have little in common conceptually, they are perceptually related as they are similar in visual form.

2.3 Priming Concepts

However, as described in Section 1.1, the GAM is not built on mechanisms of perceptual or repetition priming. It is instead centred on the idea that exposure to violent behaviour leads to the priming of violent *concepts*. In the context of violent video games, the GAM therefore predicts that playing a game which features aggression-related concepts leads to the priming of these *concepts*. This kind of priming, in which being exposed to a specific stimulus leads to changes in a person's reactions to things which are *conceptually* related to that stimulus, is known as conceptual priming (Eysenck and Keane, 2013), or the priming of a specific concept (Sternberg, 2005).

2.3.1 Stimuli which cause concepts to be primed

Stimuli which lead to the priming of specific concepts are diverse. For instance, in (Rustad et al., 2003), researchers investigated whether listening to music whose lyrics mention suicide leads to the priming of suicide-related concepts. In this study, participants either watched a "rock video" whose music contained lyrics which were related to suicide, or watched a similar video whose music did not contain suicide-related lyrics. After watching this video, the priming of suicide-related concepts were tested. Results indicated that listening to music with suicide-related lyrics primed suicide-related concepts. Similarly, in (Krank et al., 2005), researchers wanted to find out whether being exposed to alcohol-related contexts led to the priming of alcohol-related concepts. In order to investigate this question, they had participants complete tasks in one of two settings: a traditional laboratory, or a more unusual "bar laboratory". Results indicated that alcohol-related contexts cause the priming of alcohol-related concepts.

It is worth noting that one specific concept whose priming has been well-explored in the literature is aggression. For instance, (Anderson et al., 1996) investigates whether merely seeing an image of a weapon leads to the priming of aggression-related concepts. In this experiment, one group of participants are exposed to a series of "magazine photographs" of either guns or natural scenes. The priming of aggression-related concepts was then tested, with results indicating that 'mere exposure' to weapons causes the priming of aggression-related concepts. Similarly, (Bushman, 1998) looks into whether the aggression-related content of film leads to the priming of aggression-related concepts. In this publication, participants are either exposed to a violent film (*Karate Kid III*) or a non-violent film (*Gorillas in the Mist*). The priming of aggression-related concepts was then tested, with results indicating that the aggressive content of film leads to the priming of aggression-related concepts. A final example of the priming of aggression-related concepts is, of course, that the GAM asserts that playing VVGs causes this kind of priming. This topic will be covered in much greater depth later in this literature review, in Section 2.6.1.

2.3.2 The effects of priming a concept

Priming is the effect of some stimulus on subsequent behaviour. Not only are the stimuli which cause concepts to be primed varied, but the changes in behaviour which constitute priming effects themselves are also diverse. If a concept has been primed, people's reactions in relation to that concept are made easier in several ways. This facilitatory effect can be observed on a number of different tasks which can are commonly conducted in a laboratory setting. Whilst the specific tasks which are used in this thesis are expanded upon at greater length in Section 2.4, a brief overview of the variety of tasks which are used to measure priming is presented below.

Several tasks which are used to measure priming involve having participants categorise or otherwise make decisions about a series of words. For instance, in (Landau et al., 2004), researchers wanted to find out whether being exposed to things which were related to the 9/11 terror attacks led to the priming of mortality-related concepts. In order to measure this priming, they presented participants with a series of words which had letters missing, and asked them to complete these word fragments. The number of fragments which participants completed with mortality-related concepts was taken to indicate the priming of the concept of mortality.

In the same vein, in (Davies et al., 2002), researchers were interested in finding out about whether exposing people to the kind of women seen in television adverts primed concepts related to female stereotypes. In order to investigate this, they had some participants view an advert which featured a female stereotype, and other participants view an advert which did not. After this, priming of stereotype-related concepts was measured by showing participants a series of letter strings, and asking these participants to categorise these strings as quickly and accurately as possible. The rapidity with which participants categorised words which were conceptually related to female stereotypes was taken as an indication of priming. Results indicated that exposure to television adverts did, indeed, prime female stereotypes. The tasks outlined above, and how they may be used to measure priming, are covered in greater depth below in Section 2.4.

Social Priming

The priming which is dealt with in this thesis happens when exposure to a specific concept causes changes in a person's behaviour. These changes are expressed as differences in completing laboratory-based tasks on stimuli such as pictures and words. However, in addition to these changes, more serious effects on behaviour are sometimes predicted as a consequence of priming a concept. For instance, Harris et al. (2009) found that priming children by exposing them to food adverts on TV led to them consuming more snack foods after exposure. Similarly, Bargh et al. (1996) found that priming people's rudeness-related concepts by having them unscramble rude sentences led them to behave more rudely to a confederate. This idea that priming effects can be seen in socially meaningful changes to behaviour is called 'social priming', and is often seen as controversial (e.g. (Molden, 2014)). Not only have there been high-profile cases of fraud in social priming research (Bhattacharjee, 2013), but several experiments have recently failed to replicate the results of important studies of social priming (e.g. (Harris et al., 2013; Pashler et al., 2012).

To some extent the debate over social priming is of little relevance in the context of this thesis. After all, I do not measure this kind of priming in any experiment. As noted above, and described in greater detail in Section 2.4, the priming effects which I deal with in this thesis are not measured by looking for meaningful changes in social behaviour, but instead are measured via techniques such as the Lexical Decision Task and the word fragment completion task.

However, it is important to note that there is one kind of social behaviour whose priming is of incidental relevance to this thesis. Researchers like Todorov and Bargh (2002) argue the priming of aggressive concepts leads directly to people behaving aggressively. This idea forms part of the GAM. This model of VVG effects argues that the priming of aggression-related concepts by VVGs not only causes changes in tasks like categorisation and fragment completion, but also causes people to commit acts of aggression (See Section 2.5.1). The experiments contained within this thesis do not deal directly with this kind of social priming. However, they do investigate whether playing video games causes priming *in general*. Therefore, whilst the results of this thesis may cast light on whether this kind of social priming happens *as a consequence of playing VVGs*, it is important to note that whether the priming of aggressive behaviours can (or cannot) occur in general is not investigated here.

2.3.3 Associative Networks

The most common explanation of why these priming effects occur is based on the idea of spreading activation in an associative network. In an associative network, the mind is modelled as a set of discrete nodes which each contain a distinct concept and are joined together by associations (e.g. (Collins and Loftus, 1975)). Whenever an individual "sees, hears, or thinks about a concept" (Eysenck and Keane, 2013), the corresponding node in the associative network becomes activated. Additionally, the activation of a specific node "spills over"(Geeraerts and Cuyckens, 2010) and spreads out to activate associated nodes. For instance, in the network depicted below as Figure 2-1, seeing an American flag might activate 'America', whose activation might then spread to 'Patriotism' or 'Fourth of July'.

The way that this model explains the existence of priming effects is straightforward. Activating a node is thought to temporarily make that same node easier to activate again. This essentially leaves that concept "ready to be engaged in subsequent processing" (Carlston, 2013). This readiness (or 'accessibility') of a concept explains priming effects, in which processing a concept leads to that same concept being more likely to be used in future processing. It is important to note that the general idea of spreading activation in an associative network is used within the GAM.

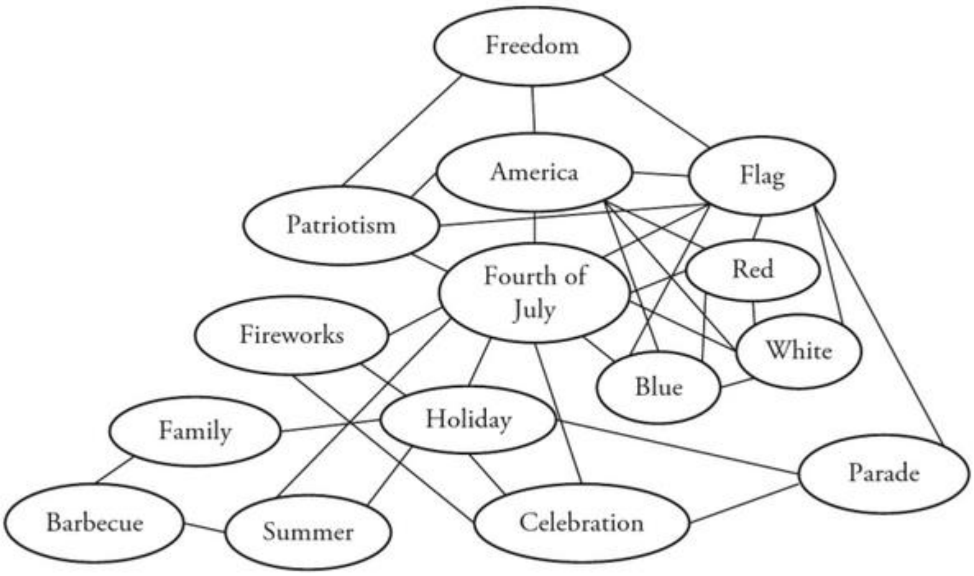

Figure 2-1: An associative network, taken from (Carlston, 2013)

2.3.4 Negative Priming

As Versace and Allain (2001) point out, "The priming paradigm is not always characterized by facilitating phenomena; in many experiments, it has also revealed inhibitory effects".

When concepts are processed by an individual, priming effects occur in which reactions to related concepts are made easier (facilitated). Conversely, when an individual *ignores* a concept, a mirror-image effect occurs in which that individual's reactions to related concepts are made more difficult (inhibited). This inhibition after ignoring is referred to as "negative priming" (Tipper, 2001).

Negative priming effects have repeatedly been demonstrated in the cognitive psychology literature. For instance, Tipper (1985) showed participants a series of images of two different concepts which were superimposed on each other. Participants were asked to name only one image, whilst ignoring the other. Those who had previously ignored a concept (e.g. 'cat') were slower at subsequently naming a related concept (e.g. 'dog'). Similarly, in (Chiappe and MacLeod, 1995), researchers demonstrated that ignoring the presentation of a word (e.g. 'banjo') made categorization decisions on a related word (e.g. 'fiddle') slower.

As outlined above, negative priming is observed when people ignore specific information. This has led to this effect's utilisation in experiments that investigate the circumstances which cause people to ignore specific pieces of information. For instance, Goeleven et al. (2006) tested for a negative priming effect in order to find out whether individuals with depression were less able to ignore sadness-related information than individuals without depression. They found that this was, indeed, the case.

2.4 Measuring Priming

Several tasks have been created which exploit the presence of priming effects in order to measure the activation of concepts. In this section, I will describe three of the most commonly-used of these tasks: The Lexical Decision Task, the image categorisation task, and the word fragment completion task.

2.4.1 The Lexical Decision Task

Lexical Decision Tasks (LDTs) are commonly used to detect priming effects in both the cognitive psychology literature and the social psychology literature. However, more importantly, LDTs are also commonly used to measure the activation of concepts after people have played a variety of video games. For instance, Bösche (2010) looked for a priming effect on the LDT to measure the increased activation of "aggressive and positive cognitions" after playing both violent and non-violent video games. Greitemeyer and Osswald (2011) similarly used an LDT to find out whether playing prosocial games led to the activation of prosocial concepts. In the same vein, Yao et al. (2009) used an LDT to investigate whether playing games which feature sexual content such as *Leisure Suit Larry* leads to the activation of sex-related concepts.

In an LDT, participants are presented with a series of letter strings on a computer monitor. These strings can either be words (e.g. 'soldier') or non-words (e.g. 'slodier'). Non-words may either be random letter strings (e.g. (Smeesters et al., 2006)), or anagrams formed by partially scrambling words used elsewhere in the LDT (e.g. (Pichon et al., 2007)). Participants are told that they must categorise each string as either a word or a non-word as quickly as possible by pressing a button. The theory goes that if a concept is primed, then reactions to strings which are related to that concept will be speeded up. Therefore, the priming of a concept can be measured by seeing how quickly participants make decisions about strings which are related to that concept (Koriat, 1981).

2.4.1.1 Scoring a Lexical Decision Task

Measuring the priming of a specific concept on an LDT is fairly simple. Some of the words in an LDT are typically related to the concept whose priming researchers are interested in measuring (the 'target' concept), whilst other words are not. For instance, in (Bushman, 1998), researchers were interested in whether violent videos primed aggression-related concepts. Their LDT therefore contained words which were related to the target concept of aggression (e.g. 'punch') and words which were not related to it (e.g. 'snail'). Typically, priming effects are measured by testing for differences between a participant's reaction to target-related and target-unrelated words. In this analysis, experimental manipulations are treated as between-participants factors whilst a participant's reaction times to either target-related or target-unrelated words are treated as two levels of a within-participants factor. Priming is tested for by looking for a significant interaction between these factors (e.g. (Holland et al., 2005; Kunda et al., 2002; Pichon et al., 2007)). Researchers do not generally explain *why* statistics are conducted like this. However, there seems to be a good reason for why this approach might be effective. A participant's reaction time to target-related words may be influenced by both the priming of a specific concept, and also that participant's reaction time to words *in general*. These individual differences between participants introduce variance into the univariate analysis of reaction times to target-related words. For instance, consider the case of a participant who was heavily primed by a target concept but slow at reacting to strings in general. This participant might have a similar overall reaction time to target-related words as a participant who was *not* primed by any concept but very fast at reacting to strings in general. Looking at the difference between a participant's reaction time to target-related and neutral words removes variance caused by these individual differences from analysis, and reduces the risk of Type II error. For example, in the Bushman study, the priming effects of violent videos were tested via a 2 x 2 x 2 ANOVA, with videotape type (violent or non-violent) and sex (male, female) as between-participants factors and word type (aggression-related, aggression-unrelated) as a within-participants factor. A significant interaction between videotape type and word type was observed, indicating that violent videos primed access to aggression-related concepts. Similarly, in (Holland et al., 2005), researchers wanted to find out whether the smell of citrus in a room would prime cleaning-related concepts. They therefore used an LDT which contained both cleaning-related and cleaning unrelated words. Priming effects were tested via a 2 x 2 ANOVA, with the presence of citrus scent (present, absent) as a between-participants factor and word type (cleaning-related, cleaning-unrelated) as a within-participants factor. A significant interaction between these factors was observed, indicating that the smell of citrus primes cleaning-related concepts.

A similar, though less common, way of analysing LDT data whilst controlling for individual differences is entering a participant's reactions to target-unrelated words as a covariate in an ANCOVA, as in (Davies et al., 2002). However, it is important to note that the rationale for using this specific statistical test is not well-justified in the literature, and appears in only a small fraction of the studies in existence.

2.4.1.2 Scoring a Lexical Decision Task with Multiple Targets

It is more infrequently the case that researchers are not just interested in the priming of one concept, but rather are interested in comparing the priming of two concepts. For instance, in (Smeesters et al., 2006), researchers were interested in whether showing people both 'heavy' and 'thin' models would prime heavy and thin-related concepts. Similarly, in (Glock and Kneer, 2009), researchers wanted to find out whether reading reports on the effects of VVGs before playing one influenced both aggressive and "antiaggressive" (Glock and Kneer, 2009) concepts.

In cases like these, LDTs are constructed which contain separate sets of words for each of the target concepts. For instance, the (Glock and Kneer, 2009) example described above contained both aggression-related words (e.g. 'bloody') and antiaggressive words (e.g. 'peaceful'). In order to analyse this data, both sets of words are again entered into a repeated measures analysis and are used to control each other.

2.4.1.3 Scoring Non-words

The stimuli used in LDTs consist of both words and non-words. Whilst some words in an LDT are always related to a target concept, sometimes non-words are formed by transposing letters within a target-related word (e.g. 'slodier') and are themselves therefore related to a target concept. Target-related non-words are thought to be primed in LDTs in a similar manner to words (e.g. (Perea and Lupker, 2003; White, 1986)), and sometimes non-words are included in statistical analysis of priming via a separate repeated measures analysis (e.g. (Yao et al., 2009)). However, it should be noted that hypotheses about priming, as a general rule, relate to the priming of words, and not non-words.

2.4.1.4 Building a Lexical Decision Task

Lexical Decision Tasks have been used for almost half a century (e.g. (Meyer and Schvaneveldt, 1971)). However, despite this longevity, there is no widely-accepted methodology for constructing the list of strings which an LDT uses as stimuli. This is in stark contrast to the well-developed methodologies for constructing other measurement procedures, such as questionnaires (e.g. (DeVellis, 2016; Kline, 2015)). However, despite this lack of an overarching methodology, there are several *methods* which researchers have used to build LDTs for their studies. These are detailed below.

One way to generate strings for an LDT is for researchers to come up with these strings themselves. For instance Anderson et al. (1996) investigated whether exposing people to images of guns led to the priming of aggression-related concepts. The researchers themselves compiled the word list for this study by taking a mixture of words from a thesaurus and from previous studies. Similarly, several studies do not contain any explanation of where the word lists for their LDTs have come from (e.g. (Barlett et al., 2006; Bartholow and Heinz, 2006)). It seems likely in these cases that word lists have again been generated by the researchers themselves.

It is important to point out that, whilst expedient, this approach may lead to experimental results which are hard to interpret. For instance, Ramasubramanian (Ramasubramanian, 2007) wanted to find out whether media literacy influenced the priming of racial stereotypes. This priming was measured on an LDT which contained words which were theoretically related to stereotypes (e.g. 'traditional', 'uneducated'). The researchers did not describe how these words were selected for use. Results of the study seemed to show that training people in media literacy decreased the priming of stereotypical concepts. However, since the criteria used to select these words is unclear, it is also unclear whether they really *are* related to stereotypes. For instance, experimenters may well associate the word 'traditional' with racial stereotypes, but there is no evidence that this association generalises beyond the experimenters themselves. It is therefore difficult to say what the priming of these words actually means.

A more rigorous way to construct an LDT is therefore to have a separate group of people generate these stimuli, rather than the experimenters themselves. For instance, in (Davies et al., 2002) researchers were interested in developing an LDT which could measure the priming of concepts related to female stereotypes. In order to generate their word list, they instructed a large group of undergraduates to "generate a list of adjectives to characterize the female stereotype" (Davies et al., 2002). Similarly, in (Baldwin et al., 1993), researchers were interested in how different sentences primed concepts which were related to specific attachment styles. In order to generate a list of words which were related to specific attachment styles, they asked participants to complete a series of sentences such as "if I depend on my partner, she might ______"(Baldwin et al., 1993).

An alternative approach to this problem is for the experimenters themselves to generate a large word-list, and then have a panel of judges rate the relevance of each of these potential LDT stimuli. For instance, Glock and Kneer (2009) wanted to generate a list of aggression-related words. They therefore ran a pre-study in which they had "participants rate a total number of 90 adjectives on a 7-point Likert scale with respect to their aggressive content"(Glock and Kneer, 2009). They then used only the words which were judged as being most aggression-related in their experiment. Similarly, Pichon et al. (2007) wanted to build a list of words which were related to religiosity for use in an LDT. In order to find these stimuli, they had a set of participants rate 154 words on a 7-point Likert scale with respect to their religiosity. They then used the most religion-related words in their LDT. In the same way, in (Bösche, 2010) researchers wanted to construct an LDT for measuring the priming of both aggressive and nonaggressive concepts. In order to generate a word list for the LDT, they generated a list of words themselves and then sorted these words into aggressive and nonaggressive categories on the basis of the "ratings of independent participant" (Bösche, 2010). These studies do not usually mention where their initial pools of words come from. For instance Davies et al. (2007) had 18 participants rate 87 different words for sexual connotations and used this information to build an LDT which can detect the priming of sex-related concepts. However, the origin of the 87 words is unclear. This lack of information is common within the literature (e.g. (Glock and Kneer, 2009; Pichon et al., 2007)).

2.4.2 The Word Fragment Completion Task

Word fragment completion tasks involve participants 'filling in the gaps' in a series of words which have letters missing. These fragments can typically be turned into words which are related to several different concepts (e.g. 'K I _ _' can become either 'KISS' or 'KILL'), and the proportion of fragments which a participant turns into words that are related to a given concept is used to measure the priming of that concept. This task has been used to investigate the priming of concepts in a variety of domains. For instance, in (Chopik and Edelstein, 2014), researchers were interested in whether death-related adverts on websites primed death-related concepts. To test this priming, they had participants complete a word fragment completion with fragments which could be completed to form both death-related and death-unrelated meanings (e.g. 'C O F F _ _' can become both COFFIN and COFFEE). Similarly, (Kim et al., 2014) wanted to find out whether alcohol-related storylines in the television show *ER* caused the activation of alcohol-related concepts. They tested for this priming by using a word fragment completion task with fragments which could be completed to form alcohol-related and alcohol-unrelated meanings (e.g. 'D R _ _ _' can become both 'DRINK' and 'DRIVE'). The scoring of a word fragment completion task is relatively simple. The activation of a specific concept is generally taken to be the proportion of words which are completed with meanings which are related to the target concept (e.g. (Carnagey and Anderson, 2005; Choi et al., 2013))

Building a Word Fragment Completion Task

(Koopman et al., 2013) lays out a cohesive methodology for developing word fragment completion tasks. This process involves rigorous iterative steps of item creation, piloting, item reduction, and reliability and validity analyses. However, despite its good intentions, this methodology does not yet enjoy wide uptake. In fact, to the best of my knowledge, it has not yet been used to develop a single word fragment completion task.

Instead, as with the other tasks outlined above, the creators of word-fragment completion tasks typically work in an ad-hoc manner. In several cases, authors do not mention how their word fragments are generated (e.g. (Choi et al., 2013; Kim et al., 2014)). In other cases, researchers simply use a list of words drawn from a previous study. For instance, (Chopik and Edelstein, 2014) draw their list of death-related fragments from (Greenberg et al., 1994). However, there are dangers in this approach. (Spencer et al., 1998) uses a word fragment completion task to measure the priming of concepts which are associated with African-American stereotypes. This list contains fragments like 'H O S _ _ _ _', which can be turned into 'HOSTILE' and 'W E L _ _ _ _', which can can be completed as WELFARE (Spencer et al., 1998). However, whilst these fragments are drawn directly from a similar study, (Gilbert and Hixon, 1991), the authors of this original study do not mention how these fragments were generated. It is therefore unclear whether they reflect generally-held stereotypes.

2.4.3 The Anderson Word Fragment Completion Task

Measuring the priming of aggression-related concepts by VVGs has been a focus of much of the research which has been conducted under the aegis of the GAM. A variety of different instruments have been used for measuring this effect. For instance (Glock and Kneer, 2009) measured the priming of aggression-related concepts by seeing how quickly participants were able to categorise aggression-related words in a Lexical Decision Task.

However, by far the most common way of measuring the activation of aggression-related cognitions in the literature related to the GAM has been by using one specific word fragment completion task, known as the Anderson word fragment completion task.

Since its first published use over a decade ago (Anderson et al., 2003), the Anderson word fragment completion task has been used in a broad spread of experiments. It has been used to look at the impact of aggression-related cognitions on teen dating violence (Jouriles et al., 2013, 2011). It has been used to investigate whether exposing people to heat-related words increases their aggression-related cognitions (Nathan DeWall and Bushman, 2009). It has even been used in attempts to find out the factors that lead supervisors to become abusive (Garcia et al., 2014).

However, more specifically, this task has been used in a variety of experiments which investigate whether the predicted effects of the GAM extend to the situation of playing a VVG. Not only has the Anderson word fragment completion task been used to look at the effects of playing VVGs on the activation of aggression-related concepts in general (e.g. (Anderson et al., 2004)), but it has, more recently, been used to look at how specific features of VVGs might mediate this process. For instance, (C. P. Barlett et al., 2008) uses the Anderson word fragment completion task to look at how the amount of blood in VVGs affects the priming of aggression-related concepts.

Details of the task

This task consists of a specific set of 98 word fragments, a set of recommendations for this set's use, and a key for the scoring the completion of these fragments. The task itself, and the accompanying information, is publically available from Anderson's website (Anderson et al., n.d.) and is also included in this thesis as Appendix A.

The 98 fragments which form the task vary in length, from fragments with only three letters (e.g. 'h _ t') to those with nine (e.g. 'd i s _ _ s _ e d'). Similarly, fragments vary in the number of letters which are left blank, with some having only one letter missing (e.g. 'b _ r n') and others having several (e.g. 'b _ h _ _ _'). Whilst the majority of the fragments included in the test can be turned into several different words, of the 98 fragments only 50 can be 'completed' into words with aggression-related meanings.

There are 98 fragments in the word fragment completion task. 50 of these fragments may be completed to form aggression-related words. The scoring key which comes with the word fragment completion task defines which of the 98 these 50 are, and also defines the other possible words which each fragment can be turned into. For instance, the fragment 'a n g _ _' is keyed as having five possible completions. These consist of three neutral completions ('angel', 'angle', 'anglo') and two aggression-related completions ('anger','angry'). The recommendations for the use of the task are broad, with Anderson noting that he himself gives participants three minutes to complete as many fragments as possible, but that giving participants either more, less, or unlimited time would also be valid approaches (Anderson et al., n.d.).

2.4.4 Image Categorisation Tasks

Image categorisation tasks measures the priming of concepts by looking at how quickly individuals are able to categorise images as belonging to one category as opposed to another. In this task participants are shown a sequence of pictures and are asked to sort these pictures into different pre-specified categories as quickly as possible. This categorisation is usually done (like the LDT) by having participants press specific buttons, though sometimes participants are told to verbalise the name of the relevant category (e.g. (Tipper and Driver, 1988)). Image categorisation tasks are commonly used to investigate priming effects in the cognitive psychology literature (e.g. (Lloyd-Jones and Humphreys, 1997; Martinović et al., 2009)).

Additionally, image categorisation tasks are commonly used for measuring negative priming effects. For instance, in (Tipper and Driver, 1988), researchers wanted to find out whether ignoring a concept led to the negative priming of related concepts. They therefore repeatedly asked participants to ignore a picture of some concept (for instance, a cat), and then had them categorise a picture of something from the same category (for instance, a dog). Results indicated that ignoring a concept negatively primed categorisation decisions about things from the same category. Similarly, when (Ballesteros and Mayas, 2015) investigated the effects of ageing on negative priming, they first instructed participants to ignore a series of images, and then tested for negative priming by having them categorise the previously-ignored items as either artificial or natural. In a related vein, (Buchner et al., 2003) used an image categorisation task to investigate the negative priming effects of auditory distractors. Participants were played either animal-related or instrument-related sounds, and asked to categorise a series of pictures as either animals or instruments. Being exposed to conceptually irrelevant sounds led to the negative priming of categorisation decisions.

Just as there is not a widely-accepted way to generate the words for LDTs or the fragments for word fragment completion tasks, it seems that there is no widely-accepted methodology for generating the stimuli for use in an image categorisation task either. Some researchers employ artists to draw their images (e.g. (Sperber et al., 1979)). Others draw images themselves (e.g.(Tipper and Driver, 1988)). Still more do not mention where their images come from (e.g. (Buchner et al., 2003; Bussemakers and De Haan, 2000)). However, some image categorisation tasks use images which are drawn from banks of picture norms (e.g. (Damian, 2000)). These banks are sets of standardised images which are intended for use in "memory tasks" (Snodgrass and Vanderwart, 1980) like image categorisation. These images are consequently similar to each other along potentially confounding dimensions such as size and style, as well as being pre-sorted into specific categories, and tagged with a variety of metadata. For instance, (Snodgrass and Vanderwart, 1980) contains a set of 260 black-and-white line drawings which are sorted into 15 different categories and equalised by visual complexity, whilst (Rossion and Pourtois, 2004) contains a coloured and high-resolution bank of these 260 stimuli. Similarly, (Bonin et al., 2003) is a set of 299 images with attached metadata showing things like name agreement and conceptual familiarity in French.

2.4.5 Statistical Transformation of Reaction Time Data

Both the LDT and image categorisation tasks involve measuring the reaction times of participants to some stimulus. However, there are specific problems with the distribution of this kind of data. More specifically, "long spurious reaction times are almost certainly always present" (Ratcliff, 1993) due to momentary inattention of participants. These outliers can artificially increase the spread and skew of data, and lead to Type II errors (or 'false negatives') if they are not dealt with during statistical analysis. The two main ways that this issue can be achieved are via are either “data trimming or rescaling to remove the nuisance scores” (Heathcote et al., 1991).

The first of these techniques, trimming, involves removing slow reaction times from a dataset. What, precisely, constitutes a ‘slow’ reaction time varies from study to study, with some “excluding data longer than some absolute time, some percentage of the data, or data that are some proportion of standard deviations above the mean” (Whelan, 2008). The disadvantage of this approach to reaction time data is that “no reliable rule can be used to establish absolute cutoffs because they are highly dependent on the particular data that were observed” (Whelan, 2008). Therefore, whilst trimming may increase the power of studies which use reaction time data (Ratcliff, 1993), it can be difficult to implement correctly and should be used with “extreme caution” (Fazio, 1990).

A contrasting approach to reducing the impact of spurious slow responses in reaction time data is through using transformations on a dataset which minimize their effects (Ratcliff, 1993). The two most common transformations are log-transforming reaction times and taking their inverse (i.e. 1/RT). Both of these transformations “reduce the impact of long response times in the tails of the distributions, and therefore would reduce the impact of long outliers” (Ratcliff, 1993). Whilst an inverse transformation may lead to slightly more power than those using a log transformation (Whelan, 2008), both techniques “are commonly employed”(Fazio, 1990) in studies which use reaction time data.

2.5 The GAM in General

Some academics believe that playing VVGs leads to antisocial effects. Others do not. The most popular way for academics to justify why playing VVGs might lead to antisocial effects is currently by fitting them into a theory of aggression called the General Aggression Model (GAM). This section describes what the GAM is and the effects that it predicts. It then goes on to describe how video games fit into the GAM. Following this I highlight some of the debate over the validity of the GAM when applied to VVGs, before moving on to describe features of VVGs which are thought to influence the effects which the GAM predicts.

Academics, journalists, and policy-makers have been concerned about people imitating the damaging behaviour that they see, hear, or read about in the media for over two centuries. Authorities in the late 1700s were so worried that readers of *The Sorrows of Young Werther* would copy Goethe’s protagonist and commit suicide themselves that the book was banned in Denmark, Germany and Italy (Coleman, 2004). Sensational murders in the 1860s were thought to be the consequences of reading violent dime-fiction (Calhoun, 2007). Concerns in the 1950s about children copying comic book violence led to both a series of US Senate hearings, and the eventual self-regulation of the industry under the rigid 'Comics Code'(Stevens, 2015). In a similar vein, research as early as the 1980s has predicted potential negative effects from exposing people to the violent content of digital games like Zaxxon (Anderson and Ford, 1986) (Seen below as Figure 2-2).

Figure 2-2: Zaxxon

Thirty years on from this study there is still no consensus on whether the predicted antisocial effects of VVGs have materialised or not. Some academics argue that the negative consequences of playing VVGs are both real and important (e.g. (Anderson and Dill, 2000)), whilst others equally passionately argue that they are neither of these things (e.g. (Valadez and Ferguson, 2012)).

However, in recent years a single theoretical model has risen to prominence amongst academics who believe that playing VVGs leads to antisocial consequences. This rise has continued to the point that even its fiercest critics call it "the default model for many digital game researchers" (Elson and Ferguson, 2014). However, this model is not without controversy, with other researchers strongly disputing the validity of its claims (e.g. (Ferguson and Kilburn, 2009)). This model is the GAM, or General Aggression Model.

As its name suggests, the GAM (Anderson and Bushman, 2001) attempts to provide a general explanation of how aggression occurs in human behaviour. The GAM specifies two interlinked sets of factors which lead to aggressive behaviour. Not only are there factors which influence aggressive behaviour in the short-term within the context of a single "social episode" (Anderson and Carnagey, 2004), but there are also other factors which influence this behaviour over longer periods of time. In the following sections I will briefly describe both of these in turn.

2.5.1 Short-Term Factors in the GAM

In the short-term the GAM predicts that a person's aggressive behaviour in a social encounter is determined along three routes (See Figure 2-3 below). A particular situation may, for a particular person, lead to:

1. Changes in cognition (for instance, the activation of specific concepts in memory)
2. Changes in affect (for instance, angry feelings)
3. Changes in physiological arousal (for instance increases in heart rate).

These routes can lead in a "relatively automatic"(Anderson and Carnagey, 2004) way to impulsive acts of aggression. Alternatively, they can affect the controlled processes through which a person appraises a situation in order to lead to thoughtful and deliberate aggressive behaviour.

It is important to additionally note that the GAM specifies that these three routes to aggressive behaviour are interlinked. For example a situation which leads to changes in arousal might, through this change, indirectly lead to the increased activation of aggression-related knowledge structures and hence aggressive behaviour (Anderson and Bushman, 2002).

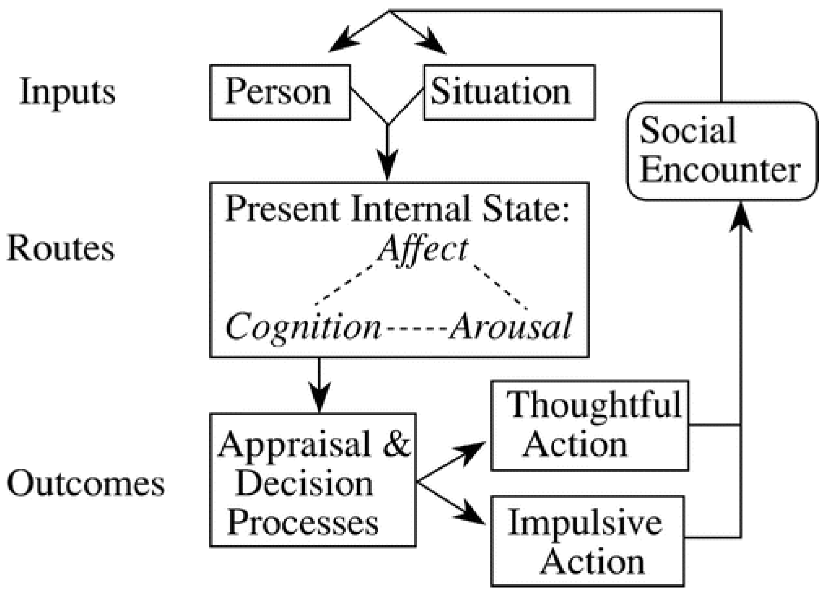

Figure 2-3: The short-term causes of aggressive behaviour in the GAM, from (Anderson and Bushman, 2002)

2.5.1.1 Cognition and the Route to Aggressive Behaviour

The ‘cognitive route’ to aggressive behaviour in the GAM operates via the priming of “aggressive cognitions”(Anderson and Bushman, 2001). The GAM draws on associative theories of the mind such as (Collins and Loftus, 1975) and posits that when a situation meets certain aggression-related criteria, concepts which are related to aggression are activated in a person’s memory (Anderson and Bushman, 2002). This activation then spreads to associated aggression-related concepts. The aspects of a situation which can lead to this activation are varied and include both the presence of a weapon and provocation (For a more exhaustive list, see (Anderson and Carnagey, 2004)).

Priming is an important mechanism within the GAM. The activation of aggression-related concepts is assumed to make those same concepts temporarily easier to activate for a short time, and therefore more likely to be used when dealing with future events. This ease of activation leads directly to aggressive behaviour in the short term by increasing the likelihood that normal behaviours are interpreted as “involving aggression, [and] thereby increasing the likelihood of an aggressive response”(Huesmann and Kirwil, 2007).

Activation of Knowledge Structures

The GAM integrates several theories of how humans store and use specific kinds of knowledge through the concept of “knowledge structures” (Anderson and Bushman, 2002). Under the GAM, a knowledge structure is any set of concepts in an associative network which have “become strongly linked together”(Buckley and Anderson, 2006) through experience (See also (Bushman and Anderson, 2001) for a similar description).

Activation of Scripts

The authors of the GAM categorise a variety of things, including beliefs, attitudes, schema, and scripts as knowledge structures (Anderson and Carnagey, 2004). Scripts provide a good example of how the activation of knowledge structures leads to aggressive behaviour under the GAM. Scripts are a well-known and widely-studied subject in cognitive psychology (e.g. (Anderson, 1990)) and may be described as sequenced "programs for behaviour" (Huesmann, 1988). When confronted with a new situation, people are thought to somehow sort through their available scripts and interpret the situation according to the most appropriate 'program for behaviour' that is found in their collection.

As they are knowledge structures, under the GAM scripts are simply treated as "sets of particularly well-rehearsed, highly associated concepts" (Carnagey and Anderson 2003) within a person's larger network of associated concepts. Because activation spreads between associated concepts in a network, the activation of aggression-related concepts can therefore lead to the activation of a script, or other knowledge structure. For example, Figure 2-4 can be used to demonstrate how, under the GAM, playing *Call of Duty* might lead to aggressive behaviour in the short term. Being exposed to the depictions of guns in this game theoretically causes the activation of the concept 'gun'. This activation might then spread to an associated script for retaliation, causing this 'program for behaviour' to be more likely to be used "both as an interpretational guide to perception … and as a behavioural guide for action"(Anderson et al., 1998), leading to aggressive behaviour on the behalf of the player. In the way outlined here, under the GAM spreading activation and "priming effects" (Bushman and Anderson, 2001) lead to aggressive behaviours through the activation of knowledge structures.

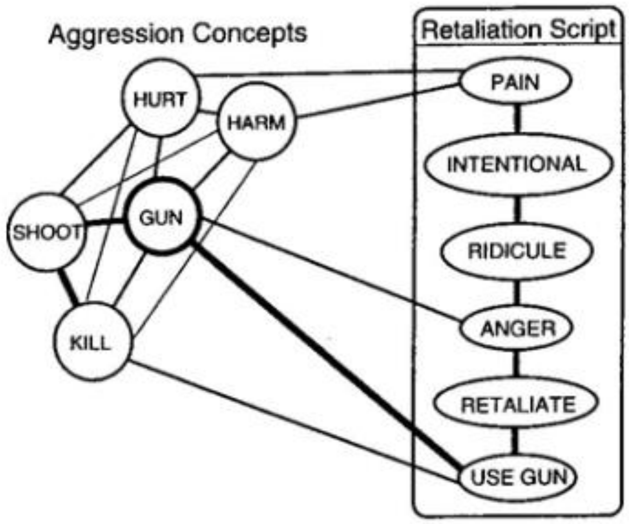

Figure 2-4: The activation of the concept 'gun' spreading to a retaliation script, taken from (Anderson and Carnagey, 2004)

2.5.1.2 Affect, Arousal, and the Route to Aggressive Behaviour

The 'cognitive route' described above is only one of three ways in which the GAM predicts aggressive behaviours. Whilst aggression may be "largely based on the activation and application of aggression-related knowledge structures stored in memory"(Bushman and Anderson, 2002), under the GAM arousal and affect can also lead to aggressive behaviour.

(Anderson and Bushman, 2002) specifies three ways in which arousal can lead to aggressive behaviour. Firstly, the more aroused an individual is, the stronger their behaviour may become, including aggressive behaviours. For instance, a highly aroused individual who was in a situation which would generally feature some form of aggressive behaviour might be expected to behave in an extraordinarily aggressive fashion. Secondly, if an individual is aroused by something which is unrelated to aggression, this arousal may be "mislabelled as anger in situations involving provocation" (Anderson and Bushman, 2002), thus leading to aggressive behaviour. Thirdly, it may be the case that having high levels of arousal is such an unpleasant state that it will lead to aggressive behaviour in the same way that other "painful stimuli"(Anderson and Bushman, 2002) do.

