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The Effects of Displayed Violence and Game Speed in First-Person Shooters on Physiological Arousal and Aggressive Behavior

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Contents

Abstract

Many studies have been conducted to examine the effects of displayed violence on outcomes like aggressive behavior and physiological arousal. However, they often lack a proper manipulation of the relevant factors and control of confounding variables. In this study, the displayed violence and game speed of a first-person shooter were varied using the technique of modding, so that effects could be explained properly by the manipulations. Aggressive behavior was measured with the standardized version of the CRTT (Ferguson et al., 2008). Physiological arousal was operationalized with four measurements: galvanic skin response (GSR), heart rate (HR), body movement, force on mouse and keyboard. A total of N = 87 participants played in one of four conditions (low- vs. high-violence, normal- vs. high speed) while physiological measurements were taken with finger clips, force sensors on input devices, and a balance board on the chair they sat on, after which their aggressive behavior was measured with the CRTT.

The results of the study do not support the hypothesis that playing digital games increases aggressive behavior. However, it provides further evidence that the CRTT should only be used in a standardized way as a measurement for aggression, if at all. There were no significant differences in GSR and HR, but with a higher game speed, participants showed less body movement to meet the games higher requirements. Also, higher game speed and displayed violence caused an increase in applied force on mouse and keyboard. Previous experience with digital games did not moderate these findings.

Thus, the present study does extend previous research. It shows not only the methodological advantages of modding, but also the test-theoretical problems of the highly diverse use of the CRTT. It provides evidence that there are game characteristics other than displayed violence that should be controlled since they might have an effect on relevant outcome variables. Further research needs to identify more of those game features, and it should also improve our understanding of the different measures for physiological arousal and their interrelatedness.

Chapter 1

Introduction

Digital games have become an important part in terms of recreation, education and economy, basically in everyday life for people of any age or gender. They can be favorite pastime, a powerful learning tool, a gold mine, an art form, blessing and curse, all at the same time. In 1958, William Higinbotham, using an oscilloscope and analog computer, created Tennis for Two, one of the first computer games, to entertain visitors of the Brookhaven National Laboratory in New York. The last part did not change - people still use computer games for entertainment. Everything else, however, changed vastly over the last 50 years. Today, digital games are played in 67% of American households (Entertainment Software Association, 2010), 1 in 4 Germans older than 14 is a digital game player (Quandt & Festl, 2010), and German adolescents from 12 to 19 spend 79 minutes each day playing digital games, on weekends even more (Medienpädagogischer Forschungsverbund Südwest, 2009).

The popularity of digital games in any population shows that they have become a societal phenomenon, and thus, an interesting subject for social scientists of all fields. And like with most societal phenomena, there is a good side and a bad side to its suspected effects. One of the most discussed and researched effects is the link between digital games (especially violent ones) and aggression. There is a lively discussion, sometimes hot tempered, among the digital game scientist, about the magnitude of this effect on behavior outside the laboratory. However, this debate was carried into the general public, and it has become a very emotional dispute between scientists, politicians, journalists, parents and gamers, if nothing else. Even with the mixed results and contradicting effects produced by different scholars, strong opinions are expressed publicly through mass media channels, of which neither side is legitimated by the current state of research.

The literature on the effects of displayed violence on aggressive behavior in digital game players provides plenty of laboratory experiments that generally share a certain design: Behavioral test results (e.g. the Competitive Reaction Time Task; originally by

Taylor, 1967) and physiological variables (mostly systolic/diastolic blood pressure and heart rate, sometimes galvanic skin response) are compared for groups that either played a first-person shooter or another non-violent game (e.g., Anderson et al., 2004; Anderson & Dill, 2000; Arriaga, Esteves, Carneiro, & Monteiro, 2006; Barlett, Branch, Rodeheffer, & Harris, 2009; Winkel, Novak, & Hopson, 1987).

The problem with this approach is that the games used as operationalization of the conditions in these studies differ on more variables than just the displayed violence, e.g. the perspective, required spatial attention, required hand-eye coordination, etc. Even though some researchers try to control for that by using games that score similarly on a few variables like difficulty, enjoyment, action, frustration, and differ on violent graphics and content (e.g., Anderson et al., 2004), the vast differences between the considerably dated games used in those studies become apparent once one takes a look (or plays) them. Although there is a lot of proof for a difference in the short-term effects of those games on physiological arousal and aggressive behavior, the question whether this can be traced back to the displays of violence remains unanswered because there are plenty of other possible causes that were not eliminated or controlled in these studies.

One very obvious difference between first-person shooters and other digital games is the game speed. First-person shooters require the players to reach their limits of attention, reaction capabilities and also the hand-eye coordination. Movement of the controlled avatars often exceeds human speed. In fact, unlike other games, most first-person shooters employ a key one must press to stop running and walk or crouch instead. While it is required to be moving by using the control keys on the keyboard all the time to make a harder target, at the same time the player has to look around in a 360° angle to spot possible enemies through mouse movements. What the player actually sees on the screen through the eyes of the avatar at a time is only a small part of the full and rich non-linear three-dimensional environment. Although there is no research on the specific effects of game speed on physiological arousal or aggressive behavior, there are indications that first-person shooters tend to be perceived as faster than other games.

The present study is conducted to examine the short-term effects of game speed and displayed violence in a latest generation first-person shooter on physiological arousal and aggressive behavior. To test this, the game speed and the displayed violence are varied on two levels each. This is realized by creating a modification of the relevant game variables, and only those. This makes sure that every possibly confounding variable is controlled, and results can be traced back to either violence or speed. The aim is to put past studies into perspective, and facilitate game modding as a tool for digital game researchers.

Chapter 2

Digital Game Effects Theory

Defining the following terms is important when discussing assumptions about the effects of digital games and the game content itself.

2.1 Basic Definitions

Aggressive Behavior

There are many definitions of aggressive behavior, as it can be expressed in many different forms. Baron and Richardson (1994) define aggressive behavior as behavior, not necessarily physically injurious nor illegal, intended to cause physical harm or humiliation to another organism that wishes to avoid the harm. Although aggression also can be directed towards objects, it is sufficient do define it as strictly interpersonal for this work.

Violence

To distinguish violent behavior from aggressive behavior, it is loosely defined as "typically restricted to acts which are intended to cause serious physical harm" (Ferguson & Rueda, 2009, p. 121).

Arousal

The definition of Dorland's Medical Dictionary for Health Consumers (2007) for physiological arousal as "a state of responsiveness to sensory stimulation or excitability" is broad enough to cover all measures used in this work.

Digital Game

The definition for digital games in this work is made in two steps. Firstly, Juul (2005) defines a game as follows:

> A game is a rule-based system with a variable and quantifiable outcome, where different outcomes are assigned different values, the player exerts effort in order to influence the outcome, the player feels emotionally attached to the outcome, and the consequences of the activity are negotiable. (p. 36)

Aarseth (2003) defines digital games as games in virtual environments, which can be described by a tripartite model: gameplay (the players' actions, strategies and motives), the most fundamental game-structure (the rules of the game), and a clearly defined game-world (e.g., fictional content, topology/level design, textures).

First-Person Shooter

In this work, a first-person shooter is defined as a digital game featuring a first-person perspective in which the player maneuvers through a three-dimensional world and sees the environment and actions through the eyes of an avatar while trying to shoot opponents usually with guns and other projectile weapons.

2.2 The Digital Game-Aggression-Link

Claims of a causal relation between digital game playing and aggressive behavior have a rich history. Many of these assumptions, however, are based on anecdotes or speculations (e.g., media reports), some by field experts (e.g., teachers, parents), and few by scientists (e.g., psychologists). It might be due to the complexity of human behavior or the limitations of experimental (laboratory) psychology, that researchers tend to produce mixed results instead of a definite proof for a causal link of the magnitude some claim it has. However, there are also some scholars who do not believe in the link at all, or consider it weak and unimportant compared to other influences, especially in childhood and adolescence. There is, to say the least, a big discrepancy between the mostly homogeneous public opinion, and the heterogeneous current state of research on the effects of digital game playing.

What could be an interesting scientific discourse has turned out to be an ideological war between followers of those two beliefs, blurring the line between subjective conviction and objective empiricism. Polite allusions are made and parallels to other (unrelated) fervid public discourses are carefully drawn, certainly not for the best of a reasonable discussion, e.g. by Anderson (2004):

> Video game industry representatives and their "experts" have criticized the existing violent video game research literature, much as the tobacco industry found "experts" to criticize all research on the possible causal links between smoking and lung cancer. (p. 115)

as well as Ferguson and Kilburn (2010):

> Whatever techniques used by Anderson et al. to garner unpublished studies, these techniques worked very well for their own unpublished studies but poorly for those from other groups. (p. 175)

and even on a more personal level by Huesmann (2010):

> Among those scholars with a vested interest in video games, (...) because playing these games is an important part of their identity (e.g., Ferguson; Jenkins) (...), there is a lasting expressed disbelief that media violence can cause aggressive behavior. Their disbelief seems to be compounded by their failure to grasp observational learning theory. (p. 180)

Even the titles of replies to a scientific paper (Anderson et al., 2010) published in reputable journals read more like expressions that could be found in a tabloid's front page headline: "Much Ado About Nothing" (Ferguson & Kilburn, 2010), "Much Ado About Something" (Bushman, Rothstein, & Anderson, 2010), and "Nailing the Coffin Shut on Doubts That Violent Video Games Stimulate Aggression" (Huesmann, 2010).

If experimental results are so arbitrary that different researchers come to different conclusions about them, and still have valid points, that means two things:

1) The methodology of digital game research has to be improved, leading to a methodologically distinct framework, thus more reliable and valid results.
2) Thorough theories or models capable of explaining the diversity of results have to be built, and consequently attempts to find proof or disproof for them by more and better research have to be made

Two groups of digital game scholars made some first steps in that direction: Anderson and Bushman (2002) published their General Aggression Model, including many domain specific cognitive theories of aggression (see section 2.2.1). This has become the default model many digital game researchers use to design studies and interpret results. Ferguson et al. (2008) took a different approach with their Catalyst Model, allowing for other influences to intercept or facilitate the effects of digital game playing. These two models are explained in detail in section 2.3, while chapter 3 gives an overview of current research on the effects of digital game playing on aggression and physiological arousal and discusses some of the methodological flaws repeatedly confounding the results of those studies.

2.2.1 Five Domain Specific Cognitive Theories of Aggression

Anderson and Bushman (2002) include five popular domain specific cognitive theories of aggression in their General Aggression Model (see section 2.3.1). These theories are supposed to explain the acquisition and execution of behaviors, as well as the expectations about behavior of others, and how these all are modified by repeated exposure to violent media content.

Cognitive Neoassociation Theory

The cognitive neoassociation theory states that thoughts, emotions, and behavioral tendencies of any kind are all linked together in a memory network (Collins & Loftus, 1975). Those concepts can have strong and weak associations, depending on their semantic similarity (e.g., hunger, thirst) and how often they are activated at the same time (e.g., chair, sit). There are also associations between cues and events during which they are repeatedly present, and the cognitive or emotional responses to these events. An activated concept automatically activates strongly associated concepts as well. However, deliberate higher-order processes (e.g., estimating consequences) can suppress or facilitate those activations, if enough resources are available. According to Berkowitz (1990), aversive events (e.g., frustrations, provocations) cause negative affect, which again is linked to all kind of cognitive, motor, and physiological responses with tendencies of flight (feelings of fear) and fight (feelings of anger). The cognitive neoassociation theory is specifically fit to explain hostile aggression, as shown with a simplified example by Anderson, Arlin, and Bartholow (1998) in figure 2.1. Associations are displayed by lines between concepts, with the strength of an association represented by the line thickness.

Script Theory

The script theory (Schank & Abelson, 1977) is integrated into the cognitive neoassociation theory and claims that scripts are clusters of concepts with extremely high associations due to very frequent (and successful) repetitions, mostly causal behaviors linked to certain aims, plans and protocols. When such a set of concepts is linked so strongly, it becomes a unitary cluster in the memory network that explains situations and, often automatically, defines the "right" behavior. A behavior is validated as a useful alternative by repeated social learning processes, and then written into the semantic memory. Scripts also heavily influence expectations and beliefs about the intentions of others in social situations (Anderson, 1983). The more often a script is used, the more likely it is to be linked to other concepts in the network, having a higher frequency and probability of being activated by a higher number of possible paths. But the links of the

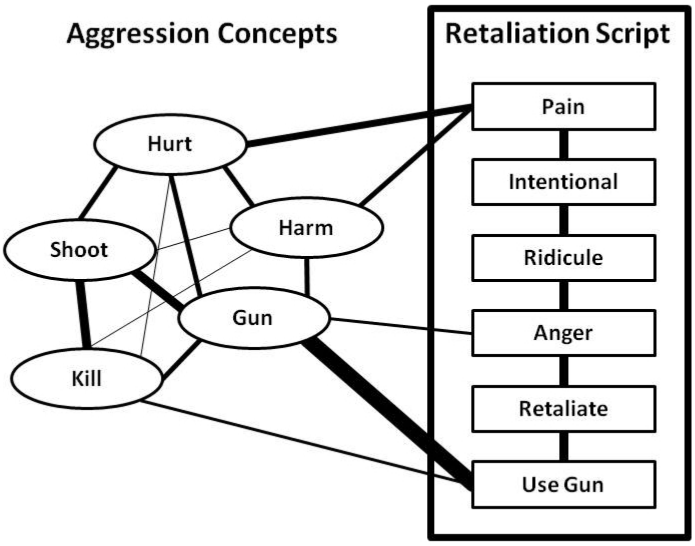

Figure 2.1: Example association network of aggression concepts and a retaliation script by Anderson et al. (1998).

script itself are strengthened as well, making it more unspecific and therefore accessible in many ambiguous situations.

The acquisition of aggressive scripts through repeated exposure to media violence was first suggested by Huesmann in 1986 and later adopted by others (e.g., Anderson & Dill, 2000). The theory explains automatic processes and generalization of specific social behaviors (e.g., person judgments). In figure 2.1, the example of a simplified retaliation script is integrated into an associative network of aggression concepts.

Social Learning Theory

The basic assumption of the social learning theory (SLT; Bandura, 1977) is that all social behavior is acquired by either direct experience or observation of attractive, rewarded models and subsequent imitation. Thus, new expectations about social mechanisms in life are developed, and old concepts may change, if a certain behavior has been observed or experienced frequently (e.g., behavior of parents). It explains how the means of instrumental aggressive behaviors are understood and acquired (Bandura, 1983), and beliefs about social behavior are internalized. Assuming that people can learn from avatars or characters in digital games like they learn from humans, especially games containing realistic violence that is not socially sanctioned should have a strong effect. Longer playing times also facilitate this effect due to greater consolidation and reinforcement of the modeled behavior.

Social Interaction Theory

In their social interaction theory, Tedeschi and Felson (1994) define coercive actions (e.g., in the form of aggressive behavior) as means of social influence on the behavior of others. On the basis of conscious calculations or expectations about the outcome, those actions have the purpose to gain something considered valuable (objects, but also information or services), display oneself in a certain manner (e.g., capable, tough), or respond to subjectively wrong behavior of others (e.g., punishment, retribution). This theory is specifically fit to explain aggression as an instrument to reach ultimate goals. For example, hitting someone very quickly would not only settle an current quarrel, but also reduce the likelihood for possible future conflicts or fights due to a certain reputation. According to the social interaction theory, experiencing violence in a digital game as useful means to influence others and reach ultimate goals could be transferred to ambiguous situations in real life.

Excitation Transfer Theory

Zillmann (1983) stated that physiological arousal, once evoked by any event, decreases only slowly to its normal level, and thus it may be mistakenly attributed to a consecutive, but unrelated event. If the second event caused aggression in a person, the arousal from the first event, even if related to something completely different, would increase the feeling of aggression. Zillmann (1988) also claims that through this transfer of arousal (or excitation), a person may extend the feeling of aggression (and willingness to act aggressively) over a longer amount of time, even after the arousal has dissipated. The excitation transfer theory is especially useful to explain short-term effects of digital game playing on subsequent behavior. According to this theory, violent digital games could increase the arousal necessary to act aggressively, and persons with a disposition for aggressive behavior then act more violently than they normally would.

2.3 Explanatory Models

While it is good to have theories that can explain some aspects of the link between digital game playing and aggression, it is the next logical step to unite those theories in an exhaustive, explanatory model. Building such a model has several advantages (Anderson & Bushman, 2002): 1) It is more parsimonious than a set of theories. 2) It is more capable of explaining actions with several motives. 3) It eases the development of interventions for clinical cases. 4) It helps localizing developmental problems in children, and governments to establish adaptive systems. Two competing models are presented in greater detail the following section: the General Aggression Model (GAM) by Anderson and Bushman (2002), which has a long tradition in digital game research, and the Catalyst Model by Ferguson et al. (2008). Also, the Downward Spiral Model (Slater, Henry, Swaim, & Anderson, 2003) is briefly introduced, and compared to the other two.

2.3.1 General Aggression Model

The basic assumption of the General Aggression Model (GAM; Anderson & Bushman, 2002) is that knowledge structures like perceptual and person schemata or behavioral scripts develop from experience and can influence (social) perception, behavior (conscious and automated), affect, and beliefs. GAM focuses on episodes, i.e. persons in situations, consisting of personal or situational input, interpretative routes (thoughts, feelings, arousal), and behavioral output through appraisal and decision processes.

Inputs

In GAM, input is always any situational feature (e.g., aggressive cues, provocation, frustration, pain and discomfort, drugs, incentives) and/or personality variable (e.g., traits, sex, beliefs, attitudes, normative values, long-term goals, and learned scripts). Naturally, these features can influence each other in the long run, as, for example, increasingly violent persons might interpret ambiguous situations as more hostile than they actually are.

Routes

The behavioral output that results from the combination of input factors is influenced by the present internal state that they create. The internal states of most interest concern cognition (e.g., hostile thoughts, scripts), affect (mood and emotion, expressive motor responses), and arousal. Naturally, they all are highly interconnected.

Outputs

Outcome behavior is dependent on either automatic or heavily controlled processes. Immediate appraisal is relatively effortless and spontaneous, occurring unconsciously and without much cognitive resources. However, it is also heavily influenced by the present internal state, which then again is dependent on person and situation factors. All in all, immediate appraisal leads to impulsive (though not necessarily wrong) (re-)actions. If a person has enough resources (mostly time and mental capacity) and the output is important, but the immediate appraisal is unsatisfying, the decision can be reappraised

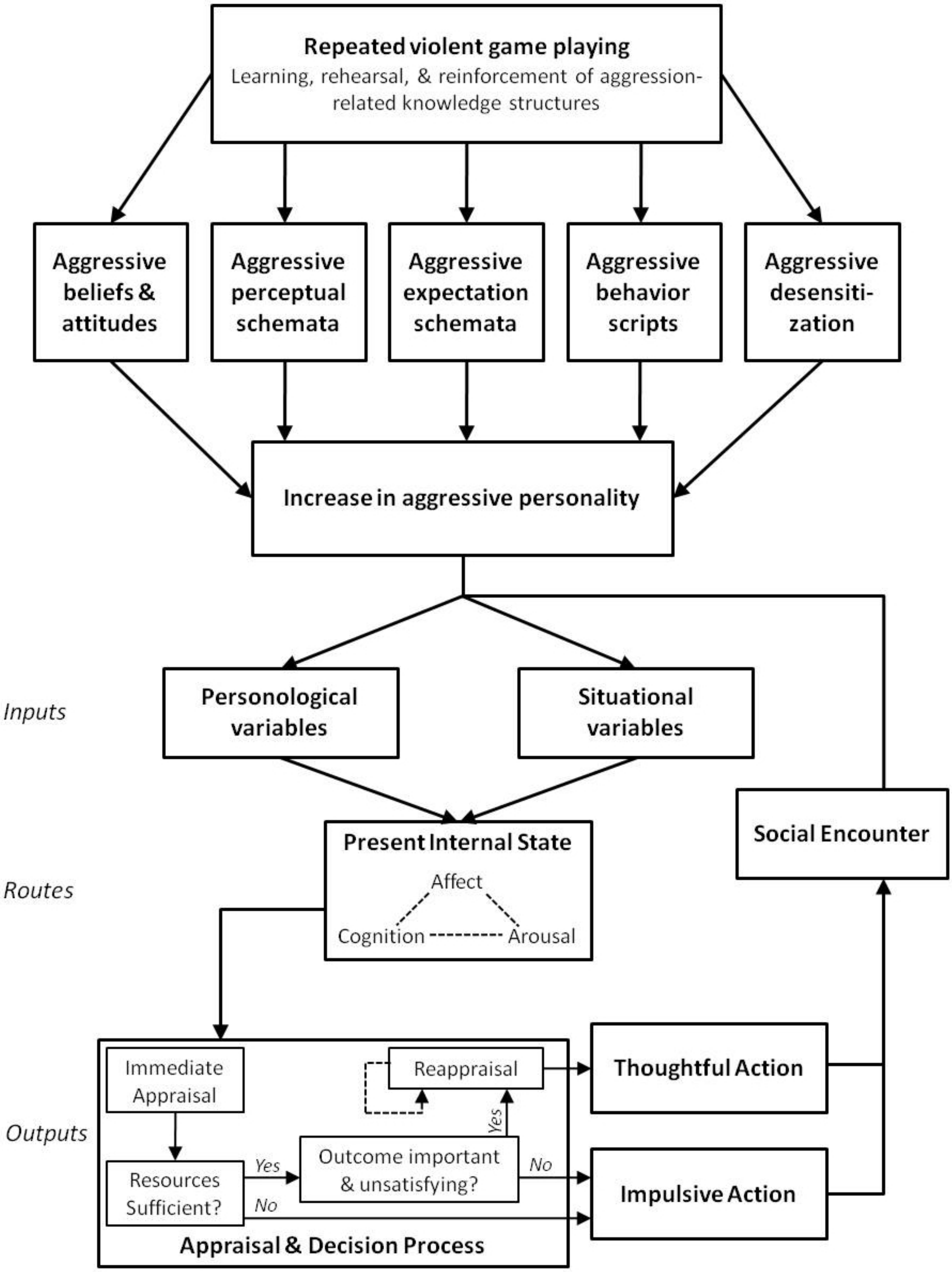

Figure 2.2: The General Aggression Model by Anderson and Bushman (2002).

(numerous times, if necessary). In any case, the output determines a reaction, which becomes part of the input for the next episode.

Personality

Past experiences are part of a person's mindset for the present episode, but they also determine plans, expectations, goals, and other long-term aspects of the future. Those mechanisms (beliefs and attitudes, perceptual schemata, expectations, behavior scripts, and desensitization) result from the development, automating, and reinforcement of existing knowledge structures. Frequent use of violent digital games, for example, may lead to permanent perceptual biases, attitude changes, and aggressive behaviors.

A diagram of the whole model is shown in figure 2.2.

Weaknesses and Limitations

Several major weaknesses of GAM are discussed here, some practical, and some on a more theoretical level: First of all, and most importantly, the model completely neglects competing cognitive schemata. Even if it was indeed true that aggressive schemata and scripts are learned by playing violent digital games, people tend to do other things as well, and subsequently acquire different or contradicting schemata. What are the hundred times a problem is solved violently in a digital games compared to the thousands of non-violent solutions for school or family issues? The cognitive neoassociation theory specifically states that concepts can exist next to each other despite being contradictory or competing, and not including this in the GAM is a strong theoretical weakness.

