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Event-related, High-resolution Content Analysis
of First-Person-Shooter Games

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Abstract

Playing violent video games has become a very popular leisure activity in recent years. Depending on the user's decisions and actions in a game, every player creates his or her individual game content. Knowledge about this individual game content is crucial for the evaluation of potential effects of media usage on cognitions, affects, and behavior. This study analyzes the individually generated content of a typical first-person-shooter game with high temporal resolution. 13 experienced game players played the typical multiplayer first-person-shooter game "Tactical Ops. – Assault on Terror" for 50 minutes on average. Playing phases and transitions between playing phases are analyzed on both an intra-player and inter-player level. Continuous physiological response measures (heart rate, skin conductance) are associated with game content, revealing distinct arousal levels for different game playing phases, events, and transitions. Discussion of results addresses the question of whether physiological responses are able to validate event-related, longitudinal content analyses and whether they indicate immediate media effects.

Event-related, High-resolution Content Analysis of First-Person-Shooter Games

Video games are the fastest growing segment of the entertainment industry (Entertainment Software Association, 2005). The vast majority of video game content raises no reason for concern. In fact, plenty of evidence has been found for positive effects of exposure to video game content (overviews provide Calvert, 2005; Gunter, 2005; Peng, 2004). For example, video games have positive effects on learning (Prensky, 2005), on motivation for exercise and training (O’Conner, Fitzgerald, Cooper, Thorman & Boninger, 2001; Coleman, 2001), on spatial skills (Subrahmanyam & Greenfield, 1996; DeLisi & Wolford, 2002), and on skills in understanding and interpreting scientific and technical information (Greenfield, Brannon & Lohr, 1994; Greenfield et al., 1994). Video games have also been shown to foster academic performance (Durkin & Barber, 2002) and can even serve as a therapeutic tool (Griffiths, 2005).

This paper, however, focuses on a video game genre whose content and design was frequently criticized: so-called first person shooter games (FPSG). Those games account for 27% of all video game sales (National Institute on Media and the Family, 2002, 2003; Entertainment Software Association, 2005). FPSG are designed to engage players in virtual violent activities from a first-person perspective. As an example – the top-selling action game Halo, a FPSG designed for the Xbox, is introduced to the user by the following claim: “You are the last of your kind. Bred for combat, built for war. You will fight on foot, in vehicles, in the air and beneath the surface of a mysterious alien ring orbiting in the depths of space.” (Bungie Studios, 2005).

The featured violence in those types of video games and its context has elicited criticism from youth advocates and researchers around the world who fear anti-social effects as a result of violent portrayals in video games (e.g., Children’s Now). However, whether violent video games are in fact related to aggressive cognitions, affects, and behaviors is still under controversial

discussion. Three meta-analyses have been conducted so far in order to integrate research findings on video game violence and aggression (Anderson & Bushman, 2001; Sherry, 2001; Anderson, 2004). Anderson and Bushman (2001) as well as Sherry (2001) report relatively small, but significant effects. In his recent meta-analysis Anderson (2004) stated that exposure to video game violence leads to increased aggressive behavior, cognitions, and affects. Interestingly, he found that less rigorous studies tend to find smaller effects than more rigorous studies, suggesting that previous analyses on effect sizes may have underestimated the true magnitude of the negative consequences of playing violent video games. Recent neuroscience studies on this issue provide a neuro-physiological explanation for the link between virtual violence and aggressive cognitions and affects (Weber, Ritterfeld, & Mathiak, in press).

Taking all findings together – also findings in studies that found no effects (cf., Weber, Ritterfeld, & Kostygina, in press) – negative effects of violent video game play have to be assumed, although rather small in size. Additionally, negative effects are mediated and moderated by various player-related variables (for example, how players perceive and understand the game they play; see Potter & Tomasello, 2003) and, more important for this study, game-related content variables. The interesting questions are: How does violence in violent video games look like? What kind of violence is featured by which game? In which context does violence appear in video games?

So far, only a few studies have systematically analyzed the content of FPSG and violent video games in general. Moreover, most content studies available apply a methodology developed for non-interactive media. For example, game ratings like the ones from the Entertainment Software Rating Board (ESRB) provide information on the content of games and the extent of violence, sexual issues or abuse of substances included in the games (ESRB, 2005).