A key feature of the GAM's predictions about the causes of aggressive behaviour is that the three routes described above are inter-related. For instance, changes in aggressive affect may lead to the triggering of aggression-related cognitions and the activation of aggression-related scripts (Barlett and Anderson, 2013).

This model of the interactions between affect, arousal, cognition and behaviour has two major implications for the research conducted within this thesis. Firstly, it suggests that (under the GAM, at least) the priming of aggression-related concepts may be the product of playing a game *which does not depict aggression*. Indeed, it may even be the case that aggressive behaviour is the product of playing such a game. For example, consider the case of a fast-paced and difficult video game which does not contain violent content such as *Tetris*. Changes to players' heart rates and frustration from the game's mechanics might cause the priming of aggression-related concepts, despite the lack of aggression-related content within the game itself. This might, in turn, lead to aggressive behaviour on the behalf of the players. Crucially, all of this would be happening in a way which was independent of the depiction of aggression by the video game itself.

The corollary of this implication is that there will be significant quantities of noise in any measurement of the priming of aggression-related concepts in a VVG. The reason for this is differences between participants' levels of arousal and affect. To stay with the example of *Tetris*, one participant may be inexperienced at this kind of game and become angry at their inability to fit rapidly-falling blocks together successfully. Similarly, one participant may find this game particularly arousing, whilst another may not. These differences *between participants but within a single game* should lead to changes in the priming of aggression-related concepts under the GAM. Therefore, it seems likely that any measurement of the priming of aggression-related concepts by the content of VVGs is likely to contain large amounts of variance due to the influence of affect and arousal.

2.5.2 Long-Term Factors in the GAM

The GAM does not just predict that situations lead to people displaying aggressive behaviour in the short term. It also predicts that various situations may lead to longer-term, more permanent changes in aggressive behaviour.

2.5.2.1 Reinforcement of Aggression-Related Knowledge Structures

The primary way in which long-term changes in aggression-related behaviour are predicted is through the reinforcement of aggression-related knowledge structures (Anderson and Bushman, 2002). Reinforcement refers to the idea that repeatedly activating a knowledge structure will lead to that knowledge structure becoming easier to activate again, not over short periods of time, but over long periods of time. In fact, the GAM predicts that this effect will occur to the point where these knowledge structures "eventually become part of the person's personality" (Anderson et al., 2010). Knowledge structures which may become reinforced are the same ones which the GAM predicts will be activated temporarily during an aggression-related situation: namely aggressive beliefs and attitudes, perceptual and expectation schemata, and behavioural scripts (See Figure 2-5 below).

However, the authors of the GAM themselves note that “of the five types of variables identified as contributing to the long-term increase in aggressive personality, four involve aggressive cognitions” (Anderson and Bushman, 2001). In addition to the reinforcement of knowledge structures outlined above, the long-term effects of playing VVGs may also be caused by processes of ‘desensitization’.

However, how exactly this process of desensitization works seems unclear from the literature. Whilst desensitization has been mentioned by the authors of the GAM since the early 2000s (e.g. (Anderson and Bushman, 2002)), for many years it has not been specified exactly *why* desensitization might lead to an increase in aggressive personality. In more recent publications, however, the authors of the GAM have clarified this point and now describe desensitization effects as being a precursor to cognitive and affective outcomes. These outcomes include changes in knowledge structures such as increases in beliefs that violence is normative, and decreased negative attitudes toward violence (Bushman and Anderson, 2009). It therefore seems the case that ‘of the five types of variables identified as contributing to the long-term increase in aggressive personality, *five* involve aggressive cognitions’.

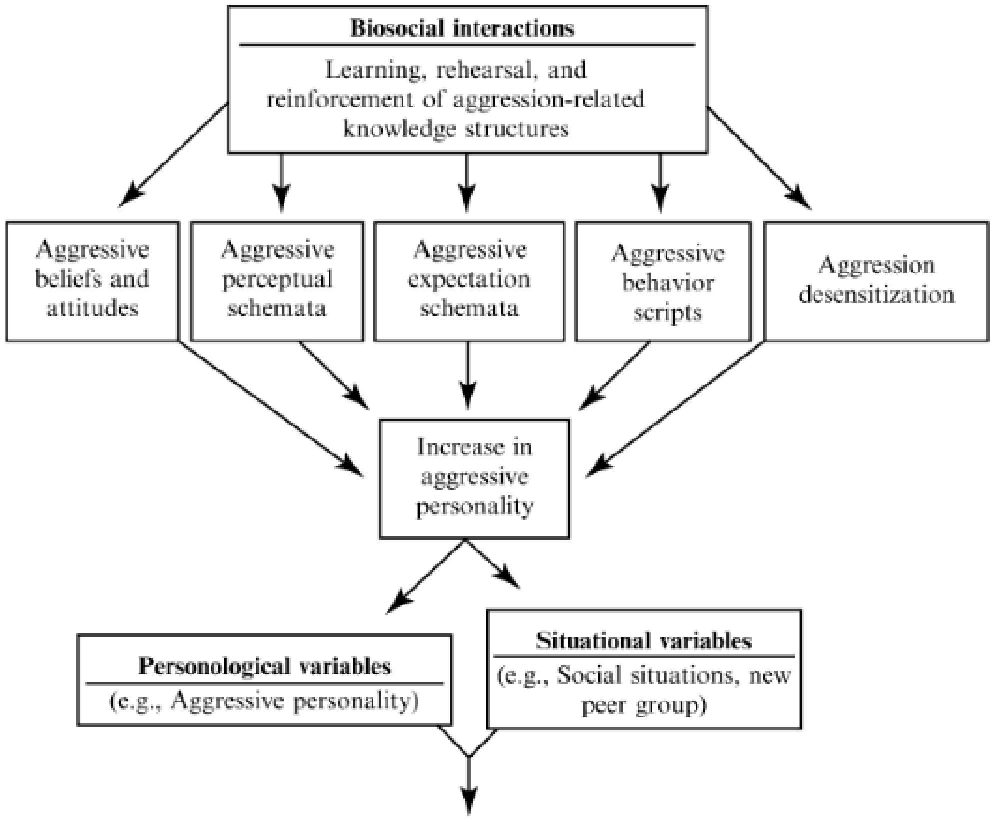

Figure 2-5: Long-term changes in aggressive behaviour under the GAM, taken from (Anderson et al., 2004)

2.5.2.2 The Secondary Importance of Affect and Arousal

In (C. Barlett et al., 2008) the author notes that, under the GAM, "aggressive cognitions are the most theoretically important route to long-term aggressive personality changes". This sentiment is certainly echoed throughout the literature. The authors of the GAM repeatedly highlight that "the temporary nature of moods and of physiological arousal leads us to expect either very weak long-term effects or none at all" (Anderson et al., 2010) from changes in these variables. By contrast, the activation of aggression-related concepts and knowledge structures are described as having comparatively much more important effects:

> "Temporary mood states and arousal dissipate over time, but the repeated rehearsal of aggressive cognitions can lead to long -term changes in multiple aspects of aggressive personality"

(Anderson, 2003)

2.6 The GAM and Violent Video Games

The extent to which playing VVGs really does lead to increased aggression is unclear. Over a decade ago the GAM's authors claimed that "a consensus is emerging that violent video games can cause increases in aggressive behavior in children and in young adults"

(Anderson et al., 2004). In the same year, other researchers echoed this feeling, writing that "there is a growing consensus within the social sciences that exposure to violent media increases aggression" (Uhlmann and Swanson, 2004). Six years later one media psychologist was bold enough to publish a paper with the title "Nailing the coffin shut on doubts that violent video games stimulate aggression" (Huesmann, 2010). However, despite this strong rhetoric, to this day both the validity of the GAM and its effects remain undecided (Ferguson, 2015). Indeed, a fierce (and often acid) debate rages over the legitimacy of almost everything to do with the GAM. Elements of the GAM which are under continual discussion are varied, and range from the prevalence of publication bias in the literature (Ferguson, 2007; Rothstein and Bushman, 2012), to the validity of the measures of aggression which are used to support the claims of the GAM (e.g. (Ferguson et al., 2008; Ferguson and Rueda, 2009)). One area of debate which is of particular relevance to this thesis is that the priming of aggressive concepts which has repeatedly been observed in the VVG literature may be the product of systematic confounding.

2.6.1 VVGs and the priming of aggression-related concepts

The activation of aggression-related concepts is predicted to cause both short-term (see Section 2.5.1) and long-term (see Section 2.5.2) effects on aggressive behaviour under the GAM. The way that video games fit into this chain of cause and effect is simple. Under the GAM, violent video games "influence aggressive behavior by increasing the relative accessibility of aggressive concepts in memory" (Anderson and Bushman, 2002; Carnagey and Anderson, 2003). In other words, the effects of VVGs on their players are largely predicated on their ability to prime aggression-related concepts.

2.6.2 Debate over the validity of VVG effects

However, it is unclear from the experimental literature whether playing VVGs actually does prime aggressive concepts. Numerous studies have seemingly demonstrated that playing VVGs leads to the priming of aggression-related concepts. For instance, in (Anderson et al., 2004) participants were exposed to either a violent game or a non-violent game. Players of non-violent games completed the Anderson word fragment completion task with significantly fewer aggression-related words. Similarly, in (Bösche, 2010), participants who had played a violent video game recognised aggression-related words more quickly in a LDT than those who had played a non-violent video game.

However, recent research has challenged both the validity of experiments like these and the generalizability of the effects which they demonstrate. As noted in (Adachi and

Willoughby, 2011), experimental research into the effects of VVGs is often conducted using a setup in which each experimental condition is represented by a different commercial off the shelf (COTS) video game, without any attempt to "equate the violent and non-violent games on other dimensions that may be related to aggression". For instance, (Uhlmann and Swanson, 2004) wanted to find out about the effects of playing a violent video game as opposed to a non-violent video game. In order to compare the effects of this feature of video games, they had one group of participants play *Doom* and another group of participants play *Mahjongg: Clicks*. Similarly, in order to investigate the long-term effects of playing violent video games, (Hasan et al., 2013) had participants play either a violent video game or a non-violent video game for three consecutive days. The VVGs used in this study were *Condemned 2*, *Call of Duty 4*, and *The Club*, whilst the non-violent games were three racing games: *S3K Superbike, Dirt 2* and *Pure*.

An issue with this methodology, in which experiments are conducted "between video games" (Barlett et al., 2007), is that it may lead to false positives. As (Valadez and Ferguson, 2012) put it, "the first limitation with experimental research [into the effects of VVGs] is the failure of many studies to adequately equate video game conditions on confounding variables such as competitiveness, difficulty, and pace of action". Indeed, this limitation has been mentioned by the authors of experiments which use this methodology. For example, (Barlett and Rodeheffer, 2009), tests the effects of playing a violent and realistic video game (*Conflict Desert Storm*) as opposed to a violent and unrealistic video game (*Star Wars Battlefront 2*) and a non-violent game (*Hard Hitter Tennis*). However, whilst this study found that playing *Conflict Desert Storm* led to significantly more aggressive feelings than playing the other two games, the researchers were clear to note that they were not confident in their "ability to state that the games were similar on frustrating or difficultly [sic]", and that interpretation of these results should take into account that "this could have impacted the results".

Recent findings seem to support the severity of this issue. For instance, in (Anderson et al., 2004), participants either played a violent game called *Marathon 2* or a non-violent game called *Glider Pro 4*. The results of this widely-cited experiment found that playing a violent game (as opposed to a non-violent game) led to greater aggressive affect. However, (Przybylski et al., 2014) recreated this experiment whilst taking into account the complexity of the different interfaces in each game. They found that the only significant effect of playing the violent or the non-violent game was an indirect one, mediated by players' perceptions of mastery-of-controls. In other words, playing a violent video game might well lead to aggression-related outcomes, but only “insofar as the more complex control interface impeded player competence” (Przybylski et al., 2014). In (Kneer et al., 2016), researchers demonstrated that it is likely that this effect also extends to priming. This study again attempts to discover whether it is the violent content of VVGs that leads to the priming of aggression-related concepts in the literature, or whether this effect is in fact the confounded product of “the third variable – game difficulty”(Kneer et al., 2016) . Rather than use two different games, they instead manipulated the game *Team Fortress 2* to form different conditions. In some conditions, players burned each other to death by shooting flamethrowers at each other, whilst in others they were instead equipped with devices which “exhausted rainbows … [which] incapacitated characters by making them drop to the ground convulsing with laughter” (Kneer et al., 2016) (See Figure 2-6). Additionally, conditions were formed in which the game was either more or less difficult. Experimental results not only yielded a null effect for violent or non-violent conditions, but additionally revealed that the difficulty of the game had a significant effect on the priming of aggression-related concepts. A similar experiment was conducted in (Przybylski et al., 2014). In this experiment, researchers manipulated the violent content of a game by creating one game in which players “used firearms to maim and dispatch the opponents, leaving them spewing blood and lying dead in the game world”, and a second game which was identical in gameplay, but different in content. In this game, players instead “used a psychic-ball power that teleported competitors away”. Results again indicated that violent or non-violent content had no effect on aggressive feelings.

Figure 2-6: Violent and non-violent conditions from (Kneer et al., 2016)

Null results like the ones described above are commonly found by researchers seeking to test the theory that playing VVGs leads to aggressive behaviour (e.g. (Ferguson et al., 2015; Przybylski et al., 2014; Valadez and Ferguson, 2012)). This has led to some dispute over the size, the significance and the importance of the effects of playing VVGs. Some metaanalyses have been conducted by researchers who openly support the GAM's predictions. These studies report r_+, a pooled equivalent of Pearson's r which takes into account the different sample sizes used in different studies. These studies generally estimate the size of the effect of playing VVGs on aggression at around $r_+=0.20$ (e.g. (Greitemeyer and Mügge, 2014): $r_+=0.18$; (Anderson et al., 2010): $r_+=0.21$; (Anderson et al., 2004): $r_+=0.20$). This effect size is held by the authors of the GAM to be socially important:

> "there are circumstances in which small effect sizes warrant serious concern: When effects accumulate across time, or when large portions of the population are exposed to the risk factor, or when consequences are severe, statistically small effects become much more important. All three of these conditions apply to violent video game effects"
>
> (Bushman and Huesmann, 2014)

By contrast, critics of the GAM claim that the literature is subject to widespread publication bias in which null results are suppressed (Ferguson, 2007). They claim that when this bias is taken into account, effect sizes sink as low as $r_+=0.04$, with a 95% confidence interval which crosses 0 - in other words, an insignificant effect (Ferguson, 2007).

It would seem that in the words of one media effects scholar, at least when it comes to the priming of aggression-related concepts by VVGs, "overall, making clear, declarative statements from this body of work is difficult." (Ferguson, 2015).

2.6.3 The time-course of VVG effects

It is important to note that this debate over the validity of the GAM's predictions extends to encompass how the aggression-related consequences of playing VVGs function over time.

As described in Section 2.5.2, the GAM predicts that playing VVGs for greater lengths of time will lead to greater effects on aggression-related variables. However, the results of experimental research into this topic have been mixed. For instance, in (Valadez and Ferguson, 2012) researchers were interested in investigating the influence of a variety of gameplay factors on players. One of their questions was discovering whether the length of time that was spent playing a VVG influenced its effects on players' hostile feelings. They therefore had one group of players play a VVG for a shorter period of time (15 minutes) and another play the same game for a longer period of time (45 minutes). Results indicated that length of play had no effect on hostile feelings. Similarly, in (Barlett et al., 2007), researchers had participants play the shooting game *Time Crisis 3*, They then measured player arousal, how hostile players felt, and how aggressively players completed story stems. This measurement was made at three different points: Before play ('baseline'), after 15 minutes, and after 30 minutes. Whilst significant differences were observed in hostility and the completion of aggressive story stems "from baseline" (Barlett et al., 2007), no effects were observed between 15 and 30 minutes. However, contrastingly, in (Hasan et al., 2013), researchers had participants play a VVG for three consecutive days. Results of this study indicated that greater length of play led to greater amounts of both aggressive behaviour and hostile expectations.

The studies described above paint a confused picture of the effects of playing VVGs for either minutes or hours. However, the effects of playing VVGs for shorter periods of time (such as mere seconds or milliseconds) are even less clear. The cognitive psychology literature contains a variety of studies which suggest that priming effects occur even if participants are only exposed to stimuli for very short periods of time. For instance, in (Perea and Gotor, 1997), exposing participants to stimuli for periods of time as short as 67ms led to the priming of reactions to conceptually related words. Similarly, in (Bueno and Frenck-Mestre, 2008), exposing a participant to a word for 27ms was shown to prime participants' reactions to associated words. However, despite this evidence in the cognitive psychology literature, research on whether the effects of VVGs occur even after brief exposures is non-existent.

It is consequently unclear from the literature how much time it is necessary to spend playing a VVG before the GAM's predicted effects occur. Furthermore, it is also unclear whether spending a greater amount of time with a game is likely to increase that game's priming effects. Whilst proponents of the GAM make strong suggestions that greater lengths of play should lead to greater effects on aggression-related variables, these predicted effects have thus far failed to materialise under experimental conditions.

2.6.4 Why VVGs might prime aggression-related concepts

The theoretical reason for the priming of aggression-related concepts in VVGs is that authors of the GAM believe that "violent video games, by their nature, require the activation of aggressive thoughts, whereas nonviolent games do not require it"(Anderson et al., 2010). However, the precise rationale behind this statement is unclear. In no major publication do the authors of the GAM unambiguously state *why* the activation of aggression-related concepts is a necessary consequence of playing a game with violent content. The closest which the authors come to explicitly defining why playing violent video games causes the activation of aggression-related cognitions is the sentiment that "we know from related research that merely seeing a picture of a gun or other weapon can increase the accessibility of aggressive thoughts"(Anderson and Dill, 2000). This has been taken by some (e.g. (Ferguson and Dyck, 2012)) to indicate that, under the GAM, VVGs prime aggression-related concept simply because they contain representations of aggression-related things like guns and killing and violence.

Another justification for this mechanism can be found in the GAM's roots. As mentioned in publications like (Barlett and Anderson, 2013), the priming effects which the GAM predicts are adapted from pre-existing theories of how viewers respond to television such as (Berkowitz, 1984) and (Huesmann, 1988). Indeed, the GAM's authors themselves openly point out that "many of the underlying psychological processes identified in the TV-movie literature also apply to video games"(Anderson and Bushman, 2001) and that this borrowing has been done "most obviously"(Anderson and Dill, 2000). It is therefore not controversial to suggest, like Sherry in his influential meta-analysis, that the prediction that exposure to violence will lead to the priming of aggressive cognitions has "been transferred almost unscathed between [TV and video game] domains"(Sherry, 2001).

2.6.5 Why VVGs might not prime aggression-related concepts

However, whilst the GAM's theory that priming happens in video games may be based on how people respond to television, recent research suggests that there are key differences between how people engage with video games and how they engage with television programmes. In 2003, one video game scholar was able to write that "the traditional—and most popular—research approach … has been to consider video games as extensions of drama and narrative" (Frasca, 2003). The same is not true today. Video games may be like television in that they contain representations of real or imaginary people and events. However, as Juul noted in *Half-Real* (Juul, 2011), video games, unlike television, are also systems in which players engage in competition according to a set of rules. Therefore, whilst "controlling a character that hits a character controlled by another player" (Juul, 2011) might seem on one (representational) level to be an act of aggression, on another level it is just one of many "symbolic interactions" (Juul, 2011) whose meaning lies in how it affects in-game winning or losing. In other words, "in a game, things are not what they seem"(Juul, 2011).

The extent to which players of video games pay attention to the imaginary or real concepts (people, places, violence) which a game depicts during play and the extent to which they ignore this information in order to focus on winning the game is currently unknown. There are, however, a broad spectrum of different opinions on the issue.

At the far end of this spectrum are researchers who argue that "it is common for gamers to lose all interest in the fiction … and to switch their focus onto the rules" (Kirkpatrick, 2011). Scholars such as Espen Aarseth argue that, when engaging in a video game, gameplay is paramount, and any real or imaginary concepts which are represented in a game often fall at the experiential wayside:

> "the dimensions of Lara Croft's body, already analyzed to death by film theorists, are irrelevant to me as a player, because a different-looking body would not make me play differently. When I play, I don't even see her body, but see through it and past it."
>
> (Aarseth, 2004)

This perspective is criticised by other academics who note that it highlights one particular way of engaging with video games and ignores others. (Bateman, 2015), for example, points out that "for players who actively engage in roleplay – and this is a significant proportion of videogame players … representation *always* matters".

Other academics see representation as an optional element of play in digital games. For instance, as Klevjer (2013) notes, when playing *Quake*, a player can successfully complete the game whilst only "literally manipulating dynamic shapes on the screen", each player also has "the option to pretend to be shooting enemies with a gun". Similarly, Calleja and Langgaarsvej (2009) state that "an ongoing story [is] generated by the player adopting a narrative attitude towards the interpretation of certain representational signs and the mechanical operations that animate them", but that this specific attitude is by no means mandatory.

Other opinions suggest that the features of individual games may influence the extent to which their players engage with them as representations. For instance, Juul himself puts forward the idea that the more competitive a game is, the more likely it is that players ignore the concepts which are represented within the game in order to focus on competing successfully:

> "Any game that enforces its goals strongly or is highly competitive, pressuring the player to improve his or her performance, will push the player towards information reduction, in order to only think about what is relevant for the present task. If the

fiction is not relevant for the player's task, it becomes possible for the player to play the game as if it were an abstract game."

(Juul, 2007)

The literature also suggests that some video games might cause their players to engage with the concepts that they represent more than others. For instance, Fernández-Vara (2011) argues that players of adventure games such as *Monkey Island* must necessarily engage with the concepts which are represented within these games. This is because "Adventure games always have a story inextricable from gameplay"(Fernández-Vara, 2011). For example, *Monkey Island 2: LeChuck's Revenge* contains a puzzle in which the player must trap a rat by baiting it with cheese. In order for the player to play the game successfully, they must first understand that one set of on-screen pixels represents a rat, and that this rat is the analogue of a real-world rat, and that rats like cheese (See Figure 2-7). In other words, playing the game successfully would necessarily mean engaging with the concepts which it represents. However, this is not thought to be the case in all games. As Sageng (2012) puts it, "it is insignificant to the actions of a chess player whether he pretends that the knight piece is an actual knight". Similarly, as *Tetris* can be played successfully without thinking about falling blocks, it is not necessary for players to think about the blocks in *Tetris* as representations of real blocks.

Figure 2-7: A rat-based puzzle in Monkey Island 2 Special Edition: LeChuck's Revenge. *Taken from ("Monkey Island 2 Special Edition: LeChuck's Revenge - Rat in the Soup Gameplay Movie - GameSpot," n.d.)*

Whether and why players of games engage with in-game concepts is unclear. It is therefore unclear from this literature whether players of VVGs engage with the violent concepts which are depicted in these games. In the words of one media effects researcher, "By borrowing a theoretical framework that is appropriate for the study of more passive media such as television, the concern is that new media such as games may be functionally different enough to cause a problem" (Williams and Skoric, 2005).

2.7 The GLM and the Effects of Video Games Beyond Aggression

The GAM describes how games with aggression-related content can lead to their players learning aggressive behaviours. However, this is not the only type of content which a video game can feature, and these are not the only behaviours which a game can teach its players. Indeed, recent years have seen an upturn in research into 'serious' games whose main purpose is not enjoyment, but the acquisition of "skills, knowledge or attitudes useful in reality" (Bergeron, 2006). Examples of games which are intended to teach players new and useful behaviours are both numerous and diverse. For instance, in (Baranowski et al., 2003), researchers were interesting in changing children's' eating behaviours. They therefore developed *Squire's Quest*, a medieval-themed game in which individuals participate in completing "goals related to eating more fruit, 100% fruit juice, and vegetables" (Baranowski et al., 2003). Contrastingly, (Knight et al., 2010) describes *Triage Trainer.* This game is intended to teach individuals appropriate behaviours in the context of a major accident. In this game, players take on the role of a first-responder at the scene of a bomb explosion, and must tag a number of casualties with priority levels appropriate to their injuries.

In order to further generalise the General Aggression Model so that its predictions and effects encompass games like these, and not just VVGs, Buckley and Anderson proposed the General Learning Model or GLM (Buckley and Anderson, 2006). As shown in Figure 2-8 below, the GLM bears a striking similarity to the GAM.

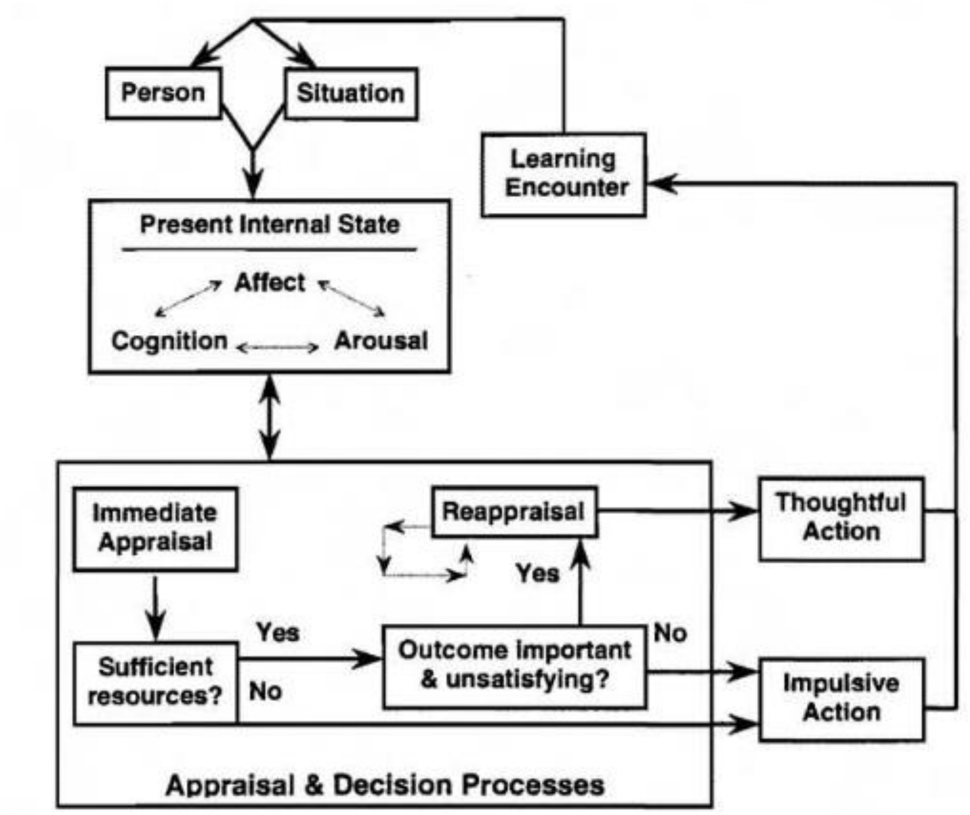

Figure 2-8: The short term causes of behaviour change in the General Learning Model, taken from (Buckley and Anderson, 2006)

Just as in the GAM, the GLM involves three routes through which a situation can lead to changes in behaviour. These are, again, a cognitive route, an affective route, and an arousal-based route. Just as in the GAM, exposure to a game may lead to the activation of knowledge structures, changes in arousal, and influences to players' moods. Just as in the GAM, these routes may interact in order to determine subsequent player behaviour. Just as in the GAM, in-game behaviour may lead to long-term changes in behaviour through the reinforcement of specific knowledge structures (See Figure 2-9 below). Indeed, the only difference between the predictions of the GAM when it comes to violent video games and the predictions of the GLM when it comes to video games in general seems to be the removal of 'desensitisation' from the GLM's list of long-term causal factors in behaviour change.

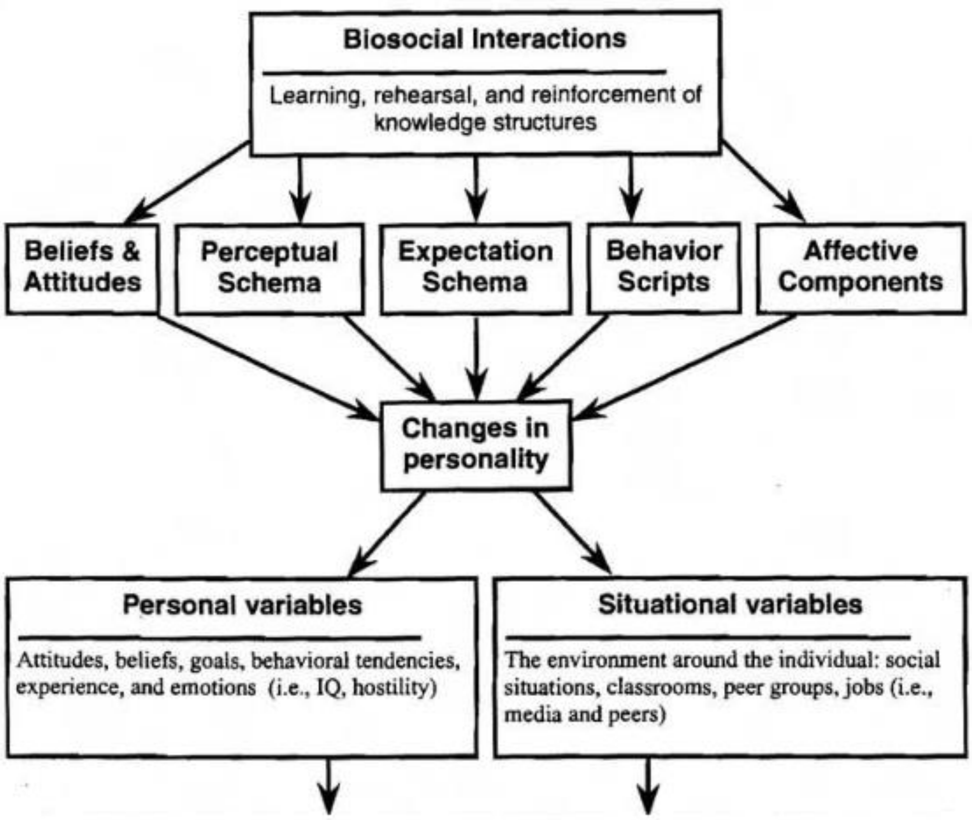

Figure 2-9: Long-term changes in aggressive behaviour under the GLM, taken from (Buckley and Anderson, 2006)

2.8 Features of Violent Video Games and the GAM

The GAM makes no predictions about how the specific features of a VVG might either add to or detract from its effects. In recent years researchers have begun the process of filling this hole in the literature. Several experiments have been conducted which investigate how the features of VVGs influence the activation of aggression-related concepts. These features range from the presence of in-game profanity (Ivory and Kaestle, 2013), to the gender of the player's avatar (Eastin, 2006), to the kind of rewards which players are given in a VVG (Carnagey and Anderson, 2005).

Of particular relevance to the experiments contained in this thesis are the effects of the realism of VVGs on the activation of aggression-related concepts, and, to a lesser extent, the effects of narrative content. In the following section I will therefore summarise the literature which deals with these features.

2.8.1 Graphical Realism in Video Games

Realism refers to a game's ability "to mimic things that exist, or events that have happened in real life" (Malliet, 2006). This term is often used to describe the quality of in-game graphics. Several technological innovations in modern VVGs can be used to make these games look more like their real world counterparts. For instance, the increasing processing power of modern computers allows them to render 3D models which use ever larger numbers of polygons. This has allowed the transition of objects in VVGs from simple geometric shapes to "more realistic or organic" (Tavinor, 2009) forms (See Figure 2-10). Similarly, developments in techniques like precomputed lighting are thought to allow modern VVGs more graphical realism than was previously possible (e.g. (Granberg, 2014; Thorn, 2013)).

Figure 2-10: A low-polygon character in Redguard*, an early instalment in* The Elder Scrolls *series, and a more high-polygon version taken from a newer instalment,* Skyrim. *Images taken from ("The Elder Scrolls Adventures: Redguard Images - GameSpot," n.d.) and ("Last Dance with Tullius - I - The Elder Scrolls Sandbox - Wikia," n.d.).*

This is the kind of realism which one academic uses when he asserts that *Riven* is more realistic than *Myst* because of its "more detailed texture maps" (Wolf, 2003). It is the kind of realism which (Slater et al., 2002) advises can be improved through using more advanced shaders. It is also the kind of realism which is described in (Van Mierlo and Van den Bulck, 2004) when the authors express concerns that "the realism of video games is becoming comparable to the realism of television violence" due to their increased "graphical resolution".

2.8.2 Behavioural Realism in Video Games

However, changes in the dimensions of texture maps and the number of polygons in 3D models are not the only factors which are relevant to the realism of video games. As (Frasca, 2003) notes, video games are not just sequences of images, but rather simulations of events. Therefore, it may not "suffice to observe what is visible on the computer or television screen", but "in addition, one must look at the program rules that govern the pace of the game" (Malliet, 2006) as well. In other words, when it comes to realism the way things behave in video games matters. This idea that a game's realism is also to do with how closely its "objects and characters act in comparison to the same object in the real world”(Cheng and Cairns, 2005) is sometimes referred to as that game’s ‘behavioural realism’ or ‘simulational realism’ (Ribbens and Malliet, 2010) as opposed to its ‘graphical realism’.

Just as there are a variety of ways that VVGs can be made more graphically realistic, there are several different methods that can be used to make them more *behaviourally* realistic. For instance, physics is thought to play an important role in “conveying realistic fictional worlds” (Tavinor, 2009) in video games. Therefore, a common way to make in-game characters “realistically interact” (Schell, 2014) with each other is through the use of ragdoll physics. In this approach, game developers build a physical simulation of each of a game’s characters as a collection of jointed bodies joined together into a skeleton. They then simulate the reaction of this ‘ragdoll’ to whatever force killed them, and animate the enemy accordingly. When ragdoll physics is used, in-game characters therefore react to collisions in a way which is in keeping with how they would behave the real world.

By contrast, a very different way to add behavioural realism to a VVG is through the tactics which non-player characters (NPC) use. Whilst the NPCs in some recent VVGs, such as 2016’s *Doom*, are not “capable of advanced tactics and teamwork”(Gilroy, 2016), other VVGs feature NPCs who *do* behave using realistic tactics. For instance, in the recent VVG *The Last of Us*, enemy characters used ‘flanking’ tactics on the player (Rabin, 2015). In this tactic, one group of NPCs ‘pins down’ the player with bursts of continuous fire, whilst a second group “maneuvers around to their flank and then cuts across from the side to finish them off” (Rabin, 2015). This is not the only way that NPC tactics in VVGs can mimic the way that real-world combatants fight. As game designer Ernest Adams points out in (Adams and Rollings, 2007), there are a plethora of enemy tactics which can influence the realism of a VVG:

> “Depending on the degree of realism offered, tactics can include flanking maneuvers, sneak attacks, creating diversions, cutting off enemy supply lines, killing the superior officers to leave the troops without leadership, taking advantage of the effects of bad weather, and so on. “

2.8.3 Realism and the effects of VVGs

When it comes to violence in the media, realism has always been a thorny issue. Since the early 1970s, researchers have argued that the more ‘real’ on-screen violence seems, the more aggressive viewers themselves are likely to become (e.g. (Geen, 1975)). This link between realism and aggressive behaviour in other media is mirrored in academic accounts of the potential effects of VVGs. For instance, in his 2001 meta-analysis, Sherry proposed that the reason why fantasy and human violence-themed games garnered generally larger effect sizes on aggression-related measures than sports games was due to their realism. His reasoning behind this was that human-violence themed games imagery is "more graphic, thus providing a more powerful prime for associated networks than more abstract images found in the older sports games."(Sherry, 2001). Similarly, (C. Barlett et al., 2008) links the increased realism of modern VVGs to potentially increased effects, writing that "theoretically, violent video game graphics quality could be related to aggression-related variables, as they are more graphically enhanced to depict violent acts and blood in great detail and quality.". This view, that greater realism may lead to more aggressive behaviour, is echoed throughout the VVG literature (e.g. (Ivory and Kalyanaraman, 2007; Krcmar et al., 2011).

Realism is a widely-discussed topic when it comes to the effects of VVGs. However, despite its seeming importance, realism's actual influence on aggressive behaviour remains unclear. The reason for this is the presence of several null or otherwise confusing results in the literature. An example of this occurs in (C. Barlett et al., 2008). In this experiment, researchers wanted to find out whether increasing "video game graphics quality" (C. Barlett et al., 2008) leads to increases in aggression-related variables. However, they did this by having one group play *Mortal Kombat 2* on a SNES, a second group play *Mortal Kombat 4* on an N64, and a third group play *Mortal Kombat: Deadly Alliance* on a Playstation 2. Results indicated that using an N64 caused players to access more violent scripts than using either a SNES or a Playstation 2. It is possible that the use of a 'between games' setup may have led to confounding as described in Section 2.6.2, and hence these results. An experiment into graphical fidelity whose results are similarly unclear is (Krcmar et al., 2011). In this study, researchers again wanted to find out whether "increased graphical realism will inevitably lead to greater effects" (Krcmar et al., 2011). However, they investigated this issue by having some participants play *Doom,* whilst others played *Doom 3*. Whilst no significant effect was found for aggressive behaviour in this study, it is again difficult to say whether this is due to several factors besides graphical realism, such as difficulty, varying between these games.

Ultimately, when it comes to the realism of VVGs, it seems that one VVG researcher is correct when they state that "the research literature on this issue is not very strong" (Gentile, n.d.).

2.8.4 Narrative Context and the effects of VVGs

A feature of VVGs which is closely related to realism is narrative context. Realism describes the extent to which a game imitates the real world. Similarly, narrative context describes the things in a game which place a player's actions within the context of a real or imaginary world (Sauer et al., 2015).

Narrative context can be manipulated in a variety of ways. For instance, text boxes can tell players about the motivation of characters, as in *Final Fantasy X*. Similarly, cut-scenes can let players know how their actions fit into a larger world, as in *Grand Theft Auto V*. Dialogue trees can even project the idea that a player's actions affect people and have moral implications, as in *Mass Effect*.

However, the literature which deals with how narrative context influences VVG effects is minimal. A small number of studies suggest that a violent narrative context in a VVG leads to increased aggressive behaviour. For instance, in (Sauer et al., 2015), researchers gave participants biographical pieces of text before having them play an FPS. These biographies described the player's character in the game as either an antisocial, violent individual or as a prosocial, non-violent individual. After play, players were tested for aggressive behaviours. Results indicated that exposure to an antisocial biography before play led to more aggressive behaviour after play. Similarly, in (Schneider, 2004), researchers were interested in how the presence or absence of a narrative context in a VVG might lead to different effects on that game's players. In order to investigate this issue, they had some participants play games which they judged to have little narrative context (*Doom 2*, *Quake 2*), and other participants play games which they judged to have a strong narrative context (*Outlaws*, *Half-Life*). The results of this experiment suggested that the narrative context of VVGs might lead to increased effects.

However, by contrast, in (Ferguson and Rueda, 2010), researchers found that the presence of either an antisocial or prosocial narrative context had little effect on post-game aggression. In this experiment, some players played a game in which their character was a "bad guy", *Hitman: Blood Money*. Other players played a game in which their character was a "good guy", *Call of Duty 2*. Results of this study suggests that changes to narrative context had little effect on any aggression-related variable.