Secondly, its described processes are very passive and mechanistic. The input goes in, is processed, and output is produced, which is part of the next input. Although this seemingly abstract description of how we learn to act may be true in principal, the model does not account for protective or immunizing factors, which is especially important when considering that pathologically aggressive personalities may result from reinforcement and learning processes. Taking the model "as is", everyone who plays violent digital games would suffer from their effects. However, this is obviously not the case, as both everyday life observations and scientific results are very ambiguous. Imagine someone who frequently plays digital games, but lives in a harmonic and peaceful family environment - what weight is more powerful? The model does not specifically deny genetic, personality and environmental influences, but they are artificially excluded.

Another weakness is the model's understanding of digital violence. While it is plausible that frequent exposure to real-life aggression leads to an increase of aggression in several facets of personality, a player has no intention to harm another individual through a digital game, nor are there intentions of others to harm the player. The question whether digital violence can be equalized with real-life violence in terms of knowledge structuring processes has not been answered sufficiently yet. The model's attempt to anticipate this parity cannot be justified by the current state of research.

Finally, the GAM might not be relevant for the majority of violent digital game players. The social learning theory accounts for people of all ages, but the empirical foundation, e.g. the famous bobo doll studies, was gained with psychological experiments and observations on children, not adults. The theory explains well how children adopt problematic behavior by watching adults act violently, but it is adults, not children, who make the audience of digital games. While children might copy observed behavior uncritically, even when seen in a digital game, it seems unlikely that grown adults are that unmindful.

2.3.2 Catalyst Model

The Catalyst Model of Violent Crime by Ferguson et al. (2008) is an alternate view of the relationship between violent digital games and behavior, more focusing on innate motivations, genetic dispositions, and other more fundamental environmental factors (e.g., the family). The model states that an aggression-prone personality develops mostly through a biological path and genetic dispositions. However, these invariant factors are moderated by environmental aspects (in a positive or negative direction). According to this model, people with an aggressive personality, under a given environmental setting, are more likely to act aggressively. Also, short-term environmental stressors or catalysts (e.g., financial difficulties, relationship problems, legal troubles) increase the likelihood for more aggressive behaviors for individuals with an according disposition. Biological factors can make a person prone to aggressive behavior, but the environment determines the motivation to do so.

The role of digital game violence in this model is not causal, not even very important at all. They are considered stylistic catalysts, that is, a person with a disposition for violence may act aggressively similar to the actions seen in a digital game. The characteristics of a behavior may be formed by digital violence, but not be the reason or motivation to act violently in the first place. The acts of violence would still occur in another form, even without previous exposure to violent games. Contrary to GAM, the individual is seen as an "active" modeler of its own behavior, so it seeks out modeling opportunities according to the innate motivational system. An individual with a disposition for violence would be susceptible to violence even when presented with contrasting modeling opportunities.

A diagram of the whole model is shown in figure 2.3.

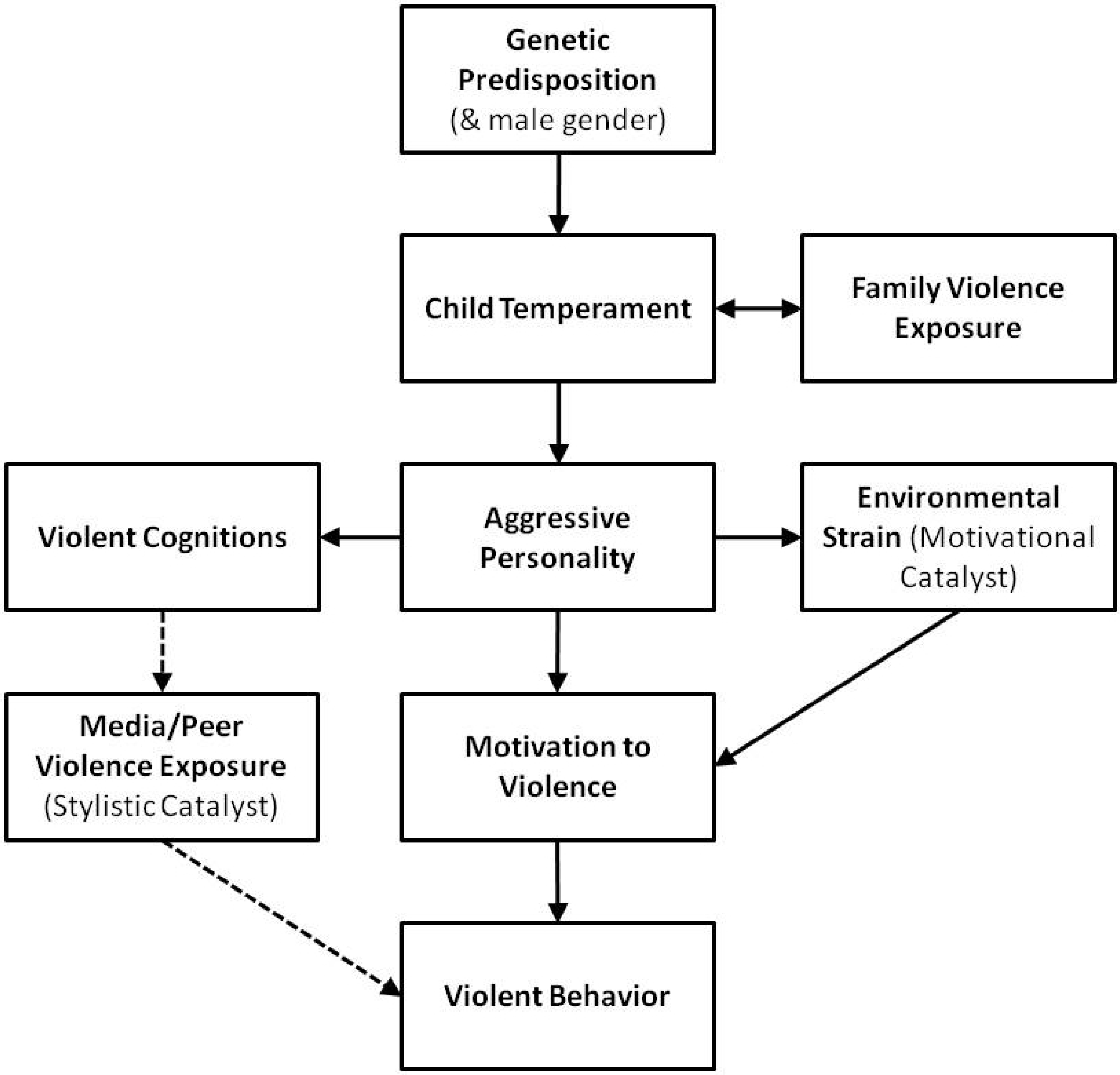

Figure 2.3: The Catalyst Model of Violent Crime by Ferguson et al. (2008).

Weaknesses and Limitations

In theory, the Catalyst Model is capable of explaining a lot of effects found in the literature, and offers a strong alternative to GAM. However, it has not been tested thoroughly, nor is it frequently regarded as an explanation for effects in the literature on digital games. To this point, the model seems more like a promising concept, more because of missing empirical application than a lack of theoretical background.

2.3.3 Other Models

With the current weaknesses and limitations of both Catalyst and General Aggression Model, it is only reasonable that they are not satisfying enough to some researchers' ideas and findings. Therefore, other more domain-specific models have been developed, more fit for specific research paradigms, and more capable of explaining certain effects. However, those models usually could be integrated into the higher-order models, and thus are rather complementing than competing. One example is the Downward Spiral Model by Slater et al. (2003) that aims to explain the long-term relation between violent media use and aggressive behavior.

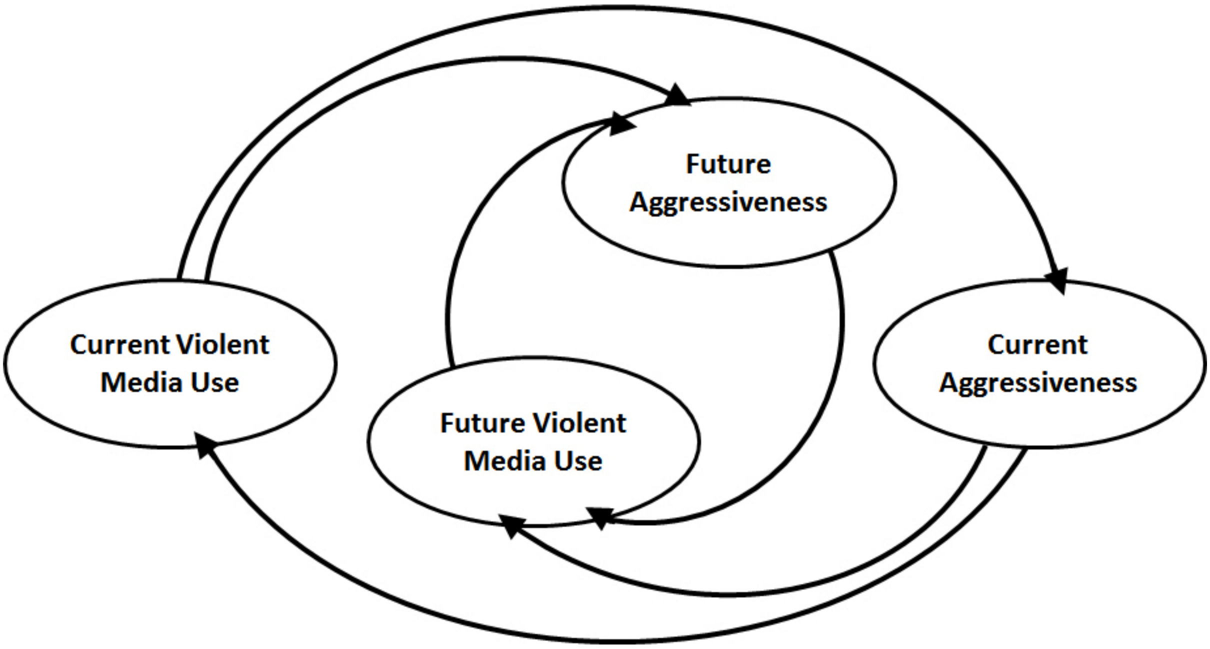

Figure 2.4: The Downward Spiral Model by Slater et al. (2003).

Additionally to the assumption of GAM, that media violence facilitates current and future aggression, this model also states that aggression explains the current and future use of violent-media content. While this may sound trivial - and indeed it would be surprising to find anything else - this mechanism is not part of GAM and only partially in the Catalyst Model (although it could be easily expanded to cover the whole downward spiral). The model expects persons attracted to violent media content because of an aggressive disposition to be particularly vulnerable to the effects of said exposure. Thus, the two are causal in both directions, they have a reciprocal relationship, and, by definition, reinforce each other over time. The Downward Spiral Model shares some of the GAM's weaknesses. Most importantly, immunizing or protective factors are excluded from the spiral, and it is being very unspecific about the exact characteristics of aggressive dispositions. Excluding the described effects from GAM or the Catalyst Model bears no advantage as well: Both models could be extended to explain the Downward Spiral mechanisms, though with very different views. While this is actually a long-term prospective of the effects described by GAM and perfectly fits its predictions, the logic of the Catalyst Model would tell us that there is in fact a Downward Spiral, though digital games are only a catalyst of another higher-order variable (like family violence), making it seem like aggression and and violent media have a causal link.

A diagram of the whole model is shown in figure 2.4.

Chapter 3

Literature Review and Findings

In their meta-analysis from 2001, Anderson and Bushman included 35 research reports that fit their literature search criteria. Scholars certainly have not stopped publishing since, although already in 2003, Anderson et al. claimed that "the scientific debate over whether media violence increases aggression and violence is essentially over" (p. 81). Yet, there seem to be a few "tenacious" scholars who continue to publish (apparently superfluous) studies, theories, models and critiques. For their latest meta-analysis, Anderson et al. (2010) used a total of 136 research reports. With new publications (both journal papers and books) and conferences almost on a monthly basis, the overview presented here can hardly be exhaustive. Its purpose is to present an overview of the recent research on the effects of digital game playing on aggression and some popular paradigms, but also to discuss methodological problems and limitations.

Because the object of research itself, digital games, is constantly changing as well, only the more recent studies are discussed here. Results on the effects of digital games that were played 15 or more years ago might not be so relevant for the games we play today, and newer studies are far more likely to use newer games as stimulus material. It should be mentioned though, that often enough this is not the case, which constitutes one of the main weaknesses in digital games research (see 3.4).

More generally, psychological research on digital games can be assigned to three categories: experimental and causal studies, correlational and longitudinal studies, and meta-analyses.

3.1 Experimental and Causal Studies

The main body of psychological research on the effects of digital games consists of laboratory experiments. Many of these studies share a certain design: Study participants either play a first-person shooter or a non-violent game while physiological reactions are measured simultaneously. Afterwards, participants' perform a test or fill out a questionnaire to assess aggressive cognitions, emotions or behaviors, which are then compared for the two groups. While this approach has some limitations and flaws (see 3.4), the findings cannot be disregarded and therefore will be summarized here. Due to the relevance for this work, only laboratory experiments with an adult sample are discussed.

3.1.1 Aggressive Cognitions

There are plenty of studies that investigate the facilitation of aggressive cognitions (e.g., thoughts) through violent digital game playing. While cognitions themselves are hard, if not impossible to measure, there are some aspects, like semantic activation, that can be measured, but are considered only superficial features of actual cognitions. Accessibility of aggressive thoughts is assumed to be a prerequisite for subsequent aggressive behavior (since it is highly unlikely that someone acts violently without any violence-related thoughts), and also relatively easy to measure. However, the mere activations of aggressive associations are not problematic. First of all, they are not necessarily expressed through behavior (or at all for that matter). In addition, the thoughts themselves can easily be suppressed. Many aggression-related cognitions are simply part of the way we think (keeping the theory of cognitive neoassociative networks in mind). If somebody sees the image of a gun, e.g. in a digital game, it is only natural to have gun-related associations (e.g., shots, crimes, war). In fact, we would probably find it very strange if such stimuli would not cause associations like that in a person at all. Accordingly, aggressive semantic activations can be considered one of the less serious effect of digital game playing, but they still tell us something about how we experience (violent) games.

One popular way to measure accessibility of aggressive thoughts is the word completion task (Roediger, Weldon, Stadler, & Riegler, 1992), which involves examining a list of words with one or more letters missing, and filling in the missing letters. The words are ambiguous in a way that each item can make more than one word. For example, one item is "explo_e", having the two possible completions "explore" or "explode". An accessibility of aggressive thoughts score is then calculated for each participant by dividing the number of aggressive word completions by the total number. This measurement has been used by several authors with significant results, indicating that playing violent digital games facilitates the accessibility of aggressive thoughts (e.g., Anderson et al., 2004; Barlett & Rodeheffer, 2009; Barlett et al., 2009; Carnagey & Anderson, 2005; Sestir & Bartholow, 2010). It should be mentioned however that Cicchirillo and Chory-Assad (2005) did not find any significant differences between two groups that either played a violent or a non-violent digital game using a shorter version of this test.

Anderson and Carnagey (2009) assessed accessibility of aggressive thoughts in a slightly different manner: They had their participants read aloud aggressive words (e.g., assault, choke) and control words (e.g., desert, listen) presented on a screen and recorded the reaction time between stimulus presentation and verbal identification. Participants who had played a violent digital game before had shorter reaction times on trials with aggressive words than those who had played a non-violent game. There was however an interaction between the game violence and trait aggression: Participants with a high trait aggression that played a violent game had a much higher accessibility of aggressive thoughts.

Another method was used by Ivory and Kalyanaraman (2007), who let their participants rate the similarity of aggressive (e.g., choke, wound) and ambiguous (e.g., animal, drugs) word pairs. A higher accessibility of aggressive thoughts should lead to a relatively more aggressive interpretation of ambiguous words, resulting in higher similarity ratings. However, the test did not yield any significant results between the experimental groups.

Giumetti and Markey (2007) presented short stories with negative outcomes for the protagonist to their participants, and asked them to write down 20 unique things the protagonist either might do, feel, or think. Participants in the violent group listed significantly more aggressive responses than those from the non-violent group. However, this was moderated by the dispositional trait of anger: Only participants with a high or moderate trait anger that played a violent digital game gave significantly more aggressive responses. This finding corresponds well with those by Anderson and Carnagey (2009) (see above).

A somewhat similar measurement for hostile social information processing was used by Brady and Matthews (2006). Their participants watched a videotaped social scenario, in which a teacher alerts his class to his suspicion and disappointment that some students have cheated. He then hands back a high test score to a student and asks to speak with him at the end of class. Participants were asked to rate the likelihood that the teacher would accuse the student of cheating. However, the authors did not find a difference between a high violent and a low violent game group.

Finally, Uhlmann and Swanson (2004) were interested in the effects of game playing on the implicit self-concept, assessed with a modification of the Implicit Association Task (IAT; Greenwald, McGhee, & Schwartz, 1998). The IAT assumes that sorting well-associated categories together is easier than grouping categories together that are not associated. People with an aggressive self-concept should have shorter reaction latencies on the the "Self = Aggressive" IAT than the "Self = Peaceful" IAT. In their study, playing a violent digital game facilitated this effect significantly.

3.1.2 Aggressive Emotions

Measuring human emotion is in many respects more difficult than measuring semantic activations and even behavior, since there are many facets and aspects that can be expressed differently (or not at all), and have different meanings to the individual. For example, both anger and hostility can be considered aggressive emotions, but they are obviously not the same, and probably result in different actions. Only sometimes emotions can be seen from the outside, and even then the emotional display can be ambiguous. Scientists struggle to find clear definitions for emotional constructs, so psychological instruments always measure the periphery of human emotion. These measured signals are never the same as emotion, they do not show a true value. Still, there is lots of research on the effects of digital game playing on emotions around. Nevertheless, it should be mentioned that all following investigations, for the lack of reliable alternatives, assessed emotions by self-report questionnaires.

Arriaga et al. (2006) used the State Hostility Scale (SHS; Anderson, Deuser, & DeNeve, 1995) to describe the participants' current aggressive feelings, using ratings of 35 adjectives, yielding significantly higher hostile feelings for participants who played a violent game. This finding was replicated by other scholars (e.g., Barlett et al., 2009; Carnagey & Anderson, 2005; Sestir & Bartholow, 2010). Using 4 different versions of the same game, Barlett, Bruey, and Harris (2007) found a significant increase in hostility only in the game conditions with a moderate and high amount of blood, not with low or no blood. However, in another study by Farrar, Krcmar, and Nowak (2006), there were no significant differences in state hostility between groups that played a game either with or without visible blood. Also, Ferguson and Rueda (2010) found no change at all in SHS after violent play. The same scale was used by Anderson and Carnagey (2009), but they clustered the 35 items into 4 factors, of which only the factor labeled "aggravation" was significantly higher for violent game players (even after controlling for frustration and experienced game difficulty), while the factors "unsociable", "feeling mean" and "positive feelings" did not change significantly. Since the authors used violent sports games for their study, they were also interested in any effects on attitudes towards violence in sports, but found no significant differences between their experimental groups. Ivory and Kalyanaraman (2007) found a significant effect of violent games on state hostility, but the authors noted that this might be the result of alpha inflation (due to the multivariate analysis), and once the covariates were excluded, the effect was rendered non-significant.

Barlett and Rodeheffer (2009) investigated the effects of realism in digital games, and found that participants who played a realistic violent game had a higher SHS score than those who played an unrealistic violent or non-violent game. In another study, participants who received a high aggressive priming had a higher SHS score than those who received a low aggressive priming before they played a digital game that could be played using either violent or stealth tactics (Panee & Ballard, 2002). Using the Reduced Profile of Mood States (Usala & Hertzog, 1989), Brady and Matthews (2006) found that playing a highly violent game (compared to a less violent one) had a significant effect on negative emotions. With the Attitudes Towards Violence Scale (Funk, Elliott, Urman, Flores, & Mock, 1999), they also found significant effects on attitudes towards alcohol and marijuana, but counterintuitively not on attitudes towards violence (and unprotected sex). This however might be a game content-specific effect of the violent stimulus *Grand Theft Auto III* (DMA Design, 2001). Frindte and Obwexer (2003) found a significant change in aggressive tendencies after playing a violent game, using the aggressive disposition trait subscale of the Freiburger Persönlichkeitsinventar (FPI; Fahrenberg, Hampel, & Selg, 1989), but not any significant changes in state anger, measured with the according subscale of the State-Trait Anger Expression Inventory (STAXI; Spielberger, 1988). This seems a little odd, since traits, not states, are relatively stable over time and should not change during a short period of playing. This makes the subscale of a personality inventory to measure short-term effects an unusual choice in the first place, and the significant results accordingly hard to interpret. Nevertheless, Uhlmann and Swanson (2004) were also looking for changes in trait aggression, using the Buss-Perry Aggression Questionnaire (BPAQ; Buss & Perry, 1992), without any significant findings.

The results found by Ballard, Hamby, Panee, and Nivens (2006) indicate as well that there is no significant change in the STAXI state anger score after violent game play, but that the violent game was significantly more frustrating. Baldaro et al. (2004) found no significant effect on any of the eight subscales (physical aggressiveness, indirect hostility, irritability, negativism, resentment, suspiciousness, verbal hostility, feelings of guilt) or the total score of the Buss-Durkee Hostility Inventory (BDHI; Buss & Durkee, 1957). Unsworth, Devilly, and Ward (2007) were interested in the generalizability of violent digital game impacts on aggressive affect. They too found a significant increase in state anger using the STAXI subscale in a pre-post violent game play design. However, only 22 of their 107 total participants had an increased anger score, while in 77 cases this value did not change and 8 participants even experienced a decrease. This led the authors to believe that there is a bias in the literature, since the significant increase in aggressive emotions found in groups of people by lots of researchers might be caused only by a small subsample, while the main part remains unaffected. With the Catalyst Model in mind, aggressive dispositions in this subsample could be responsible for the effects generalized to the whole population of game players. Of the 22 participants that had increased aggression scores after play, only 2 participants (1.87% of the total sample) had a clinically dysfunctional score (higher than two standard deviations above the mean).

This suggests that a short-term increase after violent game playing is unlikely to be of a magnitude concerning individuals' functioning.

3.1.3 Aggressive Behavior

Even if violent digital games could cause an increase in aggressive semantic activations and affect, there would hardly ever be a discussion of this magnitude in science, media, and the general public without those increases possibly resulting in aggressive or violent actions. The whole controversy whether or not there should be a harsher restriction (or even a ban) on violent digital games can be boiled down to one central question: Does violent game playing cause or facilitate aggressive or violent behavior? This is probably one of the most controversial issues in the area of game studies.

Due to ethical and methodological reasons, it is easier for a psychologist to measure aggressive than violent behavior in the lab. An instrument used in many (experimental) studies is the Competitive Reaction Time Task (CRTT, originally by Taylor, 1967), in which the participants play a number of trials of a reaction time game against a (fictional) opponent, and the loser of each trial gets punished by the winner. However, before each trial, participants set the intensity (volume and/or duration) of a noise blast (used as the measure for aggressive behavior) their opponent is supposed to hear in case the participants wins a round. The sequence of wins and losses, as well as the intensity settings of the opponent actually follow a randomized pattern. The weaknesses and limitations of this test are discussed later (see 3.4).