Those ratings, however, estimate only roughly the type of interactions in which a player becomes engaged during game play. Much more detailed content analyses focus on violence, inappropriate gender representation, profanity, or substance abuse portrayed in video games (Children Now, 2001; for overview see Smith, in press). Dietz (1998), for example, found that 79 % of all video games feature physical aggression. Thompson and Haninger (2001) not only investigated the sheer amount of violence, but to some degree also the context of violence. They examined violence in 55 console games that were rated “E” for everyone by the ESRB. They found that 64 % of the games feature violence, of which 24 % display gun violence and 60 % reward players for injuring other characters. Among games rated for a rather mature audience (“T” for teen, 13+, or “M” for mature, 17+) violence is more prevalent with findings from 90-98 % (Haninger & Thompson, 2004). Smith, Lachlan, and Tamborini (2003) found substantial amounts of increasingly realistic portrayals of violence in latest generation violent video games and FPSG in particular. Elaborate content analyses reveal that the favored narrative is “a human perpetrator engaging in repeated acts of justified violence involving weapons that result in some blood shed to the victim” (Smith, Lachlan, & Tamborini, 2003, p. 71).

The reported studies commonly concentrate on game playing examples of a sample of violent video games – typically played by game players or coders for a short period of time only. The purpose of these studies is to evaluate the type and context of violent content at large in comparing games (e.g., Baldaro et al., 2004; Ballard & Wiest, 1996; Griffiths & Dancaster, 1995; Hebert, Beland, Dionne-Fournelle, Crete, & Lupien, 2005; Reekum et al., 2004). But generalizing about game genres or specific games neglects the importance of individual game play experiences. In order to better estimate the impact of interactive media, effect studies need to address the fact that users may have very different experiences in the very same game

environment. Depending on individual decisions and actions, individual games with individual content are generated. For example, in FPSG some players may engage in brutal fights in order to kill as many adversaries as possible, facing a lot of depicted blood and dead bodies. Other players may try to avoid confrontation and apply less violent strategies to reach the goal of the game. Moreover, an interactive video game played over an extended period of time confronts the user with diverse content resulting in a broad variety of experiences in the player. In this respect, previous analyses are purely cross-sectional. None of the studies provide a longitudinal perspective, that is, an intra- and inter-player comparison of generated content in a typical FPSG played by experienced players over a typical period of game play. This study tries to fill this gap through both intra- and inter-player content analyses of game playing behavior with high temporal resolution. Specifically, we ask the following research questions:

RQ1: What type and extent of violent content do experienced players of a first-person-shooter game generate over a typical time of game play?

RQ2: Does individually generated violent content in a first-person-shooter game vary between players?

Immediate responses to video game content

To better understand the relationship between content and its impact, continuous response measures that track immediate effects on players during video game play are required.

Associating content and psychological response over time with high temporal resolution seems to be the ultimate pathway for short-term effect studies in interactive media. As a demonstration, this paper focuses on a well-developed psychological construct – the arousal construct.

Several studies have applied physiological measures to assess immediate responses to media messages (e.g. Lang, 2005; Lang, Zhou, Schwartz, Bolls & Potter, 2000), and to video

game play in particular. Gwinup, Haw, and Elias (1983) report significantly increased blood pressure and heart rates among 23 young males during video game play. Segal and Dietz (1991) found increasing heart rates, blood pressure and oxygen consumption among 32 male and female players, aged 16-25, playing “MS Pac Man”. Murphy, Alpert, and Walker (1991) found increased blood pressure and heart rates during the use of violent video games compared to non-violent video games.

Recent studies confirm early findings of increased arousal as a cause of playing violent games – even accentuated in latest-generation games – compared to non-violent games (Anderson et al., 2004; Baldaro et al., 2004; Ballard & Wiest, 1996; Murphy, Stoney, Alpert & Walker, 1995; Calvert & Tan, 1994).