It is worth pointing out that some of the experiments which are described above feature the same methodological problem as other VVG research. In both (Schneider, 2004) and (Ferguson and Rueda, 2010), experimenters use different games to form different experimental conditions. Whilst these games may well vary in terms of narrative context, they almost certainly also vary in other ways as well. For instance, (Schneider, 2004) uses *Half-Life* to form part of one condition and *Doom 2* to form part of another. *Half-Life* and *Doom 2* may both be first-person shooters, and they may have different levels of narrative context, but they are also different in a multitude of other ways. For instance, *Half-Life* was released in 1998 and features polygon-based 3D graphics whilst *Doom 2* was released almost half a decade earlier (1994) and makes use of much less sophisticated sprite-based technology (See Figure 2-11). The extent to which the results of these experiments are reliable is, therefore, unclear. Consequently, the influence of narrative context on VVG effects remains similarly unclear.

Figure 2-11: Half-Life (L). Doom 2 (R).

2.8.5 Blood and the effects of VVGs

A final feature of VVGs which it is important to mention here is the presence or absence of blood. The literature does not suggest that this feature of VVGs lead to changes in priming. However, crucially, it contains evidence that the presence of blood in VVGs leads to increases in player *arousal*. For instance, in (Ballard and Wiest, 1996), researchers exposed participants to two different versions of the VVG *Mortal Kombat*. In one condition, the game's blood effects were turned off. In the other, the game featured "spurting blood and gore". Results indicated that the presence of blood led to increased arousal, but no changes to post-game hostility. Similarly, in (Jeong et al., 2012), researchers had participants play two different versions of *Half-Life 2*. One version featured red blood, whilst the other featured blue blood. Results indicated that playing a game which featured red blood led to increases in arousal, but no changes in either hostility, anger, physical aggression, or verbal aggression.

Whilst the presence of blood in some experiments has been shown to cause changes in arousal but not aggression, this is not consistent across the literature. For instance, in (C. P. Barlett et al., 2008), exposure to blood seemed to lead to changes in *both* arousal and aggression. In this experiment, researchers had participants play different versions of the fighting game *Mortal Kombat: Deadly Alliance*. In one condition, the game had been set to not display any blood, in another condition it only displayed small amounts of blood, and in a third condition it displayed large quantities of blood. In this case, playing the game with "maximum blood" led not only to increases in arousal, but also to increases in state aggression. Similarly, in (Farrar et al., 2006), researchers investigated the effects the presence of blood using the VVG *Hitman II*. Their results indicated that playing with 'blood on' led to more "physically aggressive intentions" as measured by a customised version of the Buss-Perry aggression questionnaire.

However, whilst there is reason to believe that blood in VVGs seems to lead consistently to arousal the effect on aggression outlined above is less robust. (Krcmar and Farrar, 2009), contains a replication of *Hitman II* study described above. However, in this study, exposure to in-game blood did not cause any direct changes in aggression. Furthermore, in this study the researchers also measured the priming of aggression-related concepts. Results indicated that the presence or absence of blood had no significant effect on this variable either.

Overall, the VVG literature suggests that the presence of blood in VVGs leads to changes in arousal and may also lead to changes in aggression. The reason for this is unclear. However, it does have one critical implication. Under the GAM, changes in arousal may lead to changes in priming. Therefore, any experimentation which occurs in this thesis will have to take the presence or absence of blood into account as a possible experimental confound.

2.9 Summary

Priming and negative priming are widely-known effects in the cognitive psychology literature. Priming is commonly observed when a person has recently processed some concept. Conversely, negative priming is commonly observed when a person has ignored some concept. A host of well-established procedures have been developed to measure these effects. These techniques include Lexical Decision Tasks, image categorisation tasks, and word fragment completion tasks.

However, whilst priming may be well-established in the cognitive psychology literature, the role that this effect plays in determining VVG effects is anything *but* well-established. The

GAM is a popular way of describing how VVGs cause their players to behave aggressively. Under the GAM, the depiction of aggression in VVGs leads to the priming of aggression-related concepts. This priming in turn leads to aggressive behaviour. This theoretical relationship has previously seemed to be well-supported by empirical results. Several experiments conducted over the past two decades have seemingly shown that playing VVGs causes the priming of aggression-related concepts. However, this evidence is now highly contentious. Recent research has suggested that many of the priming effects in the VVG literature are the product of systematic confounding. As a consequence, it is unclear whether the aggression shown in VVGs really does lead to the priming of aggression-related concepts, or whether this effect may simply be due to interference from other factors such as feelings of incompetence.

The lack of clarity regarding this issue is further increased by recent scholarship in the field of game studies. Several prominent theorists from this area of research have proposed that the players of many video games ignore the concepts which are depicted within these games. If this is the case, and players of VVGs ignore the aggression-related concepts which are depicted in these games, then it would not make sense for these games to cause the priming of aggression-related concepts. By contrast, if concepts are ignored whilst playing games, then playing a game should lead to the *negative priming* of whatever concepts that game depicts.

On a final note, whilst it is unclear what the priming effects of VVGs are on their players, it is also unclear what the priming effects of several of their *features* are on their players. More specifically, the realism of modern VVGs has often been mentioned as a factor which is likely to increase their negative effects on their players. However, in contrast to these theoretical predictions, experiments which have attempted to test the effects of realism on the players of VVGs have routinely returned null results. However, it is unclear whether these null results represent the fact that priming really does not influence the effect of VVGs, or whether they may be due to the same confounding effects as other research in the VVG literature.

Overall, this literature review paints a picture of the VVG effects literature as a body of research with several important unanswered questions. It is unclear whether the realism of VVGs really does influence the extent to which playing them causes priming of aggression-related concepts. In fact, it is unclear whether playing VVGs really does lead to the priming of aggression-related concepts at all, despite the importance of priming to the GAM. It is furthermore unclear whether playing VVGs might lead to the *negative priming* of aggression-related concepts. Ultimately, it is unclear what the effects of playing VVGs might be on their players. The evidence contained within this thesis suggests striking answers to each of these questions.

3 Priming and Negative Priming in Video Games

3.1 Introduction

This chapter contains a series of experiments which investigate whether priming happens when people play video games. More specifically, these experiments investigate whether priming effects still occur in video games when known confounds in the VVG literature are absent from an experimental setup.

According to the General Aggression Model (GAM), playing games which contain depictions of aggression should cause the priming of aggression-related concepts. Numerous experiments in the VVG literature would, at first blush, seem to confirm this. A wide variety of experiments have seemingly demonstrated that exposure to the aggression-related content of VVGs leads to the priming of aggression-related concepts. However, recent scholarship has called this evidence into question. These sources note that many of the experiments which have shown priming effects in the VVG literature have also featured an experimental approach in which different experimental conditions are formed from different games. Factors such as pace and difficulty may vary between these games. This uncontrolled variation may lead to the priming effects which are reported in the literature, rather than any controlled manipulation of violent content between experimental conditions.

In fact, the possibility that uncontrolled differences in gameplay might affect the priming of aggression-related concepts is suggested by one of the core mechanisms of the GAM itself. Under the GAM, changes in affect and arousal are theorised to lead to similar changes in the priming of aggression-related concepts. Since it seems reasonable to assume that differences in *gameplay* might lead to changes in affect and arousal, it also seems reasonable to assume that these differences might influence the priming of aggression-related concepts.

Changes to priming caused by affect and arousal therefore make it seem more likely that confounding is occurring in the VVG literature. However, crucially, there is a further important corollary to the idea that affect and arousal influence the priming of aggression-related concepts. Since both affect and arousal seem likely to vary widely between participants playing a single game, it also seem likely that the priming of aggression-related concepts will vary widely between participants playing a single VVG, regardless of the priming caused by the aggression-related content of the game itself (See Section 2.5.1). Therefore, if it turns out to be the case that the aggression-related content of VVGs only causes a small priming effect, noise associated with the affect and arousal described above might 'drown out' this effect. This observation suggests that the most conservative way to find out whether the concepts within a game are primed by playing that game is to *not* use a VVGs as stimulus materials. An alternative approach is therefore used in this chapter in which participants play games which feature other, non-violent concepts (whose priming should not be influenced by differences in affect and arousal), and the priming of *these* concepts is measured. These results are then applied to the priming of in-game concepts by in-game content in general, including the priming of aggression-related concepts by the aggression-related content of VVGs.

Another important point to make regarding the methodology of the experiments in this chapter is to do with the use of custom-built games as stimulus materials. This chapter investigates whether the priming effects seen in the VVG literature remain present when the effect of gameplay differing between experimental conditions is removed from an experimental setup. In contrast to the VVG literature, which commonly uses different commercial off-the-shelf (COTS) VVGs as stimulus materials, for each of the experiments within this chapter I built a bespoke game. These games were then reskinned so that only the theme of the game differed between conditions, whilst gameplay remained exactly the same. Furthermore, in order to avoid the possibility that differences between players in affect and arousal deflate effect sizes associated with priming and lead to 'false negatives' in these experiments, I attempted to use games (and concepts) which were not related to aggression in all of the experiments within this chapter.

In the first of these experiments, participants played a run-and-gun game. Rather than use a commercial game of this genre such as *Alien Hominid* or *Metal Slug*, I instead built a bespoke version myself. This bespoke game was then reskinned so that it formed two different conditions. In one condition, the player took on the role of a soldier who sprayed a steady stream of bullets at oncoming enemies. In the other condition, the player took on the role of a baker who sprayed a steady stream of icing at oncoming cupcakes. As noted above, the key point in this manipulation was that it ensured that the only thing which differed between experimental conditions were the concepts depicted in each game. This helped to make certain that differences between gameplay in each condition was not a possible experimental confound. Participants were tested after play for the priming of both cake-related and soldier-related concepts via a Lexical Decision Task. The results of this experiment showed neither priming nor negative priming. However, it was unclear whether this lack of an effect was due to the genre of the game used in the experiment. Run and gun games (as their name suggests) might always be more related to soldiers than cakes. This might interfere with experimental results.

Therefore, a second experiment was conducted in order to clarify the previous null result. This experiment similarly tested whether playing a game primed in-game concepts when the confounding effect of gameplay was taken into account. Two version of a maze game were made. In one condition, the game was vehicle-themed. Players took on the role of a car looking for a garage whilst avoiding trucks. In the other condition, the game was instead animal-themed. Players took on the role of a mouse looking for their mouse hole whilst avoiding cats. In all other ways the games were identical. Participants were tested after play for the priming of both vehicle-related and animal-related concepts via an image categorisation task. Results of this experiment not only showed that players of this game were not primed for in-game concepts, but they even showed a clear negative priming effect.

I conducted a final experiment to discover whether the result of the previous experiment would happen even if people only play a game for a short period of time. In this online experiment, a large number of participants (n=460) played a vehicle-themed infinite runner game for one of three different lengths of time. The shortest length of play was a mere 20 seconds. Results indicated that even this length of play may lead to negative priming. However, it also highlighted that this effect was likely to be both small and delicate.

3.2 Experiment 1: Priming in Run and Gun Games

3.2.1 Introduction

In a first attempt to find out whether priming still occurs in video games when the confounding effects of gameplay are controlled within an experiment I had participants play a run and gun game. In order to avoid confounds, experimental conditions were formed by reskinning this single game so that two different versions of it were created which were identical in every way except for the concepts that they depicted. One game featured a cake-related theme, whilst the other had a soldier-related theme. I then tested after play for the priming of these concepts. If the content of video games primes their players, then playing a cake-themed game should prime the concept 'cakes', whilst playing a soldier-themed game should prime the concept of 'soldiers'.

In run and gun games the player controls an avatar which advances through an environment whilst shooting a stream of projectiles at oncoming hazards. There was one main reason why this genre of game genre seemed appropriate for use in an initial experiment. This reason was that run and gun games initially seemed amenable to reskinning. Spraying streams of projectiles at hazards is a common thing to do in a variety of situations. For instance, fire-fighters spray streams of water onto fires. Similarly, farmers spray streams of insecticide onto crops. The ubiquity of the run and gun's genre's core mechanic therefore made it seem an ideal choice for this experiment. It appeared that I would be able to easily change the graphics of a run and gun game so that it featured different sets of concepts and thereby create experimental conditions which avoided the confounds present in the VVG literature.

However, the fact that run and gun games seemed capable of being reskinned with a variety of concepts was not the only reason for this genre's selection. In addition to this, run and gun is a fairly popular genre of game, which suggested that the results of this experiment would generalise well to gaming situations outside of the laboratory. Finally, run and gun games do not necessarily require complex controls, and therefore can be used by participants who do not have a strong gaming background.

The choice of concepts closely followed the selection of game genre. Two examples of spraying projectiles which seemed very dissimilar were bakers spraying icing onto cakes, and soldiers spraying bullets onto enemies. Therefore, the run and gun game was reskinned to depict these concepts. However in order to test for priming it was necessary to build a Lexical Decision Task (LDT) which contained strings related to both cakes and soldiers.

Before I describe the experiment itself I will therefore first describe how this LDT was constructed.

3.2.2 Building the Lexical Decision Task

Measuring priming via an LDT involves having participants make decisions about a series of strings, which are both words (e.g. 'soldier') and non-words (e.g. 'slodier'). These strings are typically related to 'target' concepts which experimenters are interested in seeing primed. As described in Section 2.4.1.4, there is no commonly-accepted methodology for creating these lists of strings. However, steps *are* taken in the literature by experimenters which are likely to improve the validity of their LDTs.

A common technique in the literature is to recruit a group of participants, and then use these participants to judge whether a set of candidate words are related to target concepts. After this judging step is completed, a LDT can be built which takes the relatedness-to-target of words into account, as well as other factors such as word length and frequency.

3.2.2.1 Method

Participants

20 participants were recruited for judging how related words were to cakes and soldiers. All were native English speakers from the UK. All were Computer Science students, aged 18-21. 17 were male, and 3 were female.

Procedure

An initial pool of 100 potential words was created. These were generated through a combination of introspection, and also by reference to the Edinburgh Associative Thesaurus (Coltheart, 1981). This is a collection of word associations drawn from empirical studies with British participants. This initial pool contained a set of words which I believed might be related to either cakes (e.g. 'cake', 'icing') or soldiers (e.g. 'grenade'), and is included in this thesis as Appendix B.

Some LDTs solely use words which researchers have themselves generated, like the pool described above. However, this approach may potentially lead to experimental results which are hard to interpret (see Section 2.4.1.4). Therefore, in order to ensure that the words used in the final LDT actually *were* related to the target concepts, the initial pool of items was then judged for relatedness by 20 participants. The characteristics of these participants are described in the section above. As in previous studies (e.g. (Glock and Kneer, 2009; Pichon et al., 2007)), each of the potential words in the pool was presented to participants alongside two 7-point Likert scales. These scales allowed each participant to rate the extent to which each word was associated with two target concepts. In this case, target concepts were cakes and soldiers (See Figure 3-1).

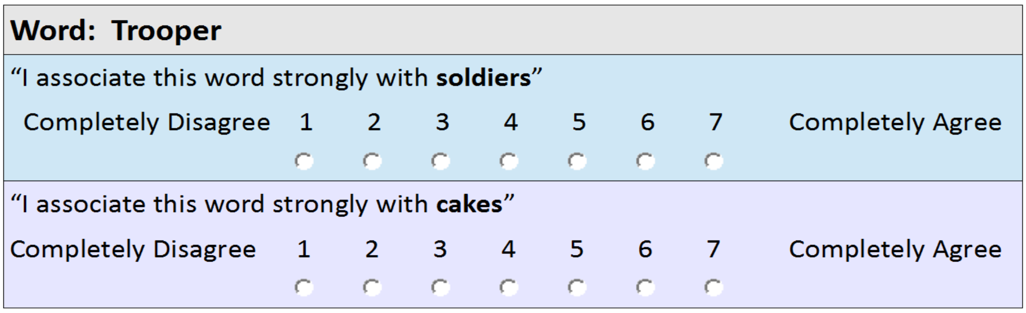

Figure 3-1: Scales for judging a sample word

This judging stage led to each word in the pool being associated with two scores. These scores showed the extent to which that word was associated with both cakes and soldiers. Items were then taken from the pool to form an LDT which contained an equal number of words which were both (1) strongly related to cakes, and strongly unrelated to soldiers (e.g. 'sugary'), and (2) strongly related to soldiers, and strongly unrelated to cakes (e.g. 'rifle'). For instance, as shown in Table 3-1 below, participants rated 'sponge' an average of 6.9/7 on the Likert scale when it came to this word's relatedness to cakes. They also rated this word only of 1/7 on the Likert scale when it came to relatedness to soldiers. This word was therefore selected for use in the final LDT.

As in the development of previous LDTs (e.g. (Barlett et al., 2006)), these word lists were also adjusted so that they were approximately matched in terms of both number of syllables and word frequency. This was estimated by using the Hyperspace Analogue to Language (HAL) corpus (Brysbaert and New, 2009) of linguistic metadata. An equal number of words which I judged to be neutral were also added to this list, in order to prevent participants from guessing the purpose of the LDT (e.g. 'excerpt'). '%' characters were inserted between the characters of each word in order to make them more difficult to read, and therefore increase overall reaction times (i.e. 'cake' became 'c%a%k%e'). Following this, each word had its middle characters scrambled in order to form a list of non-words. The list of stimuli produced by this process are included as Appendix D.

3.2.2.2 Results

The procedure outlined above generated 12 cake-related words, 12 soldier-related words, 12 neutral words, and 36 corresponding non-words. The initial pool of 100 words, tagged with relatedness to target concepts, is included in this thesis as Appendix C. Similarly, the stimuli which make up the LDT itself is included as Appendix D.

Table 3-1 below provides representative examples of how some of the 100 initial words were judged to be related to both cakes and soldiers. Table 3-2 summarises the relatedness, word frequency, and number of syllables for the sets of words used in the final LDT.

Word	Mean Relatedness to Cakes	Mean Relatedness to Soldiers
Strongly related to cakes, strongly unrelated to soldiers		
Cupcake	6.90 (0.31)	1.00 (0.00)
Bake	6.70 (0.48)	1.00 (0.00)
Strongly related to soldiers, strongly unrelated to cakes		
Army	1.00 (0.00)	7.00 (0.00)
Barracks	1.10 (0.31)	6.90 (0.31)
Neither strongly related to soldiers nor to cakes		
Dough	3.30 (1.49)	1.20 (0.63)
Dead	1.00 (0.00)	4.30 (1.49)
Layers	5.20 (1.03)	2.60 (1.57)
Piece	4.90 (1.59)	2.00 (1.49)

Table 3-1: Sample words and summary statistics. Standard deviations in brackets.

	Judged relatedness to cakes	Judged relatedness to soldiers	Syllables	Frequency per million words
Cake-related words	6.26 (0.77)	1.26 (0.51)	2.00 (0.77)	29.4 (39.90)
Soldier-related words	1.06 (0.18)	6.49 (0.78)	2.08 (0.51)	30.4 (38.90)
Neutral words	N/A	N/A	2.13 (0.46)	26.8 (1.40)

Table 3-2: Means and standard deviations for the Lexical Decision Task. Standard deviations in brackets.

3.2.2.3 Discussion

This method for developing a word list appeared to be effective. To begin with, the process ‘caught’ several potentially confounding words, and prevented these stimuli from being added to the LDT. Examples of these are words like ‘dough’ and ‘dead’, which are shown in Table 3-1 above. These words were not included in the LDT because they were judged to be neither strongly related to soldiers nor to cakes. When putting together my initial word pool I assumed that these words were either strongly and unambiguously related to cakes, or strongly and unambiguously related to soldiers. However, it is now clear that this is not the case. The reason why is unclear, and seems to vary from word to word. For instance, whilst one may eat a ‘piece’ of cake, further investigation has uncovered that this word is also a slang term for a gun. This might explain why some participants judged it to be related to soldiers. Contrastingly, whilst ‘dessert’s dictionary definition is solely to do with cakes, the word is phonetically identical to ‘desert’, which is a thing that a soldier might do.

In addition to filtering out potential confounds, the procedure also seemed to successfully create two separate and distinct sets of words. These consisted of a set of words which were likely to be highly-related to soldiers and not at all related to cakes, and a set of words which were likely to be highly-related to cakes and not at all related to soldiers. The evidence for this lies in the summary statistics for each group of words. Whilst the final list of 12 cake-related words scored close to maximum, on average, on the 7-point Likert scale for cake-relatedness (6.26), they scored, on average, close to minimum on the scale for soldier-relatedness (1.26). Similarly, the 12 soldier related words were on average not judged to be related to cakes (1.06), and judged to be highly-related to soldiers (6.49). It is important to note that the standard deviations associated with these means are all very small. This is a positive sign, as it indicates that these ratings are stable across participants, and therefore should be reliable.

When it comes to the number of syllables and frequency of the words which ended up in the LDT, the process also seems to have worked well. Judges’ ratings produced a large number of words which were highly related to a single target concept. For instance, the mean relatedness of 37 different words in the pool was within a single scale point of maximum (i.e. 7) for either cakes or soldiers. This abundance of viable candidates allowed me to carefully select the specific words which I included in the final LDT. This, in turn, led to both word lists being well matched in terms of mean word frequency and number of syllables.

3.2.3 Experimental Method

Aim

This experiment aimed to investigate whether the priming effects seen in the VVG literature remain when known confounds are removed from an experimental design.

Hypothesis

The VVG literature predicts that players are primed for the concepts depicted in the games that they play. However, a separate body of literature suggests that players may be negatively primed for the content depicted in the games that they play. Therefore, I hypothesise that one of these effects will occur in this case.

Either players of the soldier-themed game will be negatively primed for the concept of soldiers, or they will be primed for the concept of soldiers, depending on which of the theories outlined above is dominant. Likewise, players of the cake-themed game will either be negatively primed for the concept of cakes, or they will be primed for the concept of cakes, depending on which of the theories outlined above is dominant. Or, more formally: :

H1: Reaction times to soldier-related words on an LDT will either be slower or faster for people who play a soldier-themed game, whilst reaction times to cake-related words on an LDT will exhibit the same relationshipfor people who play a cake-themed game.

Design

The experiment had a 2 (game theme) x 2 (word type) mixed design. Participants played either a soldier-themed run and gun game, or a cake-themed run and gun game. Each participant was then tested for their reaction times to both cake-related and soldier-related words on the LDT.

Measures

An LDT was used to measure the priming of both cake-related and soldier related concepts. This was implemented using the *E-Prime* software suite, and was administered via a desktop computer with a 17” 4:3 CRT monitor, an i5-650 CPU, and 8 gigabytes of RAM.

Participants were presented with each of the words and non-words generated through the process described above. They indicated that a particular string was a non-word by pressing the ‘z’ key, and a word by pressing the ‘m’ key. Following eight practice trials, each participant’s correct reaction times to both cake-related words and soldier-related words were recorded. In line with the literature, each of these reaction times were also log-transformed (See Section 2.4.5). More specifically, natural logarithms of reaction times in milliseconds were used in this experiment.

Reaction times to cake-related and soldier-related non-words (e.g. 'ckae', 'slodier') were also similarly recorded and log-transformed for each participant. Whilst these were not used to investigate any pre-specified hypothesis, they were also analysed for priming effects, as it may be the case that target-related non-words are primed in the same way as words (See Section 2.4.1.3).

It is important to note that this is a LDT with multiple target concepts, and therefore priming will be tested for by looking for an interaction effect on a repeated-measures ANOVA, as described in Section 2.4.1.2.

Games

The run and gun game used in this experiment (See Figure 3-2) was representative of the genre, in that it featured a combination of side scrolling motion and target-shooting (i.e. 'running' and 'gunning'). Participants in the soldier-themed condition used their mouse to aim an automatic rifle, and shot a stream of bullets from this gun by holding down the left mouse button. Their avatar was a soldier, which would continually move through an environment stylised to look like the concrete ruins of a city. This avatar could also be manoeuvred by using the arrow keys on the keyboard. Waves of enemy soldiers would crawl up from below the player, drop down from above them, and approach the player from either side of the screen. Once an enemy had been shot a specific number of times it would be killed and fall off the screen, and a number of points would be added to the player's score. If an enemy reached the player before being killed, then the screen would briefly flash red, and the player's score would be halved as a penalty.

The cake-themed condition was identical to the game outlined above in terms of mechanics. However, the concepts depicted in this game were quite different. The soldier avatar was replaced by a baker. The automatic rifle was replaced by a piping bag. Tracer fire from the gun was replaced by a stream of pink icing. The decaying urban environment was replaced by a landscape composed of enormous cakes. Finally, enemy soldiers were replaced by cupcakes. Figure 3-2 below illustrates these different conditions.

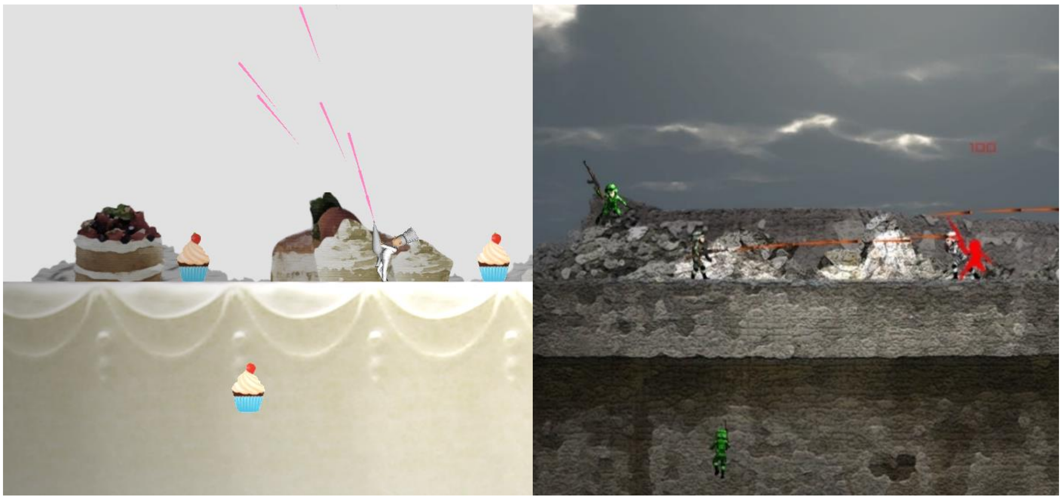

Figure 3-2: Cake-themed and soldier-themed run and gun games

Participants

An experiment using this experimental set up had not been conducted before, and consequently the sample size required to achieve high statistical power was unclear. Therefore, I used 40 participants, as player experience research commonly uses samples of approximately this size (e.g. (Denisova and Cairns, 2015)). 40 native English speakers took part in the experiment. 28 of these participants were men and 12 were women. 16 of the participants were frequent gamers, playing at least once a day. A further 9 played at least once a week. The remaining 15 participants played once a month or less. 14 of the participants were aged 18-24, 9 were aged 25-29, 6 were aged 30-34, and the remaining 11 were aged 35 or older.

Participants were randomly assigned to experimental conditions, with 21 playing the game featuring cake-themed concepts and 19 playing the game featuring soldier-themed concepts. Participants were offered a piece of chocolate in exchange for taking part in the experiment.

One additional participant indicated before play that he was dyslexic. Due to the fact that the results of this study are based on the ease with which participants can read and interpret words, this participant's data was discarded and not used in this study.

Procedure

After agreeing to take part in the experiment, participants were given an informed consent sheet, which is included in this thesis as Appendix E. Participants were then guided to a desk with a computer and informed that the experimenter would not talk to them for the rest of the experiment unless absolutely necessary. They were then given written instructions which explained the basics of how to play a run and gun game, but without mentioning any soldier or cake-specific words such as 'gun' or 'kill'. This lack of written reference to any target-specific concepts was done to avoid any potential priming effects from exposure to these concepts in a game's instructions. Instead, instructions told participants that they were going to be confronted with a series of 'things' which would move towards them, and to 'spray' as many of these things as possible.

These instructions also told players that when they were ready they should press the 'play' button on a computer in front of them. When they did this, they were then exposed to either the run and gun game featuring cakes or the run and gun game featuring soldiers. After four minutes of play, the game ended and a screen informed the participant that another task was about to begin. Participants are informed by the screen to move to an adjoining computer, where a Lexical Decision Task was ready. Participants were given on-screen instructions detailing how to complete the LDT. Following completion of this task, participants were fully debriefed by the experimenter.

3.2.4 Results

Means and standard deviations for each treatment are presented below. These statistics are based on the log-transformed reaction times of participants.

Game Theme	Word Type	Reaction Time	N.
Cake-themed	Cake	7.09 (0.28)	21
	Soldier	7.19 (0.27)	21
	Total	7.14 (0.27)	21
Soldier-themed	Cake	7.01 (0.25)	19
	Soldier	7.12 (0.27)	19
	Total	7.07 (0.26)	19
Total	Cake	7.05 (0.27)	40
	Soldier	7.16 (0.27)	40
	Total	7.11 (0.27)	40

Table 3-3: Mean reaction times to words for players of cake-themed and soldier-themed games. Standard deviations in brackets.

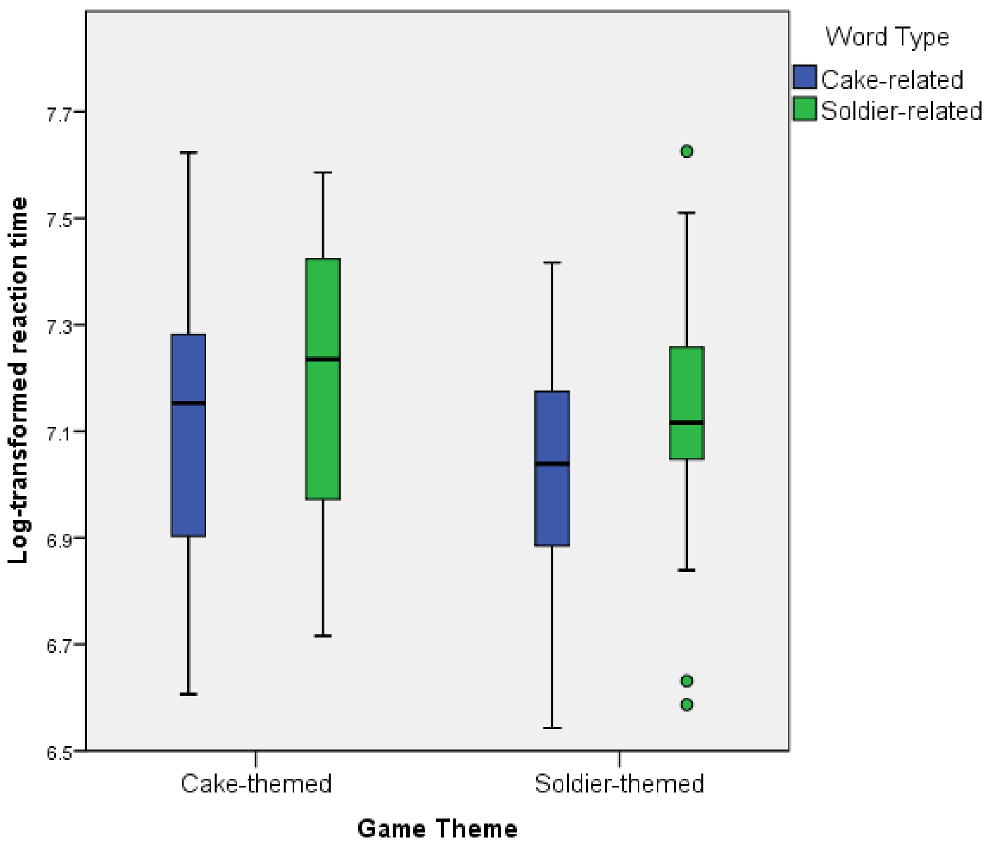

Figure 3-3: Box plot of reaction times to words, split by condition

The effects of game theme (cake-themed, soldier-themed) on reaction times to soldier and cake-related words was tested via a 2x2 mixed-design ANOVA, with game theme as a between-participants factor and word type as a within-participants factor. Results indicated that there was a statistically significant main effect for word types, $F(1,38) = 19.871$, $p<0.001$, $\eta^2 = 0.3450$. There was no statistically significant effect for game themes, $F(1,38) = 0.900$, $p=0.349$, $\eta^2 = 0.023$. There was no statistically significant interaction effect between game theme and word type, $F(1,38) = 0.074$, $p=0.787$, $\eta^2 = 0.001$. A graph showing these effects is presented below as Figure 3-4.

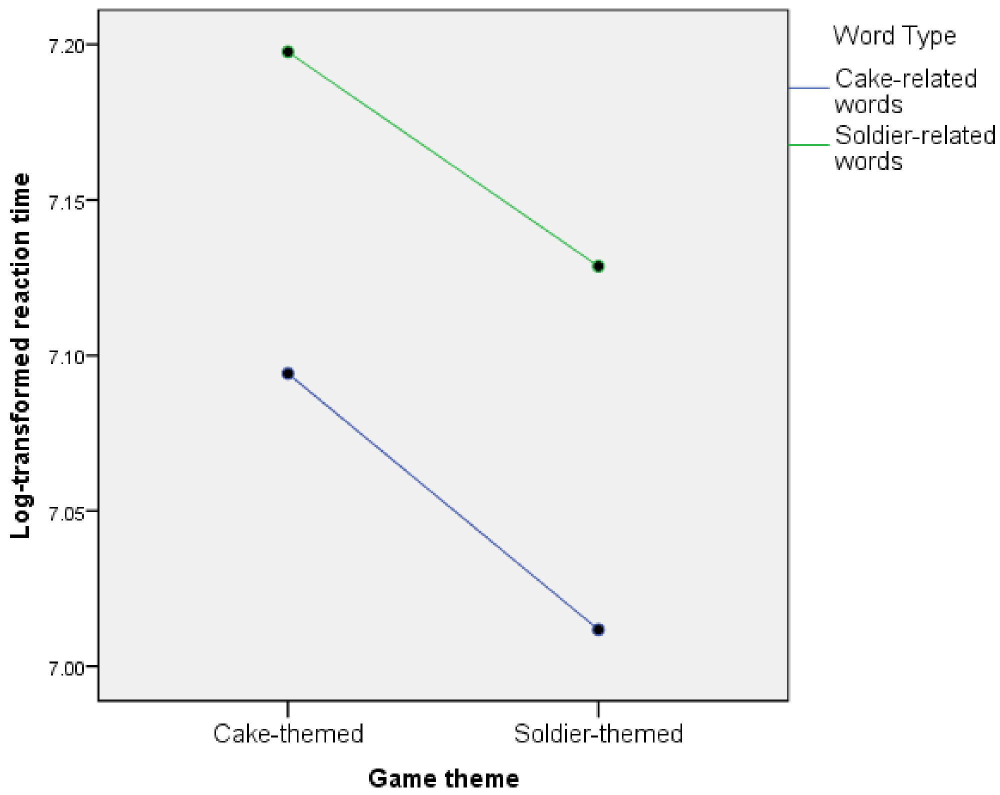

Figure 3-4: Line graph of the interaction between word type and game theme

Following this analysis, the data was further explored by testing for priming effects on non-words as well as words. Means and standard deviations for each treatment for non-words are therefore presented below. These statistics are again based on the log-transformed reaction times of participants.

Game Theme	Non-Word Type	Mean	N.
Cake-themed	Cake	7.19 (0.32)	21
	Soldier	7.30 (0.33)	21
	Total	7.25 (0.32)	21
Soldier-themed	Cake	7.13 (0.24)	19
	Soldier	7.35 (0.31)	19
	Total	7.24 (0.27)	19
Total	Cake	7.16 (0.28)	40
	Soldier	7.33 (0.32)	40
	Total	7.24 (0.31)	40

Table 3-4: Mean reaction times to non-words. Standard deviations in brackets.

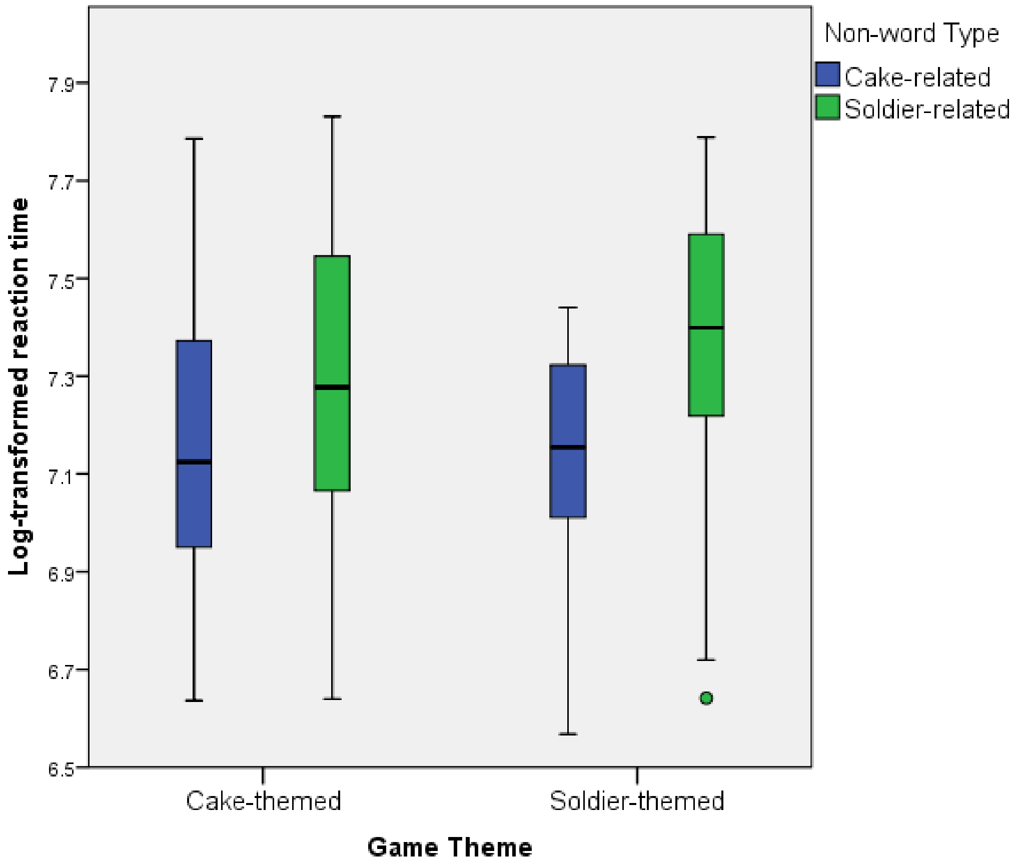

Figure 3-5: Box-plot of reaction times to non-words, split by condition

The effects of game theme on reaction times to soldier and cake-related *non-words* was tested via a 2x2 mixed-design ANOVA, with game theme as a between-participants factor and non-word type as a within-participants factor. Results indicated that there was a statistically significant main effect on Non-Word Type, $F(1,38) = 89.343$, $p<0.001$, $\eta^2 = 0.648$. There was no statistically significant effect on Game Theme, $F(1,38) = 0.004$, $p=0.949$, $\eta^2 = 0.0001$. There was a statistically significant interaction effect between Game Theme and Non-Word Type, $F(1,38) = 10.913$, $p = 0.002$, $\eta^2 = 0.078$. A graph showing these effects is presented below as Figure 3-6.