Anderson and Dill (2000) found no significant effect on the volume settings of the noise blast, but they found that participants who played a violent game significantly increased the duration setting in trials directly after a loss (not in trials after a win though). Participants in the study of Bartholow, Bushman, and Sestir (2006) had a significantly higher aggression score if they had played a violent game, although unfortunately the authors did not report how exactly this score was calculated from the volume and duration settings. Bartholow, Sestir, and Davis (2005) multiplied the average noise intensity and duration settings to form a composite aggressive behavior score, which was significantly increased after violent play. Carnagey and Anderson (2005) found that the mean "aggressive energy score" calculated by multiplying the volume with the square root of the duration for each trial was significantly higher when players were rewarded for violent actions in a game than for those who were punished for it or played a non-violent game. Ferguson et al. (2008) and Ferguson and Rueda (2010) were not able to find significant effects of violent game play on CRTT volume and duration, neither in a randomly assigned violent condition, nor when participants chose the violent game themselves. In the experiment by Sestir and Bartholow (2010), participants could only set the volume, not the duration, and they found a significant increase in the average volume settings over all trials. With the same version, Anderson et al. (2004) found a significant effect of game violence on the average setting, but whether the enemies in the game were aliens or humans made no difference in the subsequent volume settings. To this, Anderson and Carnagey (2009) added the total number of high volume settings (volume settings of 8-10 on a total scale of 0-10) as a measure for aggressive behavior. Both scores were significantly higher when participants had played a violent sports game before. In the two-phase version of the CRTT used by Bartholow and Anderson (2002), the participants played two complete rounds with 25 trials each. During the first phase, only their opponent could set the duration and intensity of the noise the participant would receive for losing a trial. During the second phase, the roles were reversed, so that the participants could retaliate for the punishment they received during phase 1. There were no significant effects on the duration settings whatsoever, but a significantly higher average volume setting for men who played a violent game, and significantly more high volume settings for men and women who played a violent game. Yet another way to assess aggressive behavior with the two-phase CRTT was used by Anderson et al. (2004): They compared the volume setting of the first trial (because this is the first opportunity for the participant to retaliate after being provoked), and the average volume settings of trials 2-9, 10-17, and 18-25. They also manipulated the opponent's intensity pattern of phase 1, one being ambiguous (random), and the other with an increasing volume. There was an interaction effect between the provocation pattern and the game: Participants that played a violent game and received an ambiguous pattern set the volume significantly higher on the first trial. The average volume settings of the other blocks remained unaffected by the type of game.

Another interesting measure for aggressive behavior is the Hot Sauce Paradigm (Lieberman, Solomon, Greenberg, & McGregor, 1999), in which participants are asked to prepare a cup of chili sauce for another (fictional) participant, about whom the participants are being told he or she does not like spicy foods. The amount of sauce used to spice the chili is the measurement for aggressive behavior. Fischer, Kastenmüller, and Greitemeyer (2010) found that playing a violent game caused participants to use significantly more hot sauce. Barlett et al. (2009) added an additional measurement for aggression to this method. In their experiment, participants could choose between four sauces with different strength of spices. Using this method, they found that playing a violent game caused participants to use significantly more of a hotter sauce.

The results of Brady and Matthews (2006) indicate that after playing a violent game, participants behaved significantly more uncooperatively in a game with another (fictional) participant, during which they could cooperate or compete to earn points. Rewording the Buss-Perry Aggression Questionnaire (Buss & Perry, 1992) so that it would tap state aggression rather than trait aggression, Farrar et al. (2006) investigated the effects on aggressive intentions, with a significant increase after violent game play. This finding was replicated by Krcmar, Farrar, and McGloin (2011), but they did not find a significant effect on verbal aggression. In a teacher/learner paradigm, participants gave significantly less reward to a male confederate (total number of jellybeans for correct answers), and significantly more punishment to a female confederate (seconds holding the confederate's hand in cold water), if they played a violent game beforehand.

There are also scholars who measure aggression with in-game behavior. Not surprisingly, Panee and Ballard (2002) found that participants, who were trained to use violent actions in a game, used more aggressive actions in a game which could also be played stealthily. In the experiment of Barlett, Bruey, and Harris (2007), the more blood was present on the screen, the more the participants used a weapon instead of martial arts to beat their opponent in a game (that offered no non-violent solution). Why the use of a weapon is considered behaving more aggressively than the use of bare fists to kill an opponent, remains a theoretical puzzle yet to be solved.

3.1.4 Physiological Arousal

Our arousal level changes several thousand times a day because of virtually everything we encounter in everyday life. Thus, changes in arousal are completely normal, although it could become a serious health risk when increased too often for too long. Moreover, increased arousal (of all kinds) is more commonly operationalized as an indirect measure for increased aggression (of all kinds). Different instruments can measure myotic, epidermal, respiratory, cardiovascular, and other signals of physiological arousal. While those values are all summarized under the theoretical umbrella of arousal, naturally they do not correlate perfectly with each other since they depend on different somatic responses and are activated by different external stimuli, although they are all interconnected through the autonomous nervous systems. And naturally, not only aggressive or stressing stimuli cause arousal, but also neutral (e.g., riding a bike) and rather positively connoted stimuli (e.g., a kiss). Humans attribute the valence of arousal by its (perceived) cause, or the situation it is experienced in (and sometimes erroneously, see Excitation Transfer in section 2.2.1). Due to the diversity of arousal measures, and to increase the validity of possible effects, it has become common practice to use different methods simultaneously. For ethical (and practical) reasons, scholars tend do discard invasive methods like a myogram, and rely on non-invasive measurements, e.g. heart rate (HR), blood pressure (BP), or galvanic skin response (GSR).

While it is relatively simple to assess HR and BP with a cuff attached to the arm so it does not interfere with the game playing (for which one usually needs both hands), things are a bit more complicated with GSR, since it needs a spot on the skin that sweats (though not too much), ideally the palm (for sensors with glue) or fingers (for sensor clips). That is why in many studies, to keep the process of game playing as natural as possible, physiological arousal is measured before and after play, but not during play itself, since there would be way too much movement artifacts in the sensor data. Other researchers want their data to be as exhaustive as possible, thus making their participants only use one hand (see 5.2.1 for the attempt of this work to combine the two approaches).

The overall results on the effects of violent digital games on physiological arousal are mixed. While many studies found a significant increase in heart rate during or shortly after play (Barlett et al., 2009; Barlett, Bruey, & Harris, 2007; Barlett & Rodeheffer, 2009; Borusiak, Bouikidis, Liersch, & Russel, 2008; Frindte & Obwexer, 2003; Ivarsson, Anderson, Åkerstedt, & Lindblad, 2009; also Arriaga et al., 2006, though only for female participants), there are also some studies that indicate that violent digital games have no effect on this measure (Anderson et al., 2004; Anderson & Carnagey, 2009; Baldaro et al., 2004; Ballard et al., 2006; Carnagey & Anderson, 2005). The results of Carnagey, Anderson, and Bushman (2007) show weaker HR reactions to a video of real life violence after playing a violent game. Staude-Müller, Bliesener, and Luthman (2008) found that participants had a significantly higher HR when playing a violent game compared to a non-violent one, but that HR was still significantly lower than the baseline measure. Although not significant, Panee and Ballard (2002) even found that those who played a non-violent game had a higher HR.

Similarly, there is evidence that violent games cause increases in systolic and/or diastolic BP (Baldaro et al., 2004; Borusiak et al., 2008; Brady & Matthews, 2006; Frindte & Obwexer, 2003), as well as evidence against it (Anderson et al., 2004; Anderson & Carnagey, 2009; Carnagey & Anderson, 2005; Panee & Ballard, 2002).

The results for GSR show the same pattern: Some studies indicate a significant effect (e.g., Arriaga et al., 2006, though only for female participants), and some do not (Ivory & Kalyanaraman, 2007; Schneider, Lang, Shin, & Bradley, 2004, found a faster decline in GSR when a violent game had no story). The results of Carnagey et al. (2007) show weaker GSR reactions to a video of real life violence after playing a violent game. On the contrary, Staude-Müller et al. (2008) found stronger GSR reactions to aggressive stimuli after violent play, but weaker GSR reactions to aversive stimuli. They also found that violent game playing significantly decreased the respiration rate. Barlett and Rodeheffer (2009) were unable to find significant effects on body temperature.

3.1.5 Duration of short-term effects

There is one study by Barlett et al. (2009), who where interested in the longevity of the discussed short-term effects. Their results indicate that aggressive thoughts and feelings were only significantly increased for less than 4 minutes, aggressive behavior (using the Hot Sauce Paradigm) less than 5 minutes, and HR between 4 and 9 minutes after violent game play. After the respective time periods, the effects were reduced to non-significance. Sestir and Bartholow (2010) found that aggressive semantic activations, emotions, and behavior were all increased for less than 15 minutes.

3.2 Cross-Sectional Correlational and Longitudinal Studies

Some aspects of digital game effects cannot be researched with (laboratory) experiments. For example, determining the effects of repeated exposure to digital games on academic performance would be extremely difficult with an experimental setting. One group would just not be allowed to play any game (for several years), while the other group would be forced to play them every other day or so. Not only being unethical (and hard to find complaisant participants), it would also be impossible to actually control the behavior reliably. Therefore, researchers just assess variable states, in longitudinal studies repeatedly over time, and calculate if one value changes systematically with others. However, correlational results are not causal and have to be interpreted with caution. According to Cohen (1988), a small effect (r) is around $\pm$ .10, a medium r around $\pm$ .30, and a large r around $\pm$ .50.

Unfortunately, there is no standardized instrument to measure violent digital game exposure. Most researchers tend to use the Violent Video Game Exposure (VVGE) questionnaire first introduced by Anderson and Dill (2000), in which participants name their five favorite games, how often they play them (from 1 to 7) and how violent the games are (from 1 to 7). The VVGE score equals the average of the five products of frequency and violence. Anderson and Dill (2000) found a significant correlation between VVGE and aggressive and non-aggressive delinquent behavior (rs = .46/.31 respectively), trait aggression (r = .22), but counterintuitively also with perception of personal safety (r = .35), and not with crime likelihood (r = -.05). Other variables were correlated with VVGE as well, namely mild physical aggression (r = .31), verbal aggression (r = .20), and attitude towards violence (r = .24) (Anderson et al., 2004). Similar relations were found by Bartholow et al. (2005), using the Buss-Perry Aggression Questionnaire to assess the significant correlations of VVGE and physical aggression (r = .33), verbal aggression (r

$= .19$), anger ($r = .18$), though hostility was non-significant ($r = .03$). Koglin, Witthöft, and Petermann (2009) replicated these results partially (significant physical aggression $r = .20$, anger $r = .25$; non-significant verbal aggression $r = .14$, hostility $r = .10$). However, the correlation with physical aggression was not significant when anger was included as a mediator variable. While Uhlmann and Swanson (2004) found a significant correlation between VVGE and trait aggression ($r = .33$), while other scholars were unable to find this link in their studies (Ferguson et al., 2008; Ferguson & Rueda, 2009). Barlett et al. (2009) noted that the significant correlation with aggressive behavior was reduced to non-significance with the presence of the GAM's three internal state variables (aggressive thoughts, aggressive feelings, and arousal) as mediators. Ferguson and Rueda (2010) even found that participants with a high VVGE had a significantly reduced state hostility after a stressful task.

Of particular interest are some of the findings of Brady and Matthews (2006), since they support assumptions of the Catalyst Model (Ferguson et al., 2008), although the authors do not specifically mention this model. They did not find significant correlations between VVGE and both attitude towards violence and hostile attribution, but between the latter two and exposure to home violence. They also reported a significant link between exposure to community violence and an increased BP, as well as attitude towards violence.

The two-year longitudinal study by Hopf, Huber, and Weiß (2008) investigated the effects of media violence on violence and delinquency of German students in the lowest track of the school system, having two measuring points, one in grades 5-7 ($n = 653$; M(age)=12.0, $SD = 1.07$), the other in grades 7-9 ($n = 314$; M(age) $= 14.7$, $SD = 0.82$). The results indicate a significant relation between VVGE at time 1 and violence at time 2 (longitudinal $\beta = .18$), as well as delinquency ($\beta = .29$). Möller and Krahé (2009) found that VVGE of 295 German secondary school students (M(age) $= 13.34$, SD $= 0.83$) at time 1 predicted the physical aggression at time 2 significantly ($\beta = .27$, with a remaining sample of 143 students), but not indirect aggression. However, with moderators like hostile attribution and normative beliefs taken into account, the effect on physical aggression was reduced to non-significance ($\beta = .11$). The longitudinal study by Anderson et al. (2008) is particularly noteworthy, because it employs three samples from two different countries, two from Japan ($n = 181$ and $n = 1050$ respectively), and one from the US ($n = 364$). The age ranged from 12-15, 13-18 and 9-12, respectively. They assessed VVGE and physical aggression at two times (the lags were 4 months, 3-4 months, and 5-6 months, for the respective sample), using different instruments for both measures in all three samples. Nevertheless, they found an overall correlation between VVGE at time 1 and physical aggression at time 2 ($r = 0.28$). The estimated more direct longitudinal path for VVGE was larger for the two younger samples (β = .152) than for the older sample (β = .075). However, it should be noted that the link between physical aggression at time 1 was an extremely good predictor for time 2 (β = .549), while the link between VVGE at time 1 and physical aggression at time 1 was also relatively weak (β = .154).

3.3 Meta-Analyses

Despite the diversity of methodology and results in research on violent digital games, and the controversy about the whole issue, several authors tried to summarize the primary experimental and correlational data into meta data, and to determine the overall effects on all aspects of aggression.

Anderson and Bushman's first meta-analysis was published in 2001. For this, they retrieved 35 research articles that included 54 independent samples with 4,262 participants from the database *PsycINFO*, using several search criteria. In line with their General Aggression Model (see 2.3), they found small to medium effects for physiological arousal (r = .22), prosocial behavior (r = -.16), aggressive cognition (r = .27), aggressive affect (r = .18), and aggressive behavior (r = .19), although the latter effect was much larger for aggression against inanimate objects than against humans (rs = .41 and .14, respectively). The meta-analytic update by Anderson (2004), employing 44 research articles, replicated the results. Except for aggressive behavior (r = .20) however, they do not report actual numbers, only some histograms. In a similar manner, Anderson shows that research with "best practice" finds stronger results compared to research with "not best practice", coded with a criteria catalog by the author. Only studies that had no weakness according to this guide were classified as "best practice". Unfortunately, this coding guide is described only very vaguely, and some points are left entirely to the subjectivity of the author, e.g. "the violent game contained little or no violence" and whether there were differences in difficulty or enjoyment between the conditions.

Also in 2001, another meta-analysis was published by Sherry, using 25 independent studies, reporting somewhat weaker effects. He found an overall estimate of the correlation between digital game playing and aggression of r = .15, and specific differences between experimental (r = .11) and survey studies (r = .16), as well as between studies that used a behavioral measure (r = .09) and a paper-and-pencil measure (r = .19).

There are two meta-analyses by Ferguson (2007a, 2007b), both dealing with the issue of a possible publication bias (the tendency of authors and publishers to publish significant results, and to withhold non-significant results) using 25 and 17 studies, respectively. In one paper (2007b), he finds a small link between VVGE and aggression (r = .14) similar to the finding by Sherry (2001). However with the publication bias present in the literature taken into account, he estimates this effect to be much smaller (r = .04). In the other publication (2007a), he also distinguishes between experimental studies (r = .29; with correction for publication bias r = .15) and non-experimental studies (rs = .15 and .06) on aggressive behavior. Anderson et al. (2010) found a total of 136 published studies which they used in their latest meta analysis, again focusing on the aggression aspects of the General Aggression Model while distinguishing between "best practices" and "not best practices" studies and also regarding a possible publication bias. Again, they found small to medium effects for physiological arousal (r = .18), prosocial behavior (r = -.11), aggressive cognition (r = .175), aggressive affect (r = .12), aggressive behavior (r = .24), and also empathy (r = -.19). "Best practice" studies yielded larger effects on all aspects except those on aggressive affect, where "not best practice" studies produced larger effects. A publication bias, if existing at all, was so small that it did not weaken any effects significantly, according to the authors.

3.4 Methodological and Practical Issues

There are several methodological and also theoretical problems associated with research on the effects of digital games. The most critical issues will be discussed in the following section.

3.4.1 Measuring Aggressive Behavior

Researchers have been looking into the causalities of violence for ages, and at the same time have always been struggling with valid methods to measure violent or aggressive behaviors. Especially since research ethics committees have been established at many universities, provoking violent behaviors in study participants legally and with sufficient external validity (so that the behaviors would not only occur in the lab), has become a difficult task for behavioral scientists. As Ferguson and Rueda (2009) point out, "violent behaviors (...) are typically restricted to acts which are intended to cause serious physical harm" (p. 121), while "aggression as a class of behavior is much broader than violent behavior and can include numerous acts (...) which are neither physically injurious nor illegal" (pp. 121-122). Therefore, behavioral scientists can study aggressive behaviors in their laboratories, but not violent behaviors. This would not necessarily be a problem, if such aggressive behavior measurements had a high external validity. However, scholars criticized both standardization and external validity of methods to assess aggressive behaviors (Giancola & Chermack, 1998; Giancola & Zeichner, 1995; Ritter &

Eslea, 2005; Savage, 2004; Tedeschi & Quigley, 1996, 2000). Still, even with the vast amount of criticism, one measure of aggressive behavior dominates the empirical literature on violent digital games and aggression: The (Taylor) Competitive Reaction Time Task or (T)CRTT. In the original version by Taylor (1967) participants were told that they would be playing a reaction time game against another participant. Before each of the 25 trials, participants had to set the level of an electric shock their opponent would receive if they win the following trial. Accordingly, they would receive an electric shock set by their opponent if they would lose the following trial. In reality, there was no other participant and the sequence of wins and losses was preset to standardize the test and provoke aggression in the participant. Although there has been some criticism concerning the TCRTT's external validity (e.g., Ferguson & Rueda, 2009), this original version of the TCRTT can be considered a (laboratory) measurement for violent behavior due to the actual physical pain caused by the electric shocks. However, for the same reason, it would also be illegal to use this method in today's research. As explained earlier, there is a modified version of the TCRTT, in the following called CRTT, that has been widely used in violent digital game research. Instead of physical pain caused by electric shocks, the CRTT uses loud noises as aversive stimuli and hence is a measure of aggressive behavior rather than violent behavior. Although Anderson and colleagues consider this test an "externally valid measure of aggressive behavior" (Anderson & Dill, 2000, p. 784; compare also Bartholow & Anderson, 2002, p. 285), Ferguson (2007a) qualifies this by noting that similarity of results in studies with indirect methodology (correlational and experimental) is unequal to proof of external validity. Ferguson and Rueda (2009) raised the question, whether the CRTT should be used as a measurement for aggressive behavior at all, since they were unable to find any link between CRTT results and trait aggression, self-reported violent crime behavior, self-reported domestic violence perpetration, and executive functioning (which has been previously linked to limited control of aggressive or antisocial behavior). However, they just had their participants perform the CRTT and a few other tests or questionnaires, unlike in the cited digital game studies where people were exposed to violent or non-violent stimuli first. They provided evidence that the CRTT would not be a good measure for aggressive personality variables, however, they did not test its use to measure short-term changes in behaviors. However, they also mention that the correlation between noise volume and duration diverge too much from study to study to be considered scores that measure the same construct.

The biggest problem of the CRTT paradigm is that it is used quite differently in many studies. The studies cited in this literature review alone report seven different ways to conduct the CRTT and/or calculate the aggression score (see section 3.1.3). Due to the diverse use of data produced by the CRTT to measure aggression, Ferguson (2007a) suspects a possible capitalization on chance. Besides this, it is a highly problematic issue from a test-theoretical point of view. If there is no standardized procedure for a test, and no standardized way to process the raw data to a meaningful score, then whatever is coming out of that test might be what was intended, but it also might not. "Aggression scores" that were calculated with vastly different procedural and statistical versions of the same test become very difficult to compare. Changing structural aspects of the CRTT might not render it useless, but it is no longer the same test. A standardized use has been suggested by Ferguson et al. (2008), but this has not been acted on by many yet.

3.4.2 Stimulus Materials

Anderson pointed out in 2002:

> In the early days of digital games, Pac-Man (...) had some parents concerned about potential consequences of playing this "violent" game. So it should come as no surprise that the violence of the "high violence" conditions in early studies is very different from the high violence games in more recent studies. (p. 110)

That means, aside from the shifts in perception of (media) violence in society, there have been vast changes in violent content of digital games over the last two decades. Still, a lot of researchers use games that are heavily outdated, even considering the time it takes to administer an experiment, write a paper, have it reviewed and published. Although it is not really considered a first-person shooter as they claim but rather a rail or gallery shooter (since the player cannot use controls to move, only shoot), Barlett, Harris, and Baldassaro (2007) used *Time Crisis 3* for their study, published in 2003 by Nextech, so it was fairly up to date. Anderson and Carnagey (2009) used, among other games, *Madden NFL 2004* (EA Tiburon, 2003), at the time of the article publication 6 years old. However, they also used *NFL Blitz* (Midway Games), a game from 1998, so there were 11 years of game development between the game and article publications. In the frequently cited study by Anderson and Dill (2000), the games *Myst* (Cyan, 1993) and *Wolfenstein 3D* (id Software, 1992) were respectively 7 and 8 years older than the publication. The stimulus material in the study by Anderson et al. (2004) was even more antique, *Marathon 2* (Bungie Software, 1995), and *Glider PRO* (Calhoun, 1991). The latter was published 13 years before the article. Tafalla used *Doom 1* (id Software, 1993) for his study from 2007, but the record, if you want to call it that, is held by Bushman and Anderson (2009), whose "latest" game was *Future Cop: LAPD* (Electronic Arts, 1998), and the oldest *Duke Nukem* (Apogee Software, 1991), published astounding 18 years before the article, so that some of the participants in their study might likely not even have been born when the game hit the shelves. Why the authors did not use a more recent game, like e.g. *Counter-Strike: Source* (Valve Corporation, 2004a), *Far Cry* (Crytek, 2004), or *Unreal Tournament 2004* (Digital Extremes & Epic Games, 2004), all three violent digital games released in 2004 and thus 5 years older than the publication, leaves room for speculation.

Considering the technological improvement in computers, we have to ask ourselves as researchers: Can we learn anything about the effects of today's games from studies on games that are 5, 8, 12 or even 18 years old? Are those games really the same in principal as new games? Or have games changed in graphics (see figure 3.1 for an example), sound, gameplay, and many other ways so drastically that they cannot be taken as one homogeneous group with the games that were created more than a decade ago? There has been little research on the psychological effects of technological advancements in digital games, but results indicate e.g. that higher image quality leads to a significantly higher immersion (Bracken & Skalski, 2009), presence, involvement and even physiological arousal (Ivory & Kalyanaraman, 2007). Even if it was true that the games commonly used in research cause increases in aggression, this would not be a big problem since those games have scarcely been played for many years anyway. Therefore, in this work, I used a currently popular, latest-generation first-person shooter.