Comparable results were found regarding different aspects of FPSG. Schneider, Lang, Shin, and Bradley (2004), for example, report that participants felt greater arousal as indicated by skin conductance if a story was added to a FPSG. Hebert, Beland, Dionne-Fournelle, Crete and Lupien (2005) examined the effect of built-in music on cortisol secretion in games with music compared with “silent” games. Participants playing “musical” video games showed significantly higher levels of cortisol, reflecting the additional stress induced by the music.

Video games also have differential physiological impacts on users. For example, Griffiths and Dancaster (1995) examined the relationship between “type A personality” (mainly characterized by impatience and hostility), “type B personality” (opposite of type A personality) and arousal during video game play. Both personality types showed higher arousal during game play compared with baseline levels. The increase of arousal was substantially higher in participants with “type A personality” compared with “type B personality”.

However, none of these studies meticulously analyzed different game events or event patterns, but only game playing sessions as a whole. Given the variety of events during a game play session which can or can not turn a FPSG into a “roller coaster ride”, event-related analyses of arousal variations during game play should give deeper insights.

Ravaja, Saari, Laarni, Kallinen, and Salminen (2004) examined physiological responses to different events in the video game “Monkey Bowling 2” (Sega Corporation, Tokyo, Japan). They defined four events which were automatically coded from recorded video game play and examined physiological responses (skin conductance, cardiac inter-beat intervals, facial electromyography activity over corrugator supercilii, zygomaticus major, and orbicularis oculi) and found reliable valence- and arousal-related physiological responses for each type of event.

Physiological measures are considered valid and reliable indicators for arousal (Ravaja, 2004). Especially heart rate and electro dermal activity (SCR; also named as skin conductance level, SCL, or skin conductance response, SCR) are highly associated with arousal. However, there are also problems when using these types of measures: Heart rates, for example, provide information on both the sympathetic (SNS) and parasympathetic nervous system (PNS). Increases in the SNS are related to emotional arousal and lead to higher heart rates. Increases in the PNS are connected to information intake and attention, resulting in lower heart rates (Turpin, 1986). Since FPSG may induce emotional arousal as well as higher levels of attention, heart rate may not be a perfect indicator for arousal. Compared to heart rates, changes in electro dermal activity are “interpretatively unambiguous” (Ravaja et al., 2004) since they are exclusively triggered by the SNS. Physiological arousal reliably results in an activation of the SNS which causes an increased skin conductance.

This study attempts to analyze arousal responses to events and event patterns in a FPSG defined by an event-related content analysis with high temporal resolution. The multiple continuous measurement of both heart rates (HR) and electro dermal activity (SCR) provides an appropriate and unbiased indicator of arousal. It may not only be used to validate the content analyses, but also to better understand what players experience when playing FPSG over time. Consequently, we ask two final research questions:

RQ3: How do arousal levels of experienced first-person-shooter game players respond to individually generated game events over an extended time of game play?

RQ4: Can continuous arousal measurement serve as validation criteria for event-related, high-resolution content analyses?

Method

We conducted an inductive, event-related content analysis of recorded and digitized FPSG playing sessions with a temporal resolution of one second. Additionally, we measured heart rates and skin conductance as indicators for arousal during video game play.

First-person-shooter game players

13 experienced German FPSG players were recruited in local video game shops. The volunteers were between 18 and 26 years of age and male. On average they had started playing video games by the age of 12 and played about 15 hours per week ($SD = 9.0$). We decided to use male players to reduce gender-generated variance in a small sample. Additionally, FPSG are predominantly played by young male players. None of the participants was familiar with the specific game used for the study. To reduce usability problems, participants were given time to practice the game before recording the game sessions until they felt comfortable with the game mechanics. On average, the volunteers played 50 minutes ($SD = 6.8$ min).

Description of first-person-shooter game and default settings

The multiplayer FPSG “*Tactical Ops: Assault on Terror*” (Infogrames Europe, Villeurbanne, France; US edition; <http://www.tactical-ops.de/>) was used as the experimental game. In this game, two groups fight as terrorists or special warrior action team (SWAT) against each other. The game provides different location settings (maps), e.g. inside and around an industrial building, at a beach area, in a forest, or in a ghost town. The plot and mission of the game are typical for the FPSG genre: Hostages have to be kept by terrorists or rescued by the SWAT; terrorists have placed bombs whereas the SWAT has to stop the bomb’s countdown; terrorists have to steal important technical items whereas the SWAT has to get it back, etc. The virtual environment contains various violent interactions that players experience from a first-

person perspective, that is, a virtual weapon is clearly visible and the player has the visual impression of holding the weapon in his own hands.