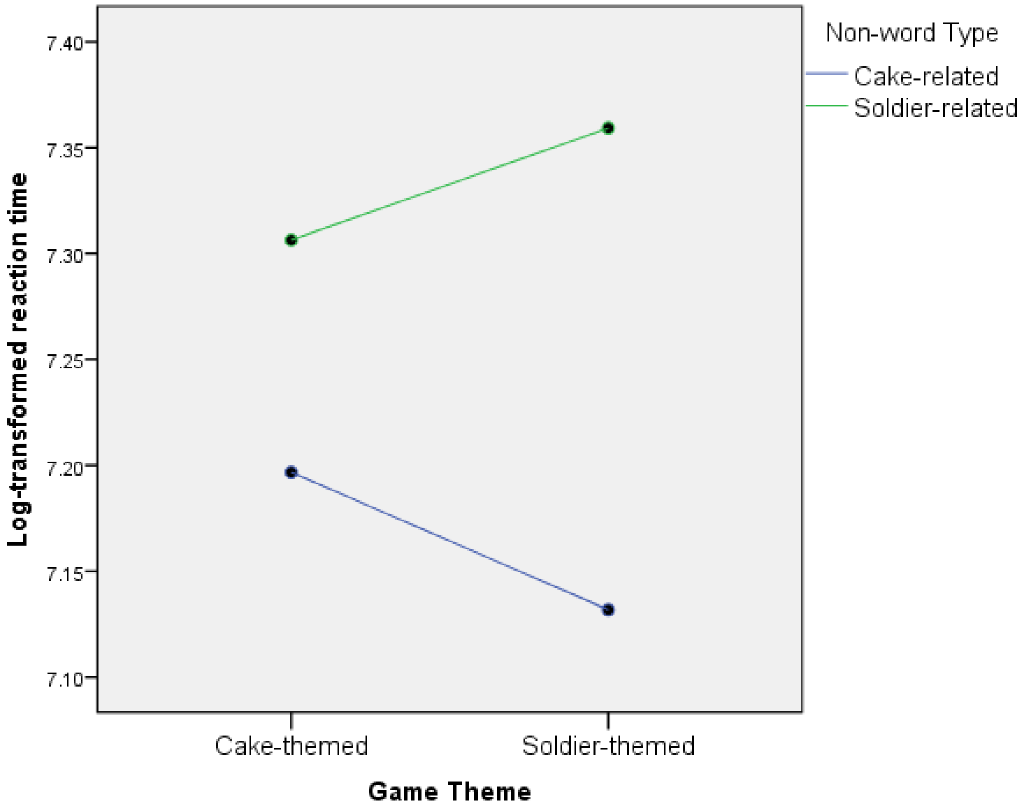

Figure 3-6: Line graph showing the interaction between non-word type and game theme

3.2.5 Discussion

The results of this experiment indicate that neither priming nor negative priming occurred in this case. Analysis of participants' reaction times to words showed no significant interaction effect between game theme and word type. In other words, when people play a soldier-themed game their reactions appeared to be neither slower nor faster for soldier-related concepts, and similarly when people played a cake-themed game their reactions appeared neither slower nor faster for cake-related concepts.

This is surprising. The VVG literature argues that players necessarily process in-game concepts. If this was the case then I would expect for in-game concepts to be primed. However, not only was there no significant difference here between conditions, but the effect size observed was very small ($\eta^2 = 0.001$).

This null result might be observed for a number of reasons. It might be that, as the player experience literature suggests (See Section 2.6.5), a negative priming reaction exists. However, this negative priming effect may be so small that the number of participants used in this experiment (n=40) did not yield enough power to detect it. Alternatively, it might be the case that a very small (positive) priming effect exists, but the setup is again not powerful enough to detect this effect. This explanation of the results might at first seem reasonable as the VVG literature is famously built on the existence of small priming effects. However, even the 'small' effects observed in the VVG literature are nowhere near as tiny as the effect seen here. Whilst VVG effects are commonly placed at around r=0.20 (See Section 2.6.2), converting the priming effect observed in this study ($\eta^2 = 0.001$) to r yields only approximately r=0.03. It therefore seems unlikely that the null result here is just a typical priming effect, rendered insignificant by low experimental power.

Another possibility is that this null result might have been caused by the accidental negative priming of soldier-related concepts in both conditions. The run and gun genre was initially selected because I felt it would be easy to reskin to form two different conditions which each featured different concepts. However, during experimental design I did not consider that this kind of game may be connected to one of the two concepts whose priming I was interested in – soldiers. It is hard to think about the mechanics of a run and gun game without using words which are in some way related to soldiers, such as like 'projectile' and 'target'. So, in one sense, *both* conditions in this game might be associated with soldiers because they both involve shooting things. After all, the genre itself is called run and *gun*. However, neither the avatar in the soldier-themed condition nor the avatar in the cake-themed condition behaved like a real soldier. Therefore in order to play these games successfully, players in *both conditions* may have had to ignore the soldier-related concepts which were suggested by each game's underlying gun-based mechanics. This possible explanation of the experiment's results is supported by the large main effect observed for word type, with participants across both conditions responding significantly slower to words which were related to soldiers than they did to words which were related to cakes.

Adding to this confusing picture is the significant negative priming effect which *was* obtained on non-words. As seen in Figure 3-6, players of a soldier-themed game were slower at reacting to soldier-related non-words, whilst players of a cake-themed game were slower at reacting to cake-themed non-words. This effect might initially seem to strongly support the hypothesis that negative priming happens in video games. However, it is best to treat this result with extreme caution. The reason for this caution is primarily that it is unclear why this part of the LDT might show a significant effect whilst the 'words' portion did not. Whilst the literature contains examples of non-words being primed in an LDT in a similar way to words, there is no evidence for why they might be negatively primed when words are *not* negatively primed.

3.3 Priming in Maze Games

3.3.1 Introduction

The first experiment in this chapter did not produce a clear-cut case for the presence of either priming or negative priming as a consequence of playing video games. However, it seems possible that this lack of a conclusive result may be due to the presence of either a small effect size or an inappropriate choice of game genre. In order to get a better picture of how priming works in video games, I ran a second experiment which aimed to minimise the impact of these factors. This experiment was similar to the previous one in that participants played a video game which was reskinned to show different concepts. However, it used a different genre of game and a larger number of participants. In this experiment, I had participants play a maze game which had either a vehicle theme or an animal theme. I then tested after play for the priming of these concepts via an image categorisation task.

In maze games, the player controls an avatar which moves through the complex and often confusing passageways of an environment in order to reach a goal. In addition to this navigation-based gameplay, games of this genre often incorporate a variety of other mechanics. For instance, maze games often contain bonus items which players can try to pick up whilst traversing the maze. They also frequently incorporate exits which the player aims to find, and time limits which place additional pressure on the player to reach these exits. As in the case of games like *Pac-Man,* maze games can also contain other hostile characters within the maze itself.

There are several reasons why the maze genre seemed like a good fit with this experiment. First and foremost, in contrast to the run and gun genre, maze games did not seem to be closely tied to a specific set of concepts. Mazes have been the core conceit of games with themes as diverse as zombies (*The Last Guy*, 2008), eating (*Pac-Man Championship Edition*, 2007), and spelunking (*Spelunky*, 2008). In addition to this factor, it was important to use a representative game in this experiment in order to allow its results to also apply to other video games. Maze-based video games have remained popular for over 40 years (e.g. (*The Amazing Maze Game*, 1976)). Using this genre should therefore make the results of this experiment generalise well to other real-life settings. Finally, maze games appeared to be a good choice as they do not require complex controls to play, and can be easily ‘picked up and played’ by experimental participants.

The choice of concepts followed the selection of game genre. I decided one game would have a vehicle-based theme and the other would have an animal-based theme. The reason for selecting these specific themes was rooted in a desire to have representative mechanics in my maze game. These included things like obstacles, exits, and bonuses. I therefore needed any themes I would use to contain concepts which fit each of these gameplay mechanics. As described later in this section, this was the case for the vehicle/animal themes. As in the previous experiment, these themes were also selected for their dissimilarity. Having two games with overlapping themes might end up with both conditions priming similar concepts, and ultimately lead to a false negative. An additional reason for selecting these specific concepts is because they allowed me to quickly set up a way of measuring priming by using standardised banks of vehicle-related and animal-related images in an image categorisation task.

In order to test for negative priming I again needed a way of measuring the priming of both sets of concepts. As mentioned above, in this experiment I chose to measure this via an image categorisation task. One important reason for using this procedure was because of pre-existing lists of animal-related and vehicle-related images. Standardised banks such as (Snodgrass and Vanderwart, 1980) and (Rossion and Pourtois, 2004) contain lists of images which are related to various categories, including animals and vehicles. These stimuli are explicitly intended for use in tasks like image categorisation. Therefore, by using an image categorisation task I avoided spending additional time creating new sets of vehicle-related and car-related stimuli myself. The choice of an image categorisation task is also supported by its academic pedigree. Image categorisation has repeatedly been used to reliably detect negative priming effects in the cognitive psychology literature (See Section 2.4.4). Finally, the use of an image categorisation task was used in this study because it was recommended for use in this context by Steven Tipper, an academic who is an expert in studying negative priming effects (e.g. (Tipper, 2001, 1985; Tipper and Driver, 1988)) (personal communication)

3.3.2 Method

Aim

This experiment aimed to investigate whether the priming effects seen in the VVG literature remain when known confounds are removed from an experimental design.

Hypothesis

The VVG literature predicts that priming should happen in this case. However, the game experience literature suggests the opposite – that negative priming may occur. Therefore, I hypothesise that either negative priming or priming will occur here. Or, more formally:

H1: Reaction times to animal-related images on an image categorisation task will either be slowed or speeded for people who play an animal-themed game, whilst reaction times to vehicle-related images on an image categorisation task will exhibit a similar relationship for people who play a vehicle-themed game.

Design

The experiment had a 2 (game theme) x 2 (image type) mixed design. Participants played either an animal-themed maze game, or a vehicle-themed maze game. Each participant was then tested for their reaction times to both animal-related and vehicle-related images on an image categorisation task.

Measures

An image categorisation task was used to measure the priming of both animal-related and vehicle-related concepts. In this task, participants were repeatedly shown images of either vehicles (e.g. a train) or animals (e.g. a dog). They were then asked to categorise these images as belonging to either vehicles or animals by pressing either the left or right arrow keys (see Figure 3-7 below). The specific images which were used in this task consisted of 10 animal-related images and 10 vehicle-related images. These were taken from (Rossion and Pourtois, 2004), which is a standardised bank of images intended for use in tasks like image categorisation, and are included in this thesis as Appendix F. This task was administered via a dedicated laptop with a 15.6” monitor, i7-4702MQ processor, G740M 2GB graphics card, and 8 gigabytes of RAM.

Figure 3-7: An image categorisation task trial

The reaction times of each participant to vehicle-related images was used to measure their priming of vehicle-related concepts. The reaction times of each participant to animal-related images was used to measure their priming of animal-related concepts (See Section 2.4.4). In order to do this, following eight training trials, each participant's correct reaction times to both animal-related images and vehicle-related images were recorded separately. Reaction times were also log-transformed in the same fashion as in the previous experiment. Natural logarithms of reaction times in milliseconds were again used in this experiment.

Games

The maze game used in this experiment was played from a top-down perspective. Players controlled an avatar which was trapped in a labyrinth of tight and twisting passages. Whilst moving through this maze, the player had to avoid moving obstacles whilst picking up bonuses and attempting to find an exit point. This search, avoidance, and bonus-collecting continued for 200 seconds, after which the game ended. Despite the players being told to look for an exit, in order to ensure that all players played the game for the same length of time, no exit was included in the maze.

Whilst the gameplay was identical in both conditions, the concepts depicted in each game varied. In the vehicle-themed condition, the player took on the role of a car, avoided trucks, and collected tyres while looking for a garage. In the animal-themed condition, the player took on the role of a mouse, avoided cats, and collected cheese whilst looking for a mouse-hole. Both games are displayed in contrast to each other below as Figure 3-8 and Figure 3-9.

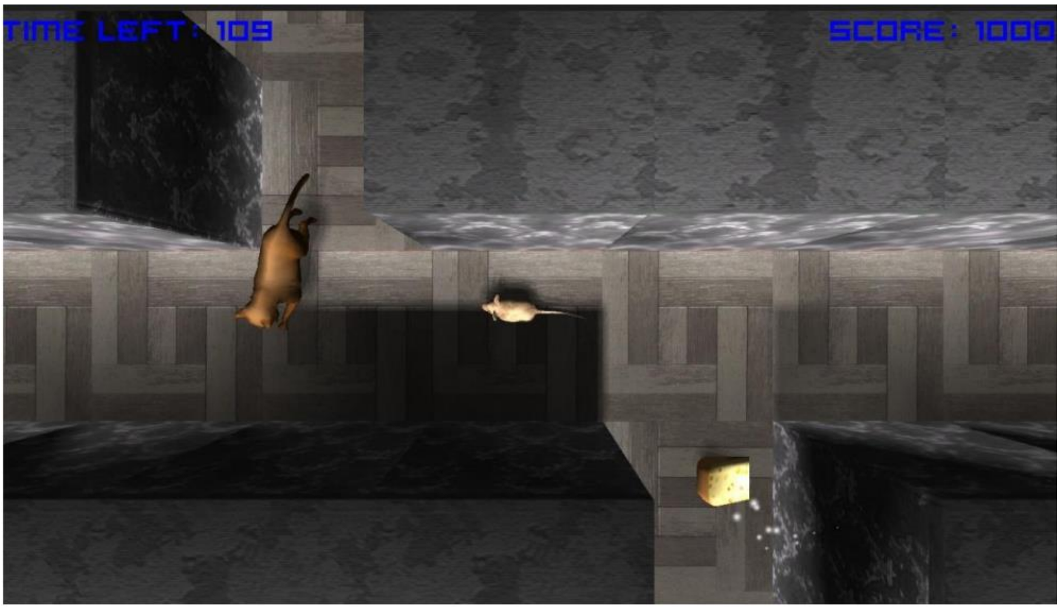

Figure 3-8: The animal-themed maze game

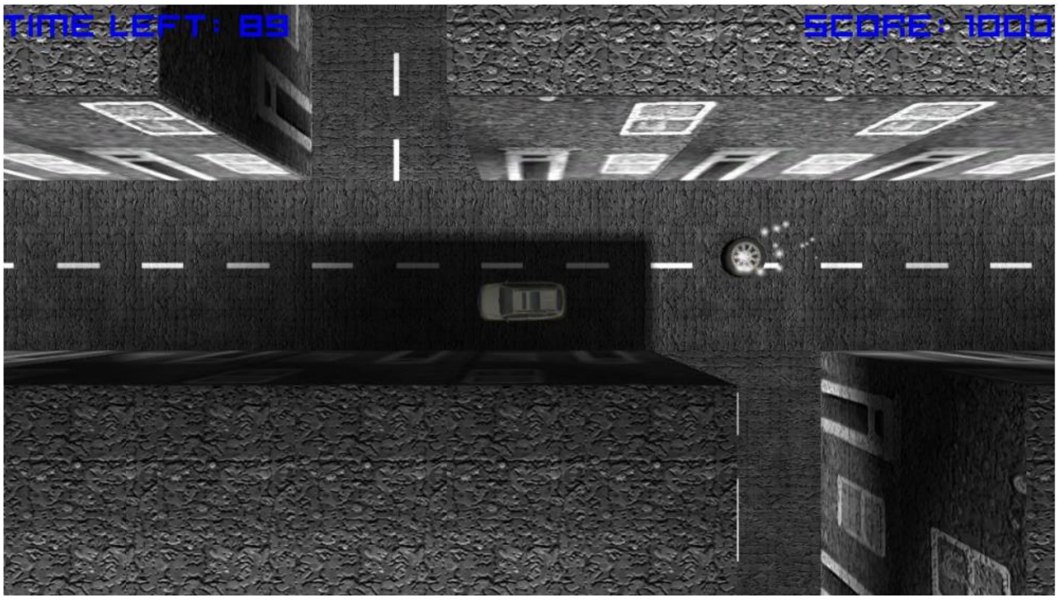

Figure 3-9: The vehicle-themed maze game

Participants

74 native English speakers took part in the experiment. Participants were randomly assigned to experimental conditions, with 37 playing the game which featured animal-themed concepts and 37 playing the game which featured animal-themed concepts. 46 of the participants were aged 18-24, 15 were aged 25-29, 11 were aged 30-34, and the remaining 2 were aged 35 or older. Participants were offered a bar of chocolate in exchange for taking part in the experiment.

Procedure

After agreeing to take part in the experiment, participants were given an informed consent sheet, which is included in this thesis as Appendix G. Participants were then guided to a desk with a computer and informed that the experimenter would not talk to them for the rest of the experiment unless absolutely necessary. The screen in front of them showed them a set of instructions for how to play the maze game. As with the previous experiment, these instructions did not mention any words related to the theme of the game that was being played. Instead, they used images to show participants how to play the game (See Figure 3-10 below).

Figure 3-10: Instructions for the vehicle--themed game

After reading the game's instructions and indicating that they wanted to continue, participants were then exposed to either the animal-themed maze game or the vehicle-themed maze game. In order to engage participants with the game, they were told in the instructions to try to find an exit before a timer ran out. After 200 seconds of play, the game ended and a screen informed the participant that another task was about to begin. Participants were informed by the screen to move to an adjoining computer, where the image categorisation task was set up and ready to begin. Participants were given on-screen instructions detailing how to complete this task. Following completion of this task, participants were fully debriefed by the experimenter.

3.3.3 Results

Means and standard deviations for each treatment are presented below. These statistics are based on the log-transformed reaction times of participants.

Game Theme	Image Type	Reaction Time	N.
Animal-themed	Animal-related	6.43 (0.15)	37
	Vehicle-related	6.49 (0.21)	37
	Total	6.46 (0.18)	37
Vehicle-themed	Animal-related	6.41 (0.15)	37
	Vehicle-related	6.52 (0.19)	37
	Total	6.47 (0.17)	37
Total	Animal-related	6.42 (0.15)	74
	Vehicle-related	6.50 (0.20)	74
	Total	6.46 (0.17)	74

Table 3-5: Mean reaction times to images for players of animal-themed and vehicle-themed games. Standard deviations in brackets.

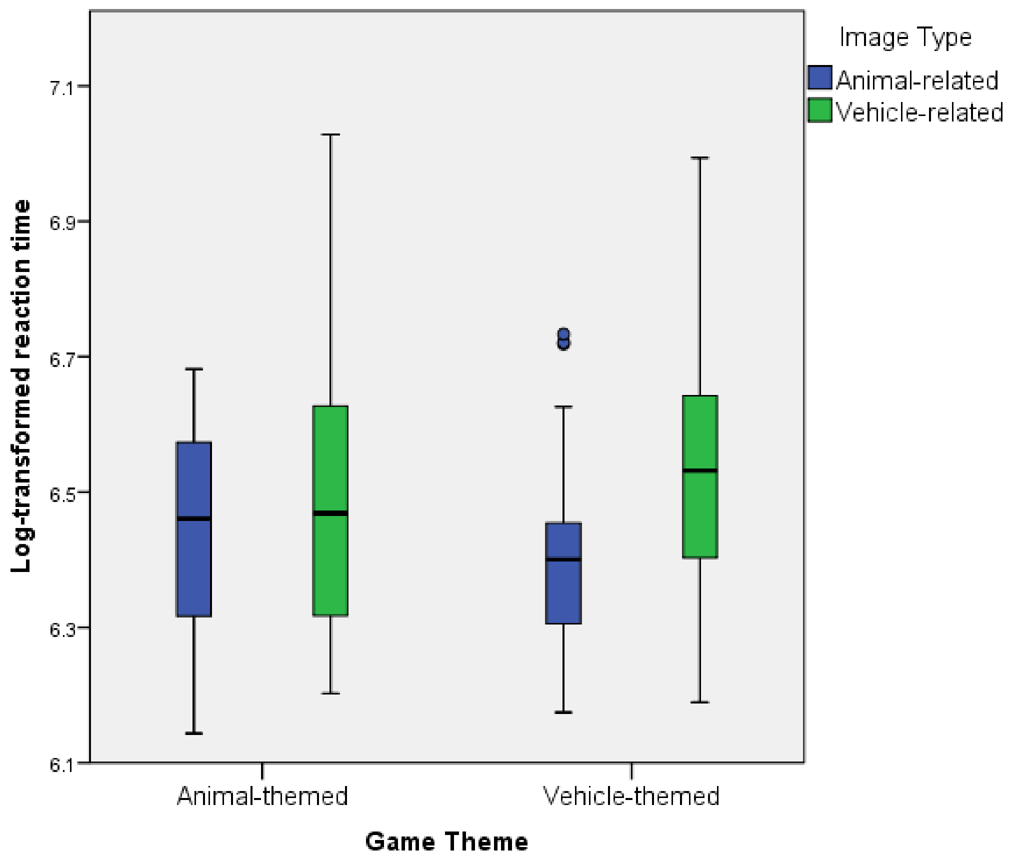

Figure 3-11: Box-plot of reaction times to animal-related and vehicle-related images, split by condition

The effects of game theme (animal-themed, vehicle-themed) on reaction times to animal and vehicle-related images was tested via a 2x2 mixed-design ANOVA, with game theme as a between-participants factor and image type as a within-participants factor. Results indicated that there was a statistically significant main effect for image type, $F(1,72) = 39.489$, $p<0.001$, $\eta^2 = 0.338$. There was no statistically significant effect for game theme, $F(1,72) = 0.012$, $p=0.914$, $\eta^2 = 0.0001$. There was a statistically significant interaction effect between game theme and word type, $F(1,72) = 5.014$, $p=0.028$, $\eta^2 = 0.043$. A line graph showing these effects is presented below as Figure 3-12.

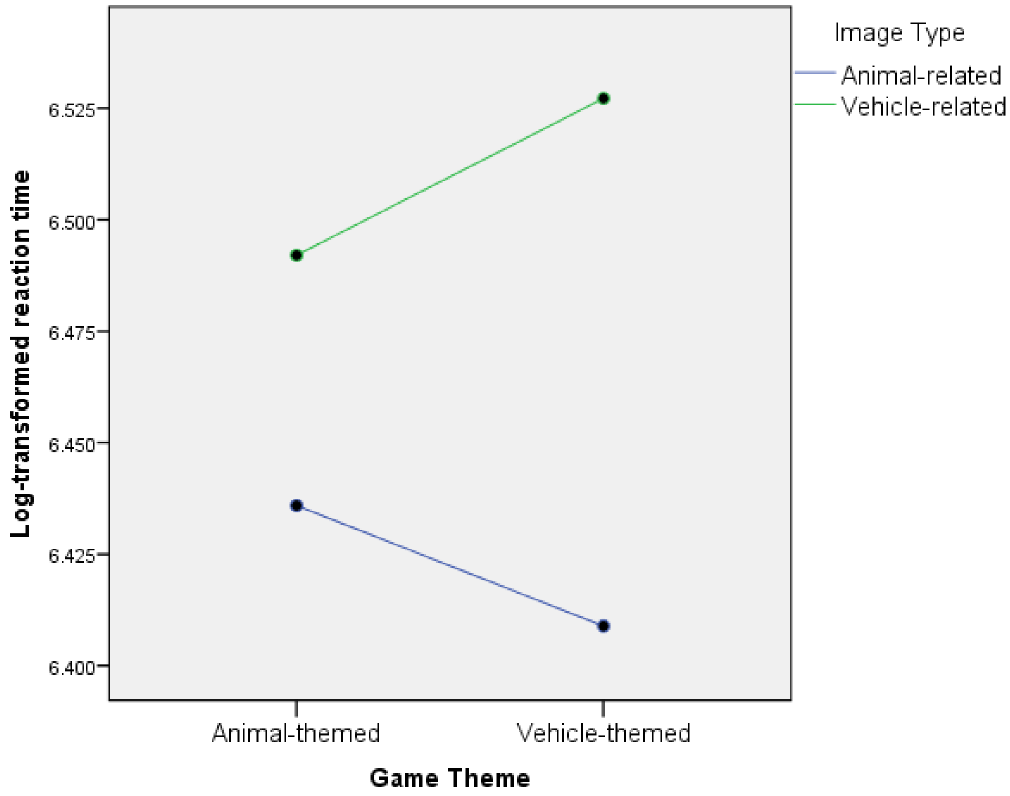

Figure 3-12: Line graph showing the interaction between image type and game theme

3.3.4 Discussion

This experiment suggests that playing video games does not lead to priming. Players of the animal-themed games were not faster at categorising animal-related images, whilst players of the vehicle-themed game were not faster at categorising vehicle-related images.

However, in addition to this, the results of this experiment suggest that playing video games can lead to *negative* priming. As seen in Figure 3-12, a significant interaction occurred between image type and game theme. Players of the animal-themed game were slower at reacting to images of animals (-6.43 vs. 6.41), whilst players of the vehicle-themed game were slower at reacting to images of vehicles (6.52 vs 6.49).

It is interesting that I obtained such a clear indication of negative priming in this experiment, but not in the previous one. This result might be due to changes I made to this experiment's design. The use of a maze game rather than a run and gun game may have eliminated variance in priming associated with that particular genre of game in the previous experiment. Additionally, using a larger sample size might have enabled the detection of smaller negative priming effects. The statistics largely bear out these conclusions. Whilst the negative priming effect observed in this study was small, it was still many times larger than the putative effect observed in the previous experiment ($\eta^2 = 0.043$ as opposed to $\eta^2 = 0.001$). In other words, whilst less than 5% of the observed variance in reaction times in this study could be chalked up to negative priming, in the previous study less than *0.1%* of it could. Therefore, it would seem that changing game genres caused a large reduction in the amount of noise present in this experiment. This supports the idea that the run and gun genre might not have been an ideal choice for an initial experiment. Furthermore, whilst the effect of $\eta^2 = 0.043$ was larger than the one observed in the previous experiment, it was still small. The existence of such a delicate negative priming effect supports the decision to use a larger number of participants in this experiment in comparison to the previous one (n=74 to n=40).

A final reason for why negative priming effects might have been seen here but not in the previous task is due to how this priming was measured. Whilst the previous experiment used an LDT, this experiment used an image categorisation task. Overall, participants completed the image categorisation task much more quickly than the LDT. Not only did the image categorisation task have fewer trials than the LDT (20 in comparison to 72), but the image categorisation task's trials were individually completed more quickly than their counterparts within the LDT (6.46 in comparison to 7.11). In fact, converting these log-transformed scores back into 'raw' reaction times reveals that image categorisation trials were completed almost twice as quickly as LDT trials (639ms in comparison to 1224ms). Since priming is well-known to decay rapidly, it may be that the briefer image categorisation task was more able to capture negative priming effects than the lengthier LDT.

3.4 Priming at short exposures

3.4.1 Introduction

The previous experiments in this chapter paint a vivid picture of what priming might look like in video games when confounds are removed from experimental designs. Not only do these experiments suggest that priming does not happen when people play video games, but they even seem to show that negative priming may instead occur. This effect in turn suggests that players ignore in-game concepts, which is an idea that features heavily in the gaming literature (See Section 2.6.5).

However, precisely *when* this negative priming occurs during play is unclear. It might be the case that players gradually realise that the skin of a particular game is meaningless, and only ignore in-game concepts after long periods of time. In this case, short lengths of play might lead to priming whilst longer lengths might lead to negative priming. Conversely, video game players may immediately ignore the theme which a game is skinned with in order to focus on the mechanics. In this case, negative priming would set in almost immediately during play.

The question of how priming (and negative priming) function over time has important consequences for understanding how VVGs affect their players. If it takes long periods of time for negative priming to set in, players of VVGs might still spend a substantial amount of time at the beginning of their play sessions being primed by in-game concepts such as guns and killing. This would support the proposed effects of models like the GAM, which rely on the activation of aggression-related concepts during play. However, if players immediately ignore in-game concepts as soon as they start playing a game, then it would seem unlikely that any substantial priming of aggression-related thoughts happens at any point whilst playing many VVGs. However, previous research on this subject is unclear. Experimental research in the literature has thus far failed to strongly support the existence of a causal relationship in which greater amounts of time playing a VVG lead to greater amounts of priming (See Section 2.6.3).

In order to investigate this issue, I had participants play an online vehicle-themed infinite runner game for either 0, 20, or 120 seconds before testing them for priming via the image categorisation task. How priming changed over time could therefore be determined by comparing reaction times between lengths of exposure (i.e. 0 seconds vs. 20 seconds vs. 120 seconds). If priming (or negative priming) occurs immediately, then there should be a significant interaction effect between measurements taken at 0 and 20 seconds. Conversely, if priming (or negative priming) takes longer to set in, then this effect should instead be seen between 20 and 120 seconds.

This experiment was in some respects very similar to the ones described earlier in the chapter. Participants played a bespoke video game, and were tested for priming via the image categorisation task. However, there were also several key differences between this experiment and the previous ones. To begin with, only a single bespoke game was used in this experiment as opposed to multiple reskinned conditions. Additionally, this experiment took place online rather than in the laboratory. Finally, the genre of game used in this experiment was different to the ones used previously.

An infinite runner game was used in this experiment. This specific genre of game was chosen in order to lend further support to the ecological validity of my findings. Previous experiments have shown negative priming effects on games which are representative of two different widely-played genres. In order to continue with this theme and provide further evidence that negative priming is an effect which generalises across a variety of contexts, I used a similarly popular genre in this experiment – the infinite runner. Infinite runner games such as *Canabalt* and *Temple Run* are extremely widely-played. *Temple Run* itself has reportedly been downloaded over 1 billion times (Webster, 2014). These games involve the player constantly moving through a procedurally generated series of obstacles. These obstacles can often only be avoided through split-second timing and quick reflexes on the behalf of the player. Furthermore, obstacles often become increasingly dense or complex as the game continues, and the speed of play is usually increased over time in order to add an extra layer of difficulty to the game.

In this experiment, participants played a game with a single theme (vehicles) for one of three periods of time. This is in contrast to previous experiments in which participants played a game with one of two different skins. Due to this change in method, negative priming is measured slightly differently in this experiment. In this experiment, rather than compare games which feature different concepts, I instead compare *the same game*, but played for *different lengths of time*. This involves two separate sets of comparisons:

1. In order to find out whether playing the game for short periods of time led to priming or negative priming, I checked whether participants' reactions to vehicle-related images wereslowed or speeded after playing the game for 20 seconds in comparison to not playing the game at all.

2. In order to find out whether playing the game for longer periods of time led to priming or negative priming, I checked whether participants' reactions to vehicle-related images were slowed or speeded after playing the game for *120* seconds in comparison to not playing the game at all.

The reason for this change in both design and measurement was due to a complementary change in the aims of this experiment. Whereas previously I needed to find out whether negative priming happened *at all*, in this experiment I was instead interested in finding out about how it behaves over time.

Addressing this new aim using a similar setup to the previous experiments would require at least two factors and four treatments. Not only, as before, would the theme of the game have to vary between participants, but the amount of time which it was played for would need to differ too. This seemed overly complex and I instead used the experimental design outlined above.

However, despite this consideration, several factors suggested that much larger sample sizes would be needed in this experiment. To begin with whilst the experimental design which I used was as simple as possible, it was still more complex than the ones used in previous experiments, with three separate treatments rather than two. Furthermore, the use of multiple comparisons in the experimental design necessitated the use a statistical correction in order to avoid a risk of false positives, and therefore required a larger sample size than was used previously in order to achieve statistical significance.

For the reasons outlined above, it therefore seemed likely that more participants would be needed in this experiment than the previous one. This need for more participants led to the third major difference between this experiment and the previous ones. This experiment was conducted online rather than in a laboratory.

Online Experiments

Running an experiment online rather than in the laboratory is appealing for many reasons. Firstly, whilst laboratory samples are limited to the specific people whom an experimenter can physically get into their laboratory, conducting a study over the internet gives an experimenter access to many thousands of potential participants. Additionally, conducting an experiment over the internet gives experimenters access to several mechanisms to recruit these participants with. These avenues for online participant recruitment include both newsgroups, portal sites, forums and social media (Hooley et al., 2012), as well as newer micro-work platforms such as *Amazon Mechanical Turk*(“Amazon Mechanical Turk - Welcome,” n.d.) and *Crowdflower*(“Make your data useful,” n.d.).

In addition to this advantage when it comes to quantities of participants, some argue that there are also advantages to the *quality* of participants who may be recruited online. Researchers have long been concerned that the widespread use of unrepresentative groups of participants in social science research might influence the ecological validity of this scholarship (e.g. (Sears, 1986)). Online experiments are argued to allow access to a greater diversity of participants (Nosek et al., 2002), and hence arguably more generalizable results. Whilst some online groups may be just as unrepresentative as their laboratory-based equivalents (Skitka and Sargis, 2006), this is not thought to be the case when it comes to online game experiments. More specifically, internet-based methods are thought to potentially allow experimenters access to large representative populations of gamers who would could not easily be recruited using a traditional laboratory-based setup (Wood et al., 2004). In addition to the participant-related benefits discussed above, there are various other advantages of this approach. For instance, as experimenters are not physically present, experimenter effects and demand characteristics are thought to be reduced, if not eliminated in online experiments (Joinson, 2007).

However, online experimentation is not without limitations. These largely centre on a lack of experimental control. For instance, whilst it would be difficult for a 20-year old to masquerade as a 70-year old in a laboratory experiment, such a thing is perfectly possible in most online experiments. Similarly, in an online experiment a single participant’s responses may actually be given by a combination of two people. Likewise, what appears to the online experimenter to be two participants may actually be merely one (Nosek et al., 2002). In the same vein, whilst experimenters in the laboratory can monitor a participant’s behaviour in order to make sure that they are “involved and serious”(Kraut et al., 2004), the same is not true of online experiments. In this case it is comparatively more difficult for experimenters to determine whether a participant’s results are genuine, and whether they are the product of either intentional or unintentional deception (Reips, 2000). Whilst the issues outlined above cannot be completely eliminated, there are several considerations which researchers can make to mitigate their effects. For instance, potentially “non-genuine” responses can be identified within a dataset as they tend to be either inconsistent or extreme (Wood et al., 2004). They can then be excluded from analysis. In a similar fashion, participants themselves can be screened. This can be done using a variety of methods, including asking participants negatively-scored ‘trick’ questions, requiring participants to sign-in, or checking each participant's IP address to prevent a single person participating in an experiment more than once (Nosek et al., 2002). Additionally, online experiments may require larger sample sizes in order to compensate for the behaviour of participants who are "not diligent"(Kraut et al., 2004). These strategies appear to be effective, with several reviews of online experiments reporting that they produce similar results to their laboratory equivalents (e.g. (Dandurand et al., 2008; Gosling et al., 2004; Lutz, 2015)).

Taking an online approach is common in studies of player experience. For instance, (Bowey et al., 2015) used an online game experiment to investigate how players' leaderboard positions influence their experience of need satisfaction. The researchers used Amazon Mechanical Turk to recruit 155 participants, who were placed in two conditions. Participants in one condition played a simple online video game, were shown that they were high on a leaderboard, and then took an online questionnaire testing need satisfaction. Participants in the other condition played the same game, were shown that they were *low* on a leaderboard, and took the same questionnaire. Results showed that being high on a game's leaderboard led to greater feelings of need satisfaction. In a similar vein, (Klimmt et al., 2007) used an online game experiment to find out whether changing a player's sense of control in a game influenced their feelings of enjoyment. Five hundred volunteers were recruited through online portals. These participants played one of three different versions of a game, and then had their enjoyment measured via an online questionnaire. These conditions differed in how easy to control the game was. Results indicated that in-game enjoyment was related to player perceptions of being effective.

Online experimentation has also begun to feature in the VVG literature. For instance, in (Williams and Skoric, 2005), researchers were interested in finding out whether playing a violent online game led to long-term increases in aggression-related cognitions and behaviours. Therefore, they recruited 213 participants via online message boards. Some participants played a violent online game for a month, whilst others acted as a control group and did not play a game. Both groups completed measures of aggression-related cognitions and behaviours before the experiment began, and again after a month. Results indicated that playing a VVG had no effect on aggression-related variables.

3.4.2 Method

Aim

This experiment aims to investigate whether priming or negative priming happen after very short exposures to video games, or if these effects only occur once players have played a game for a longer period of time

Hypothesis

The VVG literature contains no reliable evidence regarding how quickly priming sets in during play. It is therefore unclear whether priming occurs even after players have only been exposed to a game for a short period of time (such as 20 seconds), or if this effect takes a longer period of time to occur (such as 120 seconds). In order to test whether priming (or negative priming) occurs after 20 seconds, it is necessary to compare the reactions of people who have not played a game at all with those who have played it for 20 seconds. To see whether this effect occurs after 120 seconds, it is necessary to compare the reactions of people who have not played a game at all with those who have played it for 120 seconds. Or, more formally:

H1: Playing a vehicle-related infinite runner game for 20 seconds will either cause the slowing of reactions to vehicle-related images in comparison to animal-related images in comparison to people who have not played that game at all, or the speeding of reactions to vehicle-related images in comparison to animal-related images.

H2: Playing a vehicle-related infinite runner game for 120 seconds will either cause the slowing of reactions to vehicle-related images in comparison to animal-related images in comparison to people who have not played that game at all, or the speeding of reactions to vehicle-related images in comparison to animal-related images.

Design

The experiment had a 3 (length of play) x 2 (image type) mixed design. One group of participants had their reaction times measured before they played a vehicle-themed infinite runner game. A second group of participants had their reaction times measured after 20 seconds of play. A third group had their reaction times measured after 120 seconds of play. Reaction times were measured to both vehicle-related and animal-related concepts. These were transformed by taking the natural logarithm of reaction times, as in previous experiments.

Measures

The image categorisation task was again used to measure the priming of both animal-related and vehicle-related concepts. The reaction times of each participant to vehicle-related images was used to measure their priming of vehicle-related concepts. Since there was only a single target in this measurement procedure, the reaction times of each participant to animal-related images was used as a control, as described in Section 2.4.

In order to do this, following eight training trials, each participant's correct reaction times to both animal-related images and vehicle-related images were recorded separately. Reaction times were also log-transformed in the same fashion as in previous experiments.

It is important to also point out that due to the use of multiple (2) comparisons in this experiment, Bonferroni corrections were used to avoid a risk of false positives. Thus, in this experiment $\alpha = 0.025$.

Games

The infinite runner game used in this experiment attempted to reproduce the fast-paced gameplay of games like *Temple Run*, but using a car-based theme. Participants took on the role of a small SUV, driving into increasingly dense traffic. In order to survive, the participant had to quickly anticipate where to place himself on the road, and switch lanes accordingly. This was done with the left and right arrows. As time passed, the participant's car travelled at a steadily increasing pace. The distance which they have covered was recorded in the top right corner of the screen. If the participant's vehicle collides with any part of the traffic he is driving against the screen faded to white and the participant was told if the distance he has achieved is a 'personal best'. The game then begins over again. This pattern of interaction continued until the participant reached one of the time limits described above. The game is shown below as Figure 3-13.

Figure 3-13: Vehicle-themed infinite runner game

Participants

This experiment took place online. The infinite runner was placed online on popular video game portal websites (i.e. 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 (i.e. I set up a Facebook page for the game and encouraged participants to share it with their friends via social media).

460 native English speakers took part in the experiment. 342 participants were men, 101 were women, 9 identified themselves as 'Other', whilst 8 preferred not to state their gender. The majority (267) of these participants were frequent gamers, playing at least once a day. A further 121 played at least once a week. 36 preferred not to answer the question, whilst the remaining 36 participants played once a month or less. 282 of the participants were aged 18-24, 98 were aged 25-29, 64 were aged 30-34, and the remaining 16 were aged 35 or older.

Participants were randomly assigned to experimental conditions, with 169 taking the image categorisation task before playing the game, 142 taking it after playing the game for 20 seconds, and 149 taking the image categorisation task after playing for 120 seconds.