It is hard enough to find adequate violent games for research, though: There are no clear answers to the questions, whether or not ice hockey games are violent, or if Super Mario is acting aggressively when he jumps on a Goomba. And even when two games are clearly about fighting, the violence of one game does not necessarily equal the violence of another. However, even more problematic is the selection of stimuli for control groups, so called "non-violent games". In experimental laboratory psychology, it is absolutely vital to manipulate the variable a researcher is interested in, while controlling all other possibly confounding variables so that they do not interfere with any effect that should be explained by the manipulation. However, this is rarely taken into consideration in digital game research. It is very convenient to divide games into two groups (violent and non-violent), but one should not forget that the occurrence of violence is unlikely to be the *only* difference between two games. Those differences can be conflating variables that might confound any result if they are not controlled. For example, a first-person shooter is likely to be more violent than a regular racing game. However, a first-person shooter is also played from the first-person perspective (hence "first-person"), probably has a narrative, intriguing characters, and is controlled with keyboard and mouse, all features very unlikely to find in a racing game, but that might have an impact on taken measures in an experiment. While Carnagey and Anderson (2004) are making a good first step when they say that "the obvious solution for future studies is to do more pilot testing

Figure 3.1: Duke Nukem, used in the study by Bushman and Anderson (2009); *Counter-Strike: Source*, an available alternative; *Unreal Tournament 3*, used in this work.

or manipulation checks on such aggression-relevant dimensions" (p. 9), this statement neglects two problems: Firstly, it might be hard for a researcher to even find all the aggression-relevant aspects and control for them via a simple questionnaire that asks how exciting, frustrating, or fun a game was (e.g. Carnagey et al., 2007). Secondly, not even the purely aggression-relevant aspects might be interesting to control, but also those that change the overall experience of a game. The question really is: What is really found when we discover differences between a group that played *Grand Theft Auto: Vice City* (Rockstar North, 2002) and another that played Tetris? (Cicchirillo & Chory-Assad, 2005). This work's section on modding (see 5.1.2) offers a suggestion how to address some of the problems commonly encountered in experimental digital game research.

3.4.3 Lack of Observable Impact

Considering that the break-through game of the first-person shooter genre, *Doom 1* (id Software, 1993), was published nearly 20 years ago, almost a whole generation grew up with a wider and wider selection (and increasing use) of violent games. By now, the adolescents from 1993 have raised an entire population under the effects of having played games like *Doom 1*, and the new generation has access to even more violent games. Even admitting that those negative effects take long to fully develop, is it not just about time that those "time bombs" start to explode all over the world? Sherry (2007) discusses the question why we cannot find observable links as follows:

> Perhaps a better question to ask at this point in the history of video game research is why researchers have not been able to produce dramatic effects demonstrating that violent video games do indeed drive aggression. Further, why do some researchers (e.g., Gentile & Anderson, 2003) continue to argue that video games are dangerous despite evidence to the contrary? If video games are the threat that these researchers claim they are, the popularity of violent video games would dictate that we would see an increase in violent crime. However, the U.S. Department of Justice reports that violent crime rates have decreased 50% during the past decade and are at the lowest levels that have been since the department began tracking crime in 1973 (U.S. Department of Justice, 2002). If these games are having the dramatic effects that some claim, it is not being realized in the streets of America. (p. 258)

Sherry is right: If there are no sudden outbreaks of aggression, or even an overall increase in violent crimes, then the negative impact of violent games must be subtle. However, subtle effects is neither what the general public is warned about, nor what has been theorized and modeled in research by many. But if the effects are subtle, how do we explain the many short-term findings? It all breaks down to the issue of external or rather ecological validity: Do aggressive actions shown in laboratory settings actually reflect naturalistic behavior?

3.5 Modding

Mod or modification is a term mostly applied to PC games, especially to first-person shooters. Mods are usually produced by the players, companies or game publishers are rarely involved. They can be entirely new games in themselves, but they usually require the user to have the original game. They can include or consist of small additions like new items, weapons, models, textures, music and levels or change the whole story line and add game modes that do not resemble the original game at all. Mods that consist of new content for the original game are referred to as "partial conversions", while those that create an entirely new game or game mode are called "total conversions".

It is not uncommon for PC games to be designed with modifications in mind. Many game publishers not only allow people to alter and publish content, but also provide players with the necessary modding tools, like the uncompiled (or raw) game code, a level editor, a compiler and extensive documentation for all of these to assist mod makers and ensure a generally high quality of published mods. It is even possible for a game mod to become equally or more popular than the original game. In the case of *Counter-Strike*, Valve Corporation obtained the rights to the mod and published the game as a retail stand-alone version in 2000.

Only few researchers have yet dealt with the subject of modding as a method for digital game research. Hartig, Frey, and Ketzel (2003) introduced game modding as a tool for experimental-psychological research in general by creating a mod for *Quake III Arena* (id Software, 1999). To study the effects of violent digital games on cardiovascular responding and desensitization to violence, Staude-Müller et al. (2008) used the unmodified *UT 2003* (Epic Games, 2003) for the violent condition, and a publicly available mod in which opponents are temporarily frozen instead of killed for the non-violent condition. Bluemke, Friedrich, and Zumbach (2010) created three versions of a simple point-and-click game (violent, non-violent, abstract) to study the effects of displayed violence on aggressive cognitions using implicit measures. Carnagey and Anderson (2005) used three versions of *Carmageddon 2: Carpocalypse Now* (Stainless Games, 1998): One rewarded the player to kill pedestrians, while another punished the player for it, and the third version did not allow killing pedestrians at all. Finally, Hartmann and Vorderer (2010) modified game models in *Half-Life 2* (Valve Corporation, 2004b) so that they would either look like humans or aliens, and act aggressively or peacefully.

Chapter 4

Research Questions and Hypotheses

The goal of the study presented in this thesis is to is to disambiguate previous findings on the effects of digital games by identifying and controlling potential confounding variables that potentially cause false estimations of effects. To test this, displayed violence as well as another exemplary variable typical for violent first-person shooter games were experimentally manipulated, while all other relevant game variables were the same. It was not important really which variable next to the violence would be manipulated, since this work's aim was not to provide evidence for effects of a specific game feature. The goal was to draw attention to the idea that there are usually disregarded characteristics inherent to first-person shooters, which might be having an effect that conflates with effects of displayed violence (or even overlays them), and therefore have to be accounted for in terms of experimental control. Utilizing the method of game modding, this work tries to establish an improvement of the current most common research paradigm, so that it goes along with usual standards of experimental psychology. It also aims to spread two recent measurements for physiological arousal which are reflected in a more behavioral level: body movement, and force (which could also be considered symptomatic for aggression).

To determine the second independent variable next to the violence, a more ore less intuitive approach was used. This game feature had to be present in almost any first-person shooter, but not in many other genres, and be capable of somehow impacting on the experience or the effects of displayed violence. One very obvious difference between first-person shooters and other digital games is the game speed. First-person shooters require the players to reach their limits of attention, reaction capabilities and also the hand-eye coordination. Movement of the controlled avatars often exceeds human speed. In fact, unlike other games, most first-person shooters employ a key one can press to stop running and walk or crouch instead. While it is required to be moving by using the control keys on the keyboard all the time to make a harder target, at the same time the player has to look around in a 360° angle to spot possible enemies through mouse movements. What the player actually sees on the screen through the eyes of an avatar at a time is only a small part of the full and rich non-linear three-dimensional environment. Although there is no research on the specific effects of game speed on physiological arousal or aggressive behavior (or anything else, for that matter), in the study of Arriaga et al. (2006), speed was the only dimension (except for violence, of course) that was experienced significantly higher in a violent digital game than in two non-violent digital games by the participants.

In the experiment conducted for this thesis, common instruments to measure aggressive behavior and physiological arousal were taken to assess and compare the effects of displayed violence and game speed. The two models presented in the theory section predict oppositional outcomes: According to GAM (Anderson, 2002), playing a violent game would increase aggressiveness, while the Catalyst Model (Ferguson et al., 2008) would only predict this if someone with an aggressive disposition deliberately picked a violent game as a stylistic catalyst for violent behavior. Consistent with the literature, displayed violence was predicted to have effects, but they were expected to be confounded with the game speed. Regarding aggressive behavior, the following two hypotheses were tested:

> H1: Individuals who play a violent digital game act more aggressively in a subsequent behavioral test than individuals who play a non-violent digital game.

The effects of game speed are expected to interact with the effects of displayed violence. Not only is game speed expected to influence physiological arousal (read further) and thus might have an indirect effect on aggressive via this route, the increased game speed would make it possible to experience more violent actions in the same time. Also, a higher difficulty due to the heightened speed might cause a higher frustration, resulting in increased aggression (Dollard, Miller, Doob, Mowrer, & Sears, 1939).

> H2: Game speed facilitates the effects of displayed violence. Individuals who play a high-speed violent digital game act more aggressively in a subsequent behavioral test than individuals who play a normal-speed violent digital game. Game speed does not make a difference if individuals play a non-violent digital game.

While game speed should only facilitate the effects of displayed violence on aggressive behavior, hypotheses for physiological arousal are somewhat different. It is reasonable to assume that games with a high rate of image variability, constant and rapid on-screen changes, can also have physiological effects on their players, sometimes even serious ones like nausea, a symptom of what is commonly known as motion sickness (e.g., Stoffregen, Faugloire, Yoshida, Flanagan, & Merhi, 2008). Although few people suffer from this extreme phenomenon, it is not unlikely to assume that a higher game speed might have effects on the players' general level of physiological arousal. Since an increased speed makes a game harder to control, players must use more of their cognitive and motor skills to perform at the highest level. This, again, should be associated with increased arousal. Due to the inconsistent effects of displayed violence on standard physiological arousal measures (galvanic skin response, heart rate), the effects of game speed are expected to be more consistent than those of displayed violence.

> H3a: Individuals who play a high-speed digital game have higher GSR scores during play than individuals who play a normal-speed digital game.
> H3b: Individuals who play a high-speed digital game have higher HR scores during play than individuals who play a normal-speed digital game.
> H3c: Individuals who play a violent digital game have higher GSR and HR scores during play than individuals who play a non-violent digital game. However, this effect is smaller than the effect of game speed.

The two behavioral measurements of physiological arousal, force and body movement, could be considered somewhat unconventional. Though body movement in itself in digital game players has been researched (Bianchi-Berthouze, Kim, & Patel, 2007), it has been used as a measurement for physiological arousal mostly in a medical context, e.g. sleep laboratories (Franco et al., 2004), and only by very few in digital game research (van den Hoogen, IJsselsteijn, & de Kort, 2008; van den Hoogen, IJsselsteijn, de Kort, & Poels, 2008), although with promising results nonetheless. With regard to body movement during play, players should show less movement in the high-speed condition, since any "unnecessary" motion could put their in-game performance at risk. When the player has to fully concentrate on the game, there is just less capacity left to change posture or to wiggle with a foot, for example.

> H4a: Individuals who play a high-speed digital game show less body movement during play than individuals who play a normal-speed digital game.
> H4b: Playing a violent digital game does not have any effect on body movement.

Only very few researchers have used force sensors on keyboard, mouse, or other input devices as measurement for arousal, but again with promising results (Sykes & Brown, 2002; van den Hoogen, IJsselsteijn, & de Kort, 2008; van den Hoogen, IJsselsteijn, de Kort, & Poels, 2008; van den Hoogen, IJsselsteijn, & de Kort, 2009). Researchers from other fields used force as a measurement for users' affective state (Mentis & Gay, 2002; Park, Zhu, Jung, McLaughlin, & Jin, 2009), e.g. frustration. Therefore, force could be a measure for physiological arousal and aggressive behavior, or rather the link between the two. Consistent with the assumption of H1, displayed violence is expected to increase applied force on mouse and keyboard.

> H5: Individuals who play a violent digital game apply more force on mouse and keyboard during play than individuals who play a non-violent digital game.

Consistent with the results of Sykes and Brown (2002) and van den Hoogen, IJsselsteijn, and de Kort (2008), showing that force increases with game difficulty, and considering that higher speed also means higher difficulty, game speed is expected to have a similar effect, also presumably somewhat weaker.

> H6: Individuals who play a high-speed digital game apply more force on mouse and keyboard during play than individuals who play a normal-speed digital game.

Those effects are also expected to add up.

> H7: Individuals who play a high-speed violent digital game apply more force on mouse and keyboard during play than individuals who play a normal-speed violent game or high-speed non-violent game. Individuals who play a normal-speed non-violent game apply the least force on mouse and keyboard.

Chapter 5

Methods

5.1 Stimulus Material

The purpose of this study was to isolate two variables of a digital game (violence and speed), manipulate them, and to assess the effects of these variables on physiological arousal and aggressive behavior. Following the hypotheses presented in the previous chapter, the experiment required a violent and a non-violent, a slow and a fast version of the same game. Unfortunately, such a game does not exist. There are special versions of violent first-person shooter games which are less violent in order to get lower age ratings, but they are not truly non-violent, just less gory.

This meant that after finding a suitable violent game, this game had to be altered so it would be non-violent. In addition, the game speed had to be manipulated in that way as well.

5.1.1 The Game

As described earlier, there is a lot of research on violent digital games, while at the same time there is no clear definition of violence. For this study, a game that would most explicitly display acts of physical violence was needed. Without having a clear scientific consensus on what a violent digital game actually is, I had to use a societal, normative, or legal criterion. Therefore, I chose a game whose version was indexed by the Unterhaltungssoftware Selbstkontrolle (Self-Monitoring of Entertainment Software), Germany's software rating organization. This basically means it is illegal to make the game available to minors in any way, or to advertise it publicly. Differences between the version that has been indexed in Germany due to the explicit graphical display and the legal version with an age rating of 16+ have been discussed thoroughly by schnittberichte.com (2007).

Another important factor for picking a game was its technical and graphical quality (see section 3.4). Based on these criteria, *Unreal Tournament 3* (UT3; Epic Games, 2007), was chosen for this study. At the time the experiment was administered, the game was about 2.5 years old, so it was not brand new, but still could compete with more recent games.

Another important reason to pick UT3 for the experiment was its "modability" and available support from a very active modding community (the concept of modding is discussed in more detail in 3.5). The user-friendly editor for UT3, UnrealEd (UEd) comes with the game and is a powerful tool that can be used to alter every object of the game or to add entirely new content. It allows designing new levels, weapons, player models as well as the editing of existing game features, from simple sound files to large graphical effects.

Epic Games, the developer of UT3, also released the *UnrealScript* (UScript) source code (which can be downloaded from their official modding resource website *http://udn.epicgames.com*) to the general public in 2010. UScript is the Unreal Engine's scripting language. It is an object-oriented and event-driven programming language very similar to Java and C++, with some influences from Visual Basic. The released code basically allows everyone to learn about the logical relations of the game and edit them, like event triggers (e.g., what sound file is called when a weapon is fired), event sequences (e.g., in what order graphic effects appear when a weapon is fired) or general object properties (e.g., how much damage a fired projectile inflicts). This allows modders to create new simple codes for the interaction with a weapon, or complex ones like entire game modes.

The Unreal Tournament (UT) series has a long history of modding from its earlier versions (UT, UT 2003 and UT 2004), with lots of exhaustive tutorials, examples, modding-dedicated websites (e.g., *http://www.moddb.com*), message boards (e.g., *http://forums.epicgames.com*) and a big community that is eager to help out beginner modders if they have a question.

5.1.2 Modding

For a more specific terminology, UT3 makes the distinction between mod and mutator. What was described as partial conversion earlier is called a mutator in UT3, i.e. additional content for the original game. Mutators can be activated and deactivated in the game, just like a plug-in for common software applications. Thus, a mod for UT3 always means a full conversion of the game. For the necessary manipulations of the game for this thesis, creating several mutators (being less work than creating a mod) was sufficient.

Modding the Violence

To make UT3 non- or at least substantially less violent, more than one element of the game had to be modified: the visual displays of gore, the weapons, the feedback, and the language.

The Gore The biggest part of the displayed violence in UT3 is the visual gore. Depending on the ammunition type, weapons usually cause massive blood loss and/or spectacular body explosions ("gib" in UScript language). These very explicit displays of violence can be disabled in the settings of UT3, effectively making the indexed version look like the 16+ version. However, characters (hereafter "pawns") in the game would still literally drop dead when their health was reduced to zero, so there was still a clear display of violence that had to be removed. On the other hand, players needed some kind of visual feedback when they hit or killed another pawn, even in the non-violent condition.

To solve this problem, a mutator that altered the death animation of every pawn in the game was coded in UScript. Instead of dropping to the ground like a string puppet, pawns would now freeze if they were killed. Furthermore, to avoid confusion between dead pawns and pawns just standing still, they would also drop their weapon and become spectrally transparent. Once the player would look in another direction, the ghost-like pawn completely disappeared, so the map could not get crowded with them. This mutator is referred to as "Death Fading" hereafter.

The Weapon Other obvious indicators of violence in UT3 are the weapons. Due to the game's setting in a dark, war-torn end time, all weapons in UT3 have a very futuristic and martial look. The tendency of weapons to increase the likelihood of aggression by their simple presence in a real situation has been investigated in several studies (e.g., Berkowitz & LePage, 1967). Although there is no empirical data on a possible similar effect of weapons in digital games, there are results on priming effects of photos of weapon (Anderson et al., 1998). Therefore, it is not unreasonable to expect a similar effect for weapons in digital games. Since a weapon is required to play a first-person shooter (hence "shooter"), the only way to minimize such an effect is to make the weapon look unlike a real weapon.

To reduce the workload and avoid overstraining the ability of novice players, only one weapon was modded, while the other weapons in the game were replaced by instances of the one chosen weapon via an existing mutator in UT3 (see 5.1.2). The Flak Cannon was an ideal choice for the modification because its secondary firing mode is a ballistic grenade that could easily be transformed into a tennis ball.

For this purpose, the original Flak Cannon and all related objects (like sound files and ammunition) were duplicated in UEd. All explosion and smoke effects of the grenade were removed, and the grenade texture was replaced with the texture of a tennis ball that was publicly available (Bjørklund, 2004). Then, I designed a new texture for the Flak Cannon in *Adobe Photoshop*. This texture should resemble a toy nerf gun, so bright colors like pink, yellow, turquoise and red were used extensively. Finally, I placed a Fisher Price label on the weapon's stock to make it look more like a real toy. The weapon still had its old raw model (size, surface, outline), but with a new overlay.

Because the firing and detonation of the projectile still sounded too much like a grenade, the sound files were replaced as well. The files that resembled the sound of a tennis ball machine were copied from *Team Fortress 2* (Valve Corporation, 2007), another first-person shooter with a comic-like look. The whole package named ToyGun for obvious reasons, was saved and compiled for use in UT3. At this point, the weapon looked and sounded like a toy gun, but still physically behaved like the original weapon.

From the UScript Source, copies of the Flak Cannon scripts were taken and altered so they would fit the new ToyGun. First of all, the weapon's primary firing mode (ripping metal shards) was disabled. Typically, tennis ball do not have a damage radius like a grenade, and would only inflict damage upon pawns in case of a direct hit. Hence, the explosion radius was set to 0. Also, the starting ammunition was raised to 15, and the maximum ammunition to 50, so especially novice players would not have to worry about running out of ammunition during a match.

Because of the ToyGun's reduced firing modes and damage radius, the Flak Cannon had to be altered accordingly in order to avoid gameplay advantages for the players in the violent conditions. Therefore, another duplication of the Flak Cannon was created and saved as FlakGun. Models, Textures, and other objects stayed the same, only the damage radius and impact explosion effect were disabled exactly like in the ToyGun's scripts, as well as the primary firing mode. The ammunition settings were matched as well.

After that, there were two weapons, the ToyGun and the FlakGun, that shared the same weapon model (or skeleton), but with a colorful texture for the non-violent condition, and the regular martial texture for the violent condition. The sound files for the non-violent conditions and the texture of its ammunition were altered as well. Other than that, the weapons behaved exactly the same in terms of ballistics, control, firing frequency, and damage.

The Feedback In UT3 there are more cues for violence than the gib and the weapons. Mainly two things had to be altered for the non-violent conditions. One was the flashing red screen that alerts the player if the own pawn is hit by a projectile and gives a general

Figure 5.1: Screenshots from the violent and non-violent experimental conditions.

direction of the damage source. The other element that had to be modified was the voices of all pawns that could be heard by the player when the pawn was nearby (because they automatically insult other pawns), or, of course, if the player's pawn itself was talking (which happens automatically after certain events). The voice volume of pawns can be reduced to zero in UT3's settings menu. However, this does not turn off the pain screams of pawns that take damage or die. Both the pain screams and the red flashing could be disabled with UScript and were implemented as an extension to the Death Fading mutator. To still alert the player when the pawn was hit, arrows around the weapon's cross-hairs indicated from where projectiles that hit the player's pawn were fired.

The Language UT3 is full of violence or aggression related words that appear both in UT3's menu and during the game after certain events. Table A.2 (appendix) shows all words that were changed for the non-violent condition, with its description and a translation (since the modified version was in German).

Also, in the standard settings of UT3, players constantly get information about the deaths and achievements of all other pawns on the bottom left of their screen. This, again, could be turned off with UScript. Two typical scenes from the violent and non-violent version are shown in figure 5.1.

Modding the Speed

To manipulate the game speed, the UT3 Speed Modification Mutator (Chatman, 2008) was retrieved from a public UT3 resource website. While UT3 has its own mutators that modify the game speed, they only allow three settings: fast, normal and slow. The UT3 Speed Modification Mutator allows to set the game speed on any value between 25% and 400%. In the normal speed conditions, this mutator was just disabled, so the game speed was set to default (100%). After extensive pretesting with players of different skill and experience, the value in the mutator set to 140% for the high speed conditions, so the difference was big enough, but the game was still playable, even for beginners.

Other Mutators

UT3 comes with a lot of preinstalled mutators that can be activated to (in some cases drastically) change the game experience, even for expert players. The Weapon Replacement mutator, was used to replace all weapons in the game with either the ToyGun (in the non-violent conditions) or the FlakGun (in the violent conditions), so they were the only available weapons in the game. Additionally, the No Super Pickups mutator was enabled to remove all special items and boosts. There were two reasons for that:

1. While items like a damage amplifier make sense for the violent conditions, it would

Table 5.1: Mutators used in the experimental conditions

	Low Violence	High Violence
Normal Speed	Death Fading No Super Pickups UT3 Stats Logging Weapon Replacement (ToyGun)	No Super Pickups UT3 Stats Logging Weapon Replacement (FlakGun)
High Speed	Death Fading No Super Pickups UT3 Speed Modification (140%) UT3 Stats Logging Weapon Replacement (ToyGun)	No Super Pickups UT3 Speed Modification (140%) UT3 Stats Logging Weapon Replacement (FlakGun)

have been difficult to invent a convincing non-violent version.
2. Experienced players might know where to find those items in a level and thus have a very different game experience than the inexperienced players.

One other mutator, the UT3 Stats Logging Mutator (Contreras, 2009), was retrieved from a public UT3 resource website. This mutator was used because it automatically creates logfiles of each UT3 game. This made it easier to assess the performance of each player, as well as the difficulty level they played.
Table 5.1 gives an overview of the mutator in each condition.

5.2 Physiological Arousal

In the experimental setup, there were four different ways to assess physiological arousal, two psychophysiological measurements, heart rate (HR) and galvanic skin response (GSR), and two behavioral indicators, body movement and force.

5.2.1 Heart Rate and Galvanic Skin Response

In this study, HR and GSR were measured with the Wild Divine IOM Lightstone Biometrics USB Widget. This device provides three plastic finger clips, two for GSR, and one for HR, and it is connected to the computer via USB. In a first-person shooter like UT3, players need both hands to play the game. This raised the question how to attach the finger clips.

In UT3, or any first-person shooter, one hand is needed for keyboard controls, and the other for the mouse. Players move their pawn through the game with the W (forward), A (left), S (backward), D (right) keys. To use these 4 keys adequately, at least three fingers are required. There are other actions like duck and jump that have to be performed with other keys, so usually all five fingers of the keyboard hand are busy or at least have to be available to play the game properly.

This left only the mouse hand as a viable solution. The mouse itself is necessary to look around and shoot. The mouse wheel usually is used to switch between weapons, the left and right mouse buttons trigger a weapon's primary and secondary firing mode respectively. Since one firing mode was deactivated anyway (see 5.1.2), the participants only needed one mouse button. Because players would only be able to use one weapon, the mouse wheel had no use either. This meant that only the index finger (for right-handed players) or the middle finger (for left-handed players) was needed to click the left mouse button and fire the weapon.

It was possible to attach the clips to the player's thumb, middle or left finger (for right-handed and left-handed players respectively) and the ring finger without the plastic cases getting in the way or becoming uncomfortable. Another problem were the motion artifacts, since the mouse is used heavily during a first-person shooter game. It was clear that the fingers with the sensors had to be fixed in a comfortable way, while still giving the player the freedom to move the mouse and click the left mouse button.

The best way to do this was to find a way to attach and detach the IOM device's plastic cases to the mouse, so every player could find a comfortable position for the hand. Therefore, the plastic cases and the mouse were wrapped with hook-and-loop tape, sparing only the left mouse button. This way, the clips could first be attached to the participant's fingers, and then fixed on the mouse (see figure 5.2).

A few pretests with this setup showed that the data loss due to motion artifacts and the general nature of these devices was not bigger than with the clips attached to a resting hand.

5.2.2 Body Movement

To measure players' body movement, the Nintendo Wii Fit Balance Board was used. The Balance Board is shaped like a household body scale, but instead of one it has four sensors, one in each corner. Shifts in posture or movement increase the weight on one sensor while decreasing the weight on others. From the weight in all sensors, the Balance

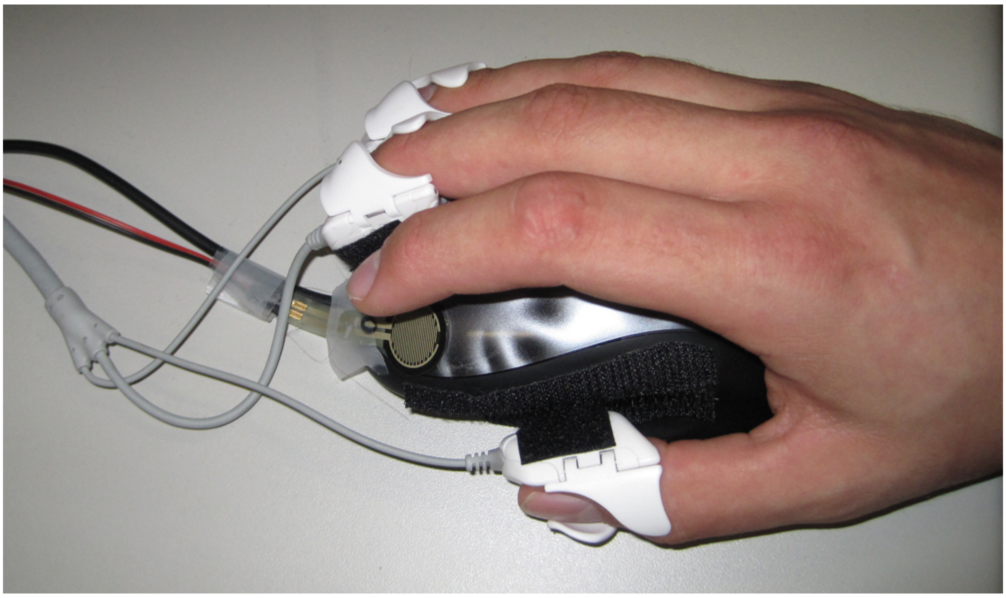

Figure 5.2: The IOM device attached to the mouse.

Board can calculate the actual weight of the person sitting on it. Since weight should be a constant (at least for the short duration of this experiment), changes in the sensors always meant there was a movement of the body while the person was sitting on the board. This was a cheap, easily accessible, and very reliable method to measure movement or postural changes in the players. Unlike in the study by van den Hoogen, IJsselsteijn, and de Kort (2008), in which a chair was mounted on top of a modified Balance Board, the board itself was placed on a hard-top wooden seat, and participants were required to sit on it during the experiment (see figure 5.3). The Balance Board connected via Bluetooth with the PC.

5.2.3 Force

Force was measured with seven SparkFun Force Sensitive Resistors (FSRs). These FSRs change their resistance depending on how much force is being applied to the 0.5 inch (12.7 mm) sensing area. The higher the force, the lower the resistance. When no force is being applied to an FSR, its resistance will be larger than 1MΩ. One FSR can sense applied force anywhere in the range of 100 g to 10 kg with a resolution of ±50 g or better (SparkFun Electronics, n.d.). According to the manual, the accuracy is not very high, but since only relative differences between experimental groups were important, and not absolute force values, the sensors were sufficient for the purpose of this study.

The FSRs are very sensitive to the surface they are attached to. A convex or concave surface would bend the sensor, which might reduce the dynamic range and cause a resistance drift. Therefore, the Cherry Infinity Corded MultiMedia Keyboard JK-0200 was

Figure 5.3: The Balance Board as used in the experiment

chosen because its keys are flat, hard, and also big enough for the sensor. Unfortunately, it was impossible to find a mouse with perfectly flat buttons and the right size for the sensors (and also enough space for the hook-and-loop tape, see 5.2.1). The device closest to the requirements seemed to be the Logitech MX 518 Optical Gaming Mouse, which is also designed explicitly for digital gaming.

The two pins from the bottom of the sensor were connected to the LabJack U3 Low Voltage hub (see figure 5.4). This hub transforms the input from the sensors into voltage data with a range of 0 V to 2.5 V and provides a digital output via USB (see 5.2.4). The sensors were fixed on the left mouse button and on the keyboard keys W, A, S, D (movement), C (duck), and left CTRL (jump) with thin, double-faced adhesive tape.

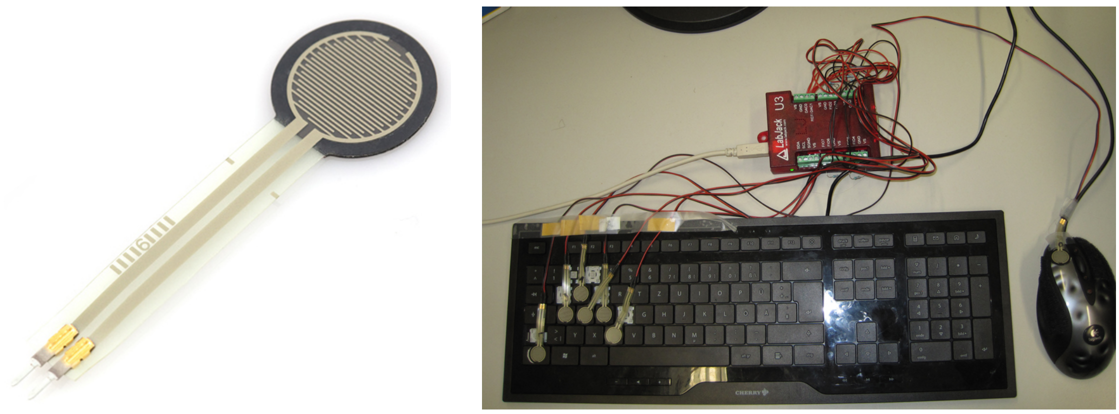

Figure 5.4: A force sensitive sensor and the final setup used in the experiment.

5.2.4 Data Collection

To collect the data from all three sources (IOM device, force sensors via LabJack U3 hub, Balance Board), a small program was written in Python (see A.1). Drivers and python libraries to access the input from the LabJack hub were available on the manufacturer's website (LabJack Corporation, 2010), and a private coder kindly provided the same for the Balance Board (*WiiYourself!*, 2010). Libraries for the IOM device have been coded before at the department of social psychology and media psychology in Cologne. Another unpublished library for the IOM data processing was provided from the company MediaScore. A separate file for each source was created with ten time-stamped logs per second.

5.3 Aggressive Behavior

For the reason of comparability and despite all its limitations (see 3.4), the measurement for aggressive behavior used in this work was the standardized version of the CRTT as introduced by Ferguson et al. (2008). In this version, participants were told that they would be playing a reaction time game against another participant, in which they had to press the space bar as fast as possible after hearing a sound signal. Before each of the 25 trials, on a scale from 1 to 10, participants had to set the volume and duration of a noise blast for their opponent. They were told that their opponent would set the volume and duration of a noise blast as well. The loser of a trial would hear the noise blast with the settings of the winner. In any case, the settings chosen by their opponent were shown on screen after each trial. In reality, there was no other participant and the sequence of wins and losses was randomized and preset to standardize the test and provoke aggression in the participant.

The first trial was always a loss, and the opponent's settings were volume 5, duration 5. After that, there were 12 wins and 12 losses randomized over 24 trials. Both volume and duration of the noise blast set by the opponent were randomized as well, including each setting from 2 to 9 three times total for each of the two (i.e. duration and volume). The volume output was calculated by multiplying a fixed factor with the volume setting. Unfortunately, Ferguson et al. (2008) did not specify the duration intervals, so I choose to increase the duration linearly by 250 ms multiplied with the duration setting. The whole test was administered with Presentation (Neurobehavioral Systems, 2010).

5.4 Game Expertise

The participants' gaming expertise was expected to be an important and possibly confounding variable for all of the dependent variables, as well as the overall game experience. Participants rated their expertise in two parts:

They stated the frequency of their first-person shooter use during the last 12 months on a 9-point scale (never; once a year; several times a year; once a month; several times a month; once a week; several times a week; once a day; several times a day).

They were also asked if they had played UT3 before, because players with expertise in this game should know about the usual game speed and displayed violence in this game, which might confound their game experience and ratings in the manipulation checks.

5.5 Game Experience

The game experience in the experiment was measured with several questions and scales to check how participants perceived the different conditions. Although the hypotheses do not predict any differences in the game experience between the conditions, this was necessary to control for possibly confounding variables, since either level of displayed violence or game speed could influence how much a game is enjoyed, how fascinating it is, etc.

Participants rated the games with regard to different aspects like emotion, perception, content, and usability. The questionnaire was administered in a browser using LimeSurvey (Schmitz, 2010) after the game phase and the CRTT.

5.5.1 Emotional Experience

To assess the participants' emotional experience during the game, a modified version of the Differential Emotions Scale (Modifikation der Differentiellen Affekt Skala, M-DAS; Renaud & Unz, 2006) was used. Players rated their emotional experience with 26 randomized items on a 7-point Likert scale from "not at all applicable" to "fully applicable" (see table 5.2).

Table 5.2: Emotional Game Experience Questionnaire

	Ich fühlte mich ...	I felt ...
Vergnügen / Delight	amüsiert	amused
	erheitert	exhilarated
	vergnügt	delighted
	unterhalten[a]	entertained
Freude / Enjoyment	fröhlich	cheerful
	glücklich	happy
	erfreut[a]	glad
Zufriedenheit / Satisfaction	ausgeglichen	balanced
	wohl	well
	zufrieden	satisfied
Faszination / Fascination	beeindruckt	impressed
	fasziniert	fascinated
	gebannt[b]	mesmerized
	gefesselt[a]	compelled
	gespannt[a]	thrilled
Ergriffenheit / Emotional Movement	bewegt	moved
	ergriffen	touched
Interesse / Interest	aufmerksam	attentive
	konzentriert	concentrated
	wach	alert
Trauer / Grief	niedergeschlagen	depressed
	entmutigt	discouraged
Angst / Anxiety	erschreckt	frightened
Langeweile / Boredom	unbeteiligt	uninvolved
	angeödet	bored
Aufregung / Excitement	aufgeregt[a]	excited

[a] All those items were added to the existing M-DAS items and scales.
[b] This item also accounts for the "Emotional Movement" scale.

5.5.2 Gameplay and Graphic Experience

To assess the participants' general gameplay experience during the game, they rated 8 items on a 7-point Likert scale from "not at all applicable" to "fully applicable" (see table 5.3).

Table 5.3: Gameplay and Graphics Experience Questionnaire

	Ich empfand das Spiel als ...	I experienced the game as ...
Schwierigkeit / Difficulty	schwierig	difficult
	herausfordernd	challenging
Geschwindigkeit / Speed	schnell[a]	fast
	hektisch[a]	hectic
Steuerung / Controls	intuitiv steuerbar	intuitively controllable
Grafik / Graphics	gewalthaltig[a]	violence containing
	realistisch	realistic

[a] Those items would also be used for the manipulation check (see 5.5.3).

5.5.3 Manipulation Check

Two different measurements were taken to check for a successful manipulation of the game variables. Participants rated eight items on a 7-point Likert scale from "not at all applicable" to "fully applicable", four each for the game speed and displayed violence (see table 5.4). Two items for the speed and one for the violence manipulation from the gameplay and graphics experience questionnaire (see table 5.3) were added.

For the second manipulation check, participants had to give the game they played an age rating. Because Germans would be more familiar with it, the participants rated the game according to the the 2009 rating criteria of the Unterhaltungssoftware Selbstkontrolle. They could choose between no age restriction, restrictions for those below the age of 6, 12, 16, 18, and no clearance (which means it would be illegal to sell the game at all in Germany).

Table 5.4: Manipulation Check Questionnaire

	Bitte geben Sie an, inwieweit die folgenden Aussagen über das Spiel zutreffen	Please specify to what extent the following statements apply to the game
Geschwindigkeit / Speed	In dem Spiel hat man sich unnatürlich schnell bewegt.	In the game, you moved unnaturally fast.
	Die Figuren in dem Spiel haben sich mit übermenschlicher Geschwindigkeit bewegt.	The figures in the game moved with superhuman speed.
	Die Bewegungen in dem Spiel waren so hektisch, dass ich ihnen manchmal nicht folgen konnte.	The movements in the game were so hectic that sometimes I could not follow them.
	Die Spielgeschwindigkeit war zu hoch, um das Spiel vernünftig spielen zu können.	The game speed was too high to play the game reasonably.
Gewalt / Violence	In dem Spiel wurde körperliche Gewalt angewendet.	In the game, physical violence was used.
	Die Figuren in dem Spiel wurden verletzt.	The figures in the games were injured.
	Den Figuren in dem Spiel wurde Schaden zugefügt.	Damage was inflicted on the figures in the game
	In dem Spiel wurden Personen umgebracht.	In the game, persons were killed.

5.6 Demographics and Compliance

Participants provided information about their age, sex, level of education, occupation, and native language. To assess the participants' compliance, they rated 3 items on a 7-point Likert scale from "not at all applicable" to "fully applicable" (see table 5.5). In two open text fields they were asked to tell what they thought might be the hypotheses behind the experiment (since that might be a problem for the CRTT).

Table 5.5: Compliance Questionnaire

German	Translation
An dem Experiment teilzunehmen hat mir gefallen.	I enjoyed participating in this experiment.
Ich fühlte mich von den Geräten und Sensoren gestört.	I was annoyed by the devices and sensors.
Ich würde an einem ähnlichen Experiment in Zukunft wieder teilnehmen.	I would participate in a similar experiment in the future.

5.7 Participants

Participants were $N = 87$ (60 male and 27 female) mostly undergraduate and graduate students from the Universities of Cologne and Hohenheim (see table 5.6) with a mean age of $M = 26.07$ years ($SD = 5.87$). 66 were currently university students. Of the 87 participants, 6 indicated their native language was not German.

The recruiting of the participants in Cologne was initiated on July 27th, 2010 by an e-mail that was sent out to various mailing lists of the University of Cologne as well as the study participant database of the department of social and media psychology (Prof. Bente). The original German recruiting mail can be seen in the appendix (see A.3). Translated, it read in short that I was looking for numerous participants for my diploma thesis study about digital games and physiological arousal, and I would appreciate everyone's support. I specifically mentioned that I was looking for game experienced and inexperienced men and women. It said that the participation would last about 60 minutes and would be recompensed with credit points (for psychology students). Participants could win one of 40 novel computer games that had been kindly sponsored by Electronic Arts. 58 participants signed up online via the CORTEX tool for recruiting participants (Elson & Bente, 2009).

The acquisition of participants in Hohenheim was initiated on August 13th, 2010 by an e-mail that was sent out to various mailing lists of the University of Hohenheim. The same text as in Cologne was used, except for the credit point compensation, since

Table 5.6: Demographics

		Cologne ($n = 58$)	Hohenheim ($n = 29$)	Total ($N = 87$)
Age		25.23 (SD = 4.34)	23.85 ($SD = 3.63$)	26.07 ($SD = 5.87$)
Sex	Male	38	22	60
	Female	20	7	27
Highest Degree	None	0	0	0
	Haupt-/Realschule	1	1	2
	Hochschulreife	38	14	52
	Pre-Diploma/Bachelor	9	3	12
	PhD	1	1	2
Students		46	20	66

there were no students of psychology in Hohenheim. 29 participants signed up online via CORTEX.

5.8 Procedure

In Cologne, the experiment started on August 2nd, 2010, and ended on August 16th, 2010. The phase in Hohenheim started on August 24th, 2010, and ended on September 2nd, 2010. Upon arrival in the lab, participants were greeted and thanked for their willingness to participate. Then, they were kindly asked to wash their hands and dry them thoroughly to have a better standardization of the baseline values measured with the IOM device attached to their fingers. Only one person could participate at a time, so there was no one else in the laboratory.

The participants were asked to read the consent form (see A.4) and to sign and return it to the experimenter. The Balance Board was calibrated, and the participants sat in front of a computer screen. They were asked, if they were left- or right-handed, since their dominant hand would be the one for the mouse. I attached the IOM device to the fingers and asked the participants to place their hands on mouse so the tip of their index finger (for right-handed participants) or middle finger (for left-handed participants) would be in the middle of the circle (the mouse's force sensor). Then, the IOM clips were attached to the hook-and-loop tape, so the hand was fixed on the mouse. The participants were asked to move the mouse around and perform some basic tasks, like opening a folder, closing a window, to see if the setup was uncomfortable.

5.8.1 Unreal Tournament 3

After starting the game, participants read instructions describing the following procedure. During this phase, the baseline of GSR and HR were measured. The participants were also verbally instructed about the game controls. Two participants asked if they could inverse the mouse axis, which was allowed for the reason of standardization.

The subjective game difficulty was considered an important confounding variable. If the game was too easy, players might have gotten bored. If the game was too hard, players might have gotten frustrated. Since a wide range of first-person shooter skills and experiences was expected among the participants, setting the difficulty on the same level for everybody was not a viable solution. To have the difficulty be as least confounding as possible, every participant played in the same subjective difficulty. More specifically, this meant that experienced players played on a high difficulty level, while beginners played on an easier level. To determine this optimal difficulty level, participants were asked to rate their own first-person shooter skills on a scale from 1 to 8, and that difficulty was set for the first of three warm-up rounds during which the difficulty could be adjusted.

The settings for their experimental condition (violent vs. non-violent, normal vs. fast) was preset before, so I started the game and left the room. After each of the three warm-up rounds, I would return to the room, ask if everything was fine with the setup, and adjust the difficulty according to their performance ratings. Since they were playing against seven computer opponents, they could be on a rank between 1 and 8. The rank was solely determined by the number of kills (or hits) they made in the given time. If they were ranked on the first place and had at least 3 more hits than the second place, I would recommend them to increase the difficulty by one level. If they were not ranked on the first place and were 3 or more hits behind the first, I would recommend them to decrease the difficulty by one level. However, they could always choose not to change the difficulty if they felt it was ideal for them. Then, the next round was started.

After the three warm-up rounds of 4 minutes each, I returned to the room to set the playing time to 12 minutes, and eventually made one last adjustment of the difficulty level. After playing this round, again I returned to the room, asked the participant to quit the game, close the script that records the data from all devices, and detach the sensors.

The whole procedure took about 30 minutes.

5.8.2 Competitive Reaction Time Task (CRTT)

Participants were told that the second part of the experiment was about to start. They were told that they would play a reaction time game against another participant in another laboratory. Instructions were also presented on the screen before the first trial. I switched the keyboards, since the one used for UT3 was missing some keys (see figure 5.4). I started the Presentation scenario, and left the room again.

In the room next door, I could watch if a Presentation log file was created, which meant the scenario was finished. This part of the study took about 7 minutes.

5.8.3 Questionnaire and Debriefing

After the CRTT ended, I returned to the room, closed Presentation, opened a browser and entered the participants' ID code into a text field to start the questionnaire. I told the participants this would be the last part of the experiment, and that they were going to answer a series of questions. To avoid confusion, I told them that, if the questions were related to a game, they always referred to the first game (i.e. UT3). Again, I left the room. Most participants needed about 10 to 15 minutes for the questionnaire. After completing the questionnaire, the participants were debriefed and informed about the simulated opponent in the CRTT setup. Also, if they had further questions, I briefly informed them about my hypotheses and what the devices were measuring. They could also put their email address on a list, if they wished to be informed about the final results of my study.

Chapter 6

Results

In the following sections, the manipulation checks for the independent variables displayed violence and game speed will be examined. Afterwards, the results concerning the above-stated hypotheses are presented. For the acceptance of the hypotheses, a significance level of $\alpha = 5\%$ was defined. Due to technical difficulties, two data sets had to be discarded from the analyses. Additionally, one participant had to drop out of the experiment due to motion sickness, leaving a total of $N = 84$ participants (21 in each condition).

6.1 Manipulation Checks

In order for the independent variables to have an effect, it was crucial that the high violent condition was actually perceived as more violent, and the high speed condition as faster. A total of 4 items was used to measure the perception of each independent variable (see table 5.4) as well as three additional items from the Gameplay and Graphics Experience Questionnaire (see table 5.3). A principal component analysis (PCA) was conducted on the 11 items with orthogonal rotation (varimax). The Kaiser-Meyer-Olkin measure verified the sampling adequacy for the analysis, $KMO = .76$ ("good" according to Field, 2009), and all KMO values for individual items were well above the acceptable limit of .5 (Field, 2009). Bartlett's test of sphericity $\chi^2(55) = 426.55$, $p < 0.001$, indicated that correlations between items were sufficiently large for a PCA. An initial analysis was run to obtain eigenvalues for each component in the data. Two components had eigenvalues over Kaiser's criterion of 1 and in combination explained 59.16% of the variance. Table 6.1 shows the factor loadings after rotation. The items that cluster on the same components suggest that component 1 represents perceived violence, and component 2 perceived speed. Therefore, mean scores for perceived violence and perceived speed were computed from their according items. One-way ANOVAs showed a successful manipulation of perceived violence, $F(1, 82) = 24.04$, $p < .05$, $\omega = .46$, as well as of perceived speed, $F(1, 82) = 19.90$, $p < .05$, $\omega = .43$. Why the factor loadings for perceived violence are higher than for speed is easily explained: The display of violence was simply more obvious for all participants, while especially for inexperienced players even the normal game speed might have seemed very hectic and blurry.

Table 6.1: Rotated Component Matrix of the Manipulation Check Items[a]

	1	2
In the game, physical violence was used	.848	
The figures in the games were injured	.894	
Damage was inflicted on the figures in the game	.878	
In the game, persons were killed	.796	
Graphical Experience: Violent	.726	
In the game, you moved unnaturally fast		.689
The figures in the game moved with superhuman speed		.632
The movements in the game were so hectic that sometimes I could not follow them		.778
The game speed was too high to play the game reasonably		.658
Gameplay Experience: Fast		.625
Gameplay Experience: Hectic		.764

[a] Rotation converged in 3 iterations.
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

There was also a significant effect of displayed violence on the game's age rating by the participants. Participants in the violent conditions assigned the game a significantly higher age clearance ($Mo = 16$) than participants in the non-violent conditions ($Mo = 12$), $U = 385.50$, $z = -4.80$, $p < .05$, $r = -.52$.

6.1.1 Game Experience

Besides the successful manipulation, it was also important to learn about the participants' experiences in emotion, perception, content and usability in all conditions.