Procedure

Players first completed an informed consent and demographics screen (included as Appendix H), and indicated that they were ready to begin the experiment. After this, what participants did next differed based on the experimental condition that they were placed in. Players in the ‘0 Seconds’ length of play condition completed the image categorisation task and then were debriefed via a short video presentation. Players in the ’20 Seconds’ condition first played the game outlined above for 20 seconds, completed the image categorisation task, and then were debrief via the same video. Players in the ‘120 Seconds’ condition played the game for 120 seconds, completed the image categorisation task, and then were debriefed in the same fashion.

3.4.3 Results

Means and standard deviations for each treatment are presented below. These statistics are based on the log-transformed reaction times of participants.

Length of Play	Image Type	Reaction Time	N.
0 Seconds	Animal-related	6.50 (0.27)	169
	Vehicle-related	6.48 (0.26)	169
	Total	6.49 (0.26)	169
20 Seconds	Animal-related	6.40 (0.17)	142
	Vehicle-related	6.43 (0.19)	142
	Total	6.42 (0.18)	142
120 Seconds	Animal-related	6.42 (0.20)	149
	Vehicle-related	6.43 (0.18)	149
	Total	6.43 (0.19)	149
Total	Animal-related	6.44 (0.22)	460
	Vehicle-related	6.45 (0.21)	460
	Total	6.45 (0.22)	460

Table 3-6: Mean reaction times to images for players of the infinite runner game, split by length of play. Standard deviations in brackets.

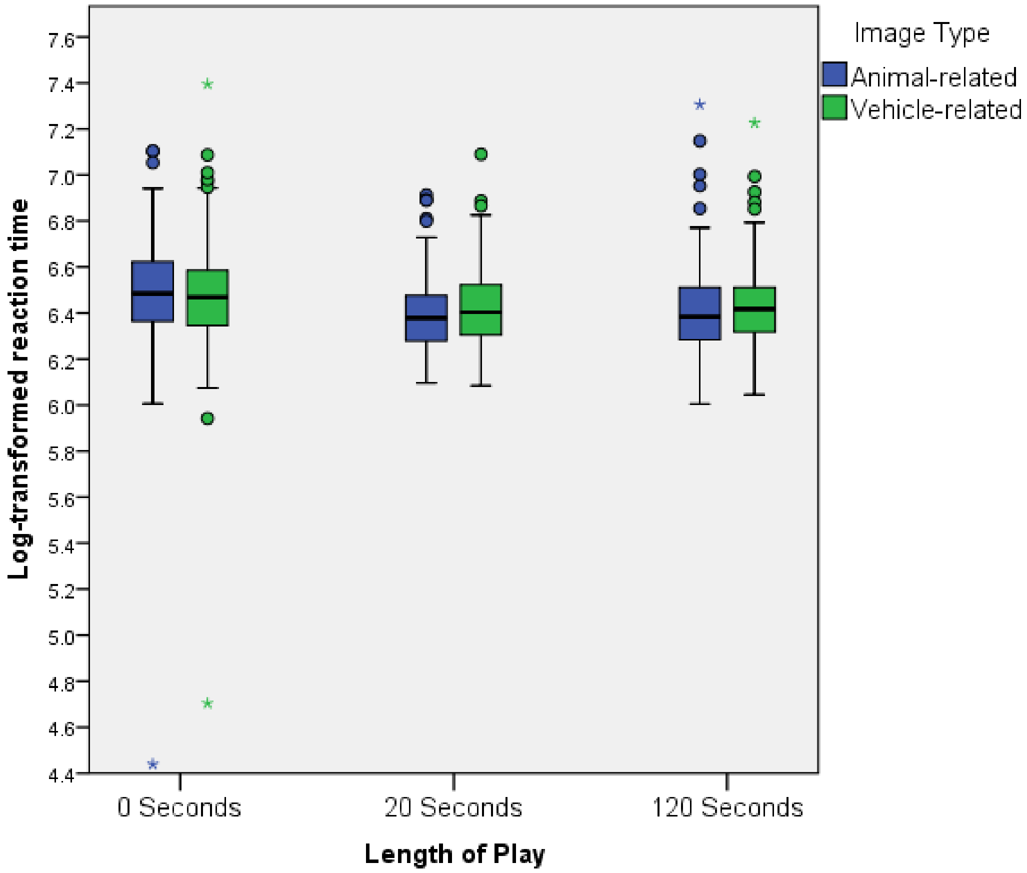

Figure 3-14: Box-plot of reaction times to animal-related and vehicle-related images, split by length of play

The effects of length of play (0 Seconds, 20 Seconds, 120 Seconds) on reaction times to animal and vehicle-related images was tested via a 3x2 mixed-design ANOVA, with length of play as a between-participants factor and image type as a within-participants factor. Results indicated that there was no statistically significant main effect for image type, $F(1,457) = 0.692$, $p=0.406$, $\eta^2 = 0.002$. There was a statistically significant effect for length of play, $F(2,457) = 5.709$, $p=-0.004$, $\eta^2 = 0.024$. There was a statistically significant interaction effect between length of play and word type, $F(2,457) = 3.183$, $p=0.042$, $\eta^2 = 0.014$.

Planned comparisons investigated whether the significant interaction effect occurred between 0 and 20 seconds, or 0 and 120 seconds.

In the first of these comparisons, the effects of length of play (0 Seconds, 20 Seconds) on reaction times to animal and vehicle-related images was tested via a 2x2 mixed-design ANOVA, with length of play as a between-participants factor and image type as a within-participants factor. There was no statistically significant main effect for image type, $F(1,309) = 0.445$, $p=0.505$, $\eta^2 = 0.001$. There was a statistically significant effect for length of play, F(1,309) = 8.334, p=0.004, η^2 = 0.026. There was a statistically significant interaction effect between length of play and word type, F(1,309) = 6.174, p=0.013, η^2 = 0.020.

In the second comparison, the effects of length of play (0 Seconds, 120 Seconds) on reaction times to animal and vehicle-related images was tested via a 2x2 mixed-design ANOVA, with length of play as a between-participants factor and image type as a within-participants factor. There was no statistically significant main effect for image type, F(1,316) = 0.325, p=0.569, η^2 = 0.001. There was a statistically significant effect for length of play, F(1,316) = 6.238, p=0.013, η^2 = 0.019. There was no statistically significant interaction effect between length of play and word type, F(1,316) = 1.597, p=0.207, η^2 = 0.005.

A line graph showing these effects is presented below as Figure 3-15.

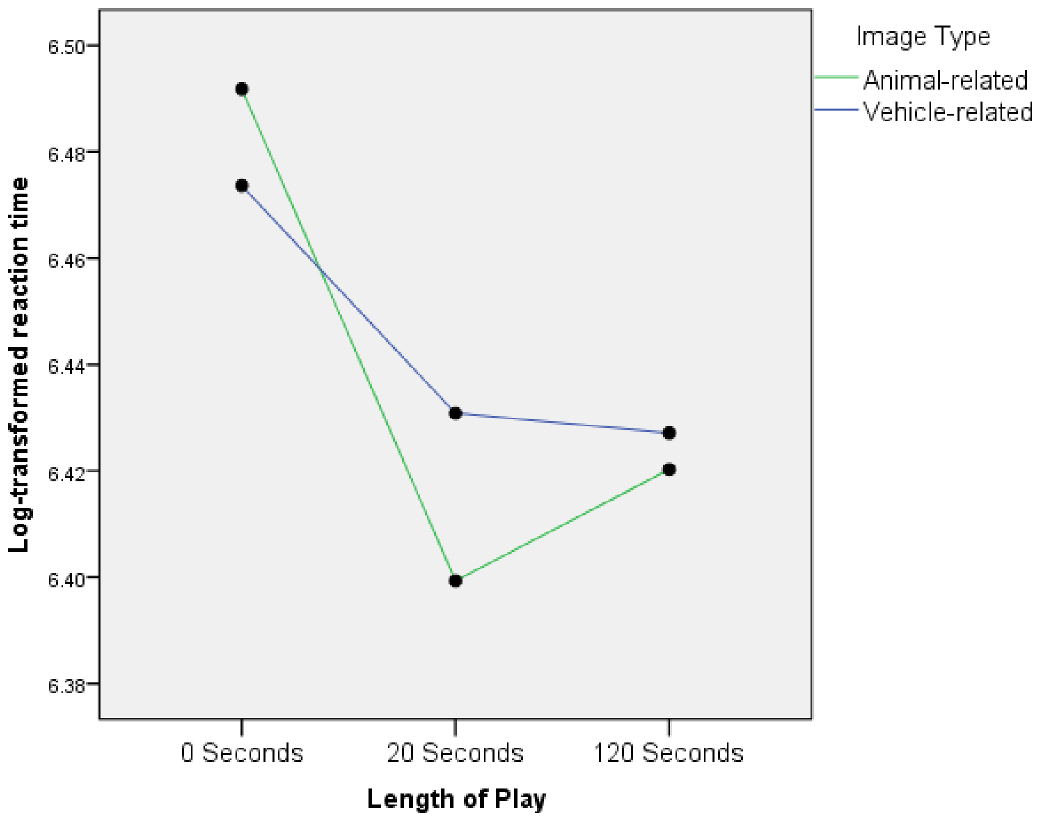

Figure 3-15: Line graph showing the interaction between image type and length of play

3.4.4 Discussion

This experiment again provides evidence that priming does not happen in video games. Neither people who had played the infinite runner game for 20 seconds, nor those who had played the game for 120 seconds, were significantly faster at categorising vehicle-related images than those who had not played the game.

Furthermore, this experiment again suggests that negative priming happens in video games. Indeed, it seems to happen even when people only play a game for 20 seconds. A significant overall interaction effect occurred between image type and length of play. Planned comparisons clarified that this effect occurred between players in the 0 seconds condition (i.e. people who had not played the game at all) and players in the 20 seconds condition. Whilst people who had not played a vehicle-themed game were quicker at reacting to images of vehicles (6.473) than images of animals (6.491), the opposite was true for those who had played the vehicle-themed game for 20 seconds. These participants were instead *slower* at reacting to images of vehicles (6.430) than images of animals (6.399). In other words, playing a vehicle-themed game for 20 seconds caused the relative slowing of reaction times to vehicle-related images, indicating negative priming of this concept.

The effect size associated with this interaction was, however, small (η^2 = 0.020). On the one hand, this result seems in keeping with the small effect sizes observed in previous experiments. These paint a picture of negative priming as an effect with a generally small magnitude. On the other hand, the effect size in this experiment seems particularly small even in comparison to prior results (η^2 = 0.043 and η^2 = 0.078). This shrinkage may potentially be caused by a variety of factors. For instance, it may be due to running the experiment online. Online experimentation is thought to lead to the inclusion of 'nuisance' scores which can inflate the spread of a dataset and thereby make effect sizes seem smaller. This may have been the case here - as shown in Figure 3-14, several extreme outliers were present in the dataset. However, this is not the only explanation for this result. The smaller effect size may alternatively be due to changes in my experimental method. Previously, the interaction effects which I measured were theoretically produced by participants ignoring one concept in one condition, and ignoring another in a second condition. By contrast, in this case no concept was ignored in the '0 Seconds' condition, whilst 'vehicles' was ignored in the '20 Seconds' condition. This change may have led to the smaller effect size observed here.

The argument that negative priming is a small and delicate effect which may be greatly influenced by even subtle changes in experimental setup is supported by a further result within this experiment. Whilst negative priming was observed for participants who had played the game for 20 seconds, no such effect was observed for those who had played it for 120 seconds. This result is interesting because in the previous experiment, people who had played a maze game for a similar length of time (200 seconds) *did* show negative priming. However, as noted above, the way that different time-conditions were compared within this experiment seemed likely to make effect sizes smaller than the method used in previous experiments. This result therefore seems to suggest that when it comes to reliably observing negative priming effects, an experimental setup may be needed which maximises power by having one concept negatively primed in one condition, and another negatively primed in another (as in Experiment 2).

One final point of interest in these results is that the reaction times for participants who had played the game for either 20 seconds of 120 seconds seem to be much quicker overall at categorising *both* types of images when compared to participants who had not played the game at all (6.414 and 6.423 in comparison to 6.482). This observation is borne out by the significant main effect observed between these lengths of play. The reason for this main effect is unclear. Playing fast-paced video games is widely thought to lead to the speeding-up of reaction times to a broad variety of tasks (e.g. (Dye et al., 2009)). This speeding of reaction times to the image categorisation task may just be one instance of the general boost to processing that gaming is thought to provide. Alternatively, this effect might be specific to the control scheme used in the game itself. In the infinite runner game, the player moves around by using the left and right arrow keys. These same keys are then later used in the image categorisation task. It seems possible that practice with a keyboard in the game might lead to a general speed-up on the image categorisation task. However, regardless of its cause, this effect's presence points to one key thing about statistical analysis in experiments like this one. In this case I tested for negative priming by looking for an interaction between reactions to target-related stimuli (i.e. vehicle-related images), and target-unrelated stimuli (i.e. animal-related images). Conducting analysis this way controls for 'global' effects to reaction times like the ones described above. However, if this experiment were only to measure reaction times to target-related concepts, its results would be vulnerable to these effects. For instance, the presence of the large main effect on both kinds of images may have led to a Type I error, and the conclusion that priming rather than negative priming happening here.

3.5 Conclusions

Proponents of the GAM work under the assumption that VVGs prime aggression-related concepts because they have aggression-related themes. According to this view, playing *Call of Duty* might prime the concepts ‘shooting’ and ‘killing’ simply because this game contains depictions of these things. Under the GAM, this activation spreads to other concepts and causes aggressive behaviour through the activation of aggression-related knowledge structures. Furthermore, the GAM argues that this priming can even lead to long-term changes in behaviour through the reinforcement of these knowledge structures (See Section 2.5.2).

However, the results in this chapter fly in the face of this perspective. In this chapter I conducted a series of experiments which investigated whether priming still occurs in video games when known confounds from the VVG literature were eliminated. In order to be additionally conservative, I even made sure to manipulate concepts *other* than aggression in order to minimise potential variance from within-conditions variation in arousal and affect (See Section 2.5.1.2). However, across three experiments and three different representative genres of games I did not *once* find any evidence that playing a video game led to the priming of the concepts which featured in that game. Neither cakes, soldiers, animals, nor vehicles were primed in either run and gun games, maze games, or infinite runners. Neither using 40 participants, nor 74 participants, nor even *460* participants allowed the detection of a priming effect. Since priming does not seem to happen when playing video games *in general*, it therefore does not make sense for it to specifically happen in violent games. Whilst this observation strongly conflicts with the point of view outlined above, it is in keeping with recent research which has questioned whether the priming of aggression-related concepts in the VVG literature really is due to the violent content of these games (See Section 2.6.2). Researchers such as Kneer et al. (2016) instead propose that these effects can be explained by confounding from third factors such as incompetence. The experiments in this chapter used proper controls to eliminate the presence of proper confounds, and repeatedly found no priming effects. The results of these experiments therefore lend further credence to this alternative explanation for priming in the VVG literature.

This lack of a priming effect also suggests similarly important consequences for how the GAM proposes VVGs affect their players. If aggression-related concepts are not primed by games with aggression-related content, then this priming cannot spread to other aggression-related knowledge structures. If these aggression-related knowledge structures are not primed, then their activation cannot lead to short-term aggressive behaviour and their reinforcement cannot lead to long-term aggressive behaviour. In other words, these results suggest that many of the mechanisms for triggering aggressive behaviour which the GAM proposes simply do not function when playing VVGs. However, the lack of a priming effect does not *completely* negate the GAM's prediction that playing VVGs leads to violent behaviour. The GAM is a flexible model, and allows for three different routes by which any situation can lead to both short-term and long-term aggressive behaviour. Even if VVGs do not cause the priming of aggression-related concepts, they may cause changes in either affect or arousal. For instance, a particularly demanding game of *Call of Duty* might make a player angry and aroused in a similar way to a stressful game of tennis. These changes, in turn, may bring about aggressive behaviour. However, as described in Section 2.5.2, the effects of arousal and affect alone on long-term changes in aggressive behaviour are likely to be minimal. As one of the GAM's authors puts it, these routes are likely to lead to "very weak long-term effects or none at all" (Anderson et al., 2010).

Before moving on to discuss other implications of the results of this chapter, it is important to directly address one key limitation of this research. As noted earlier, the experiments contained within this chapter involved manipulating concepts other than aggression in a variety of games, and then generalising the priming of these concepts to VVGs. Whilst this approach has striking advantages, it also has one drawback - it allows the suggestion that these results do not generalise to VVGs. However, it is important to point out that this suggestion seems unlikely. After all, other experiments in the literature in which priming in VVGs have been measured whilst controlling for potential confounds have returned similar results to the ones seen in this chapter (See Section 2.6.2). Furthermore, the literature contains no tenable reason for why the aggression depicted in VVGs might still prime aggression-related concepts when the depiction of other concepts does not prime these concepts. Indeed, the idea that priming happens in a similar way for any arbitrary concept is a key facet of the General Learning Model (GLM).

On the topic of the GLM, it is important to point out that aggression is not the only kind of behaviour which games are theoretically thought to potentially teach. In recent years games have been widely discussed as a possible avenue for people to learn a variety of other, more useful behaviours. When it comes to this learning, however, the absence of a priming effect may prove to be a double-edged sword. As described in Section 2.7, the General Learning Model generalises the GAM to cover the learning of *any* behaviour from games, and not merely aggression-related behaviours. Under the GLM, playing a game which depicts some behaviour leads to the learning of that behaviour. For instance, under the GLM, playing the healthy-eating themed serious game *Squire's Quest* would teach positive behaviours related to ingesting lots of "fruit, 100% fruit juice, and vegetables" (Baranowski et al., 2003). This effect theoretically is caused by the same priming, activation and reinforcement of knowledge structures proposed in the GAM. Since it seems that this process may not happen, it also seems that learning useful behaviours by playing games may be a more difficult process than has previously been assumed.

Thus far this I have discussed the absence of priming effects within this chapter. However, in the three experiments presented here I did not just fail to see priming in video games. These experiments also seemed to suggest that a complementary process of negative priming occurs when people played video games. Furthermore, this negative priming effect appeared to happen even when games were only played for very short periods of time. These results provide experimental evidence for the long-running assertion in video game studies that games should not be considered as simple "extensions of drama and narrative" (Frasca, 2003). A common opinion in video game studies holds that because games are both competitions and representations, players may ignore fictional elements of games in order to compete more effectively. In other words, whilst thinking about soldiers may be an essential part of watching *Band of Brothers* or *Saving Private Ryan*, players of *Call of Duty* may ignore the fact that this game is soldier-themed during play in order to focus on maximising their in-game effectiveness (See Section 2.6.5). The negative priming in these experiments supports this hypothesis. Negative priming occurs when participants have been ignoring a specific concept. The results of this chapter therefore suggest that players of video games really do ignore the concepts which their games are skinned with. Furthermore, it appears to be the case that players begin to ignore in-game concepts very early in play, with the results of the final experiment in this chapter showing negative priming even after only 20 seconds of play.

When it comes to the VVG effects literature, this negative priming effect's existence might challenge the assumptions of the GAM even more strongly than the absence of priming does. The GAM integrates a set of disparate theories which were themselves designed to explain the effects of violent film and television. Critics have long warned that "new media such as games may be functionally different" from these "more passive media" (Williams and Skoric, 2005), and this difference may lead to serious consequences for the GAM's application to video games. This criticism now appears well-founded. The results of this chapter suggest that the unique, interactive nature of video games leads to quite different effects on their players. It looks to be the case that players attempt to 'filter out' the fictional content of games in order to focus on gameplay itself rather than paying attention to and processing this content as the GAM assumes. Consequently, playing video games leads to negative priming rather than priming.

It is interesting that this effect has not previously been observed in the VVG literature. There are several explanations for why this might be the case. The most obvious of these is suggested by how delicate this effect seems to be. The experiments conducted within this chapter appeared to show that negative priming effects were sensitive to even subtle changes in experimental design. The fact that this effect only seems to be easily observable under certain specific setups may explain why it has not been previously observed in the literature. However, there are other alternative explanations for why negative priming may not have been observed in the VVG literature. To begin with, the lack of negative priming effects in the literature may be because the experiments in the VVG literature always measure the priming of aggre*ssion-related* concepts. The GAM itself predicts that factors such as affect and arousal will influence the priming of these concepts (See Section 2.5.1). Because the priming of aggression-related concepts is correlated with affect and arousal, changes in these variables might necessarily make researchers 'miss' real negative priming effects. It also seems possible that a negative priming effect has always happened in VVGs, but the methodology common to the VVG literature has confounded studies and rendered this effect invisible. The experiments in this chapter rigorously control everything *other* than the presence or absence of specific concepts in a game. It seems as though this methodology allows the precision which is necessary to observe small negative priming effects.

From this discussion is might initially seem that the results of this chapter bear important implications for the effects of VVGs. This point of view is supported by both the variety of games in which a lack of priming was seen in during this chapter, by the representativeness of these games, and also by the fact that similar effects were observed both inside the laboratory and in an online experiment. However, it is crucial to note that before the results of this chapter *are* generalised to VVGs as a whole, it is important to take into account a third possible reason for the disparity between the results in the VVG literature and the results observed in this chapter. This reason is to do with realism.

As noted in Section 2.8, the increasing realism of modern VVGs has long been thought to lead to changes in the effects that they have on their players (e.g. (Sherry, 2001)). Modern

VVGs are extraordinarily realistic. Games like *Grand Theft Auto V* not only feature graphics which closely mimic the real world, but also have physics engines which accurately imitate how real-world objects move and collide, and non-player character (NPC) behaviours which strikingly replicate how real people act in a variety of situations. By contrast, the games used in this chapter are strikingly *unrealistic*. The soldiers in the run and gun game used earlier in this chapter did not behave like real soldiers. The cats in the maze game were not rendered using high-fidelity, realistic graphics. The vehicles in the infinite runner game did not change lanes in a physically realistic way. However, it is unclear from the literature what the effects of these differences in realism may be on priming effects (See Section 2.8.3). Furthermore, it may be realism itself, rather than a methodological issue, which accounts for the difference between the results of this chapter and the results in the VVG literature. Many of the games used in the VVG literature are, in one way or another, more realistic than the games used in this chapter. If increasing the realism of VVGs leads to changes in priming, then this difference may explain why priming is common in the VVG literature but negative priming is observed here.

Before drawing any conclusions about how the results of this chapter might be of importance for players of VVGs in general it is therefore first important to investigate realism. It may well be the case that the differences in realism between the games used in this chapter, and VVGs in general, might have led to the differences in priming which were observed in this chapter.

4 Priming and the Realism of Violent Video Games

4.1 Introduction

The experiments in the previous chapter suggest that priming may be a less common phenomenon in video games than was previously thought. Priming was neither observed in a run and gun game, nor in a maze game, nor in an infinite runner game. Furthermore, these experiments even suggest that a small and delicate *negative priming* effect may happen when people play video games. However, these conclusions are highly contentious. The lack of a priming effect, and the possible existence of negative priming, conflicts with much of the VVG literature. In this body of work priming, rather than negative priming, is routinely observed.

As noted throughout this thesis, one ready explanation for this difference between the results collected in the previous chapter and the results present in the VVG literature is well-known methodological failings in the VVG effects literature itself (See Section 2.6.2). A systematic lack of control between experimental conditions may have led to a slew of experimental results which suggest that the violent content in VVGs causes the priming of aggression-related concepts, whilst this effect is actually due to the influence of other factors such as incompetence.

In the experiments reported in this chapter, I attempted to minimise uncontrolled variation in competence between experimental conditions. This was achieved by building bespoke games which do not differ in gameplay or difficulty between experimental conditions. Due to this difference in experimental methodologies, it seems possible that uncontrolled variation in factors such as incompetence may be responsible for the difference between the results of the previous chapter and the priming seen in the VVG literature. If this was the sole influence which might reasonably account for the divergence of these results from the VVG literature then it would seem relatively safe to begin describing how the results of the previous chapter might have repercussions for players of VVGs in general. However, this is not the only thing which may have led to this disparity. It is possible that the difference between the results seen in the previous chapter and the results seen in the literature is due to the influence of realism.

Several popular VVGs feature a high degree of realism. In contrast, the games used in the previous chapter were not very realistic. Not only did the graphics of these games not closely imitate the real world, but in-game objects did not behave like their real world counterparts either. Several theorists suggest that the realism of VVGs strongly influence their priming effects (See Section 2.8). If this is the case, and realism really does play an important part in determining VVG effects, then it is possible that the effects seen in the previous chapter only apply to less realistic games, and do not generalise to more realistic VVGs. However, it is currently unclear from the literature what the influence of VVG realism on the priming of aggression-related concepts actually *is.* Without understanding this relationship, it is difficult to confidently make predictions about what the consequences of the effects seen in the previous chapter might be for the wider world.

In order to investigate whether VVG realism affects the priming of aggression-related concepts, I therefore conducted a series of three experiments. In each of these experiments, participants played different versions of a single VVG. In some conditions, these games were highly realistic in a specific way. In other conditions, they were not. After play, players were tested for the priming of aggression-related concepts.

There are several important points to make about the methodology used in these experiments. To begin with, these experiments again use bespoke games to avoid confounds when testing experimental hypotheses. All of the experiments in this chapter were again undertaken by building a single game, and then manipulating that game to form separate conditions which differed in only specific and pre-planned ways. This approach was again selected in order to avoid the possible effects of the uncontrolled variation which is found in the VVG literature in general, and the VVG realism literature in specific (See Section 2.8.3). In a similar vein, the experiments in this chapter again took place online and involved very large sample sizes. This method was used in order to ensure that there was adequate statistical power to find out whether changes in realism caused even small differences in priming. Additionally, in order to avoid the possible confounding effect of blood on arousal, none of the experiments in this chapter feature any blood or gore (See Section 2.8.5).

However, it is important to point out that there is one key way in which the experiments in this chapter strongly contrast with those in the previous chapter. Whilst the experiments in the previous chapter did not feature VVGs, every experiment which investigates realism in this chapter uses VVGs as stimulus materials. This approach was selected for a simple reason. In order for this chapter's results to generalise well to VVGs, the differences in realism which feature in its experiments must be representative of the kinds of differences in realism that are found in real VVGs. However, it appeared that many forms of VVG realism have no non-aggressive analogue. Relevant examples of these kinds of realism include both realistic death animations and realistic NPC tactics. Therefore, for this chapter to present the most persuasive evidence of the influence of realism on priming in VVGs it was necessary to measure this impact directly by using VVGs as stimulus materials.

In the first of these online experiments, participants played a violent driving game which was manipulated to form four different conditions. In some of these conditions, the graphics were detailed and realistic. In others, they were simple and block-like. In addition to this difference in graphical realism, some participants were given a violent real-world motivation for playing the game in the form of a text-box at the beginning of play, whilst others were given simple functional instructions. Results of this experiment indicated that greater graphical realism led to *less* priming of aggression-related concepts, rather than more. The manipulation of text-boxes seemed to have little (if any) effect on players.

Therefore, I ran a second online experiment in order to investigate whether a different type of realism might influence priming in VVGs. In this experiment, I made two different versions of a first-person shooter (FPS) game. In one of these conditions, a physics engine gave enemies physically realistic deaths. In the other condition, these deaths were instead animated via unrealistic pre-recorded animation sequences. The results of this experiment indicated that this kind of realism has little effect on the priming of aggression-related concepts in VVGs.

A final online experiment was run in order to find out whether greater behavioural realism in VVGs might influence the priming of aggression-related concepts. Two different versions of the FPS game used in the previous experiment were again made. However, in this experiment these versions did not differ in terms of the physics engine which they used. Instead, in one condition non-player character (NPC) enemies used realistic squad-based tactics, whilst in the other condition they used less realistic, simpler behaviours. Player perceptions of competence were also measured in case differences in competence between conditions might confound results. The results of this experiment indicated that greater behavioural realism led to significantly *less* priming of aggression-related concepts, even when the influence of competence was taken into account.

Overall, the results of these three experiments indicated that it is extremely unlikely that greater realism in VVGs leads to any important increases in the priming of aggression-related concepts. Therefore, the effects observed in the previous chapter should also occur in more realistic games.

4.2 Experiment 4: Graphical Realism and Priming in VVGs

4.2.1 Introduction

One of the most common ways that video games "mimic things that exist" (Malliet, 2006) is by *looking* like things that exist. Over the past few decades the graphics in digital games have progressed from simple abstract shapes to complex and realistically rendered three-dimensional objects (Wolf, 2003). This change in technology has allowed the violence depicted in VVGs to look more and more similar to its real-world counterpart. It is argued in the VVG literature that the greater graphical realism of modern VVGs may lead to associated increases in the priming of aggression-related concepts. However, whilst a link between graphical realism and priming has been repeatedly proposed in the literature (e.g. (Krcmar et al., 2011; Sherry, 2001)), the actual existence of this relationship remains unclear.

In a first attempt to investigate the relationship between realism and the priming of aggression-related concepts in VVGs, I had participants play a violent driving game which either featured detailed, realistic graphics or more simple and unrealistic graphics. After play, priming of aggression-related concepts was tested via the Anderson word fragment completion task. However, in addition to manipulating graphical fidelity, I also manipulated the narrative context of play. Some participants were given a violent motivation for their in-game actions in the form of a text box before play, whilst others were given simple functional instructions.

The reason for altering the narrative context of play was more speculative than the rationale which lay behind my manipulation of graphical realism. Many VVGs not only depict realistic-looking acts of violence, but also place this aggressive behaviour within the context of an imaginary world. This narrative context is commonly developed through the use of things like text-boxes or cut-scenes. Research has suggested that these techniques may influence the effects of a VVG, but whether this is actually the case remains unclear. This experiment seemed like a good place to clarify this issue, and therefore I also included a manipulation of narrative context.

The game that I used in this experiment was a violent driving game. These VVGs incorporate aspects of racing games alongside other violent behaviours, such as attacking other racers or killing pedestrians. Examples of games like this are the *Grand Theft Auto* and *Carmageddon* series (See Figure 4-1 below). This kind of game was selected for use in the experiment for similar reasons to the genres used in the previous chapter. In order for this experiment to generalise to VVGs in general, it was important that I used a type of game which was representative of popular VVGs. Violent driving games are extremely popular, with *Grand Theft Auto V* selling over 65 million copies (Makuch, 2016). This kind of game therefore seemed like a good fit for this experiment. Similarly, I needed to use a game which could be picked up and played easily, without extensive training beforehand. The violent driving game used in this experiment had simple gameplay and an easy-to-understand control scheme, and therefore also seemed to fit this bill.

Figure 4-1: Violent driving in Grand Theft Auto IV, taken from *(ridz0r, 2010)*

On a final note, it is worth pointing out that priming is measured slightly differently in this chapter to how it was measured in the previous chapter. Previous experiments involved measuring the priming of concepts such as animals and vehicles. There is no single dominant psychometric test for measuring the priming of these specific concepts in the literature. This chapter, however, involves measuring the priming of aggression-related concepts. By contrast, there *is* a single, widely-used way of measuring the priming of aggression-related concepts in the VVG literature. This is the Anderson word fragment completion task (See Section 2.4.3). I therefore use this task to measure the priming of aggression-related concepts throughout this chapter.

4.2.2 Method

Aim

This online experiment aimed to investigate whether graphical realism and narrative context lead to greater priming of aggression-related concepts in VVGs.

Hypothesis

H1: Participants will complete more fragments with aggressive meanings on the Anderson word fragment completion task when graphical realism in a VVG is high.

H2: Participants will complete more fragments with aggressive meanings on the Anderson word fragment completion task when given a violent narrative context in a VVG.

Design

The experiment had a 2 (graphical realism: low, high) x 2 (narrative context: absent, present) between-participants design. Participants played either a violent driving game with detailed and realistic graphics, or a violent driving game with abstract and unrealistic graphics. Furthermore, before play some participants were given simple functional instructions for how to play the game, whilst others were given a violent motivation for their in-game actions.

Measures

The Anderson word fragment completion task was used to measure the priming of violent concepts. As described in Section 2.4.3, this task involves participants completing 98 word fragments within a set period of time. Some of these fragments can be completed to form aggression-related words (e.g. 'ki__' can be completed to form 'kill'). The proportion of fragments which a participant completes with aggression-related meanings is used to measure their priming of aggression-related concepts. Participants were given three minutes to complete this task, as suggested in the materials for this task (Anderson et al., n.d.).

Games

The violent driving game used in this experiment was played from a first-person perspective. In this game, players used the arrow keys to manoeuver a car through the bustling streets of a city. As in games such as *Grand Theft Auto*, this urban environment was filled with pedestrians. Players were told that they must move through this city as quickly as possible whilst hitting as many pedestrians as possible in order to succeed at the game. Gameplay ended after 100 seconds.

The graphical realism conditions were formed by building two different versions of this game. In the condition with high graphical realism both the car, pedestrians, and the city itself were rendered using textured 3D models. By contrast, in the low graphical realism condition, these things were rendered using simple block-coloured cubes (See Figure 4-2).

Figure 4-2: Different levels of graphical realism in the violent driving game

The narrative context conditions were formed by giving players different text-boxes before play. In the condition where narrative context was absent, players were told that the game that they were about to play involved moving as far through an environment as possible whilst hitting as many moving obstacles as possible. In the condition with narrative context present, players were instead given a violent rationale for their in-game actions. A text-box before play in this case instead told them that they were a violent individual who was must carry a bomb as far as possible in their car whilst killing as many pedestrians as possible (See Appendix K).

Participants and Setting

As with the previous experiment, this experiment took place online. The game was placed online on popular video game portal websites (e.g. kongregate.com, newgrounds.com). Participants were recruited both through these portals and via social media.

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

Participants were randomly assigned to experimental conditions, with 359 playing a game with low graphical realism and 351 playing a game with high graphical realism. 349 played the game with narrative context absent, whilst 361 played the game where it was present.

As before, participant IP addresses were recorded at the beginning of the experiment and only the first set of data from each unique IP was used in this experiment.

Procedure

Players first completed an informed consent and demographics screen, and indicated that they were ready to begin the experiment. This is included as Appendix I. Following this, they played the game outlined above for 2 minutes. After this, they completed the Anderson word fragment completion task. They were then debriefed via a short video.

4.2.3 Results

Means and standard deviations for each treatment are presented below. Additionally, the number of kills which participants made in each treatment are also presented below.

Graphical Realism	Narrative Context	Proportion of fragments completed with aggression-related meanings	Number of kills	N.
Low	Absent	0.25 (0.14)	23.63 (14.38)	162
	Present	0.24 (0.14)	22.56 (14.89)	197
	Total	0.25 (0.14)	23.04 (14.65)	359
High	Absent	0.23 (0.12)	25.34 (14.98)	187
	Present	0.22 (0.12)	27.00 (16.12)	164
	Total	0.22 (0.12)	26.12 (15.52)	351
Total	Absent	0.24 (0.13)	24.55 (14.71)	349
	Present	0.23 (0.13)	24.58 (15.59)	361
	Total	0.24 (0.13)	24.56 (15.15)	710

Table 4-1: Summary statistics for players of the violent driving game. Means, and standard deviations in brackets.

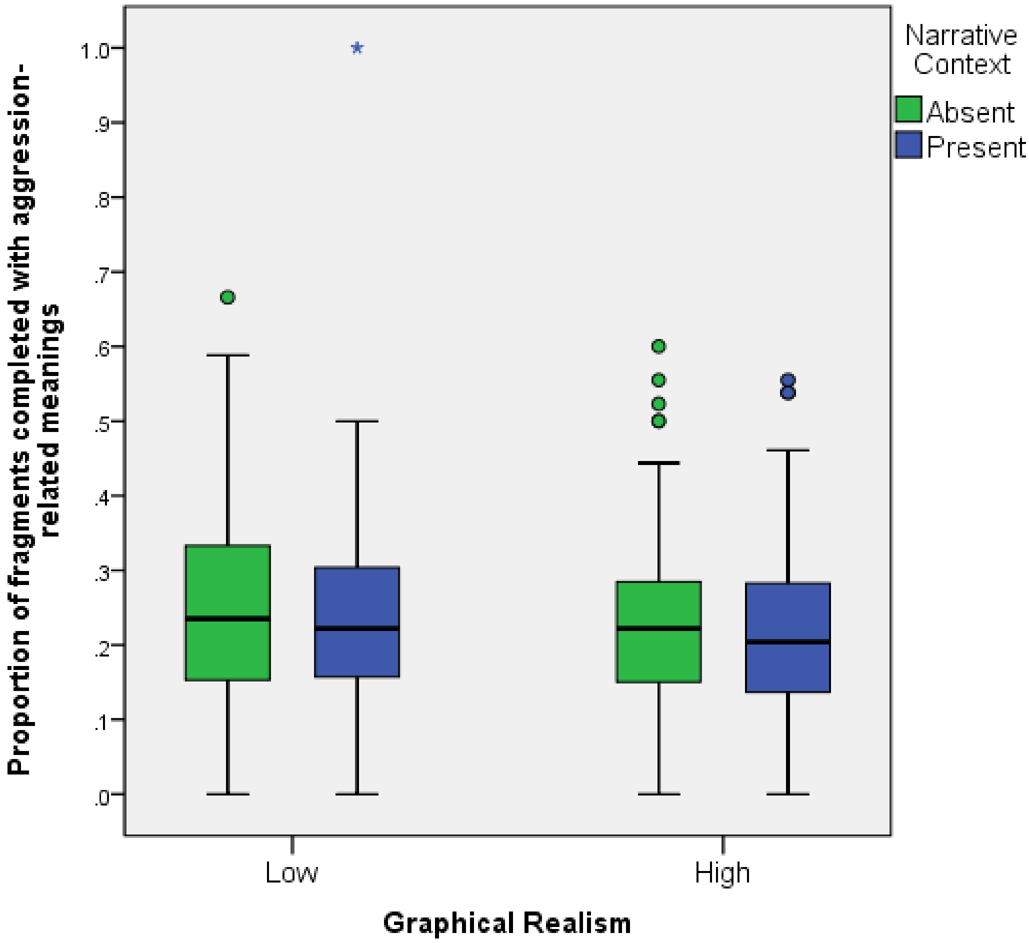

Figure 4-3: Box-plot showing responses to the Anderson word fragment completion task, split by violent driving game condition

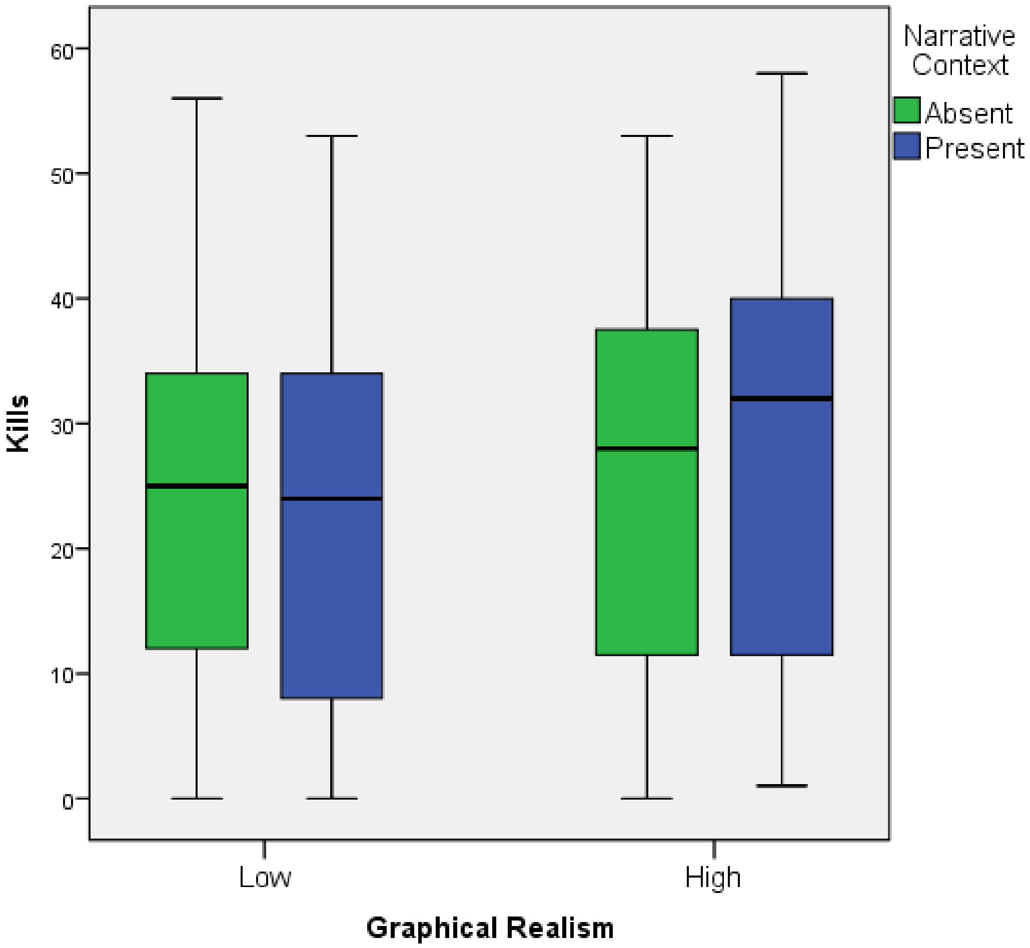

Figure 4-4: Box-plot showing number of kills, split by violent driving game condition

The effects of graphical realism and narrative context on the priming of aggression-related concepts were tested via a 2x2 ANOVA, with graphical realism (low, high) and narrative context (absent, present) as between-subjects factors. There was a significant main effect for graphical realism, $F(1,706) = 6.017$, $p=0.014$, $\eta^2 = 0.008$. However, this effect was in the opposite direction to the one which was hypothesised. Playing a violent video game with realistic graphics caused significant *less* priming of aggression-related concepts (M = 0.220, SD = 0.117) than playing one with unrealistic graphics (M = 0.242, SD = 0.134). There was no significant main effect for narrative context, $F(1,706) = 1.253$, $p=0.263$, $\eta^2 = 0.002$, and no significant interaction between these factors, $F(1,706) = 0.033$, $p=0.855$, $\eta^2 < 0.001$

In order to be as conservative as possible, the data was further explored following this analysis. I was concerned that playing a game with more realistic graphics might lead players to avoid killing pedestrians, and thereby lead to fewer instances of in-game violence. This lack of violence might then cause the observed results, rather than the graphical realism itself. A 2x2 ANOVA, with graphical realism (low, high) and narrative context (absent, present) as between-subjects factors and number of kills as dependent variable was therefore conducted. This revealed a significant effect of graphical realism on the number of kills a player made in game, $F(1,706) = 7.312$, $p = 0.007$, $\eta^2 = 0.01$. However, this relationship indicated that players in a game with more realistic graphics killed significantly more pedestrians ($M = 26.12$, $SD = 15.52$) than players in a game with less realistic graphics ($M = 23.04$, $SD = 14.65$). Therefore, this aspect of player behaviour in game could not have been responsible for the observed effects. The presence or absence of narrative content had no significant effect on the number of kills which players made in game, $F(1,706) = 0.068$, $p = 0.795$, $\eta^2 < 0.0001$. There was no significant interaction between these factors, $F(1,706) = 1.435$, $p = 0.231$, $\eta^2 = 0.002$.

4.2.4 Discussion

Interestingly, this experiment's results contradict the idea that realistic graphics lead to more priming in VVGs. Participants who played the violent driving game with high graphical realism showed significantly *less* priming of aggression-related concepts ($M=0.220$) than those who played the game with low graphical realism ($M=0.242$).

The effect size associated with this result was small ($\eta^2 = 0.008$), and it might consequently seem that this result is of little practical importance. After all, this indicates that less than 1% of the variance in responses to the word fragment completion task was due to differences in graphical realism. It is crucial to note that the practical importance of this effect is of little relevance to the overall aims of this experiment. This experiment did not set out to discover the extent to which greater graphical realism led to *less* priming, but whether greater graphical realism led to *more* priming. Regardless of size of this effect, its directionality and significance clearly shows that greater graphical realism is not responsible for greater priming in VVGs.

However, it would be overly cautious to discard this effect as practically unimportant. Small effects are common in the VVG literature. Indeed, the effects of VVG play on priming are estimated to stand at around $r = 0.20$. Furthermore, these small effects themselves are held to be of great practical importance (See Section 2.6.2). The η^2 seen here is equivalent to $r = 0.09$. Whilst this result is therefore a bit smaller than the effects commonly seen in the literature, it does seem reasonably similar in scale. Given the context of the VVG literature, this experiment therefore suggests that low realism graphics in VVGs may have behaviourally important effects on their players.

On the topic of the VVG literature, the counterintuitive direction of this effect seems to fit uncomfortably with much of this body of research. The idea that greater graphical realism leads to more priming is commonplace in the VVG literature, whilst the idea that greater graphical realism leads to less priming is unheard-of. However, upon closer inspection, this experiment's result seems very much in line with the literature. Crucially, whilst the VVG literature contains bold *theoretical* arguments for a link between greater graphical realism and greater priming, prior experimental evidence does not support the existence of this relationship. In fact, whilst multiple studies on the effects of graphical realism have been conducted, all have reported null results (See Section 2.8.3).

The reason why the significant effect seen here fits well with the literature is, again, related to effect sizes. As noted above, the effect size observed here was small (η^2=0.008). Reliably testing for such a small effect requires a large sample size in order to achieve adequate statistical power. This was the case in this experiment (n=710). However, by contrast, not only are experiments in the VVG literature conducted using much smaller sample sizes than those used here, but they also routinely contain large amounts of uncontrolled variation between conditions (See Section 2.8.3). It therefore seems possible that if graphical realism causes a small change in priming, this would be reflected in the literature, not in the form of small but significant results, but in the form of null results. When viewed in this light, this experiment's result not only fits in with the literature on graphical realism in VVGs, but also clarifies the possible results of this body of research.

A final thing to note about the effect of graphical realism on priming is related to player behaviour. I was concerned that players of the VVG with high graphical realism might avoid killing pedestrians. This change in in-game behaviour could lead to participants in this condition being exposed to fewer examples of violence, and hence cause the effect described above. However, further analyses revealed that players of the VVG with highly realistic graphics killed significantly more pedestrians (M = 26.12) than those in the condition with less realistic graphics (M = 23.04). It therefore is not possible for differences in behaviour to confound results in this way.

In addition to manipulating graphical fidelity, in this experiment I also manipulated the narrative context of play. Contrary to the experimental hypothesis, the results of this experiment suggest that the presence of a narrative context has little effect on the priming of aggression-related concepts in a VVG. However, it seems likely that this result may be a consequence of an ineffective manipulation of narrative context. In this experiment, narrative context was represented by a text-box presented to the player before play. Whilst this manipulation seemed sensible because in the past many video games have used similar mechanisms, it may be the case that players in conditions where narrative context was supposedly present 'skipped' reading what was in the text-box, thereby rendering the manipulation effectively absent. Because this experiment was run online, I was unable to determine whether this was the case or not. This lack of observation is a regrettable drawback of running an experiment online.

4.3 Experiment 5: Ragdoll Physics and Priming in VVGs

4.3.1 Introduction

The previous experiment showed that greater graphical realism does not increase the priming of aggression-related concepts in VVGs. However, looking like the real world is not the only way that VVGs are realistic. In addition to featuring realistic graphics, games can also feature realistic behaviours. Indeed, over the past few decades the technology which supports VVGs has allowed these games to incorporate behaviours and physical processes which are increasingly similar to those found in the real world. For example, whilst enemies in early VVGs showed that they had died through the use of unrealistic and predetermined animation sequences, games now commonly incorporate dynamic simulations of the movement of dead bodies. Similarly, whilst non-player characters in VVGs used to act according to small and simplistic sets of rules, modern innovations in AI have enabled developers to build enemy characters which behave similarly to their real world counterparts (See Section 2.8.2).

This experiment therefore follows up on previous results by investigating the effects of this kind of realism. In order to do this, it looks at how the presence of ragdoll physics in a VVG influences the priming of aggression-related concepts. In this experiment, participants played a bespoke first-person shooter (FPS) game. This game was manipulated so that it formed two different conditions. In one condition, enemies had death animations which dynamically mimicked how the real world behaves through the use of procedurally animated ragdolls. In the other condition, enemy deaths were shown via pre-defined animations. These sequences did not behave in a similarly realistic way. After play, participants again had the priming of aggression-related concepts measured via the Anderson word-fragment completion task.

In this experiment I manipulated behavioural realism by changing whether ragdoll physics or predefined death animations are used in a VVG. These different experimental conditions reflect different approaches to how deaths are animated in VVGs. Some games use pre-defined animation sequences to show how characters are killed by bullets or other projectiles. In this approach, people’s bodies do not behave in a way which is in keeping with real world physics. Regardless of the direction or intensity of blows to a character, they still are animated using the same series of motions. In contrast to this, deaths can be animated with much greater behavioural realism through the use of ragdoll physics (See Section 2.8.2). However, this specific manipulation was not just selected because of its ecological validity. It was also chosen because the presence or absence of ragdoll physics can affect behavioural realism without altering gameplay. As noted in Section 2.6.2, recent research has shown that changes to factors such as pace and difficulty can result in non-trivial effects on aggression-related variables. Several manipulations of a game's behavioural realism might change important things about how a game is played. For instance, making bullet physics more realistic might make a game more frustrating. Similarly, making enemies behave more realistically might make a game more difficult. These changes might lead to similar shifts in players' self-perceptions of competence, and hence confound results. By contrast, how deaths are animated is inconsequential to how difficult a game is.

4.3.2 Method

Aim

This online experiment aimed to investigate whether behavioural realism leads to greater priming of aggression-related concepts in VVGs.

Hypothesis

H1: Participants will complete more fragments with aggressive meanings on the Anderson word fragment completion task when ragdoll physics is present.

Design

The experiment had a between-participants design. Participants played a first person shooter game. However, in one condition enemy deaths were shown using ragdoll physics. In the other condition they were shown using predefined death animations.

Measures

The Anderson word fragment completion task was again used to measure the priming of violent concepts.

Games

In this experiment, participants play an FPS. This genre of games revolves around the action of a player shooting at enemy characters from a first person perspective. Examples of games from this genre are *Call of Duty*, *Doom*, and *Halo*.

A custom first-person shooter game was built in Unity3D for this experiment. In this game the player took on the role of a character with an assault rifle. The player was placed in a rooftop scene, and was under continual attack from waves of enemy soldiers. (See Figure 4-5). This game was played by each participant for 4 minutes. The player's task was to kill as many enemies as possible before the time ran out. In order to do this, the player moved their character with the keyboard and aimed and shot their weapon with the mouse.

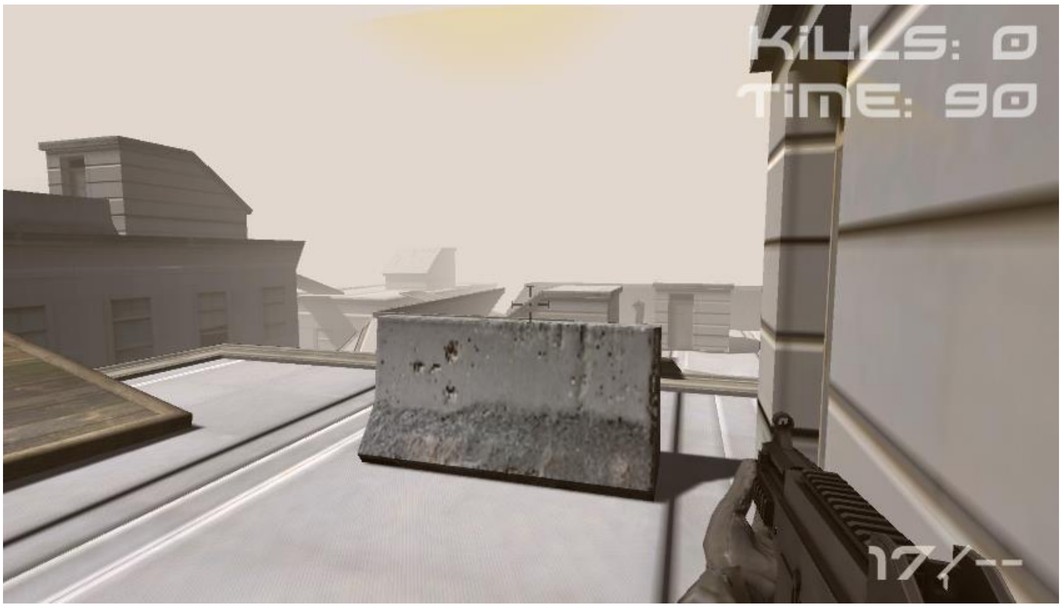

Figure 4-5: Gameplay in the FPS game

The number of player kills was displayed in the corner of the screen, as was the amount of time left in the game. If a player was hit too many times by enemies, they would 'die', the screen would fade to white, and after a brief pause the player would respawn. Conversely, if the player hit an enemy twice or more, that enemy character would die. If ragdoll physics was present in the game that was being played, this would cause the enemy's body to 'crumple' realistically, given the location and direction of the kill-shot which the player had made. Conversely, if ragdoll physics was absent in the game, this would cause a pre-defined animation sequence to play in which the enemy character fell over.

Participants and Setting

As with previous experiments, this experiment took place online. The game was placed online on popular video game portal websites (e.g. kongregate.com, newgrounds.com). Participants were recruited both through these portals and via social media.

898 participants took part in the experiment. 642 participants were aged 18-24, 201 were 25-29 years old, 43 were 30-34 years old, 12 were 35 or older. 444 described themselves as playing games at least once a day, 216 played up to once a week, 49 played up to once a month, and 151 preferred not to answer the question.

Participants were randomly assigned to experimental conditions, with 446 playing a game where ragdoll physics was absent and 452 playing a game where it was present. As before, participant IP addresses were recorded at the beginning of the experiment and only the first set of data from each unique IP was used in this experiment.

Procedure

Players first completed an informed consent and demographics screen, and indicated that they were ready to begin the experiment. This is included as Appendix J. Following this, they played the game outlined above for four minutes. After this, they completed the Anderson word fragment completion task. They were then debriefed via a short video.

4.3.3 Results

Means and standard deviations for each treatment are presented below.

Ragdoll Physics	Proportion of fragments completed with aggression-related meanings	Number of kills	N.
Absent	0.24 (0.14)	14.99 (7.62)	446
Present	0.24 (0.15)	15.39 (7.97)	452
Total	0.24 (0.15)	15.19 (7.80)	898

Table 4-2: Summary statistics for players of the first person shooter. Means, and standard deviations in brackets.

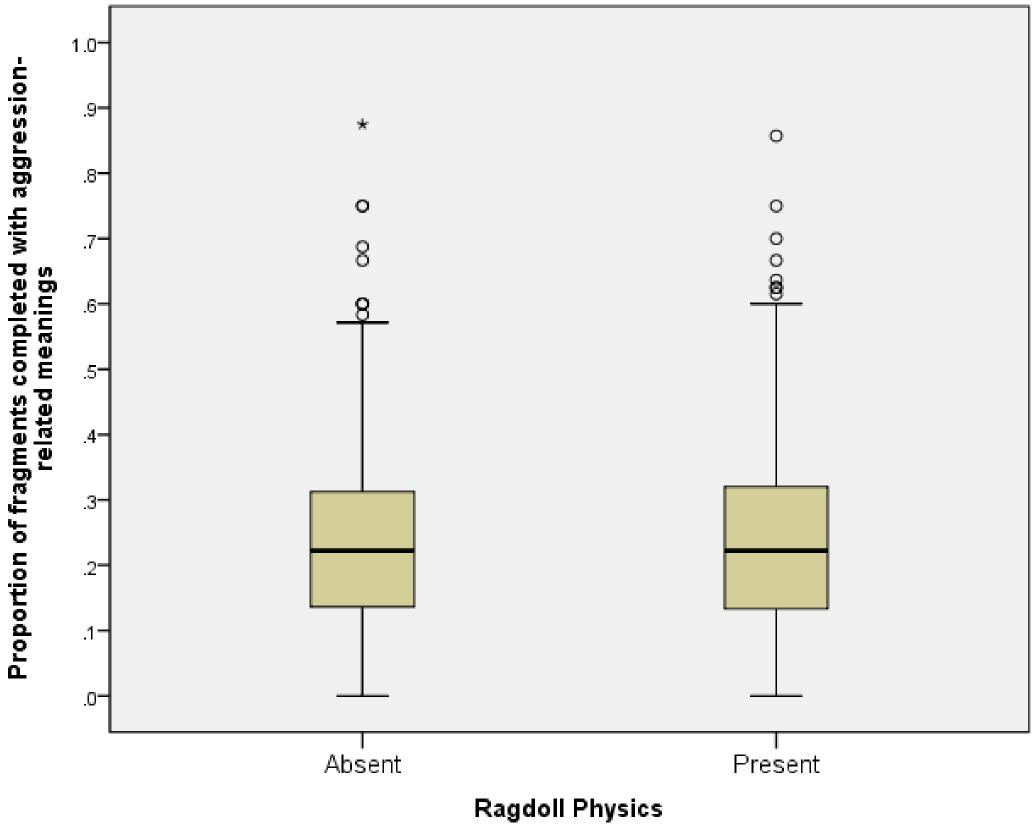

Figure 4-6: Box-plot showing responses to the Anderson word fragment completion task, split by presence or absence of ragdoll physics

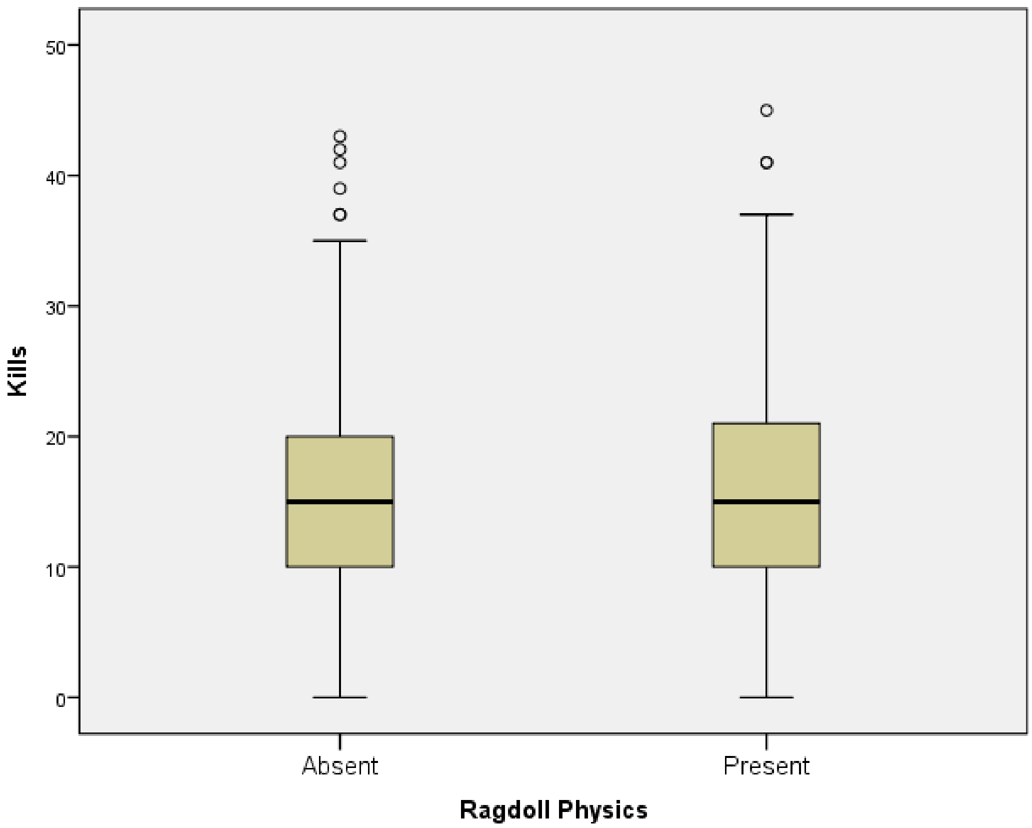

Figure 4-7: Box-plot showing number of kills, split by presence or absence of ragdoll physics

The effects of ragdoll physics on the priming of aggression-related concepts was tested via an ANOVA, with ragdoll physics (absent, present) as a between-subjects factor. There was no significant effect, $F(1,896) = 0.312$, $p=0.577$, $\eta^2 = 0.0003$.

In order to be as conservative as possible, the data was further explored following this analysis. I was concerned that playing the game with more realistic death animations might lead to players killing fewer enemies, and the null result reported above might be a product of this change in behaviour between conditions. Therefore, the effects of ragdoll physics on the number of kills which players made was also tested via ANOVA. This analysis revealed no significant effect of ragdoll physics on number of kills, $F(1,896) = 0.593$, $p=0.441$, $\eta^2 = 0.0006$.

4.3.4 Discussion

This experiment suggests that the presence of ragdoll physics in a VVG has little effect on the priming of aggression-related concepts. A large sample size was used here (n=898). However, the effect size between conditions was so small ($\eta^2 = 0.0003$) that no significant difference between people who played the game with ragdoll physics and people who played the game without ragdoll physics was detectable.

There are several possible explanations for this result. Firstly, it might simply be the case that behavioural realism *in general* has little effect on the priming of aggression-related concepts in VVGs. On the one hand, this perspective clashes strongly with theoretical explanations of how realism might help to determine the effects of VVGs (See Section 2.8). On the other hand, as with the previous experiment this explanation would be in keeping with at least some of the literature. After all, even though it is widely hypothesised that increased behavioural realism might lead to increased priming, null results in the literature have repeatedly suggested that this may not be the case.

However, caution is warranted when it comes to this interpretation of the evidence. Experiments 1-3 in this experiment suggest that negative priming may happen in VVGs. This effect is in keeping with the idea that players ignore additional details of games which are not directly related to gameplay, such as a game's theme. From the standpoint of this evidence, it is no surprise that manipulating how enemies behave when they die has little effect on priming. This feature of VVGs was deliberately chosen for the purposes of this experiment as it has no effect on gameplay. Since this is the case, the evidence in the previous chapter suggests that this feature of the game might be ignored by players regardless of its level of realism.

The argument described above brings an interesting limitation to the external validity of these results. It seems likely that manipulating the behavioural fidelity of a VVG in a different way which did not affect gameplay might lead to a similarly negligible effect. However, it is unclear whether changing the behavioural fidelity of a game in such a way that it *does* affect gameplay would produce the same lack of an effect. There are several examples of features in VVGs which both increase behavioural fidelity and also *do* affect gameplay. These features might therefore still produce significant effects on priming. In both this experiment and previous ones I have attempted only to manipulate features of games which do not affect gameplay in order to keep experimental designs clear and avoid confounds. However, it may be that because players disregard features of VVGs which do not affect their in-game success, the only features of VVGs which lead to greater priming are the very features which also affect gameplay. Because this may be the case, it is difficult to draw strong conclusions about the general influence of behavioural realism on priming from this single experiment.

It is important to point out that one final explanation for this null result might be that players were not exposed to sufficiently different conditions in each version of the game.

More specifically, it may be the case here that the presence of either ragdoll physics or pre-defined animations has an effect on priming, but as this feature of the game was not on screen for very long, there was not enough exposure to this manipulation for the effect to be measured. However, this explanation of the results does not seem likely. In this game, players were exposed to the manipulation not once, but each time they killed an enemy. Since players killed, on average, 15.2 enemies it seems likely that the manipulation was shown enough times to players for it to have an impact. Furthermore, it also seems unlikely that this null result is the product of players in one condition being exposed to the manipulation more than in the other, as players killed very similar numbers of enemies in each condition. The mean number of kills in the condition with ragdoll physics absent was 15, whilst the mean number of kills in the ragdoll physics present condition was 15.4. A follow-up ANOVA showed that there was no significant difference between these figures.

4.4 Experiment 6: Realistic NPC Tactics and Priming in VVGs

4.4.1 Introduction

The previous experiment suggested that putting more behavioural realism into a VVG has little effect on the priming of aggression-related concepts. However, it is important to note that in this experiment, enemies behaved more or less realistically *after they were killed*. The purpose of this specific manipulation was that changing behavioural realism in this way did not affect how the game itself was played. However, as a consequence of this manipulation it was also unclear whether altering behavioural realism in a different way, which did affect gameplay, would lead to a similar result. In this experiment I therefore investigated whether a manipulation of behavioural realism which *does* affect gameplay has an effect on the priming of aggression-related concepts in VVGs.

In this experiment, participants play an FPS game for 3 minutes. This game was manipulated so that it formed two different conditions. In one condition, participants played against a group of AI-controlled soldiers who only used simple tactics. In the other condition, participants played against a group of AI-controlled soldiers who use sophisticated squad-based tactics, such as flanking and laying down suppressing fire. Following play, priming of aggression-related concepts was again tested via the Anderson Word Fragment Completion Task. Player perceptions of competence were also measured to investigate whether this factor mediated the effect of behavioural realism on priming.

In this experiment I created different levels of behavioural realism by manipulating the realism of the tactics which NPCs used. There were two main reasons why I used this specific manipulation in this experiment. Firstly, this experiment's aims are based around manipulating behavioural fidelity in a way which also affects gameplay. The realism of NPC tactics is a good match for these aims as they are thought to have strong effects on player behaviour in VVGs. As pointed out by one early review of *Half Life,* there is large variation in the realism of NPC tactics in VVGs:

> Teamwork, for monsters in other games, is if they all happen to be in the same room shooting in the same direction. Here, the infantry squads will split up, trying to hit you from several sides while one guy keeps you pinned or lobs grenades
>
> (Bates, 1998)

Whilst enemies in some games may attack the player in a way which does not greatly mimic the behaviour of real world combatants, by contrast, other VVGs such as *Half Life* and *Far Cry* feature NPC soldiers who are deliberately programmed to behave in ways which are representative of actual troops in combat situations. These soldiers exhibit similarly sophisticated behaviours to the ones used by the enemies in the condition with high realism in this experiment. These include finding cover based on the line of sight of threats, and using collaborative tactics within a squad (See Section 2.8.2). Using such a representative manipulation of behavioural realism allows this study's results to be more easily applied to real world contexts.

Therefore, I set up the experiment described above in which participants play versions of a VVG with different levels of realistic NPC tactics. In this experiment I used the same bespoke FPS game as in the previous one. However, it is crucial to note that some things about this experiment are a bit different to previous experiments, and therefore the way that I measure priming is also slightly different. Unlike in previous experiments, in this experiment the manipulation of realism is deliberately designed so that it affects gameplay. Whilst NPCs in both conditions will be carrying out the same actions (shooting, moving, and reloading) in one condition they will do these things in a different, more realistic fashion. This is an important point. Because gameplay differs between conditions, one condition may be more difficult than the other. This in turn may lead to players feeling less competent in one condition than another. Feeling incompetent has been linked in the VVG literature to the priming of aggression-related concepts. Any results we obtain in this experiment will therefore take into account players' feelings of incompetence during statistical analysis. More specifically, players' perceptions of their own competence will be measured using the Player Experience of Need Satisfaction (PENS) questionnaire. This variable will then be entered into a mediation analysis as a potential mediator of the effect of realistic tactics on priming. Mediation analysis will be conducted according to (Hayes, 2013).

4.4.2 Method

Aim

This online experiment aimed to investigate whether behavioural realism leads to greater priming of aggression-related concepts in VVGs

Hypothesis

H1: Participants will complete more fragments with aggressive meanings on the Anderson word fragment completion task when realistic tactics are used by NPCs.

H2: The effect of realistic NPC tactics will be mediated by player perceptions of competence, with perceptions of lower competence leading to greater priming of aggressive concepts.

Design

The experiment had a between-participants design. Participants played either a first person shooter (FPS) which featured realistic NPC tactics, or the same game but with less realistic NPC tactics. In addition to this, competence was measured as a potential mediating variable.

Measures

The Anderson word fragment completion task was again used to measure the priming of violent concepts.

In addition to this, competence was measured via the corresponding subscale of the Player Experience of Need Satisfaction (PENS) scale (Ryan et al., 2006). This instrument is designed specifically to measure player feelings of competence.

Games

The FPS game used in the previous experiment was again used here. However, instead of manipulating this game so that there were two conditions with different death animations, it was instead manipulated so that there were different levels of realism for the tactics of the NPCs in the game.

In one condition, the tactics used by NPC soldiers were more representative of the behaviours of actual soldiers. Instead of moving along the shortest path towards the player, NPCs would attempt to 'flank' them by finding the shortest path through blind spots in the player's field of vision. If an NPC needed to reload their weapon, they would use cover and move to a location where they were safe from the player's line of sight when doing so. NPCs would also attempt to use cover when attacking the player, instead of standing in the open. Additionally, NPCs collaborated with other members of their squad by picking behaviours which were likely to work well together. For instance, if one NPC was flanking the player, another would lay down suppressing fire from cover in order to distract them. All of these features of NPC behaviour mirror common enemy AI implementations which are designed to mimic the way real soldiers act (See Section 2.8.2).

In the other condition, the tactics used by NPCs were less representative of the behaviours of actual soldiers. They did not use cover, either when reloading or when attacking the player. They did not use squad-based tactics, and they did not take advantage of the player's line of sight in order to flank them. Instead, these enemies were programmed to either advance towards the player along the shortest available path whilst firing continuous bursts from their assault rifles, or stay at a distance and fire less frequently but more accurately at the player. This behaviour is representative of less realistic NPC tactics used in some FPS games.

Participants and Setting

As with previous experiments, this experiment took place online. The game was placed online on popular video game portal websites (e.g. kongregate.com, newgrounds.com). Participants were recruited both through these portals and via social media.

1880 participants took part in the experiment. 1497 participants were aged 18-24, 366 were 25-29 years old, 3 were 30-34 years old, 10 were 35 or older. 747 described themselves as playing games at least once a day, 419 played between this amount and once a week, 315 played between this amount and once a month, and 399 preferred not to answer the question.

Participants were randomly assigned to experimental conditions, with 919 playing a game where the realism of NPC tactics was high and 961 playing a game where the realism of NPC tactics was low. As before, participant IP addresses were recorded at the beginning of the experiment and only the first set of data from each unique IP was used in this experiment.

Procedure

Players first completed an informed consent and demographics screen, and indicated that they were ready to begin the experiment. This is included as Appendix L. Following this, they played the game outlined above for 3 minutes. After this, they completed the Anderson word fragment completion task and the PENS competence sub-scale. They were then debriefed via a short video.

4.4.3 Results

Means and standard deviations for each treatment are presented below.

Realism of NPC Tactics	Proportion of fragments completed with aggression-related meanings	Competence	Number of kills	N.
Low	0.23 (0.13)	3.68 (1.54)	20.12 (10.59)	961
High	0.22 (0.12)	3.53 (1.55)	14.47 (9.13)	919
Total	0.23 (0.13)	3.61 (1.55)	17.36 (9.87)	1880

Table 4-3: Summary statistics for players of the first person shooter. Means, and standard deviations in brackets.

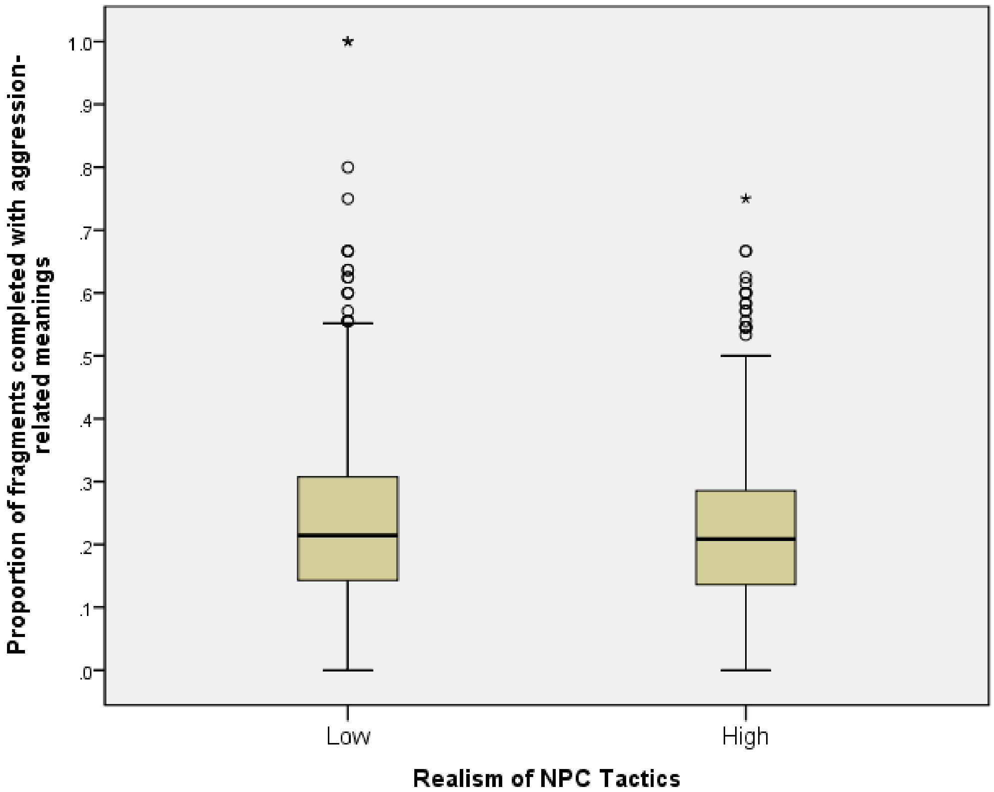

Figure 4-8: Box-plot showing responses to the Anderson word fragment completion task, split by realism of NPC tactics

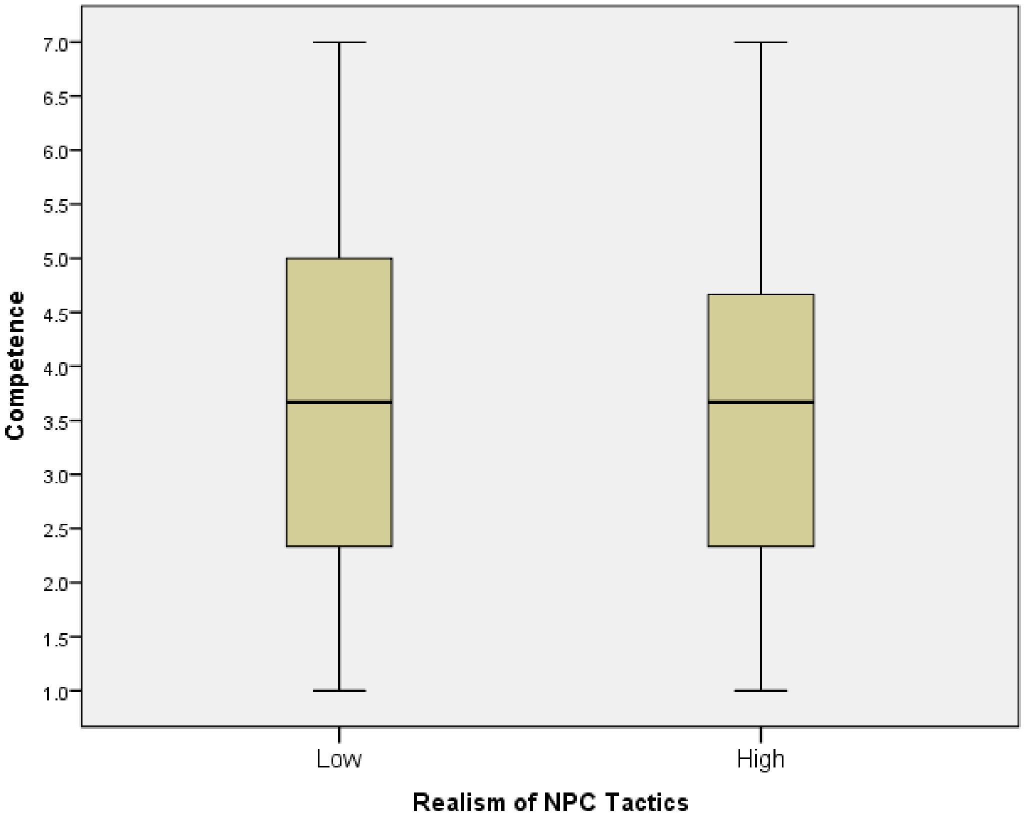

Figure 4-9: Box-plot showing player competence, split by realism of NPC tactics

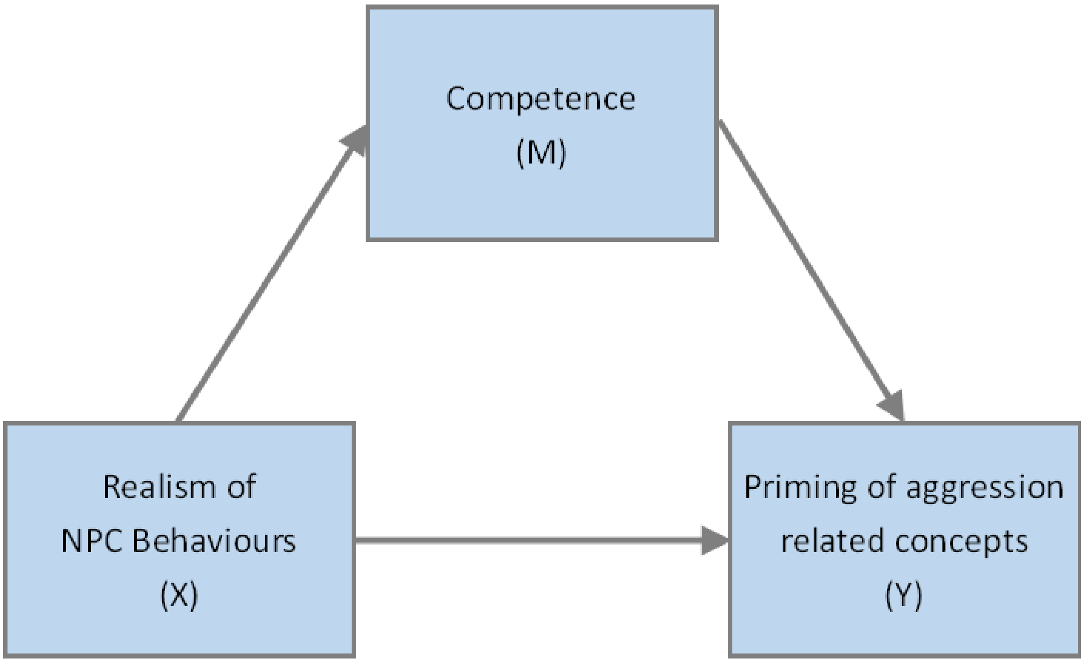

Figure 4-10: conceptual mediation model for the NPC realism experiment

The effects of the realism of NPC behaviours on the priming of aggression-related concepts were tested for following the regression-based approach described in (Hayes, 2013). The conceptual mediation model for this analysis is shown above as

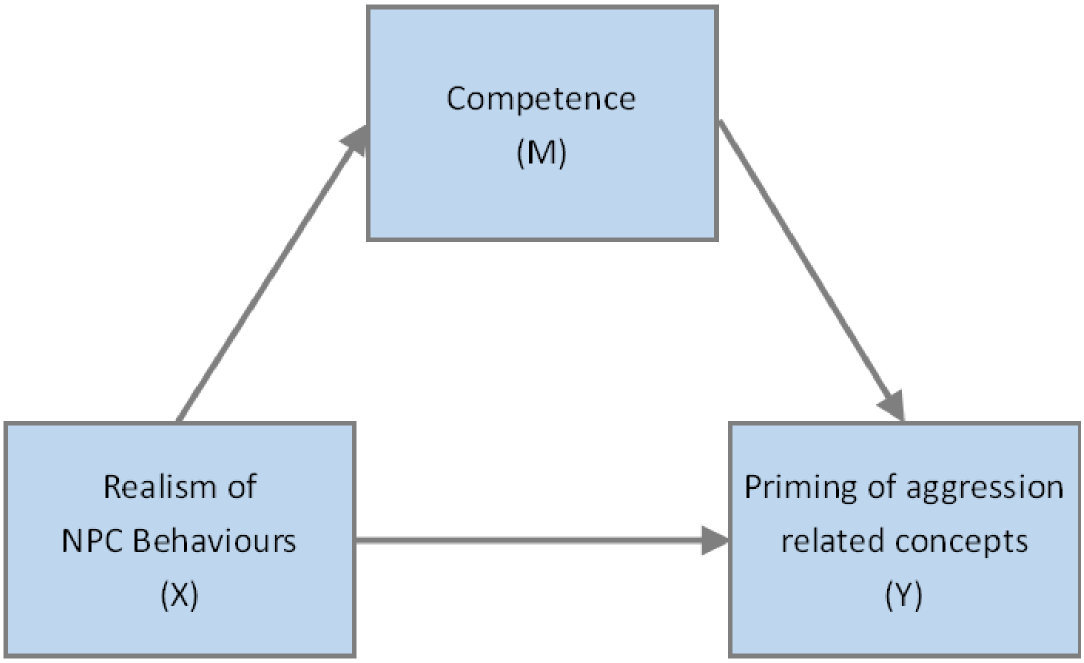

Figure 4-10. Initial simple linear regression revealed that realism of NPC behaviours had a marginally significant total effect on the priming of aggression-related concepts, $t(1878) = -1.934$, $p=0.053$, $\beta = -0.089$, $r^2 = 0.002$, with greater realism of NPC behaviours leading to the lessened priming of aggression-related concepts.