Emotional Experience

A MANOVA was run on the M-DAS factors which were calculated from the means of their belonging items. Using Pillai's trace, there was no overall significant effect of displayed violence, $V = 0.15$, $F(11, 68) = 1.12$, $p > .05$, game speed, $V = 0.13$, $F(11, 68) = 0.89$, $p > .05$, or displayed violence x game speed, $V = 0.08$, $F(11, 68) = 0.51$, $p > .05$. However, separate ANOVAs on the outcome variables revealed significant effects of displayed violence on interest, $F(1, 80) = 4.43$, $p < .05$, $\omega = .20$, and excitement, $F(1, 80) = 6.62$, $p < .05$, $\omega = .25$. Participants who played the high-violent game felt significantly more interested and excited. This finding should be taken into account when looking at the results of the further analyses.

Gameplay and Graphic Experience

A MANOVA was calculated with the Gameplay and Graphics factors difficulty, controls, and realism of graphics, which were calculated from the means of their belonging items. Using Pillai's trace, there was no overall significant effect of displayed violence, $V = 0.03$, $F(11, 68) = 0.71$, $p > .05$, game speed, $V = 0.06$, $F(11, 68) = 1.75$, $p > .05$, or displayed violence x game speed, $V = 0.06$, $F(11, 68) = 1.52$, $p > .05$. However, separate ANOVAs on the outcome variables revealed a significant game speed effect on difficulty, $F(1, 80) = 4.67$, $p < .05$, $\omega = .21$. Participants who played the high-speed game felt that it was significantly more challenging. This finding should be taken into account when looking at the results of the further analyses.

Compliance

To test for different levels of compliance between the groups, separate ANOVAs were run for the three items. Participants seemed to enjoy the experiment equally and would participate in a similar experiment in the future, regardless of condition. However, there was a significant main effect of the interaction between displayed violence and game speed on how annoyed the participants were by the devices and sensors, $F(1, 80) = 6.63$, $p < .05$, $\omega = .19$. Looking at the simple effects, participants in the normal-speed x non-violent condition were significantly more annoyed than those from the the normal-speed x violent condition (Ms = 2.70 and 1.80, SDs = 1.34 and 1.20, respectively), $F(1, 80) = 5.06$, $p < .05$. This finding should be taken into account when looking at the results of the further analyses.

6.2 Aggressive Behavior

Using the standardized version for the CRTT suggested by Ferguson et al. (2008), volume and duration were correlated to investigate whether they would both reflect aggression. The volume and duration measures for each trial correlated significantly, $r = .44$, p (one-tailed) $< .05$. Moreover, the correlation of average volume and duration measures for each participant was much higher, $r = .71$, p (one-tailed) $< .05$. Given that volume and duration are both considered values for aggressive behavior though, the correlation should be even higher than that.

No significant main effects on the mean volume settings were found for game speed, $F(1, 80) = 0.08$, $p > .05$, $\omega = .0$, displayed violence, $F(1, 80) = 3.10$, $p > .05$, $\omega = .16$, and game speed x displayed violence, $F(1, 80) = 1.32$, $p > .05$, $\omega = .06$. Looking at the significance of each simple effect, participants in the high-speed x violent condition had a significantly higher average volume than those in the the high-speed x non-violent condition (Ms = 5.12 and 4.18, SDs = 1.81 and 1.25, respectively), $F(1, 80) = 4.24$, $p < .05$. No significant main and simple effects on the mean duration settings were found for speed, $F(1, 80) = 0.00$, $p > .05$, $\omega = .0$, violence, $F(1, 80) = 0.81$, $p > .05$, $\omega = .0$, and interaction between speed and violence, $F(1, 80) = 1.28$, $p > .05$, $\omega = .06$.

According to these results, hypotheses H1 and H2 can be rejected: Individuals who played a violent digital game did not act more aggressively in a subsequent behavioral test than individuals who played a non-violent digital game. Game speed had no effect as well.

6.2.1 Other CRTT Measures

As described in section 3, there is a big diversity in the aggression score calculation with the CRTT's raw data in the literature. If they would all represent the same construct (aggression), then the differences between the experimental groups should have similar significance levels for all aggression scores. Therefore, separate aggression scores for each of the reported one-phase versions of the CRTT were calculated, and used in separate ANOVAs. The results are presented in table 6.2. All eight measures for aggression that are somehow based on mean values for the complete CRTT yielded non-significant differences between experimental conditions. However, the volume settings were mostly much closer to significance than the duration settings, which should not be the case if they were both measures for aggression. Moreover, participants who played a violent game gave significantly more high volume blasts (range 8-10) than the non-violent game players, $F(1, 80) = 15.73$, $p < .05$, $\omega = .39$ (a large effect). Apparently not all measures computed from the raw data actually seem to represent the same construct.

Table 6.2: Effects of Game Speed (GS), Displayed Violence (DV), Displayed Violence x Game Speed (DVxGS) on Aggression

Aggression Score	*df, df_R*	*F*	*Sig.*	ω
GS: Avg. volume	1, 80	0.08	.776	.0
GS: Avg. duration	1, 80	0.00	.957	.0
GS: Avg. volume after wins	1, 80	0.00	.999	.0
GS: Avg. volume after losses	1, 80	0.63	.428	.0
GS: Avg. duration after wins	1, 80	0.03	.872	.0
GS: Avg. duration after losses	1, 80	0.06	.803	.0
GS: Avg. volume x duration	1, 80	0.00	.983	.0
GS: Avg. volume x $\sqrt{duration}$	1, 80	0.04	.847	.0
GS: Total high volume settings	1, 80	0.06	.805	.0
DV: Avg. volume	1, 80	3.10	.082	.16
DV: Avg. duration	1, 80	0.81	.370	.0
DV: Avg. volume after wins	1, 80	3.33	.072	.16
DV: Avg. volume after losses	1, 80	3.40	.069	.16
DV: Avg. duration after wins	1, 80	0.61	.436	.0
DV: Avg. duration after losses	1, 80	0.81	.372	.0
DV: Avg. volume x duration	1, 80	2.61	.110	.14
DV: Avg. volume x $\sqrt{duration}$	1, 80	3.69	.058	.17
DV: Total high volume settings	1, 80	15.73	.000[a]	.39
GSxDV: Avg. volume	1, 80	1.32	.253	.06
GSxDV: Avg. duration	1, 80	1.28	.262	.06
GSxDV: Avg. volume after wins	1, 80	1.00	.320	.0
GSxDV: Avg. volume after losses	1, 80	2.28	.135	.12
GSxDV: Avg. duration after wins	1, 80	1.88	.174	.10
GSxDV: Avg. duration after losses	1, 80	0.81	.371	.0
GSxDV: Avg. volume x duration	1, 80	2.49	.119	.13
GSxDV: Avg. volume x $\sqrt{duration}$	1, 80	2.66	.106	.14
GSxDV: Total high volume settings	1, 80	0.00	.999	.0

[a] $p < .05$.

The data revealed another theoretically very puzzling finding: Although players in the violent conditions chose significantly more high volume settings, this did not cause significant differences between the averages of the experimental groups. While mathematically certainly possible, it seemed unlikely that the number of high volume blasts was the only difference. Logically, only a higher number of low volume settings (range 1-3) as a counterbalance for the high volume settings could be the cause for the equality of averages. In fact, there was a significant effect of displayed violence on total of low volume settings, $F(1, 80) = 9.21$, $p < .05$, $\omega = .29$ (a moderate effect). Following the same logic, one could argue that playing a violent game actually reduces aggressive behavior.

6.3 Physiological Arousal

Ravaja (2004) distinguishes between two kinds of psychophysiological responses for data analyses: phasic activity, i.e. physiological reactions to discrete, singular events, and tonic activity, which is the overall average of responses over a certain amount of time. Although it would be very interesting to look into group differences in reactions to specific events (e.g., the player's death), due to the limitations of this thesis, only tonic analyses will be presented and discussed here. The individual results (GSR, HR, movement, force) for each of the measures for physiological arousal are presented in the following subsections.

6.3.1 Galvanic Skin Response

It is impossible to compare raw or absolute GSR data from two individuals meaningfully, let alone groups of individuals, since people tend to have very diverse arousal baselines. That means, for example, one's arousal peak is probably close to another's neutral state. Likely causes for these differences are the participants' sex, age, weight, but also more situational factors like momentary health or recent caffeine consumption (Tsuji et al., 1996). Hence, the raw data for each separate participant were centered and transformed to z-scores, so a new standardized distribution was created that had a mean of 0 and a standard deviation of 1. Figure 6.1 shows that there was indeed an almost constant increase in GSR from the baseline at start of the experiment to the 12 minute trial phase in all conditions.

The graph also shows that there is not much of a difference in GSR between the groups in the trial phase. Indeed, no significant main effects on the mean galvanic skin response were found for game speed, $F(1, 80) = 0.10$, $p > .05$, $\omega = .0$, displayed violence, $F(1, 80) = 2.18$, $p > .05$, $\omega = .12$, but there was a significant interaction effect, $F(1, 80) = 3.57$, p

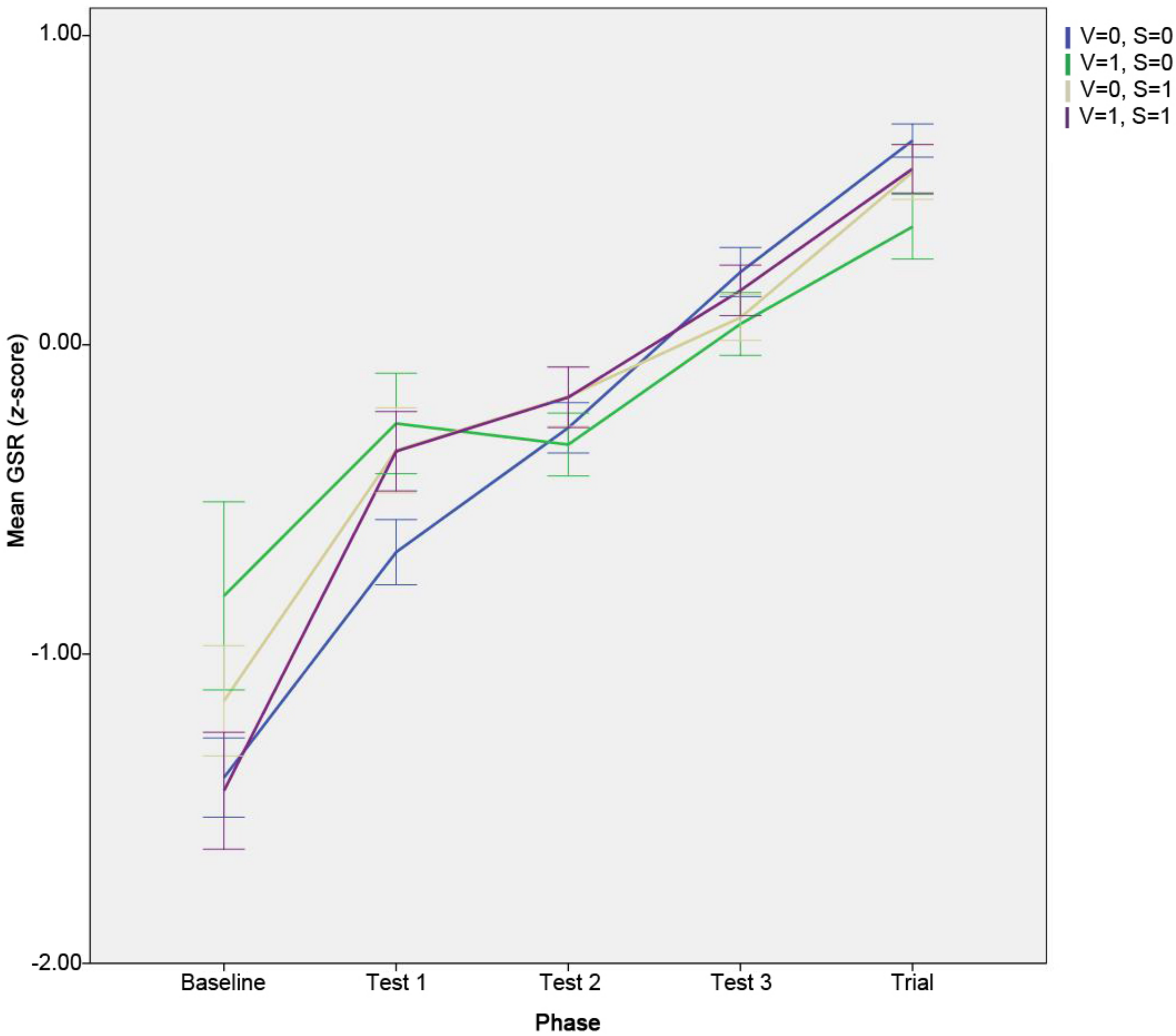

Figure 6.1: Average GSR in the experimental phases for each group.
V=Violence, S=Speed, 0=Low, 1=High; Error Bars: +/- 1 SE.

$< .05$, $\omega = .17$ (see figure 6.2). Looking at the significance of simple effects, participants in the normal-speed x non-violent condition had a significantly higher average GSR level during the trial phase than those in the the normal-speed x violent condition (Ms = 0.67 and 0.38, SDs = 0.26 and 0.49, respectively), $F(1, 80) = 5.67$, $p < .05$.

Hence, hypothesis H3a can be rejected: Individuals who played a high-speed digital game did not have higher GSR levels during play than individuals who played a normal-speed digital game.

6.3.2 Heart Rate

For the same reasons as with GSR (see above), the raw heart rate data for each individual participant were centered and transformed to z-scores. Figure 6.3 shows that

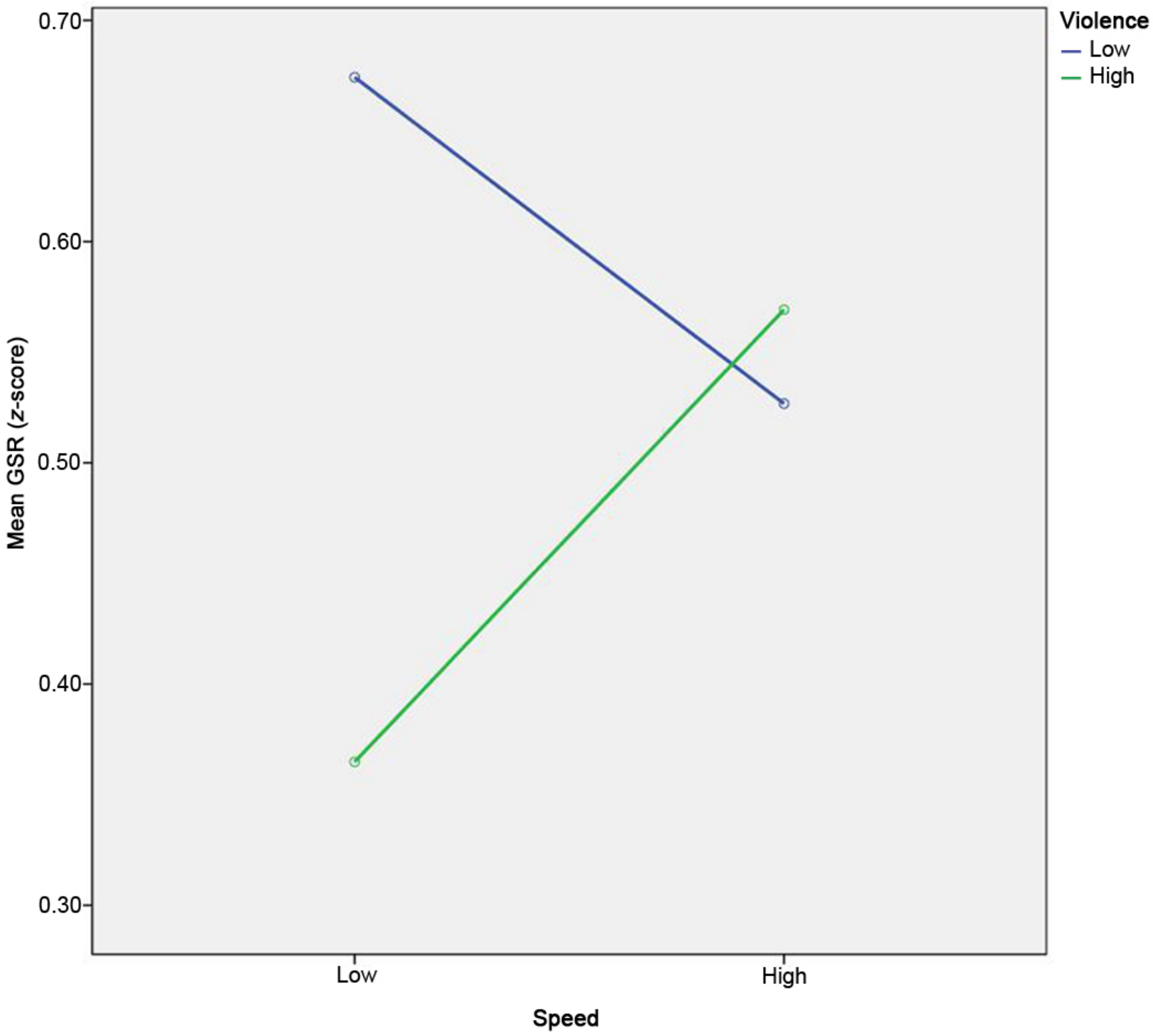

Figure 6.2: Average GSR in the trial phase for each group.

there was only a slight increase in HR from baseline to the trial phase in all conditions.

The graph also shows that there is not much of a difference in HR between the groups in the trial phase. Accordingly, no significant main effects on the mean HR were found for game speed, $F(1,\ 80) = 0.37$, $p > .05$, $\omega = .0$, displayed violence, $F(1,\ 80) = 0.00$, $p > .05$, $\omega = .0$, and game speed x displayed violence, $F(1,\ 80) = 0.17$, $p > .05$, $\omega = .0$ (see figure 6.4). No simple effect was significant as well.

Hence, hypothesis H3b can be rejected: Individuals who played a high-speed digital game did not have higher HR scores during play than individuals who played a normal-speed digital game.

Neither did displayed violence have an effect on GSR and HR, nor was it smaller than the effect of game speed, and thus hypothesis H3c can be rejected.

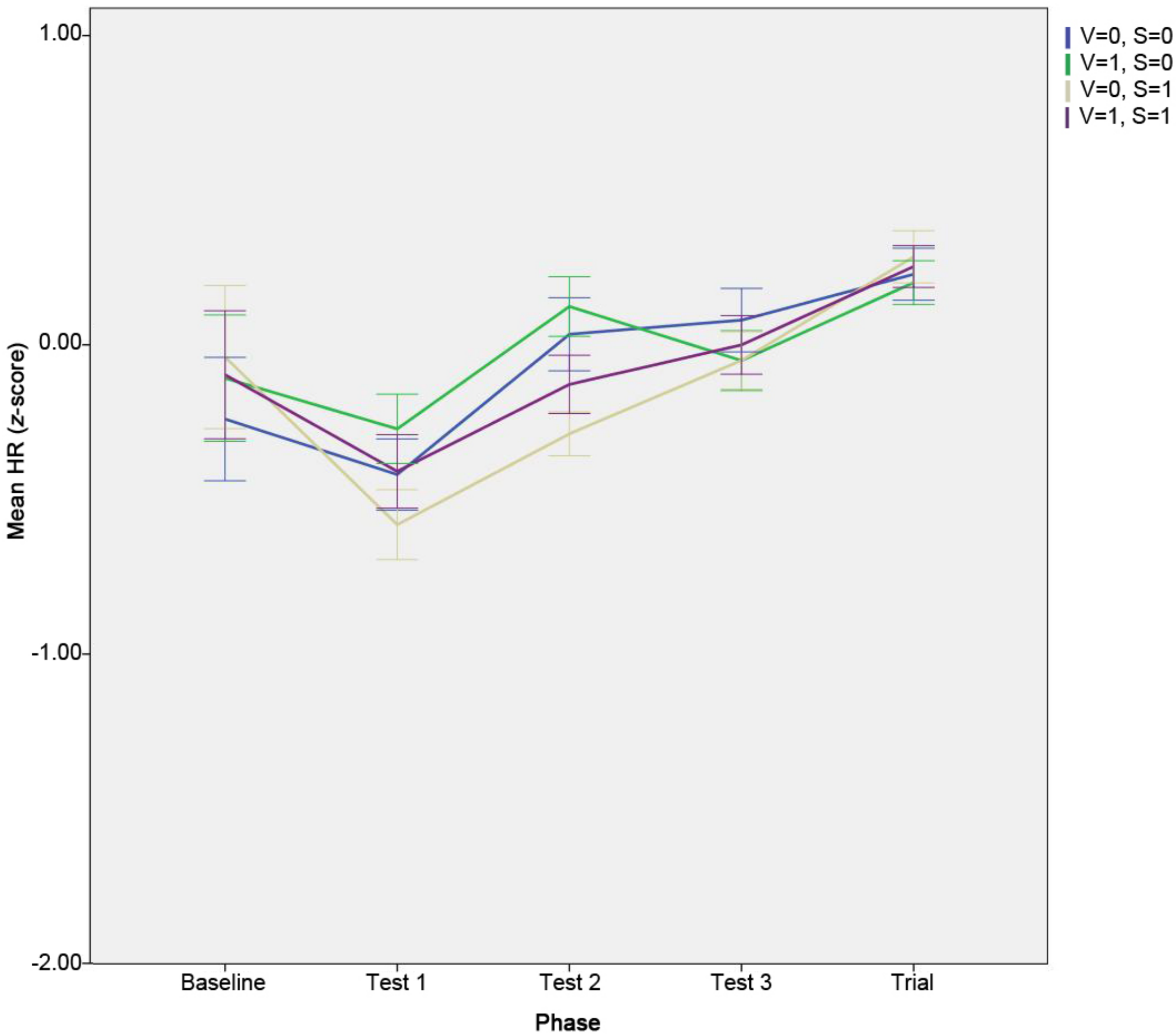

Figure 6.3: Average HR in the experimental phases for each group.
V=Violence, S=Speed, 0=Low, 1=High; Error Bars: +/- 1 SE.

6.3.3 Body Movement

Before analyzing the movement data, they had to be prepared accordingly. Heavier participants would cause shifts in the weight sensors more easily than lighter ones, so the data had to be transformed and standardized. Therefore, each absolute measure was divided by the participants weight. The variances from these relative data were calculated and averaged for all 4 sensors, and subsequently the root was extracted. This final score, the relative mean standard deviation, was used as the body movement score for each participant.

There was a significant main effect of game speed, $F(1, 80) = 10.47$, $p < .05$, $\omega = .31$, and an interaction of game speed x displayed violence, $F(1, 80) = 5.42$, $p < .05$, $\omega = .22$, but no significant main effect of displayed violence alone, $F(1, 80) = 2.01$, $p > .05$, $\omega = .10$ (see figure 6.5).