The indirect effects of the realism of NPC behaviours on the priming of aggression-related concepts were tested using simple linear regression. Greater realism of NPC behaviours led to lessened feelings of competence, $t(1878) = -2.041$, $p=0.041$, $\beta = -0.09$, $r^2 = 0.002$. Greater feelings of competence led to greater priming of aggression-related concepts, $t(1878) = 2.092$, $p=0.036$, $\beta = 0.048$, $r^2 = 0.003$. Bootstrap confidence intervals were calculated for the indirect effect of the realism of NPC behaviours on the priming of aggression-related concepts via competence. Under (Hayes, 2013) the indirect effect was calculated in this case by taking the product of the effect of realism on competence, and competence on priming. Based on 10,000 bootstrap samples, the confidence interval for this effect was entirely below zero (-0.0018 to -0.0001), indicating that greater realism of NPC behaviours indirectly led to significantly lessened priming of aggression-related concepts. However, this indirect effect appears to be very small. The effect size of the indirect effect was calculated as $R^2_{med} = 0.0002$. This statistic is conceptually similar to the η^2 statistic used in previous experiments, and represents the proportion of variance in the priming of aggression-related concepts explained by the indirect effect (Fairchild et al., 2009).

When indirect effects of realism of NPC behaviours on the priming of aggression-related concepts via competence were taken into account, the direct effect of the realism of NPC behaviours on the priming of aggression-related concepts remained marginally significant, $t(1878) = -1.83$, $p=0.066$, $\beta = -0.084$, $r^2 = 0.002$.

Following this analysis, the data was further explored by calculating the correlation between the number of kills that a player made and their competence. These variables had a moderate positive correlation when participants were pooled between conditions, $r(1878)=0.52$, $p<0.0001$. This relationship remained the same when participants were split between conditions, with moderate positive correlations occurring both for participants in the high realism condition, $r(919)=0.54$, $p<0.0001$ and participants in the low realism condition, $r(961)=0.528$, $p<0.0001$.

4.4.4 Discussion

Interestingly, this experiment's results again contradict the idea that realistic NPC behaviours lead to more priming in VVGs. Overall, the manipulation of behavioural realism in this experiment led to marginally significant differences in priming. However, this marginal direct effect ran in the opposite direction to the experimental hypothesis. Participants who played the FPS with realistic NPC tactics showed *less* priming of aggression-related concepts (M=0.216) than those who played the game without realistic NPC behaviours (M=0.228).

This counter-intuitive result might initially seem to reflect the indirect effect of a difference in competence between these conditions. As mentioned earlier, feeling incompetent is thought to lead to the increased priming of aggression-related concepts. Therefore, a simple explanation of how differences between conditions might lead to the result outlined above is that the condition with NPCs which used less realistic tactics was more challenging than the other condition. In this case, participants who played in the less realistic condition might feel more incompetent, which might lead to greater priming of aggression-related concepts. However, mediation analysis strongly suggests that this is not the case. It is true that part of the marginally significant total effect of realism on priming *was* due to a significant indirect effect via competence. However, this indirect effect was very small ($R^2_{med} = 0.0002$). Because of its small size, even when the effect of competence on priming was taken into account the direct effect of realism on priming described above remained marginally significant ($p=0.066$). It therefore seems unlikely that the effect observed here is due to changes in competence between conditions. Indeed, player competence itself did not vary dramatically between conditions. Whilst players of the game with more realism felt marginally less competent than those in the other condition, this difference was quite small ($r^2 = \eta^2 = 0.002$). Furthermore it is important to note that this effect is only marginally significant, and therefore should be interpreted only with caution - its presence cannot be given the same confidence that a significant result would bear.

It therefore seems to be the case that making NPCs use more realistic tactics may potentially lead to very slightly less priming, regardless of changes to player competence. However, it is important to point out that the size of the effect of behavioural realism on priming is extraordinarily small ($r^2 = \eta^2 = 0.002$). It therefore may be unwise to suggest that this potential effect is of much practical use. After all, this statistic represents the idea that the realism of NPC tactics only explains 0.2% of differences in responses to the word fragment completion task. However, it is crucial to note that the practical importance of this effect is of little relevance to the overall aims of this experiment. This experiment was not primarily concerned with finding out the extent to which greater behavioural realism led to *less* priming, but whether greater behavioural realism led to *more* priming. Regardless of size of this effect, its directionality strongly suggests that the presence of realistic NPC tactics is *not* responsible for greater priming in VVGs. Additionally, the small size of this effect suggests that online experiments are an important method for studying the influence of realism in VVGs. It appears to be the case that this feature only leads to effects on players of a very small magnitude. In order to have the requisite statistical power to observe these differences, it is key to have the large sample sizes which are much easier to achieve in online experiments than in the laboratory.

In addition to the marginally significant direct effect of realism on priming, this study contains some interesting evidence regarding how this feature indirectly affects the players of VVGs. Players of the game with less realistic tactics felt significantly more competent ($M=3.68$) than players of the game with more realistic tactics ($M=3.53$). This makes sense, as the sophisticated tactics used in the more realistic game might make that condition more challenging. However, in addition to this, the less competent a player felt, the less primed they were for aggression-related concepts after play. Numerous explanations are possible for this small ($r^2 = 0.003$) but surprising effect. For instance, follow-up analysis revealed a moderate ($r=0.52$) correlation between a player's competence and the number of kills that they made in a game. This correlation might suggest that highly competent players of FPS games play at a rapid pace, killing large numbers of enemies very quickly. This fast style of play may increase arousal, and hence lead to the observed priming effects. On the other hand, this result might suggest that less competent players of FPS games play more cautiously and slowly, leading to less arousal and lower priming effects. However, regardless of the reason for this result, it suggests that the relationship between competence and the priming of aggression-related concepts may be more complex than was previously thought.

Overall, this experiment suggests that increasing the realism of NPC tactics in a VVG does not increase the priming of aggression-related concepts. Whilst indirect, direct, and total effects of the realism of NPC tactics on the priming of aggression-related concepts were present, these effects were both small, of mixed significance, and additionally ran opposite to the predicted direction.

4.5 Conclusions

Over a mere few decades the technology which supports VVGs has progressed in dramatic ways. Computers have gone from drawing simple vector-based graphics in early VVGs like *Tail Gunner* to rendering photorealistic carnage in games like *Fallout 4* (See Figure 4-11). Similarly, innovations such as modern physics engines and AI implementations have made it increasingly simple for game developers to feature realistically violent behaviour in their products. It is therefore easy to see why several prominent theorists in VVG literature have raised concerns that the increased realism of modern VVGs are leading to corresponding increases in violent behaviour amongst gamers (e.g. (Sherry, 2001)).

Figure 4-11: Tail Gunner *(L), taken from (Old Classic Retro Gaming, 2014).* Fallout 4 *(R), taken from (IGN, 2015).*

However, the results of this chapter conflict strongly with a point of view which suggests that the increasing realism of modern VVGs leads to increases in priming. Across three experiments, not once was a result observed which lends credence to the idea that realism increases the priming effects of VVGs. Increasing a VVG's graphical realism did not lead to increases in priming. Introducing ragdoll physics into a VVG did not lead to increases in priming. Even making enemy characters attack the player using realistic tactics did not lead to increases in priming. When taken together, these observations seem to suggest only one conclusion. Greater realism simply does not seem to lead to greater priming in VVGs. The strength of this conclusion is further bolstered by the methodology used in these experiments. Bespoke games were used in each of the experiments in this chapter. This process ensured that only the specific kind of realism which was under test varied between conditions, and thereby minimised the risk of either a false positive or a false negative being caused by multiple features varying between conditions. Furthermore, not only were these experiments conducted online, and therefore involved video game players in an ecologically valid environment, but they were also conducted across samples of an unprecedented size for the VVG effects literature. A total of 3488 participants took part in these experiments, and the majority of these participants (n=2447) played video games at least once a week. This use of a large and representative sample suggests that if realism really did lead to increased priming effects amongst the players of VVGs, it would be reflected by a measurable positive effect in at least one of these experiments. This, however, was not the case.

However, it is important to take a moment to deal with an important possible criticism of this argument. This chapter contains three separate tests of three separate kinds of realism. The specific manipulations made in these experiments are diverse. Furthermore, for methodological reasons which I will outline below, the evidence that they provide is particularly convincing. However, the fact remains that they *do* only test three specific ways that VVGs can be made either more or less realistic. It seems possible that some other form of realism may lead to strong priming effects in VVGs. However, when viewed in the light of other evidence from the VVG literature, this objection seem overly cautious.

More specifically, whilst the idea that realism has little effect on priming conflicts strongly with the theorising of some VVG researchers, it fits very neatly with a plethora of null results in the experimental literature. As described in Section 2.8.3, a broad variety of experiments have attempted to show that greater realism leads to greater VVG effects on a variety of variables related to aggression. However, with the exception of studies testing the effects of realistic blood on players, these experiments have exclusively returned null results. This repeated absence of an effect in itself might seem to suggest that realism bears little relevance to the effects of VVGs. However, uncontrolled variation between experimental conditions in the literature makes it unclear whether this really is the case, or whether the lack of results is simply due to 'noise' between conditions. However, when these results are viewed in the context of this chapter, any ambiguity in their interpretation disappears. The experiments in this chapter clearly show that even when methodological problems are corrected, greater realism still does not cause greater effects on the players of VVGs.

Up to this point I have discussed how this chapter's results fit in with a postulated relationship in which greater realism leads to greater priming. However, this chapter did not just demonstrate the absence of a positive link between VVG realism and priming. Rather, it has shown that quite the opposite relationship to this one sometimes exists. In both Experiment 4 and Experiment 6, greater realism led to significantly *less* priming of aggression-related concepts amongst participants. To begin with, the existence of significant effects which show that some kinds of realism cause *decreases* in priming makes it seem even less likely that VVG realism might lead to *increases* in priming. However, beyond this point it is important to interpret these results with caution. The results of Experiment 6 showed that participants who had played a game with realistic NPC tactics had marginally less priming of aggression-related concepts in comparison to those who played a game without these tactics. However, the effect size associated with this result was very small ($\eta^2 = 0.002$). It therefore seems incautious to interpret it as being of any practical use. However, the same was not true of the result featured in Experiment 4. This experiment suggested that greater graphical realism in a VVG may lead to lowered priming of aggression-related concepts for the players of that game. Whilst the effect size associated with this result was small ($\eta^2 = 0.008$), it is comparable to others in the literature. Whilst it is not clear why this result occurs, it suggests that the relationship between graphical realism and priming may be more complex than was previously thought.

The results presented in this chapter have important consequences both for whether realism in VVGs leads to priming, and for the VVG literature itself. However, it is important to note that they also have important consequences for the players of VVGs. Under the GAM, the antisocial effects of playing VVGs are thought to be largely contingent on the presence of priming effects. The results seen here make it seem extremely unlikely that the increases in realism which characterise modern VVGs lead to these games priming their players to any greater extent than less realistic VVGs. This result therefore also makes it seem less likely that these games lead to violent behaviour in any meaningfully different way to their less-realistic predecessors.

Overall, this chapter strongly suggests that greater realism in VVGs does not lead to greater priming. As described above, this evidence is interesting for a variety of reasons. Not only does it clarify the results of previous studies, but it suggests important consequences for how modern VVGs might influence their players in comparison to older games. However, it is crucial to note that the key thing about these results when it comes to the aims of this thesis is not their specific contribution to the literature on realism in VVGs. Rather, the reason why these results are important here is that they support the idea that the effects seen in the previous chapter should generalise to games with a greater degree of realism.

It is true that the games used in the previous chapter suggested that priming does not happen when people play VVGs, and even suggested that negative priming may sometimes occur in this case. However, the games used in the previous chapter had a low degree of realism. By contrast, VVGs on the market and in the literature commonly feature a high degree of realism. It was therefore unclear whether the results of the previous chapter would also be of relevance to these games. The results of this chapter indicate that realism causes no significant increases in priming. Therefore, the effects which were observed in the previous chapter should not theoretically be confined to games with a low degree of realism.

5 Conclusions

5.1 Introduction and Overview of Contributions

During the course of this thesis a total of 4062 participants took part in experiments in which they played a variety of bespoke driving games, maze games, infinite runner games, run and gun games, and first person shooters. The results of these experiments provide evidence that:

- The aggression-related content of VVGs does not lead to the priming of aggression-related concepts, regardless of their level of realism
- Greater realism does not significantly increase the priming effects of VVGs, though it may sometimes *decrease* them.
- A complementary negative priming effect may happen instead of priming in video games. However, whilst this effect was repeatedly observed, its size and importance are unclear.

This chapter first provides a brief summary of the research which was undertaken in this thesis. It then discusses the implications of each of the contributions outlined above in detail. It then describes the limitations of the research conducted in this thesis. Finally, this chapter concludes by discussing the need for further work which these findings suggest.

5.2 Summary of Research

Chapter 3

The first set of experiments in this thesis investigated priming in video games. More specifically, Chapter 3 presented the results of Experiments 1-3. These experiments aimed to discover whether the priming effects commonly observed in the VVG literature remained present when known confounds were eliminated from an experimental design. These experiments repeatedly showed that priming is *not* observed when proper experimental controls are put in place. Furthermore, a small and seemingly delicate negative priming effect was observed instead.

However, it was not clear how far the results of these experiments might generalise. That is not to say that they lacked ecological validity. By contrast, they deliberately incorporated games which were representative of popular genres. Rather, it was not clear whether the effects observed in these experiments would also be the same for more realistic VVGs such as *Call of Duty* and *Grand Theft Auto V*. Realism had repeatedly been highlighted in the literature as a feature of many modern VVGs which was likely to lead to important differences in how these games affect their players. More specifically, the realism of modern games was thought to lead to significantly higher levels of priming for their players. The games used in the experiments on negative priming had a relatively low degree of realism. It seemed incautious to generalise the results of these experiments to more realistic VVGs without first understanding what the effects of realism on priming were.

Chapter 4

I therefore conducted a series of experiments which investigated the effects of realism on priming in VVGs. Chapter 4 presented the results of Experiments 4-6. In these experiments, participants played a variety of representative VVGs whose realism was manipulated in a variety of different ways. Across 3 experiments and over 3000 participants, not once was a result seen which suggested that realism increases the priming effects of VVGs. Indeed, greater graphical realism in particular seemed to lead to significantly *less* priming in VVGs.

5.3 Contributions

5.3.1 Aggression-related content in VVGs does not cause priming

The first, and most important, contribution of this thesis is that it provides compelling evidence that the aggression-related content of VVGs does not, of necessity, lead to the priming of aggression-related concepts. Furthermore, it provides evidence that this lack of an effect should apply regardless of the realism of the VVG in question.

The idea that priming does not occur in VVGs regardless of their level of realism has several important consequences for the VVG literature. To begin with, this conclusion deeply conflicts with the results of previous experiments in the literature which support the conclusions of the GAM. As noted in Section 2.6.2, several experiments have seemed to show that playing VVGs leads to the priming of aggression-related concepts. Previously, the disparity between this priming in the literature and the lack of priming in the experiments in this thesis could be laid at the feet of realism. After all, if the influence of realism really was as powerful as theorists in the literature suggested, it might make sense for effects to differ between the literature and Chapter 3. More specifically, the experiments conducted in the literature which used more realistic commercial off-the-shelf games might return priming effects, whilst the less realistic games used in Chapter 3 would not lead to these effects. However, once the purported effects of realism are removed from this equation, a much clearer picture emerges. There now seems to be only one credible explanation for difference between the results obtained in Chapter 3 and the results obtained by proponents of the GAM. This explanation is confounding.

As noted above, experiments in the VVG literature commonly make use of a between-games approach to experimentation. Using this method, different games serve as different experimental conditions. For instance, (Uhlmann and Swanson, 2004) tests the effects of violent content in VVGs by comparing players of a specific non-violent game (*Mahjongg: Clicks*) to players of a specific violent game (*Doom*). In comparison to the laborious process of custom-building bespoke games, this approach is quick and easy to implement. However, an increasingly common concern with academics is that it may have led to serious errors in the interpretation of these experiments. More specifically, whilst a significant priming effect may be observed between a non-violent game and a violent game, it is impossible to confidently say whether this effect's existence is due to differences in violent content between these games, or whether it is due to some other difference between these games, for instance frustration or arousal.

These results feed directly into this area of debate. Not only was priming not observed in the more carefully-controlled experiments conducted in Chapter 3, but quite the opposite result was observed on multiple occasions (negative priming). Not only was this the case, but the results of Chapter 4 suggests that this pattern of effects should apply even to realistic video games. This evidence strongly supports the argument that it is some other factor than the aggression-related content of VVGs which primes aggression-related concepts, if these concepts actually are specifically primed by these games at all.

This bears important consequences for the VVG literature as a whole. However, implications are even more severe when it comes to the GAM in specific, and the effects which this model predicts for players of VVGs. When taken as a whole, this thesis suggests that playing VVGs does *not* lead to the priming of aggression-related concepts, regardless of a game's level of realism. This lack of a priming effect disrupts the causal relationship between playing VVGs and violent behaviour which the GAM proposes.

As the authors of the GAM point out, the long-term changes in aggressive behaviour which their model predicts are largely rooted in changes to cognition. Whilst "temporary mood states and arousal dissipate over time" (Anderson, 2003), long-term changes in aggression are largely due to "the repeated rehearsal of aggressive cognitions". More specifically, by playing VVGs players are exposed to depictions of aggression. This exposure causes the activation and reinforcement of aggression-related concepts and knowledge structures, which is reflected in the presence of priming effects. This, in turn, leads to players behaving violently in the long-term. The studies conducted within this thesis strongly suggest that the priming effects which the GAM predicts should not materialise, even in realistic VVGs. The societal effects which the GAM predicts therefore seem as though they should be greatly reduced. Without priming effects reflecting the activation of aggression-related concepts, the consequences of playing VVGs may be limited to the "temporary mood states and arousal" which are outlined above. It seems like playing a famously frustrating VVG like *Dark Souls* may cause a player to become angry and aroused, and then act aggressively towards nearby individuals. However, it does not seem like the stabbing and killing action in this game will cause the player to learn that these are appropriate behaviours to use in real-world contexts in the way that the GAM predicts, either in the short term or the long term. In this way, *Dark Souls* seems only as likely to lead to violent behaviour as a similarly arousing and angering game such as *Flappy Bird.*

This contribution therefore bears important implications for the GAM. It suggests that if the GAM *is* a correct model of how VVGs might lead to aggressive behaviour, then the long-term effects of these games on their players have been greatly overstated in the literature. In other words, if the GAM is correct in modelling the processes which lead to aggressive behaviour, then its authors are incorrect in assuming that playing VVGs will cause these processes to function. This observation has an important implication. The experiments within this thesis investigate priming, and do not directly look at whether playing VVGs leads to aggressive behaviour. Therefore, whilst these results can show that VVGs do not lead to priming, and hence do not lead to aggressive behaviour in the way that the GAM predicts, they cannot suggest whether or not playing VVGs leads to aggressive behaviour *absolutely*. Drawing such a conclusion from the evidence presented here is far outside the scope of this thesis.

5.3.2 Greater realism does not lead to greater priming in VVGs

As noted above, the primary importance of the results presented in Chapter 4 lies in their ability to support and extend conclusions drawn from the experiments in Chapter 3. However, it is important to note that these results also represent an important contribution to the literature in themselves. As described in Section 2.8, academics have long speculated that the increased realism of modern VVGs might lead to greater effects on their players. However, the evidence presented in the VVG literature regarding this topic is weak. This weakness is largely due to the presence of the same methodological problem which plagues much of the VVG literature – uncontrolled variation between conditions. The results of this thesis shed new light on this issue. A large-scale series of online experiments which featured tight experimental controls repeatedly failed to find a positive effect for *any* kind of realism on priming. Indeed, some of the results of these experiments found that more realism led to *less* priming. This makes it seem extremely unlikely that the realism of VVGs causes any practically important increases in priming.

Whilst this contribution therefore has clear implications for literature, its practical importance is again nuanced. It might initially seem to suggest that the increased realism of modern VVGs should not increase their antisocial effects. However, this is not quite the case. Just as with the results described in the section above, the evidence related to the effects of realism on priming cannot directly be used to make statements about aggressive behaviour. This evidence instead suggests that the increased realism of modern VVGs does not lead to increases in aggressive behaviour *in the way that the GAM predicts*. However, crucially, this real-world impact is again based on the correctness of the mechanisms which the GAM proposes.

5.3.3 Negative priming may happen in video games

Whilst the most important contributions of this thesis relate to the absence of priming effects, an intriguing contribution that this research also makes is to provide initial evidence of negative priming in video games. One important implication of this effect to the literature is a disconfirmatory one. Whilst repeatedly not observing a significant priming effect in a variety of experiments is convincing evidence that this effect does not exist, even more convincing is the existence of a significant effect going in *the opposite direction*. In other words, the repeated observation of negative priming adds extra weight to the overall argument of this thesis – that the aggression-related content of VVGs does not prime aggression-related concepts.

However, this effect may also bear implications for the VVG literature in a different way. Some sources in the literature have expressed unease that the authors of the GAM have based the conclusions of their theoretical framework on how “more passive media such as television” (Williams and Skoric, 2005) function. The observation that *negative priming* might happen in video games seems to confirm the concerns of these researchers. Prominent video game theorists like Jesper Juul and Espen Aarseth argue that there are several specific differences between how viewers and readers engage with non-interactive media like films and books, and how players engage with video games. These academics point out that whilst games might well seem to depict real-world concepts, they are also competitions. Therefore, whilst in-game actions might well look like real-world behaviours (e.g. stabbing, killing, shooting), to the player they are also “symbolic interactions” (Juul,

2011) whose meaning lies in how they affect winning or losing. The negative priming seen here suggests that players may be ignoring the concepts in games and "switch[ing] their focus onto the rules" (Kirkpatrick, 2011) instead. This supports the arguments that there is a fundamental conceptual flaw in the assumptions that the authors of the GAM have made about how players engage with and experience VVGs.

5.4 Limitations and Further Work

As noted above, the importance of negative priming to this thesis is largely related to its ability to guard against the existence of priming. Furthermore, this effect's existence bears some interesting implications for the theory which underlies the GAM. However, a tantalising possibility remains that negative priming might have practical importance beyond this. Under the GAM, the repeated priming of a specific concept makes both that concept and related knowledge structures easier to activate in the long term and leads to violent behaviour. However, the GAM does not indicate what the effects of the repeated *negative priming* of a specific concept might be. This is hardly surprising. After all, this thesis marks the first time that negative priming has been observed in the context of media of any kind. Much further work is needed to overcome this limitation of the experiments presented here and determine what the importance of negative priming might be for players of video games. For instance, it may be the case that just as repeated priming in video games is thought to cause specific concepts and knowledge structures to be easier to access, repeated *negative priming* in video games might make those same concepts and knowledge structures more difficult to access. If this was the case, then VVGs could paradoxically lead to their players expressing *less* aggressive behaviour.

However, it is crucial to be cautious about the potential practical implications of negative priming. Whilst negative priming was repeatedly observed in the experiments which featured in Chapter 3, there were occasions where it was *not* observed. Even small changes in experimental design seemed to render negative priming effectively invisible. This fragility suggests that negative priming may be not just a small effect, but a delicate one which only occurs under certain specific conditions. As part of further research, it will therefore be necessary both to discover what effect size might be associated with negative priming in VVGs, and also investigate what contexts this effect may (and may not) be observed under. As noted above, it may be the case that this effect is so small, or so delicate, that its practical significance is negligible.

A second major limitation of this research is to do with the fact that realism is only one of many features of VVGs which may affect how they prime their players. Therefore, it may be the case that some other feature of VVGs exists which *does* lead their aggression-related content to prime aggression-related concepts. At first blush this statement may seem facile. After all, no matter how rigorous any argument in the social sciences is for the *absence* of an effect, it can never logically prove that the effect in question does not exist under *any circumstance*. However, it is a pertinent limitation of this research because VVGs are a 'moving target'. VVGs are not a static form of media. New features and gameplay mechanics are constantly cropping up in these games. It is a very real concern that these innovations may cause changes to the relationship between VVG play and priming. The legitimacy of this concern can be illustrated with an example from the recent VVG *Grand Theft Auto V*. Most of the action of this game is based around the kinds of driving, shooting, and navigation mechanics which featured throughout the experiments in this thesis. However, in one controversial scene, the player engages in a 'mini-game' in which they must torture a defenceless NPC. As one journalist notes, "this interactive portion has you pulling teeth and waterboarding your victim, and there's no way to skip the scene or opt out of the action"(Sliva, 2013). Whilst I can be confident in saying that the aggression-related concepts present in most VVGs do not lead to the priming of aggression-related concepts, it would be cavalier to extend this argument to an example such as this.

However, it is important not to overstate the impact of this issue. The games used throughout this thesis were representative of VVGs in general. Things like *Grand Theft Auto V's* torture mini-game are *not* representative of the kind of things that happen in VVGs in general. Mechanics like this are not currently widespread in VVGs, and it seems unlikely that it will become ubiquitous any time in the near future. However, it is also the case that games change, and the literature must also change alongside them if it is to remain relevant. Therefore, In order to ensure that the results of this thesis remain accurate, continual additional experimental work is needed to understand what effect (if any) features of VVGs have on priming. This work should particularly be used to guard against the possibility that novel features of modern VVGs increase priming. It may be the case that, as with realism, these features have little effect on this factor. However, it is crucial to bear in mind the possibility that this may not always be the case.

A final note to make about VVG features relates to blood. As noted in Section 4.1, the experiments conducted in this thesis do not feature depictions of blood. This absence is because the presence of blood in a game may increase arousal. Under the GAM this arousal may lead to changes in priming, and thereby confound experimental results. However, this feature of the experiments that feature in Chapter 4 suggests another limitation of how far their results may generalise. Recent VVGs such as *Sniper Elite III* feature extreme levels of blood and gore. It is possible that the conclusions drawn from the experiments in this thesis do not generalise to games like this one. However, it is important to point out that this seems unlikely. As noted in Section 2.8.5, a variety of experiments have directly tested the effects of blood on aggression. Whilst a robust effect on arousal seems to occur for this variable, effects on actual aggression seem to be unreliable. However, in order to be as conservative as possible, further research is needed to ensure that this is actually the case.

A further limitation of the research presented here is to do with children. In the experiments described above, all participants were at least 18 years old. This is not an accident. For ethical reasons, only adults were used in the experiments conducted within this thesis. However, this feature of this research makes it unclear whether any conclusions that are drawn from experimental evidence also apply to people who are aged under 18. Indeed, extending my conclusions in such a way might well prove problematic. Seminal work in the field of cognitive psychology has suggested that children learn from and imitate behaviours in a different way to how adults learn from observed behaviour (e.g. (Bandura, 1965)). It would therefore seem incautious to generalise these results to children. Whilst the conclusions outlined above may well apply to children, it is necessary to conduct further experimental research in order to make sure that this is actually the case.

As outlined above, additional research is required in order to better pin down what the effects of negative priming are on the players of VVGs. Further work is also needed in order to determine if any other features (and in particular, *novel* features) of VVGs might influence the effects observed in this thesis, and also to discover whether these effects generalise to children. However, when taken as a whole, this thesis also suggests the pressing need for a different piece of further work. This thesis shows that clarification of the VVG literature is needed in order to diagnose how seriously confounded this body of research really is.

This thesis contains several pieces of evidence which contradict the claims of academics who argue that VVGs lead to aggressive behaviour. In Experiment 1, playing a run and gun game did not lead to priming. In Experiment 2, playing a maze game did not lead to priming. In Experiment 3, playing an infinite runner game did not lead to priming. In Experiment 4, playing a graphically realistic game did not lead to increased priming. In

Experiment 5, playing a game with realistic physics did not lead to increased priming. In Experiment 6, playing a game with realistic NPC tactics did not lead to increased priming. Each and every one of these absences of an effect runs directly counter to the claims of prominent figures in the VVG effects community. However, more seriously, these results also contradict several pieces of experimental evidence from within the VVG effects literature. As described above, when the tightly-controlled way that these experiments were run is taken into account, this contradiction implies that the VVG literature is littered with false positives. In order to truly understand what the effects of VVGs are on their players, several previous results which have indicated that VVG play leads to priming therefore need to be replicated, and alternative explanations for the effects which they show need to be explored.

This scrutiny of the VVG literature should help to better understand what the effects, if any, of playing VVGs are. Furthermore, it should suggest credible alternative theories for how these effects might be determined. There is an irony in this call for extensive further study. Critical examination of large portions of the VVG literature is needed. More specifically, the work of several proponents of the GAM need to be checked and re-evaluated. However, this research is needed for reasons which proponents of models like the GAM wholeheartedly *support*. It may well be the case that playing VVGs really *does* lead to negative effects on players. It may well even be the case that these effects are currently leading to serious societal damage. However, in order to understand what these effects are, it is necessary to first excise any misleading evidence provided by confounds within the experimental literature.

6 Appendices

A. Anderson word fragment completion task

Word Completion Task

The first use of these materials was in a set of studies on the effects of brief exposure to violent video games on a variety of aggression-related variables. It was also used in several music lyric studies. Both articles are referenced below. **Researchers may use these materials free of charge for research purposes, with proper citation to one of the references listed below.**

Most of the 98 word fragments in this list have several possible correct completions. Fifty of the fragments can yield words that are clearly aggression-related. There may be aggressive completions possible for some of the remaining 48 fragments, but we have not found any yet.

There are several ways to administer the Word Completion Task. For example, in one of our studies participants were told that they were looking at a list of words with letters missing, and that their task was to fill in the blanks to make complete words. Participants were given three minutes to complete as much of the word task as they could. Participant responses were coded into the following categories: aggressive words, neutral words, ambiguous words, and non-words.

One could give participants more time, less time, or an unlimited amount of time to work on the task. This task could easily be computerized so that the researcher could control how long each word fragment appears on the screen before moving on to the next word.

Scoring can also be done in a variety of ways. The next few pages list completions that our participants have created, coded into the following four categories: neutral, ambiguous, aggressive, and non-words. The final pages list the word fragments in two duplicate columns. We simply cut each sheet in half after printing these stimuli to create two narrow "booklets" from each 8 1/2" x 11" set of pages. This conserves paper and printing costs.

We hope you find this task useful in your research. I would love to see copies of your research papers that use this task. Please send them to me at:

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Department of Psychology
Iowa State University
W112 Lagomarcino Hall
Ames, IA 50011-3180

Thank you!

Anderson, C.A., Carnagey, N.L., & Eubanks, J. (2003). Exposure to violent media: The effects of songs with violent lyrics on aggressive thoughts and feelings. *Journal of Personality and Social Psychology, 84,* 960-971.

Anderson, C. A., Carnagey, N. L., Flanagan, M., Benjamin, A. J., Eubanks, J., & Valentine, J. C. (2004). Violent video games: Specific effects of violent content on aggressive thoughts and behavior. *Advances in Experimental Social Psychology, 36,* 199-249.

Carnagey, N. L., & Anderson, C.A. (2005). The effects of reward and punishment in violent video games on aggressive affect, cognition, and behavior. *Psychological Science, 16,* 882-889.