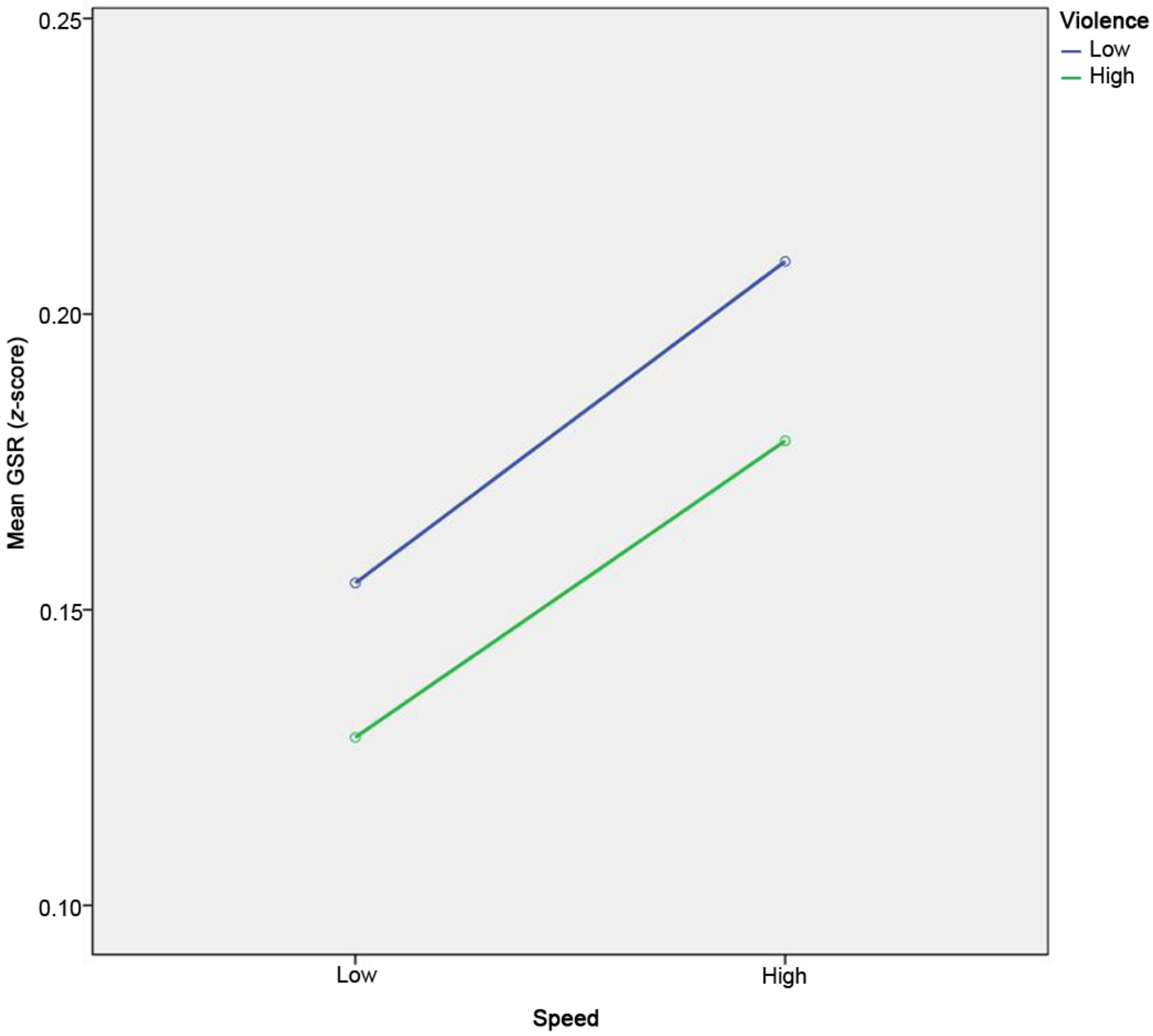

Figure 6.4: Average HR in the trial phase for each group.

There were two significant simple effects: Participants in the normal-speed x non-violent condition showed significantly more body movement than participants in the high-speed x non-violent condition (Ms = 0.11 and 0.05, SDs = 0.06 and 0.04, respectively), $F(1, 80) = 15.48$, $p < .05$. They also showed significantly more body movement than those in the normal-speed x violent condition ($M = 0.07$, $SD = 0.04$), $F(1, 80) = 7.02$, $p < .05$.

Game speed did have a significantly systematic influence on body movement, but there was also a significant interaction with displayed violence: participants who played a normal-speed x non-violent game had more body movement ($M = 0.11$, $SD = 0.06$) than individuals who played a normal-speed x violent game ($M = 0.07$, $SD = 0.04$) or high-speed x violent game ($M = 0.06$, $SD = 0.03$). Individuals who played a high-speed x non-violent game had the least body movement ($M = 0.05$, $SD = 0.04$) .

Based on these findings, hypothesis H4a has been partially confirmed: Individuals

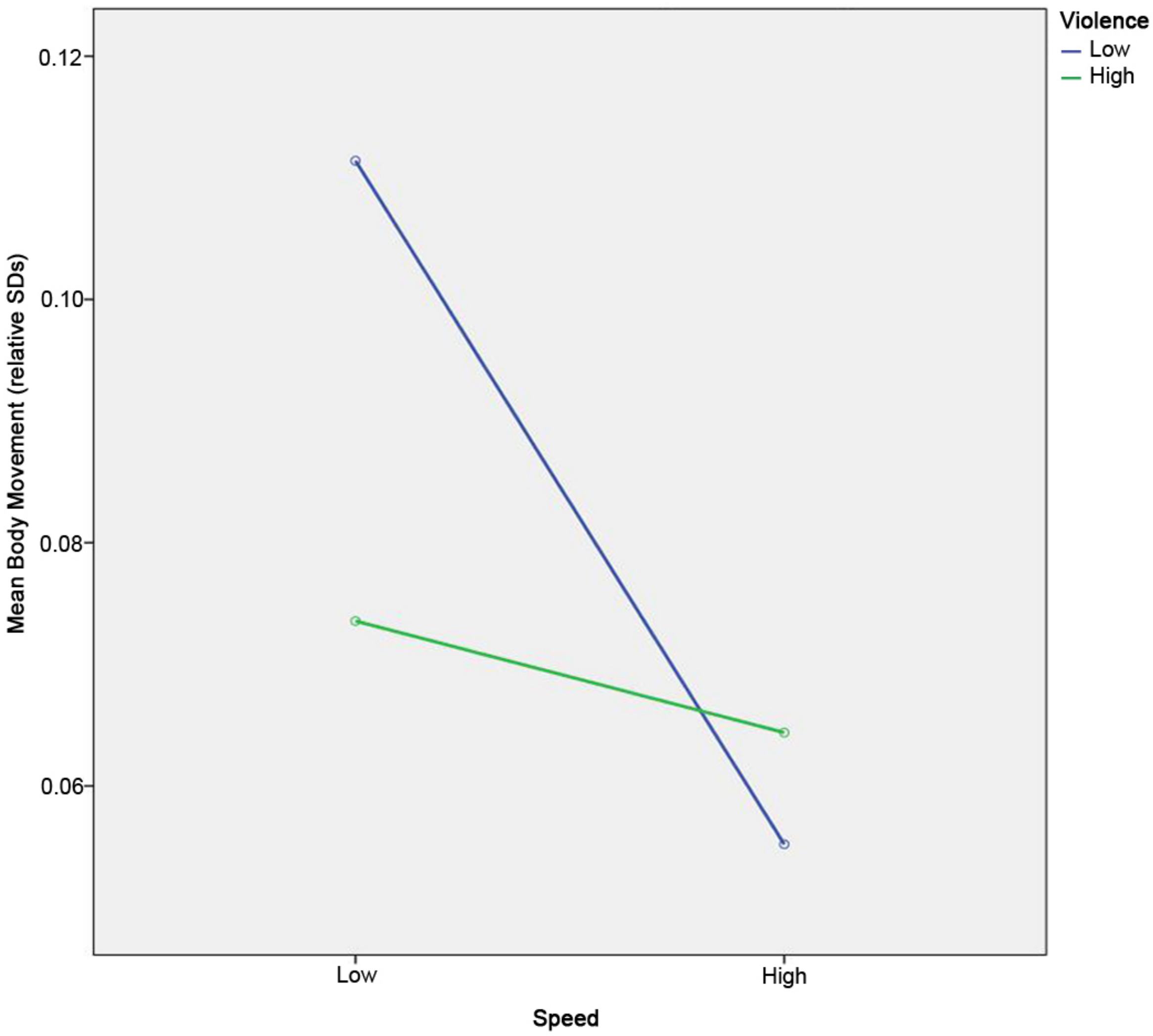

Figure 6.5: Average body movement in the trial phase for each group.

who played a normal-speed digital game did show more body movement, but only when the game was non-violent. This again means that hypothesis H4b has to be rejected: Although there was no significant main effect, displayed violence did have an effect on body movement that interacted with the effect of game speed.

6.3.4 Force

As described in section 5.2.3, the force sensors' output were voltage data with a range from 0 V to 2.5 V. Although this is a quite unusual scale for force, there was no need to transform the voltage data into a different unit (e.g., newton or kilogram) because I was only interested in relative group differences, not absolute force values. However, before analyzing the applied force on all sensors, the raw data had to be cleaned up a little. The sensors were supposed to measure the force applied to press the movement keys (W, A, S, D; C; CTRL) and left mouse button. Since the participants rested their hands on the keys to be able to react quickly, the sensors would register applied force even when the keys were not actually pressed. A pretest revealed that all force data below 0.3 V had to be discarded for that reason. Additionally, the convex surface of the mouse button caused a constant force level of approximately 0.4 V in the attached force sensor. Due to fluctuations in that offset, all values below 0.45 V in the mouse sensor had to be discarded as well. The average force applied to all pressed keys in each measurement point was calculated. For example, if a participant was pressing the left mouse button to shoot, as well as forward (W), left (A) to run diagonally, then these three values were averaged. If only one key was pressed (e.g., A to strafe sideways), then this value would be the average for that measurement point.

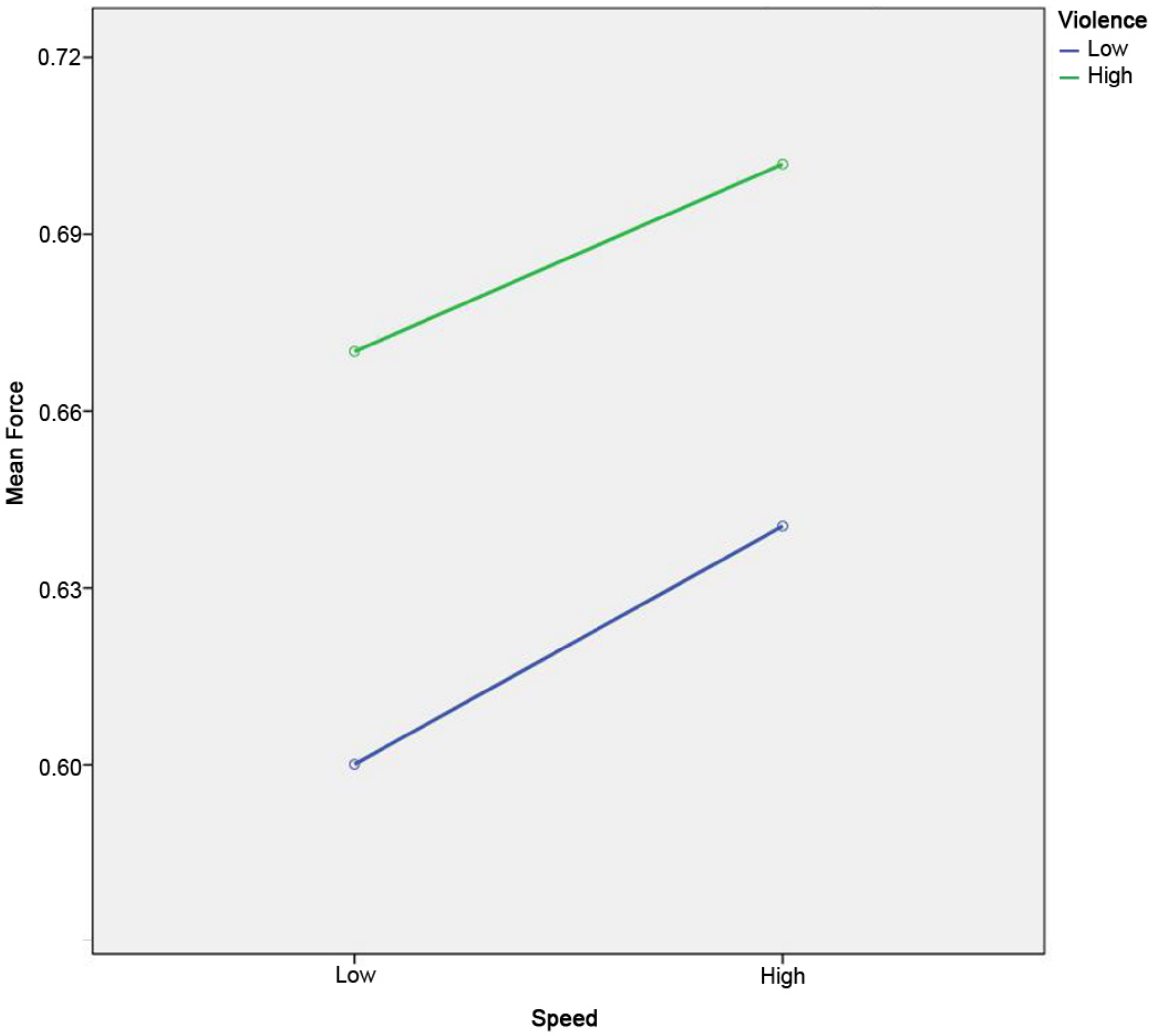

Figure 6.6: Average force in the trial phase for each group.

Consecutively, the average of these total force scores was calculated for each participant. There was a significant main effect of game speed, $F(1, 80) = 4.06$, $p < .05$, $\omega =$

.17, displayed violence, $F(1, 80) = 14.24$, $p < .05$, $\omega = .35$, but no significant interaction of the two,$F(1, 80) = 0.05$, $p > .05$, $\omega = .0$ (see figure 6.6).

Based on these findings, hypotheses H5 and H6 can be accepted: Individuals who played a violent digital game applied more force on mouse and keyboard during play than individuals who played a non-violent digital game. Individuals who played a high-speed digital game applied more force on mouse and keyboard during play than individuals who played a normal-speed digital game.

There were two significant simple effects: Participants in the high-speed x violent condition applied significantly more force than those from the high-speed x non-violent condition (Ms = 0.70 and 0.64, SDs = 0.10 and 0.08, respectively), $F(1, 80) = 6.33$, $p < .05$. Also, participants in the normal-speed x violent condition applied significantly more force than those from the normal-speed x non-violent condition (Ms = 0.67 and 0.60, SDs = 0.08 and 0.06, respectively), $F(1, 80) = 7.96$, $p < .05$. Although not all significantly different from the high-speed x violent condition, the means of force were as hypothesized: Participants who played a high-speed x violent game applied more force ($M = 0.70$, $SD = 0.10$) than individuals who played a normal-speed x violent game ($M = 0.67$, $SD = 0.08$) or high-speed x non-violent game ($M = 0.64$, $SD = 0.08$). Individuals who played a normal-speed x non-violent game applied the least force on mouse and keyboard ($M = 0.60$, $SD = 0.06$).

Therefore, hypothesis H7 can be partially accepted: Individuals who played a high-speed violent digital game applied more force on mouse and keyboard during play than individuals who played a normal-speed violent game or high-speed non-violent game. Individuals who played a normal-speed non-violent game applied the least force on mouse and keyboard.

6.3.5 Relations of Arousal Measures

Although the interpretation would be limited due to the averaged data, the four measures for physiological arousal were correlated and tested for significance. The only significant correlation found existed between galvanic skin response and body movement, $r = .28$, p (two-tailed) $< .05$. Participants with higher GSR levels also showed significantly more body movement. A causal direction cannot be discovered with these data however, and most likely one can have an effect on the other and vice-versa. A higher body movement, even when sitting, is most likely followed by increases in sweating and thus galvanic skin response. Increases in galvanic skin response on the other hand could also cause a higher agitation and thus an increased motion in a person.

6.4 Game Expertise

It is reasonable to assume that prior expertise with a game or genre might have an influence on the measurements taken. There were two measures for the participants' expertise: One was the final difficulty level they played in during the trial phase, ranging from 1 to 8. This value linearly modifies the opponents' (bots) performance during the game, thus it was interval-scaled and apt to be used as a covariate. The other was the self-reported frequency of playing first-person shooters. Since this was assessed with an ordinal scale, it was not possible to use it as a covariate. Descriptive data analysis revealed that the Median was at scale level 2 out of 9 (once a year), and a cumulative percentage of 52.4% played FPS games never or only once a year. Therefore, I decided to categorize the participants roughly into $n = 44$ "novice" (scale values 1-2) and $n = 40$ "trained" players (scale values 3-9). This seemed reasonable enough since it meant that the trained participants played FPS games on a regular basis, at least several times per year. Even with the vast reduction, the correlation between this new variable and the determined game difficulty was significant, $r = .58$, p (one-tailed) $< .05$. Other significant results in relation to game expertise are reported in detail in the following subsections.

6.4.1 Expertise and Aggressive Behavior

Entering game expertise as an independent variable for mean volume revealed no new significant main effect, but one significant simple effect: Novice participants in the high-speed x violent condition had a higher average volume than novice participants in the high-speed x non-violent condition (Ms = 5.33 and 4.01, SDs = 2.14 and 1.17, respectively), $F(1, 76) = 4.51$, $p < .05$. There were no significant main or simple effects on the mean duration. Overall, game expertise did not have a systematic effect on aggressive behavior.

Game difficulty as a covariate had no significant effect on mean volume or mean duration.

6.4.2 Expertise and Physiological Arousal

Expertise and Galvanic Skin Response

Entering game expertise as an additional independent variable revealed no new significant main effect on GSR, but a significant simple effect: Trained participants in the normal-speed x non-violent condition had a higher average GSR during play than trained participants in the normal-speed x violent condition (Ms = 0.72 and 0.32, SDs = 0.27 and 0.54, respectively), $F(1, 76) = 4.94$, $p < .05$.

Game difficulty as a covariate had no significant effect on mean GSR.

Expertise and Heart Rate

Entering game expertise as an additional independent variable revealed no new significant main effect on HR, but two significant simple effects: Trained participants in the high-speed x non-violent condition had a higher average HR during play than novice participants in the same condition (Ms = 0.43 and 0.01, SDs = 0.19 and 0.39, respectively), $F(1, 76) = 8.71$, $p < .05$. They had also a higher average HR during play than trained participants in the normal-speed x non-violent condition ($M = 0.11$, $SD = 0.37$), $F(1, 76) = 5.23$, $p < .05$.

Game difficulty as a covariate had no significant effect on mean HR.

Expertise and Body Movement

Entering game expertise as an additional independent variable revealed no new significant main effect on body movement. There were also three significant simple effects: Novice participants in the normal-speed x non-violent condition had significantly higher body movement than novice participants in the high-speed x non-violent condition (Ms = 0.11 and 0.06, SDs = 0.03 and 0.05, respectively), $F(1, 76) = 5.02$, $p < .05$. The same effect was found for trained participants (Ms = 0.11 and 0.05, SDs = 0.08 and 0.03, respectively), $F(1, 76) = 10.68$, $p < .05$. Trained participants in the normal-speed x non-violent condition did also have significantly higher body movement than trained participants in the normal-speed x violent condition ($M = 0.06$, $SD = 0.02$ for the latter), $F(1, 76) = 7.69$, $p < .05$

Game difficulty as a covariate had no significant effect on body movement.

Expertise and Force

Entering game expertise as an additional independent variable revealed no new significant main effect on average force, but it rendered the effect of game speed non-significant, $F(1, 76) = 3.35$, $p > .05$. There were also two significant simple effects: Novice participants in the high-speed x violent condition applied significantly more force than novice participants from the high-speed x non-violent condition (Ms = 0.70 and 0.62, SDs = 0.10 and 0.07, respectively), $F(1, 76) = 5.84$, $p < .05$. Trained participants in the normal-speed x violent condition applied significantly more force than trained participants in the normal-speed x non-violent condition (Ms = 0.69 and 0.60, SDs = 0.10 and 0.05, respectively), $F(1, 76) = 5.53$, $p < .05$.

Game difficulty as a covariate had no significant effect on mean force.

Chapter 7

Discussion

In the following discussion, I begin with a detailed interpretation of the findings with regard to the research hypotheses and the theoretical and empirical foundation that this work derived from. Thereby, shortcomings and limitations of the study are pointed out and potentially fruitful directions for future research are suggested.

The present study had three main goals: The first one was to check whether or not displayed violence in digital games has an effect on physiological arousal and subsequent aggressive behavior. The second was to use the case of game speed, to provide evidence that there are more characteristics than violence inherent to first-person shooter that also have an effect on the same variables and overlay or interact with the effects of displayed violence. The third and arguably most important aim was to improve the methodology of digital game studies with regard to two aspects: the use of alternative measures for physiological arousal (force on mouse and keyboard, body movement), use of game modding for experimental purposes.

The selective modification of a first-person shooter allowed me to manipulate the two independent variables without altering any other aspect of the game, thus controlling for unwanted systematic influences and accomplishing the principles of psychological laboratory research in a virtual environment.

The hypotheses of the present study were partially based on past research and established models, which describe the processes and effects of playing violent digital games. According to the widely used General Aggression Model (GAM; Anderson & Bushman, 2002), repeated exposure to violent games, very similar to real-life violence, establishes aggression as a viable solution for ambiguous social situations via several cognitive mechanisms. It also alters the perception of actually harmless situations, and reinforces the use of aggressive or violent behavior as a common response.

The Catalyst Model (Ferguson et al., 2008) on the other hand states that playing violent digital games is only a by-product of an aggressive disposition, either through biological or environmental factors, e.g. family violence. That is, violent game playing is just a possible expression (among many others) of aggressiveness, and not the cause for it. The only effect it might have is reproducing actions seen in a game, however, only due to a pre-existing disposition to do so. According to the Catalyst Model, playing a violent game should not have any effect unless the player explicitly seeks to do so and is determined to act aggressively afterwards. Since the population in this experiment was chosen randomly, and not selected on the basis of personality characteristics or socio-demographic variables, the Catalyst Model would predict no effect of displayed violence on aggressive behavior. Following the logic of GAM, the presence of displayed violence in a game should cause aggressiveness in a person.

On this basis, the first hypothesis predicted that when individuals played a violent digital game, they would behave more aggressively in a subsequent experimental paradigm in which they could punish another participant (the CRTT, originally by Taylor, 1967). Game speed was expected to enhance this effect of displayed violence, as predicted in the second hypothesis. However, using the standardized CRTT version suggested by Ferguson et al. (2008), the enunciated hypotheses were not supported: Neither displayed violence nor game speed had any systematic effect on aggressive behavior. Participants in the high-speed violent condition did have the highest average volume settings, but they were only significantly different from the high-speed non-violent condition. The average duration settings did not differ at all between the conditions.

There are three conclusions that can be drawn from this analysis: Playing a violent digital game does not increase subsequent aggressiveness (as measured by the CRTT), nor does game speed interact with any effect violence might have. This finding is in line with some research reports (e.g., Ferguson & Rueda, 2010), while it also opposes others (e.g., Carnagey & Anderson, 2005), and, thus, leaves the scientific community with yet another puzzle piece. Secondly, the manipulation was not strong enough, or rather the variation between the conditions was too small. Maybe not the actual game content, but the sheer typical look of a first-person shooter or even the knowledge that this study would be about digital games was enough to prime aggression-related concepts (Glock & Kneer, 2009) that lead to equally aggressive behavior in all conditions.

Although the manipulation check indicated a substantial difference between the violent and the non-violent conditions, it is also possible that shooting tennis balls at opponents was still perceived as violent behavior, and therefore caused a ceiling effect in aggressiveness. Creating a pro-social first-person shooter mod (handing over presents, giving hugs) could be an interesting solution to test this hypothesis.

Regardless of whether or not displayed violence actually increases aggressiveness, a third implication could be that the CRTT is not a very good measure for aggressive behavior. Further explorations of the data revealed some major inconsistencies (see section 6.2). It was shown that due to the unstandardized use of the CRTT, it would have been possible to find results with large effects for any desired outcome: Violent games increase aggression, violent games have no effect, even that violent games actually reduce aggressive behavior. Participants in the violent game conditions had significantly more high (range 8-10) and low (range 1-3) volume settings than participants in the non-violent game conditions, while the average volume settings did not differ between the conditions.

This finding is a prime example of the importance of test-theoretical quality criteria, and should be a good advice for other researchers to use any test in a theoretically sound and ideally standardized way to avoid making results not only incomparable, but altogether meaningless and random. Due to the dissimilarity in aggression scores derived from the same raw data, it is clear that not all scores calculated with the CRTT actually are measures for aggression. Regardless of what they actually show, publishing results gained with different test versions under the same "umbrella" is very problematic and might lead to a false estimation of effects.

Gaining results that can be compared to other studies was the reason to choose the CRTT as a measurement tool for aggressive behavior in this study in the first place. Obtaining results indicating that the different versions of the CRTT might hardly be comparable raises some questions about the actual state of research on violent game effects, since many studies employed diverse versions of this test and analyzed it differently. This finding queues with other criticism of the CRTT: First and foremost, its questionable external validity and the very low correlation of noise duration and volume, which are supposed to be two measures of the same construct. Also, there could be alternative motivations for seemingly aggressive response patters, such as reciprocity and social control. It is also possible that noise blasts are used instrumentally or strategically to diminish the opponent's reaction times. Other problems are the distance between the participant and the opponent and lack of alternative response options, as well as the sanctioning of aggressiveness by the experimenter (Ferguson & Rueda, 2009; Ritter & Eslea, 2005; Tedeschi & Quigley, 1996, 2000). Overall, there seem to be a handful of good reasons not to use the CRTT as a measure for aggression at all. Eventually, further (and better) methods to measure aggressive behavior in the laboratory have to be developed. Or maybe researchers have enter the field to check for the ecological validity of the results produced in their laboratories.

Increases in psychophysiological arousal, mostly measured by galvanic skin response (GSR) and heart rate (HR), during and after playing a first-person shooter, seem to be consistent findings in laboratory experiments. Therefore, it was predicted that this would be replicated, and that participants who played a violent digital game would show higher levels of GSR and HR than participants who played a non-violent game (hypothesis 3c). However, the large part of the effects of FPS games on arousal was predicted to be actually caused by an increased game speed (hypotheses 3a and 3b). This was hypothesized to show that there are FPS specific game features that might pollute measures usually predicted to be effected solely by violence.

While there was an increase in GSR in all experimental conditions, the results yielded no significant effect of displayed violence or game speed. The interaction was significant, but contrary to what was predicted, this revealed that participants in the normal-speed non-violent game condition had the highest average GSR, significantly different from the normal-speed violent condition (which had the lowest average GSR). The analysis of average HR was unremarkable: Neither did it change very much over the course of the experiment, nor were there any differences between experimental conditions. Hence, the commonly found effects of displayed violence on these more underlying biological measures of physiological arousal could not be replicated, and no systematic effect of game speed was found either.

The reasons why no differences in GSR and HR between the conditions were discovered are speculative: Again, it is possible that the manipulations of game speed and displayed violence were not strong enough to produce substantial differences between the conditions.

Most likely though, there is a ceiling effect in the data. That is, there is an increase during playing in all conditions, but that increase was not substantially higher in one of them. The differences between violent and non-violent games are usually obtained by using a violent, fast-paced first-person shooter for the one group, and a non-violent and probably slower game for the other. However, in this study, all groups played such a FPS game, and two even with an increased speed. It would be interesting to extend this experimental design by another level of speed that is substantially slower than normal, and investigate whether any setting of game speed actually effects GSR and/or HR.

Game speed was suspected to be the one of the actual causes for increases in arousal found in other studies. Since this was investigated in this study, but did not prove true, another possibility is that all conditions shared a constant game characteristic that was not manipulated, but had a strong effect on the measures, e.g. the first-person perspective. Further studies investigating this and other features systematically with the methods presented in this work could help to clarify these speculations and improve internal validity of the methods.

There were, however, some very interesting results with regard to the more behavioral measures of physiological arousal. A fast-paced game like a first-person shooter is very demanding of the players in terms of concentration, reaction capacity, hand-eye-coordination and motor skills. "Unnecessary" motion can put their in-game performance at risk, even more so with the additional obstacle of increased speed. Therefore, it was predicted that with an increase in game speed the participants would show less body movement (hypothesis 4a). Displayed violence was not expected to have any effect on motion (hypothesis 4b).

Indeed, game speed had a large effect on body movement in the hypothesized direction. However, there was an interaction with the effects of displayed violence: Participants showed more body movement when they were playing a normal-speed digital game, but only when that game was non-violent. In fact, participants in the normal-speed non-violent condition had the highest body movement (significantly higher than in any other condition), while those in the high-speed non-violent condition had the lowest. However, this condition was not significantly different from the two violent conditions. Explaining how exactly violence interacts with speed in terms of body movement remains an interesting subject for further research.

However, it was shown that at least two typical characteristics of first-person shooters (or digital games in general) have an effect on body movement. Since body movement (e.g., exercise) itself is most certainly correlated with other biological responses, it becomes more and more clear that carefulness when interpreting psychophysiological data, especially such abstract indicators like e.g. galvanic skin response, is paramount. The relations between stimuli, perception, and biological responses are so complex that a monocausal and direct link between violent games and higher-order arousal (as modeled by GAM, e.g.) seems more and more unlikely.

Until now, there has been no systematic research on how (consciously or unconsciously) suppressing body movement during game playing or any other activity might influence psychophysiological arousal measures like GSR and HR. It is possible that consciously restraining intentional actions, or even unintentional ones like a wiggle of the foot or a postural shift, to maximize performance during a certain task (in this case, winning at a digital game) could cause a higher muscular tension and activate body systems that regulate the skin conductance level or heart rate.

Research unrelated to digital games provides evidence that force can be a useful measure for affective state, e.g. frustration (Mentis & Gay, 2002; Park et al., 2009). While applying force certainly is a behavior that can be controlled, it might also happen involuntarily during a complex task like playing a digital game. Hypothesis 5 predicted that playing a violent digital game would also increase applied force on mouse and keyboards. Sykes and Brown (2002) and van den Hoogen, IJsselsteijn, and de Kort (2008) found that force increases with game difficulty. An increased game speed should result in a higher difficulty and thus probably be more frustrating. Considering that frustration can also be a cause for aggression (Dollard et al., 1939), hypothesis 6 predicted that individuals playing a high-speed game would apply more force on mouse and keyboard during play than individuals playing a normal-speed game. Hypothesis 7 predicted that those effects would add up: Individuals playing a high-speed violent digital game should apply more force on mouse and keyboard during play than individuals playing a normal-speed violent game or high-speed non-violent game. Individuals playing a normal-speed non-violent game should apply the least force on mouse and keyboard.

In fact, the enunciated hypotheses 5 and 6 were fully supported: Both displayed violence and heightened game speed did increase the applied force on mouse and keyboard significantly. Also, participants playing the high-speed violent game applied the most force, and those playing the normal-speed non-violent game the least. The condition means were as hypothesized, though not all significantly different from the high-speed violent condition. Therefore, hypothesis 7 can only be partially accepted. Further research with stronger manipulations might produce an even clearer effect. Displayed violence seems to have a stronger effect on applied force than game speed, though.

It would also be very interesting to investigate not only other formal game characteristics with regards to applied force, but also the effects of actual game content. Firing a weapon is an action that requires singular repeated use of a trigger finger, and therefore the player's action (clicking a mouse button) corresponds well with the avatar's action. Investigating whether or not this transfer changes with decreasing congruence of in-game actions and the player's behavior could be a fruitful follow-up study, e.g. if force increases when the player's avatar has to push something heavy, or decreases when the avatar has to perform a very gentle action.

The results also show that there is yet another measure for physiological arousal influenced by some FPS characteristics. This raises the question what we know about the link between applied force and GSR or HR and how this relation could have effected measurements taken in many studies that claim to have found a link between displayed violence and physiological arousal. Maybe it is a natural response to automatically increase heart rate when more force is about to be applied - a speculation as good as any other. More basic research in this area has to be conducted to help scholars interpret their data.

So far, the results were discussed in terms of a testing of the research hypothesis. I turn next to the effects I have obtained, but not predicted, through exploration of my data.

Among the many demographic variables, the one most likely to interact with the obtained results was the prior experience with first-person shooters. The one measure for expertise was the determined optimal difficulty level for each player, and the other the self-reported frequency of FPS playing, which correlated well enough with each other (r = .58) even after a vast reduction of the latter variable.

Neither entering self-reported game expertise as an independent variable, nor using the determined game difficulty as a covariate revealed a significant main effect. There were some observed simple effects however. The significant difference in the mean volume settings between the high-speed violent and the high-speed non-violent condition could only be found for novice participants. Participants with prior experience to FPS games did not differ between the conditions in terms of mean volume and duration. Trained participants in the normal-speed non-violent condition did however have a higher average GSR than trained participants in the normal-speed violent condition, while those without expertise did not differ. But they also had a lower average HR compared to the high-speed non-violent condition. These results show such a mixed pattern in independent variables that they are most likely coincidental.

With regards to body movement, the order of conditions by means did not change, and participants of all expertise levels from the normal-speed non-violent condition still showed the highest body movement. However, participants with prior experience in this condition did also have a higher body movement than those in the normal-speed violent condition, while there was no such difference for novice participants.

Interestingly enough, expertise with FPS games rendered the main effect of game speed on force non-significant. Still, novice participants in the high-speed violent condition applied the most force, but not longer significantly more than those in the normal-speed non-violent condition. Trained participants in the normal-speed violent condition applied more force than trained participants in the normal-speed non-violent condition, though. The effects of game speed on force did barely change for novice participants, but the group differences between the trained participants became smaller. It seems reasonable to conclude that expertise with a game or game genre generally reduces the impact of difficulty (here game speed) on behavior. This might be due to the sheer practice with the input device and movement sequences: A experienced player is supposedly well-aware of the fact that a light press on a key results in the same as a hard press, and could be trained to avoid time-wasting keyboard pounding.

All in all, expertise with FPS games had no influence that could be described as systematic, or even noteworthy. Some manipulations had a stronger effect on novice participants, and some on trained ones, but the differences were only significant between some conditions, and only sometimes in an expected direction. From this, however, can be concluded that apparently players of all levels of skill or expertise are equally influenced by displayed violence and game speed, and there was no habituation to either one of these.

There were, however, some limitations in this study that should be mentioned. While the weaknesses of the CRTT were already discussed thoroughly, the biggest limitation was certainly the analysis of the physiological arousal data in averaged form instead of event-based scores. There are two kinds of psychophysiological data analyses: phasic activity, i.e. physiological reactions to discrete, singular events, and tonic activity, which is the overall average of responses over a certain amount of time.

Especially the differences in GSR and HR means were only marginal, but it is certainly possible (and likely) that there were differences in the conditions during in-game events, e.g. the players death, or the death of an opponent. Since, displays of violence are the strongest during those events, as body parts and clouds of blood would fly all over the screen, the differences between a violent and a non-violent game are the biggest during these moments. It is also possible that those face-to-face combat events were more stressful for participants with an increased game speed. As the demands of the game would be even stronger then, participants could try to stay as still as possible, and release tension through movement in situations not so demanding.

With a phasic analysis it would also be possible to test hypotheses about the relations of physiological measures. The only significant, but considerably weak correlation discovered in this study existed between GSR levels and body movement. However, it could be assumed that a higher body movement causes greater force applied on the input devices, as more weight would be shifted during a key press. Such a momentary relation can hardly be discovered with a tonic analysis, and should only be investigated at phasic level, maybe even with an experimental manipulation.

There was also a bias with unknown implications in the participants' demographics. Most of the participants were university students, and thus only represent a small part of the entire population of digital game players. And although the recruiting email tried to encourage females to participate, only about a third of the sample were women. Considering the FPS playing population, this might even be an over-representation of females, but it reduces the external validity of obtained the results mostly to male players. Also, the participants knew beforehand that this study would be about first-person shooters. This circumstance could have encouraged some to sign up as it could have discouraged others. In this respect, the sample was certainly selective.

This study also delivers only very few practical implications, as it was more of scientific interest. Other than that aficionados of high-speed violent digital games might need new input devices more often, it is difficult to draw conclusions or advices for players, educators, parents or game producers. As said before, more fundamental research about the mechanisms and meanings of arousal measures is needed before practical implications can be deduced.

However, the lack of findings regarding aggressive behavior provides more support to the question, whether there should be further research on violence as a cause of digital game playing - at least in a laboratory. One generation grew up under the influences of violent games, and they are raising children that themselves play those games as well. Short-term effects are a consistent finding in laboratory research, but this effect seems to vanish in a naturalistic environment. As Sherry (2007) says, "if these games having the dramatic effects that some claim, it is not being realized in the streets of America" (p. 258) or any other country with a population fond of violent games as a pastime activity.

Every day that passes without explosions of reputed time-bombs that are violent game players adds more and more ecological validity to the hypothesis that the effects of these games have to the very subtle, if existent at all. Digital games are still a societal phenomenon, some of which might not have been discovered and/or fully understood yet. However, for the time being, it does not seem that aggressiveness is one of them.

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Appendix A

Methods

A.1 Python Readout Script

```
import time, u3, iom, threading, wiimote

# Connects to Balance Board
class mywiimote(wiimote.wiimote):
def ChangedNotifier(self, flags, new_state):
        self.weights = []
        self.weights.append((new_state.BalanceBoard.Kg.TopL))
        self.weights.append((new_state.BalanceBoard.Kg.TopR))
        self.weights.append((new_state.BalanceBoard.Kg.BottomL))
        self.weights.append((new_state.BalanceBoard.Kg.BottomR))
        self.weights.append((new_state.BalanceBoard.Kg.Total))
        self.buttons=[time.ctime(),str(time.time()-stime)]+
[str(x) for x in self.weights]
        self.outfile.write('\t'.join(self.buttons)+'\r\n')
        self.outfile.flush()

# writes files for pysio, force, and balance
control=[1]
secs=600*600
stime=time.time()
ofphys=open('outphys.txt','w')
ofphys.write('time\trtime\tGSR\tIBI\tPVA\tARO\tstate\r\n')
ofpres=open('outpres.txt','w')
ofpres.write('time\trtime\tP0\tP1\tP2\tP3\tP4\tP5\tP6\r\n')
```

```
ofbalance=open('outbalance.txt','w')
ofbalance.write('time\trtime\tTopL\tTopR\tBotL\tBotR\tWeight\r\n')

# gets data from the IOM device
def cb(d,stat,tag):
        ofphys.write(time.ctime()+'\t'+str(time.time()-stime)+'\t'+
        str(d['gsr'])+'\t'+str(d['ibi'])+'\t'+str(d['amp'])+'\t'+
        str(d['arousal'])+'\t'+str(stat)+'\r\n')
        ofphys.flush()
        if(control[0]==0):
        iom.physiostop()

def stopafter():
        time.sleep(secs)
        control[0]=0
        time.sleep(2)
        ofphys.close()
        ofpres.close()

# gets data from the LabJack U3 box
def collectlabjackdata():
        u = u3.U3()
        print 'done. Collecting data...'
        u.configIO(FIOAnalog = 0xFF)
        u.getFeedback(u3.DAC8(Dac = 0, Value = 127))
        u.getFeedback(u3.DAC8(Dac = 1, Value = 127))
        time.sleep(1)
        i=0
        try:
                while(control[0]):
                time.sleep(0.1) # interval for measurement
                x=[str(u.getAIN(k)) for k in xrange(7)]
                ofpres.write(time.ctime()+'\t'+str(time.time()-stime)+
    '\t'+'\t'.join((x))+'\r\n')
                ofpres.flush()
                i=i+1
        except:
```

```
                u.close()
        raise
        u.close()

print 'started'
iom.set_callback(cb)

remote=mywiimote()
remote.outfile=ofbalance
print 'attempting to connect to balance board'
while not remote.Connect(remote.FIRST_AVAILABLE):
time.sleep(0.1)
print 'done'
print 'starting physio'
iom.physiostart()
print 'done'
remote.weights = []
remote.buttons = []
remote.SetLEDs(0xff)

threading.Thread(target=stopafter).start()
print 'starting pressure measurement'
collectlabjackdata()
remote.SetLEDs(0x00)
remote.Disconnect()
```

A.2 Modding the Language

Changing of violence and aggression related words

Violent conditions		non-violent conditions		
German	Translation	German	Translation	Occurrence
Blutrausch[a]	Killing Spree	Du hast einen Lauf	You're on a roll	Player makes five kills without dying.
Deathmatch	Deathmatch	Spiel	Game	Game mode's name in the menu.
Double-, Multi-, Mega-, Ultra-, Monster-Kill[a]	Double-, Multi-, Mega-, Ultra-, Monster-Kill	Double-, Multi-, Mega-, Ultra-, Monster-Treffer	Double-, Multi-, Mega-, Ultra-, Monster-Hit!	Player makes two, three, four, five, six consecutive kills.
Drücke [SCHIEßEN] zum Starten!	Press [FIRE] to start!	Drücke [LINKE MAUSTASTE] zum Starten!	Press [LEFT MOUSE BUTTON] to start!	Opening screen of every game.
Erstes Blut[a]	First Blood	Erster Treffer	First Hit	Player is the first to kill another pawn in a game.
Flak-Meister[a]	Flak Master	Du bist spitze	You're doing well!	Player kills 15 pawns in a game.

continuation of table

Violent conditions		non-violent conditions		
German	Translation	German	Translation	Occurrence
Jeder gegen jeden, töten oder getötet werden. Der Spieler mit den meisten Frags gewinnt.	Free-for-all kill or be killed. The player with the most frags wins.	Jeder gegen jeden. Der Spieler mit den meisten Treffern gewinnt.	Free-for-all. The player with the most hits wins.	Description of the game mode in the menu.
Massaker[a]	Massacre	Du bist der Beste	You're the best	Player makes 30 kills without dying.
Randale[a]	Rampage	Unbesiegbar	Invincible	Player makes 15 kills without dying.
Sie sind gestorben!	You have died!	Sie sind getroffen worden!	You have been hit!	Player's pawn gets killed.
Sie töteten X	You killed X	Getroffen, X	Hit you, X	Player kills another pawn (X).
Sie wurden getötet von X	You were killed by X	Sie wurden getroffen von X	You were hit by X	Another pawn (X) kills the player's pawn.

[a] All those words were additionally announced by a distorted male voice. This announcer was deactivated in the UT3 settings though.

A.3 E-Mail to acquire participants

Liebe LeserInnen,
Für meine Diplomarbeit über Computerspiele suche ich sowohl spielerfahrene als auch -unerfahrene Männer UND Frauen. Die Studie dauert etwa 45 Minuten, in denen ihr einen First-Person Shooter spielen werdet, während euer physiologisches Arousal gemessen wird. Für die Teilnahme gibt es eine VP-Stunde.

Zusätzlich können alle Teilnehmer an einer Verlosung von etwa 40 (!) neuen absoluten Top-Spielen teilnehmen (darunter Dragon Age, Battlefield: Bad Company 2, Mass Effect 2, FIFA 10, Need for Speed: Shift, Die Sims 3). Das heißt, dass fast jeder zweite ein Spiel erhält. Solltet ihr selbst nicht spielen oder ein Spiel gewinnen, das euch nicht gefällt, könnt ihr sie immer noch gewinnbringend bei eBay o.ä. versetzen. Es lohnt sich also!
Zur Anmeldung zu der Studie geht es hier entlang:
http://www.sozpsy.uni-koeln.de/cortex/index.php?menu=experiment&expid=58

Es sei noch einmal darauf hingewiesen, dass ich explizit auch spiel-unerfahrene Spieler suche (besonders Männer), sowie dringend auch spielerfahrene Frauen benötige. Wer also so jemanden kennt, kann ihn/sie auch gerne auf diese Studie aufmerksam machen.

Solltet ihr außerdem zu keinem der Termine Zeit haben, aber gerne an der Studie teilnehmen, könnt ihr mir auch gerne eine eMail schreiben und wir finden dann einen außerplanmäßigen Termin.

Alles Gute
Malte Elson

A.4 Informed Consent Form

Vertrag zwischen Versuchsleiter und Versuchsteilnehmer/in

Liebe/r Untersuchungsteilnehmer/in,
dieses Schreiben klärt Dich über Deine Rechte und Pflichten als Versuchsperson sowie meine Pflichten als Versuchsleiter auf.

1. Freiwilligkeit der Teilnahme
Du hast Dich freiwillig dafür entschieden, an dieser Untersuchung teilzunehmen. Ich

danke Dir sehr für diese Bereitschaft, mit Deiner Mitarbeit meine Untersuchung zu unterstützen.

2. Schutz vor Schädigung und Abbruchsrecht

Die Teilnahme an der Untersuchung ist mit keinen gesundheitlichen Risiken verbunden. Außerdem möchte ich versichern, dass ich mich bemühe, Dir in dieser Untersuchung keine seelischen Belastungen zuzumuten. Dennoch möchte ich betonen, dass Du die Untersuchung jederzeit abbrechen kannst. Sollten entgegen meiner Bemühungen während der Untersuchung Belastungen auftreten, die Du als zu schwerwiegend empfindest, so kannst Du die Untersuchung ohne Angabe von Gründen abbrechen. Wenn Du den Versuch abbrechen möchtest, wende Dich bitte an den Versuchsleiter. Dir entstehen durch den Abbruch keinerlei Nachteile.

3. Unvollständige Information

In dieser Untersuchung ist es aus methodischen Gründen nicht möglich, die Teilnehmerinnen und Teilnehmer vor der Durchführung der Untersuchung über alle Details aufzuklären.

4. Recht auf postexperimentelle Aufklärung

Ich versichere, dass nach Abschluss der Erhebungsphasen der einzelnen Untersuchungsteile auf Nachfrage sämtliche gewünschte Information über Ablauf, Zweck und Ergebnisse der Untersuchung gegeben werden können. Wenn Du an den Ergebnissen interessiert bist, kannst Du mir im Anschluss an die Untersuchung Deine Emailadresse hinterlassen. Ich werde Dir die Ergebnisse zusenden, sobald diese zur Verfügung stehen.

5. Gewährleistung der Anonymität

Deine Daten werden anonym behandelt, eine Zuordnung der Daten zu Deiner Person ist nicht möglich, auch nicht zu Deiner Emailadresse. Die Daten werden nur auf Gruppenebene ausgewertet.

6. Pflichten als Versuchsperson

In Deiner Rolle als Versuchsperson hast Du einige Pflichten zu erfüllen, wenn Du Dich für die Teilnahme an dieser Untersuchung entscheidest. Die Planung und Durchführung der Untersuchung erfordert viel Zeit und Mühe. Es ist deshalb wichtig, dass Du versuchst, die Aufgabenstellung der Untersuchung so gut wie möglich zu erfüllen. Dazu gehört, dass Du offen und ehrlich auf die Fragen antwortest und die Untersuchung ernst nimmst, denn eine uninteressierte und oberflächliche Mitarbeit gefährdet die Erreichung der Untersuchungsziele.

Ich danke Dir noch einmal sehr für Deine Teilnahme!

Dieser Vertrag wurde gelesen und zur Kenntnis genommen:

(Unterschrift Versuchsleiter) (Unterschrift Versuchsteilnehmerin)