Coding Key for the Word Completion Task

Item #	Neutral	Ambiguous	Aggressive	Non-Words
1)	behind		behead	
	behave			
	Bahama			
	behold			
	behalf			
	behest			
2)	insure		injure	infere
	ensure			indure
	endure			
3)	exceed			expell
	expect			
	extent			
	extend			
	except			
	excess			
	expert			excell
	expend			
	extern			
	excels			
4)	mutter		murder	muller
	muster		mugger	mudder
				multer
				murmer
5)	pride			prode
	prime			prise
	prize			
	prude			
	prove			
	price			
	prune			
	prose			
	probe			
6)	speak		spear	
7)	flipper			
	flitter			
	flicker			
	flirter			
	flivver			
8)	explore		explode	

Item #	Neutral	Ambiguous	Aggressive	Non-Words
9)	warm		wham	
	worm			
	whim			
	whom			
10)	kite		kick	
	kiss		kill	
	kilt			
	king			
	kids			
	kind			
	kiwi			
	kink			
	kilo			
11)	tape			topo
	type			tups
	tips			
	tops			
	taps			
	tope			
	typo			
12)	hare	hurl	hurt	
	hire		harm	
	hard			
	here			
	hers			
	hero			
	have			
	horn			
	hark			
13)	after			
	alter			
	aster			
	actor			acter
	altar			
14)	chore		choke	
	chose			
15)	sample			
	simple			
	simply			
	simper			
16)	attach		attack	
	attics			

Item #	Neutral	Ambiguous	Aggressive	Non-Words
17)	compact	complot		compeat
	compost			compart
	comport			
18)	dessert	deserts	destroy	despire
	desires		despise	deshell
	deserve			desiree
	destiny			
	desired			
	designs			
	despair			
	despite			
	descent			
	descend			
	desktop			
19)	shale			shole
	shall			
	shelf			
	shell			
	shalt			
	shill			
20)	short		shoot	
			shout	
21)	repeat		rapist	
	report			
	repent			raport
22)	strife		strike	
	stroke			
	stripe			
	strive			
	stride			

Item #	Neutral	Ambiguous	Aggressive	Non-Words
23)	line	lure		
	lyre			
	lore			
	love			
	live			
	lose			
	lone			
	like			
	life			
	lake			
	lane			
	lime			
	lope			
	laze			
	lace			
	lame			
	lice			
	late			
24)	born		burn	
	barn			
25)	stereo			
	sterno			
26)	person		prison	
			poison	
27)	poster	pester		
	pastor			
28)	mingle		mangle	
	muggle			
29)	blind			
	blond			
	blend			
	bland			
30)	snore		snare	
31)	bye			
	bee			
32)	hat		hit	
	hut			
	hot			

Item #	Neutral	Ambiguous	Aggressive	Non-Words
33)	grape	gripe		
	grope			
34)	smock		smack	smuck
35)	smile		smite	smere
	smoke			smore
36)	kneel	knave	knife	
	known	knock		
	knits			
	knees			
	knack			
	kneed			
37)	tone	tine		
	tune			
38)	saab	snob	stab	
	slab	slob	snub	
	scab			
	stub			
39)	short	shark		
	shore	sharp		
	share			
	shirt			
	shirk			
40)	drain		drown	
	drawn			
41)	plane			
	prone			
	prune			
	phone			
42)	angel		anger	
	angle		angry	
	anglo			
43)	flirt			
	fleet			
	float			
	flint			
44)	first		fight	
	filet			

Item #	Neutral	Ambiguous	Aggressive	Non-Words
45)	pack pick puck peck			
46)	hare have hale	haze	hate	
47)	ant act art apt			
48)	cat cot		cut	
49)	won win wan			
50)	ate ale are age ace aye awe	ape		axe ave
51)	try cry dry fry wry	pry		
52)	was way wax wad wag wan		war wap	wat
53)	fame		fume	
54)	slip slop		slap	

Item #	Neutral	Ambiguous	Aggressive	Non-Words
55)	book	bark		
	back	balk		
	beak			
	buck			
	bank			
	bunk			
56)	ripe		rape	
	rope			
57)	forest		foment	
58)	offset		offend	
	offers			
	office			
59)	lemon			licon
	logon			
60)	crawl		cruel	
61)	create			
62)	starry	stormy		
	sturdy			
63)	match			
	mitch			
64)	furry		force	faves
	forty	fires	fired	firey
	farms			
	first			
	forks			
	forge			
	forms			
	forth			
	fares			
	ferry			
	farts			
	forum			
	forgo			
	farse			
	forte			
65)	taste			teste
	trite			

Item #	Neutral	Ambiguous	Aggressive	Non-Words
66)	nifty ninth nutty nests newts north		nasty	ninty
67)	window			
68)	winked worked walked		wicked	
69)	vision			
70)	engage		enrage	
71)	screen			
72)	hotrod		hatred	
73)	telephone			telophase
74)	dismissed discussed	disgusted		disensued
75)	central control			
76)	provide		provoke	provise
77)	pinball			
78)	outcome outside outline outdate	outdone	outrage	
79)	call	cell		
80)	rode ride		rude	
81)	manage			

Item #	Neutral	Ambiguous	Aggressive	Non-Words
82)	insect	insist	insult	
	insure			
	inside			
	insert			
	insane			
	insole			
	instep			
83)	side			sade
	soda			
	suds			
84)	bolt	boot		
	bait	butt		
	boat		beat	
	bunt	belt		
	blot	bust		
	beet	brat		
	bout			
	best			
85)	bronze			
	breeze			brouse
86)	revert	revolt		revent
87)	cool			
	cook			
	coon			
	coop			
88)	sony		slay	
	stay			
	sway			savy
	sexy			
	spry			sasy
89)	deer			
	door			
	dear			
	dour			
90)	smock		smack	smuck
91)	fruit			
	front			
	frost			

Item #	Neutral	Ambiguous	Aggressive	Non-Words
92)	lunch munch bunch hunch		punch	
93)	shore share			
94)	amuse		abuse	acuse
95)	clear			
96)	hint	hunt		
97)	water			
98)	stash swash		slash smash	

B. Initial pool of words for LDT

Word: War								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Vanilla								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Crumb								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Battle								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Camouflage								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Bakery								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Birthday								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Trooper								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Layers								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Insurgent								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Stodgy								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Bayonet								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Gunshot

"I associate this word strongly with **soldiers**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

○ ○ ○ ○ ○ ○ ○

"I associate this word strongly with **cakes**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

○ ○ ○ ○ ○ ○ ○

Word: Crumbly

"I associate this word strongly with **soldiers**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

○ ○ ○ ○ ○ ○ ○

"I associate this word strongly with **cakes**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

○ ○ ○ ○ ○ ○ ○

Word: Decorating

"I associate this word strongly with **soldiers**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

○ ○ ○ ○ ○ ○ ○

"I associate this word strongly with **cakes**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

○ ○ ○ ○ ○ ○ ○

Word: Wedding								
“I associate this word strongly with **soldiers**”								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
“I associate this word strongly with **cakes**”								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Eating								
“I associate this word strongly with **soldiers**”								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
“I associate this word strongly with **cakes**”								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Commando								
“I associate this word strongly with **soldiers**”								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
“I associate this word strongly with **cakes**”								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Shrapnel

"I associate this word strongly with **soldiers**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

○ ○ ○ ○ ○ ○ ○

"I associate this word strongly with **cakes**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

○ ○ ○ ○ ○ ○ ○

Word: Recruit

"I associate this word strongly with **soldiers**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

○ ○ ○ ○ ○ ○ ○

"I associate this word strongly with **cakes**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

○ ○ ○ ○ ○ ○ ○

Word: Patisserie

"I associate this word strongly with **soldiers**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

○ ○ ○ ○ ○ ○ ○

"I associate this word strongly with **cakes**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

○ ○ ○ ○ ○ ○ ○

Word: Icing
"I associate this word strongly with **soldiers**" Completely Disagree 1 2 3 4 5 6 7 Completely Agree ○ ○ ○ ○ ○ ○ ○
"I associate this word strongly with **cakes**" Completely Disagree 1 2 3 4 5 6 7 Completely Agree ○ ○ ○ ○ ○ ○ ○

Word: Oven
"I associate this word strongly with **soldiers**" Completely Disagree 1 2 3 4 5 6 7 Completely Agree ○ ○ ○ ○ ○ ○ ○
"I associate this word strongly with **cakes**" Completely Disagree 1 2 3 4 5 6 7 Completely Agree ○ ○ ○ ○ ○ ○ ○

Word: Death
"I associate this word strongly with **soldiers**" Completely Disagree 1 2 3 4 5 6 7 Completely Agree ○ ○ ○ ○ ○ ○ ○
"I associate this word strongly with **cakes**" Completely Disagree 1 2 3 4 5 6 7 Completely Agree ○ ○ ○ ○ ○ ○ ○

Word: Butter								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Army								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Uniform								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Helmet								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Whisk								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Grenade								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Pudding								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Chocolate								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Dessert								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Gun
“I associate this word strongly with **soldiers**”
Completely Disagree 1 2 3 4 5 6 7 Completely Agree
○ ○ ○ ○ ○ ○ ○
“I associate this word strongly with **cakes**”
Completely Disagree 1 2 3 4 5 6 7 Completely Agree
○ ○ ○ ○ ○ ○ ○

Word: Bullet
“I associate this word strongly with **soldiers**”
Completely Disagree 1 2 3 4 5 6 7 Completely Agree
○ ○ ○ ○ ○ ○ ○
“I associate this word strongly with **cakes**”
Completely Disagree 1 2 3 4 5 6 7 Completely Agree
○ ○ ○ ○ ○ ○ ○

Word: Combat
“I associate this word strongly with **soldiers**”
Completely Disagree 1 2 3 4 5 6 7 Completely Agree
○ ○ ○ ○ ○ ○ ○
“I associate this word strongly with **cakes**”
Completely Disagree 1 2 3 4 5 6 7 Completely Agree
○ ○ ○ ○ ○ ○ ○

Word: Sniper

"I associate this word strongly with **soldiers**"

Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

"I associate this word strongly with **cakes**"

Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Infantry

"I associate this word strongly with **soldiers**"

Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

"I associate this word strongly with **cakes**"

Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Barracks

"I associate this word strongly with **soldiers**"

Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

"I associate this word strongly with **cakes**"

Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Dead								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Raisins								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Tea								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Bun								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Sugary								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Sprinkles								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Sweet

"I associate this word strongly with **soldiers**"

Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

"I associate this word strongly with **cakes**"

Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Biscuit

"I associate this word strongly with **soldiers**"

Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

"I associate this word strongly with **cakes**"

Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Meringue

"I associate this word strongly with **soldiers**"

Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

"I associate this word strongly with **cakes**"

Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Fattening

"I associate this word strongly with **soldiers**"

Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

"I associate this word strongly with **cakes**"

Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Buttercream

"I associate this word strongly with **soldiers**"

Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

"I associate this word strongly with **cakes**"

Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Piece

"I associate this word strongly with **soldiers**"

Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

"I associate this word strongly with **cakes**"

Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Shortbread

"I associate this word strongly with **soldiers**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

○ ○ ○ ○ ○ ○ ○

"I associate this word strongly with **cakes**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

○ ○ ○ ○ ○ ○ ○

Word: Slicing

"I associate this word strongly with **soldiers**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

○ ○ ○ ○ ○ ○ ○

"I associate this word strongly with **cakes**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

○ ○ ○ ○ ○ ○ ○

Word: Eating

"I associate this word strongly with **soldiers**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

○ ○ ○ ○ ○ ○ ○

"I associate this word strongly with **cakes**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

○ ○ ○ ○ ○ ○ ○

Word: Brownie								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Fondant								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Recipe								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Strudel								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Caramel								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Caramel								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Custard								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Tart								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Decorating								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Piping

"I associate this word strongly with **soldiers**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

"I associate this word strongly with **cakes**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

Word: Sift

"I associate this word strongly with **soldiers**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

"I associate this word strongly with **cakes**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

Word: Pastry

"I associate this word strongly with **soldiers**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

"I associate this word strongly with **cakes**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

Word: Sponge								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Bake								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Cupcake								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Fruitcake
"I associate this word strongly with **soldiers**" Completely Disagree 1 2 3 4 5 6 7 Completely Agree ○ ○ ○ ○ ○ ○ ○
"I associate this word strongly with **cakes**" Completely Disagree 1 2 3 4 5 6 7 Completely Agree ○ ○ ○ ○ ○ ○ ○

Word: Fudge
"I associate this word strongly with **soldiers**" Completely Disagree 1 2 3 4 5 6 7 Completely Agree ○ ○ ○ ○ ○ ○ ○
"I associate this word strongly with **cakes**" Completely Disagree 1 2 3 4 5 6 7 Completely Agree ○ ○ ○ ○ ○ ○ ○

Word: Dough
"I associate this word strongly with **soldiers**" Completely Disagree 1 2 3 4 5 6 7 Completely Agree ○ ○ ○ ○ ○ ○ ○
"I associate this word strongly with **cakes**" Completely Disagree 1 2 3 4 5 6 7 Completely Agree ○ ○ ○ ○ ○ ○ ○

Word: Cream								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Fluffy								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Delicious								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Kill								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Bomb								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Sergeant								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Marching								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Landmine								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Tank								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Rifle

"I associate this word strongly with **soldiers**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

"I associate this word strongly with **cakes**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

Word: Commander

"I associate this word strongly with **soldiers**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

"I associate this word strongly with **cakes**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

Word: Shooting

"I associate this word strongly with **soldiers**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

"I associate this word strongly with **cakes**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

Word: Explosion								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Ammunition								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Pistol								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Paratrooper								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Salute								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Troop								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Stab								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Munitions								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Colonel								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Wounded

"I associate this word strongly with **soldiers**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

○ ○ ○ ○ ○ ○ ○

"I associate this word strongly with **cakes**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

○ ○ ○ ○ ○ ○ ○

Word: Medal

"I associate this word strongly with **soldiers**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

○ ○ ○ ○ ○ ○ ○

"I associate this word strongly with **cakes**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

○ ○ ○ ○ ○ ○ ○

Word: Military

"I associate this word strongly with **soldiers**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

○ ○ ○ ○ ○ ○ ○

"I associate this word strongly with **cakes**"

Completely Disagree 1 2 3 4 5 6 7 Completely Agree

○ ○ ○ ○ ○ ○ ○

Word: Sentry								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Morale								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Fighter								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

Word: Weapon								
"I associate this word strongly with **soldiers**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	
"I associate this word strongly with **cakes**"								
Completely Disagree	1	2	3	4	5	6	7	Completely Agree
	○	○	○	○	○	○	○	

C. Pool of words for LDT, tagged with relatedness metadata

Word	Association	Cake Mean	Cake Std Dev	Soldier Mean	Soldier Std Dev	Difference in Means
Cupcake	Cakes	6.900	0.316	1.000	0.000	5.900
Bake	Cakes	6.700	0.483	1.000	0.000	5.700
Icing	Cakes	6.500	0.707	1.000	0.000	5.500
Buttercream	Cakes	6.500	0.850	1.100	0.316	5.400
Bakery	Cakes	6.200	0.632	1.100	0.316	5.100
Birthday	Cakes	6.800	0.422	1.700	1.160	5.100
Delicious	Cakes	6.100	0.738	1.000	0.000	5.100
Patisserie	Cakes	6.100	0.876	1.100	0.316	5.000
Sponge	Cakes	6.200	0.919	1.300	0.675	4.900
Sweet	Cakes	5.800	1.229	1.100	0.316	4.700
Fruitcake	Cakes	6.800	0.422	2.200	1.874	4.600
Brownie	Cakes	5.800	1.317	1.300	0.949	4.500
Recipe	Cakes	5.700	0.675	1.200	0.422	4.500
Sprinkles	Cakes	5.600	1.506	1.100	0.316	4.500
Sugary	Cakes	5.500	1.434	1.000	0.000	4.500
Chocolate	Cakes	5.800	1.033	1.333	0.707	4.467
Vanilla	Cakes	5.444	1.130	1.000	0.000	4.444
Cream	Cakes	5.400	0.843	1.000	0.000	4.400
Fondant	Cakes	5.400	2.066	1.000	0.000	4.400
Decorating	Cakes	5.600	1.075	1.200	0.422	4.400
Crumbly	Cakes	5.600	0.843	1.300	0.675	4.300
Dessert	Cakes	5.900	0.994	1.700	1.494	4.200
Buttery	Cakes	5.300	0.823	1.100	0.316	4.200
Pudding	Cakes	5.300	1.494	1.100	0.316	4.200
Eating	Cakes	5.900	1.287	1.800	1.549	4.100
Oven	Cakes	5.200	0.919	1.100	0.316	4.100
Crumb	Cakes	5.556	1.130	1.571	1.134	3.984
Tart	Cakes	4.900	1.370	1.000	0.000	3.900
Wedding	Cakes	5.800	1.229	1.900	0.994	3.900
Fudge	Cakes	5.100	0.994	1.200	0.422	3.900
Bun	Cakes	4.900	1.595	1.100	0.316	3.800
Whisk	Cakes	4.800	0.632	1.000	0.000	3.800
Fluffy	Cakes	4.700	1.767	1.000	0.000	3.700
Pastry	Cakes	4.700	1.767	1.100	0.316	3.600
Caramel	Cakes	4.600	1.174	1.000	0.000	3.600
Eating	Cakes	5.700	1.059	2.200	1.687	3.500
Decorating	Cakes	5.200	1.751	1.800	1.751	3.400
Fattening	Cakes	4.700	1.567	1.300	0.949	3.400
Meringue	Cakes	4.400	1.776	1.000	0.000	3.400
Moist	Cakes	4.900	1.449	1.500	0.850	3.400
Tea	Cakes	4.700	1.252	1.400	0.699	3.300

Raisins	Cakes	4.500	0.972	1.200	0.632	3.300
Biscuit	Cakes	4.500	1.354	1.400	0.966	3.100
Butter	Cakes	4.500	0.850	1.400	1.265	3.100
Shortbread	Cakes	4.200	1.814	1.100	0.316	3.100
Stodgy	Cakes	4.700	0.949	1.700	1.252	3.000
Piping	Cakes	5.100	1.912	2.100	1.729	3.000
Piece	Cakes	4.900	1.595	2.000	1.491	2.900
Sift	Cakes	4.100	1.663	1.200	0.422	2.900
Custard	Cakes	4.100	1.792	1.300	0.949	2.800
Layers	Cakes	5.200	1.033	2.600	1.578	2.600
Slicing	Cakes	4.500	1.179	2.200	1.687	2.300
Dough	Cakes	3.300	1.494	1.200	0.632	2.100
Army	Soldiers	1.000	0.000	7.000	0.000	6.000
Infantry	Soldiers	1.000	0.000	7.000	0.000	6.000
Barracks	Soldiers	1.100	0.316	6.900	0.316	5.800
Military	Soldiers	1.000	0.000	6.800	0.632	5.800
War	Soldiers	1.222	0.667	7.000	0.000	5.778
Sniper	Soldiers	1.000	0.000	6.700	0.675	5.700
Colonel	Soldiers	1.100	0.316	6.700	0.483	5.600
Commander	Soldiers	1.100	0.316	6.700	0.675	5.600
Gun	Soldiers	1.000	0.000	6.500	0.850	5.500
Sergeant	Soldiers	1.100	0.316	6.600	0.966	5.500
Battle	Soldiers	1.000	0.000	6.429	0.787	5.429
Combat	Soldiers	1.000	0.000	6.400	1.075	5.400
Marching	Soldiers	1.300	0.675	6.700	0.675	5.400
Troop	Soldiers	1.000	0.000	6.400	1.075	5.400
Grenade	Soldiers	1.200	0.632	6.600	0.699	5.400
Paratrooper	Soldiers	1.400	1.265	6.700	0.483	5.300
Rifle	Soldiers	1.000	0.000	6.300	0.823	5.300
Bullet	Soldiers	1.000	0.000	6.200	1.476	5.200
Salute	Soldiers	1.200	0.422	6.400	0.966	5.200
Ammunition	Soldiers	1.000	0.000	6.100	1.287	5.100
Bayonet	Soldiers	1.000	0.000	6.100	1.101	5.100
Gunshot	Soldiers	1.000	0.000	6.100	0.994	5.100
Tank	Soldiers	1.200	0.632	6.300	1.059	5.100
Landmine	Soldiers	1.400	1.265	6.400	0.843	5.000
Trooper	Soldiers	1.000	0.000	6.000	0.471	5.000
Munitions	Soldiers	1.000	0.000	5.900	1.729	4.900
Camouflage	Soldiers	1.200	0.632	6.000	1.155	4.800
Commando	Soldiers	1.000	0.000	5.800	1.398	4.800
Insurgent	Soldiers	1.000	0.000	5.800	0.919	4.800
Kill	Soldiers	1.000	0.000	5.700	1.567	4.700
Sentry	Soldiers	1.000	0.000	5.700	0.949	4.700
Weapon	Soldiers	1.000	0.000	5.700	1.418	4.700
Recruit	Soldiers	1.100	0.316	5.800	1.317	4.700
Pistol	Soldiers	1.000	0.000	5.600	1.350	4.600

Fighter	Soldiers	1.000	0.000	5.500	1.509	4.500
Shooting	Soldiers	1.000	0.000	5.500	1.179	4.500
Wounded	Soldiers	1.000	0.000	5.400	1.713	4.400
Bomb	Soldiers	1.300	0.675	5.600	1.174	4.300
Shrapnel	Soldiers	1.000	0.000	5.300	1.252	4.300
Explosion	Soldiers	1.200	0.632	5.200	1.398	4.000
Medal	Soldiers	1.300	0.675	5.300	1.703	4.000
Stab	Soldiers	1.000	0.000	4.900	1.524	3.900
Uniform	Soldiers	1.300	0.675	5.200	1.229	3.900
Helmet	Soldiers	1.300	0.949	4.900	1.912	3.600
Dead	Soldiers	1.000	0.000	4.300	1.494	3.300
Death	Soldiers	1.700	0.949	4.900	1.595	3.200
Morale	Soldiers	2.300	1.567	5.400	1.430	3.100

D. Stimuli which comprise the full LDT

Stimulus	Type	Association
b%a%k%e	Word	CAKE
b%a%k%e%r%y	Word	CAKE
b%i%r%t%h%d%a%y	Word	CAKE
b%r%o%w%n%i%e	Word	CAKE
c%u%p%c%a%k%e	Word	CAKE
d%e%l%i%c%i%o%u%s	Word	CAKE
f%r%u%i%t%c%a%k%e	Word	CAKE
i%c%i%n%g	Word	CAKE
r%e%c%i%p%e	Word	CAKE
s%p%o%n%g%e	Word	CAKE
s%u%g%a%r%y	Word	CAKE
s%w%e%e%t	Word	CAKE
b%a%r%r%a%c%k%s	Word	SOLDIER
c%o%l%o%n%e%l	Word	SOLDIER
c%o%m%b%a%t	Word	SOLDIER
g%r%e%n%a%d%e	Word	SOLDIER
i%n%f%a%n%t%r%y	Word	SOLDIER
m%a%r%c%h%i%n%g	Word	SOLDIER
m%u%n%i%t%i%o%n%s	Word	SOLDIER
r%i%f%l%e	Word	SOLDIER
s%e%n%t%r%y	Word	SOLDIER
s%e%r%g%e%a%n%t	Word	SOLDIER
s%n%i%p%e%r	Word	SOLDIER
t%r%o%o%p	Word	SOLDIER
p%u%p%p%i%e%s	Word	NEUTRAL
w%o%r%d%i%n%g	Word	NEUTRAL
m%o%d%e%s%t	Word	NEUTRAL
j%e%a%l%o%u%s	Word	NEUTRAL
m%y%s%t%i%c	Word	NEUTRAL
r%e%w%r%i%t%e	Word	NEUTRAL
s%h%a%m%a%n	Word	NEUTRAL
u%n%i%c%o%r%n	Word	NEUTRAL
b%a%l%l%o%t	Word	NEUTRAL
c%i%r%c%u%s	Word	NEUTRAL
e%x%c%e%r%p%t	Word	NEUTRAL
h%e%r%e%t%i%c	Word	NEUTRAL
b%a%e%k	Non-Word	CAKE
b%a%k%r%e%y	Non-Word	CAKE
b%r%i%t%h%a%d%y	Non-Word	CAKE
b%o%r%n%w%i%e	Non-Word	CAKE
c%a%p%c%u%k%e	Non-Word	CAKE
d%e%l%o%c%i%u%s	Non-Word	CAKE
f%r%i%u%c%t%a%k%e	Non-Word	CAKE

i%n%c%i%g	Non-Word	CAKE
r%e%c%p%i%e	Non-Word	CAKE
s%g%o%n%p%e	Non-Word	CAKE
s%u%g%r%a%y	Non-Word	CAKE
s%e%w%e%t	Non-Word	CAKE
b%r%a%r%c%a%k%s	Non-Word	SOLDIER
c%o%n%o%l%e%l	Non-Word	SOLDIER
c%o%b%m%a%t	Non-Word	SOLDIER
g%r%e%d%a%n%e	Non-Word	SOLDIER
i%n%t%a%n%f%r%y	Non-Word	SOLDIER
m%a%c%h%r%i%n%g	Non-Word	SOLDIER
m%u%t%i%n%i%o%n%s	Non-Word	SOLDIER
r%i%l%f%e	Non-Word	SOLDIER
s%t%e%n%r%y	Non-Word	SOLDIER
s%a%r%g%e%n%e%t	Non-Word	SOLDIER
s%p%i%n%e%r	Non-Word	SOLDIER
t%o%r%o%p	Non-Word	SOLDIER
p%i%p%p%u%e%s	Non-Word	NEUTRAL
w%r%o%d%i%n%g	Non-Word	NEUTRAL
m%o%s%d%e%t	Non-Word	NEUTRAL
j%e%l%a%o%u%s	Non-Word	NEUTRAL
m%s%t%y%i%c	Non-Word	NEUTRAL
r%e%r%w%i%t%e	Non-Word	NEUTRAL
s%a%h%m%a%n	Non-Word	NEUTRAL
u%c%i%n%o%r%n	Non-Word	NEUTRAL
b%l%o%l%a%t	Non-Word	NEUTRAL
c%u%i%c%r%s	Non-Word	NEUTRAL
e%p%c%e%x%r%t	Non-Word	NEUTRAL
h%i%r%t%e%e%c	Non-Word	NEUTRAL

E. Informed consent form for Experiment 1

Informed Consent for Gaming Experience Study

The purpose of this form is to tell you about the study and highlight features of your participation in the study.

1 Who is running this?

The study is being run by David Zendle who is a Ph.D. student in the Department of Computer Science at the University of York.

2 What is the purpose of the study?

The study aims to investigate the experience of people playing with computer and/or video games.

3 What will I have to do?

You will be asked some demographic questions about yourself and your usual gameplaying habits. You will then play a video game, following which you will be asked some questions.

4 Who will see this data?

David will see this data and Dr Paul Cairns, who is a Reader in the department and his supervisor is overseeing him to analyse the data. David will compile the data from all participants into a large spreadsheet that will be used for further study. However, once it has been compiled, it will be completely anonymised and you will not be able to be identified with your data. The experiment may be published in an academic journal but the data will only be presented in summary form and you will not be directly identifiable in any way.

5 Do I have to do this?

Your participation is completely voluntary. You can therefore withdraw from the study at any point and if requested your data can be destroyed.

6 Can I ask a question?

Do ask either David or Paul any questions you may have about the procedure that you are about to follow. If you have any questions about the purpose or background of the study, please wait until the end and you will have an opportunity to ask David your questions.

7 Consent

Please sign below that you agree to take part in the study under the conditions laid out above.

This will indicate that you have read and understood the above and that we will be obliged to treat your data as described.

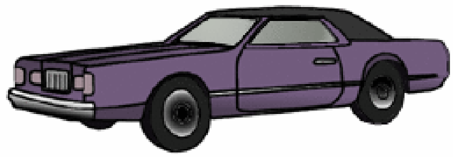
Name:

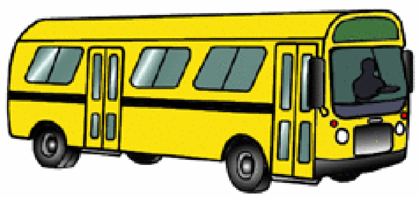
Signature:

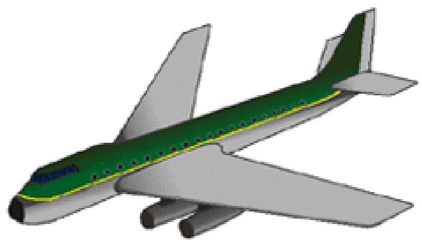
Date:

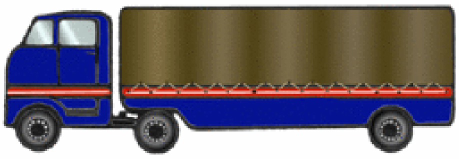
F. Images used in Experiment 2

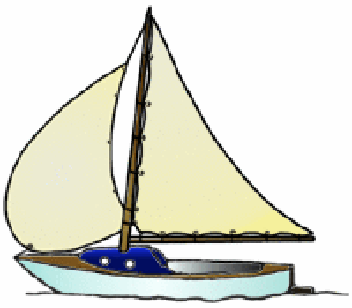
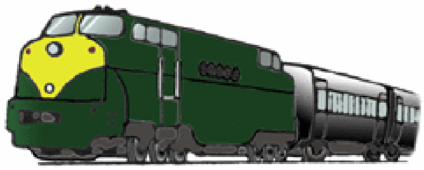
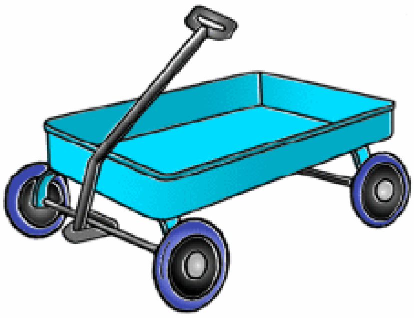
Vehicles



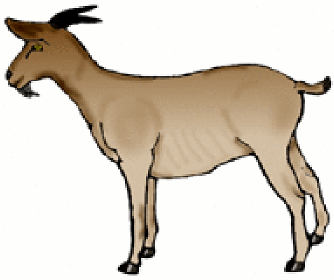


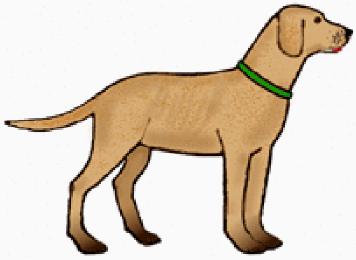


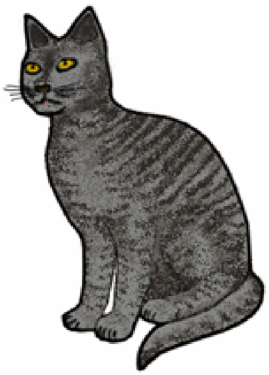


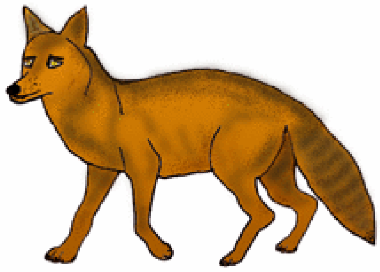




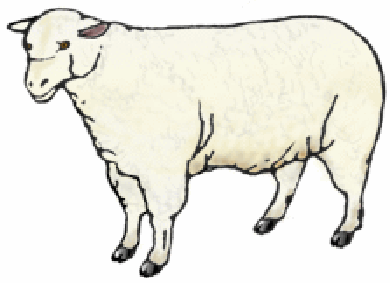

Animals









G. Informed consent form for Experiment 2

Informed Consent for Video Game Study

1 Who is running this?

The study is being run by David Zendle who is a PhD student in the Department of Computer Science at the University of York.

2 What is the purpose of the study?

The study aims to investigate various issues related to playing video games.

3 What will I have to do?

You will be given a series of tasks that should take no more than five minutes to complete in total. These will be delivered via a laptop computer. One of these will be playing a game. You will then be asked some demographic questions and debriefed.

4 Who will see this data?

David and Dr Paul Cairns will see this data. Paul is a Reader in the department and his supervisor. David will compile the data from all participants into a large spreadsheet that will be used for further study. Once the data has been compiled, it will be completely anonymised and you will not be able to be identified from your data.

5 Do I have to do this?

Your participation is completely voluntary. You can therefore withdraw from the study at any point and if requested your data can be destroyed.

6 Can I ask a question?

Do ask David any questions you may have about the procedure that you are about to follow. If you have any questions about the purpose or background of the procedure, please wait until the end.

7 Consent

Please sign below that you agree to take part in the study under the conditions laid out above.

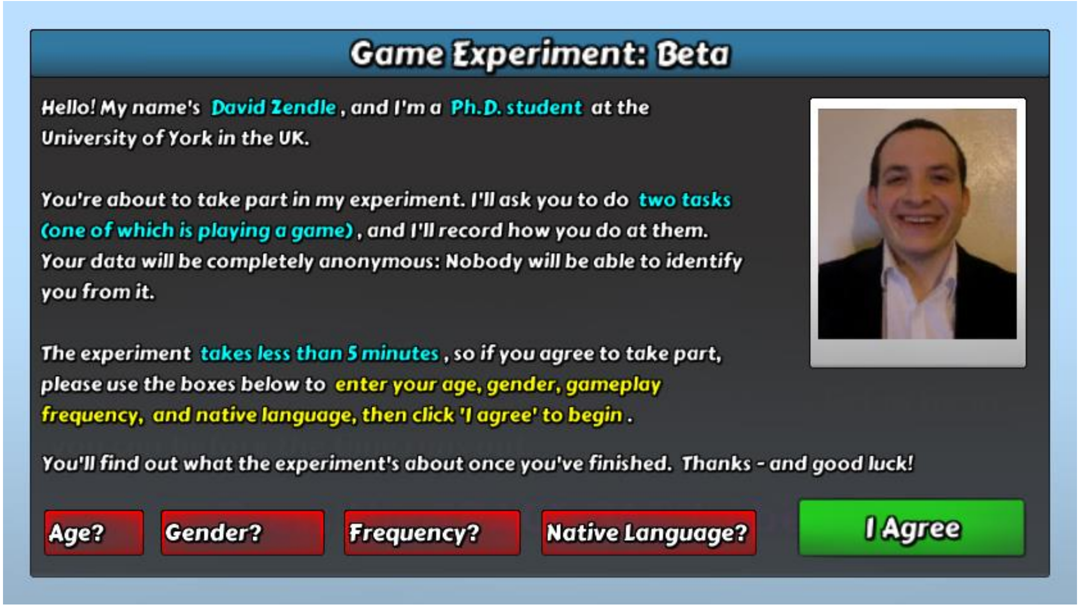
This will indicate that you have read and understood the above and that we will be obliged to treat your data as described.

Name:

Signature:

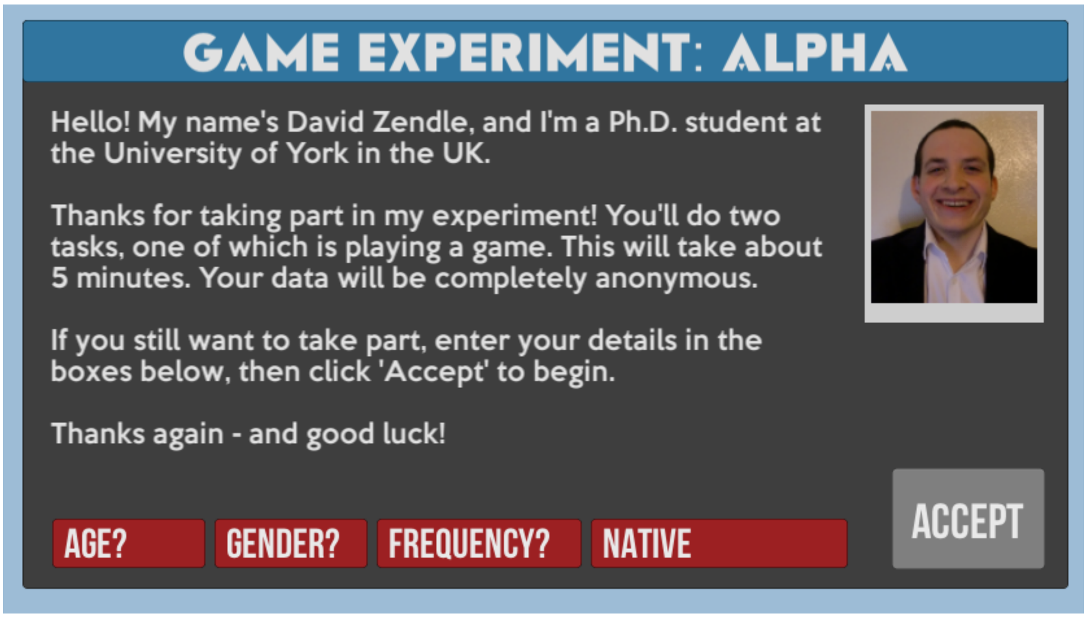
Date:

H. Informed consent screen for Experiment 3

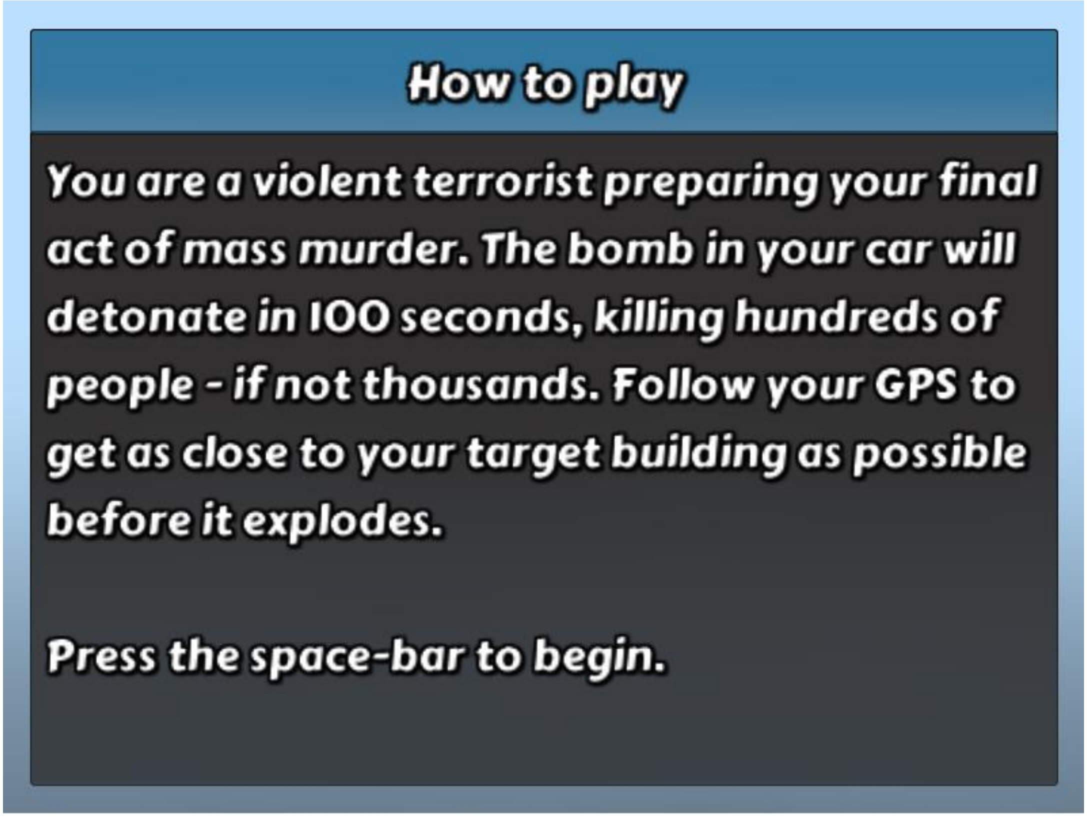


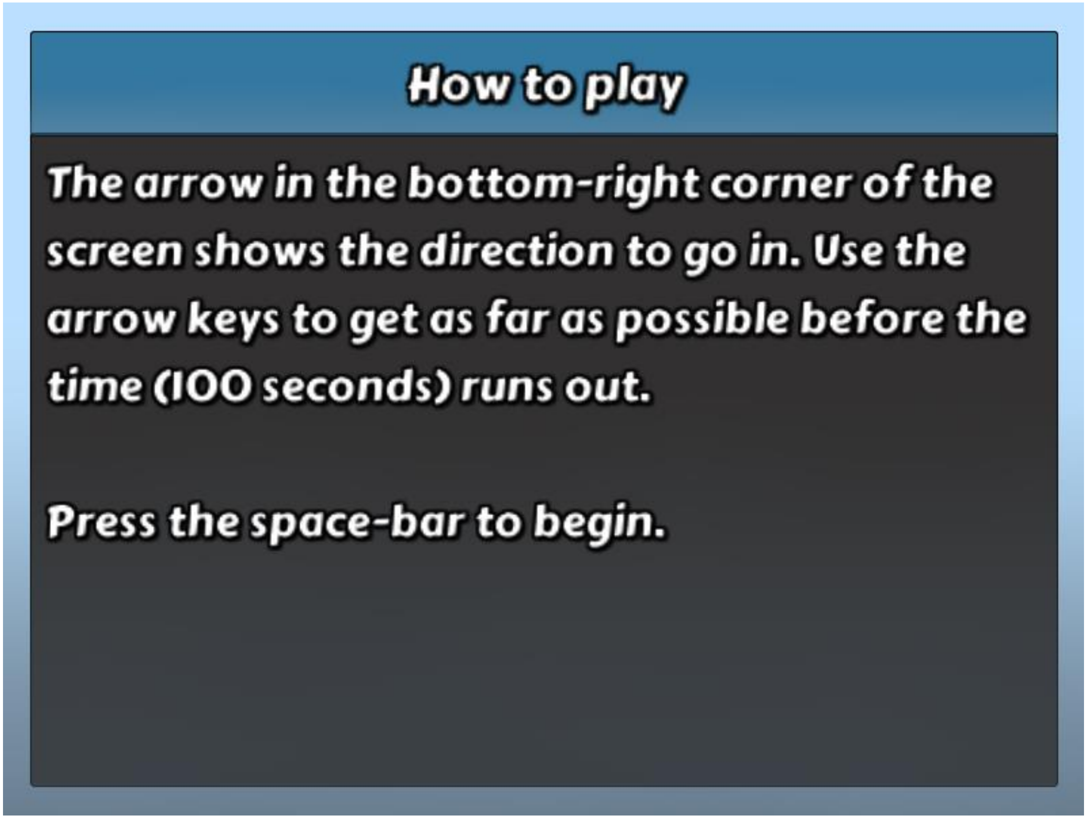
I. Informed consent screen for Experiment 4

J. Informed consent screen for Experiment 5

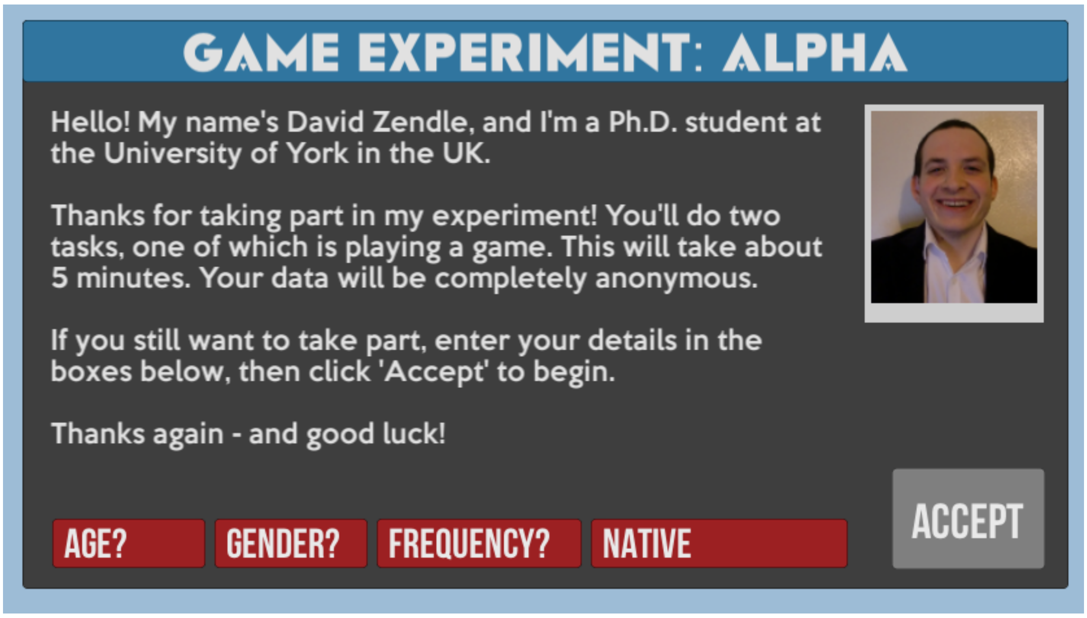


K. Instructions for Experiment 4





L. Informed consent screen for Experiment 6



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