The game is played in several rounds per map. A round is over if one of the teams has fulfilled its mission (e.g., the SWAT rescued all hostages and killed the terrorists; the terrorist team had their bomb detonated and killed the SWAT) or if a pre-determined time limit is reached. If a player is (virtually) killed before the round is over, he can observe the further game play from a viewer perspective (so-called dead mode), but has no possibility to interact with other players until the next round.

For the purpose of this study we selected the single player modus in which all game characters except the player's avatar are generated by the computer. This setting allowed us to control that a player's performance was not influenced by other human players' skills. However, the players could freely choose among a selection of 15 different virtual environments (maps). Per default setting of the game every map could be played to a maximum of 12 minutes and every round within a map was limited to 2 minutes.

Coding scheme, definition of virtual violence, and units of analysis

As the plot of FPSG usually evolves around a violent mission that endangers a player's virtual life, the distinction between violent and non-violent phases of game play was emphasized. It is hereby assumed that the level of danger in the time course of the game play determines the meaning of virtual behavior and thus, determines the players' decisions and arousal. For example, the use of a weapon in the context of danger may indicate virtual violence to overcome game opponents whereas in the absence of danger it represents the act of clearing a weapon's magazine for reloading.

Seven phases were defined describing the actions in the game plot. A phase 1 coding (“waiting time”) was necessary to define the waiting time between the end of one round and the beginning of the next round as well as to acquire information on the computer’s loading time. This phase is of no relevance for our analyses and will not be represented in the result section. Phases 2 to 7 differ in their potential of danger to the player’s virtual life:

In phase 2 (“equipment”) the player uses equipment menus of the game. The menus allow a choice between various weapons and ammunition. Mostly, this phase is entered at the beginning of a round with the opponents still being out of reach. However, in some incidents the player can be attacked without being able to defend himself. For this reason the level of danger in this phase is defined as *moderate to low*.

Phase 3 (“safe”) occurs when the player explores the virtual environment without any opponents or non-identifiable characters in the player’s field of view. The player does not interact violently. Thus, the level of danger is defined as *low*.

Phase 4 (“danger”) contains potential danger to the player. There are either characters in the player’s field of view that are identifiable as opponents or characters that cannot clearly be identified and may or may not be opponents. The level of danger to the player is higher than in phase 3, even though there are no violent actions directed to the player or committed by the player. Phase 4 is therefore defined as containing *moderate* danger.

Phase 5 (“combat”) literally defines virtual violence. Players of “*Tactical Ops*” are equipped with at least one gun, so every violent interaction is performed by using weapons. In “*Tactical Ops*.” virtual physical harm is the only type of violence that can reliably be observed. The option of using verbal violence against other players is not built into the game. Since any

virtual violence results from the use of weapons we consider shooting at opponents an indication of a *high* level of danger.

Phase 6 (“under attack”) is the most dangerous phase to the virtual character: It occurs, when the player is attacked by an opponent before or after the player used his own weapons. Since there are plenty of passive violent interactions, danger is *very high*.

Phase 7 (“dead”) coding was used to cover the time in which a player could only observe the game play because the player’s character was killed. In this phase, there was *no danger* threatening the player’s character and violent interactions could only be observed without being part of the violent interactions. This phase started when the perspective switched from a first-person perspective to a third-person perspective and ended with the end of the round.

For every phase, the beginning and ending was captured with the precision of a single video frame (25/s). After merging the content analysis data with the physiological data (see below), the time resolution was 1 Hertz. In other words, for every second of the entire game play we collected data for both the generated content and physiological response.

Additionally, 18 transitions between the phases were defined. For example, if phase 3 (“safe”) follows phase 5 (“combat”), different possible transitions exist and can be observed. The player could have killed his opponent, or a team member of the player could have killed the opponent. Both interactions lead to phase 3 if there are no further opponents around. The transition codes are used to identify various interactions within the game play. A summary and description of all transition codes can be found in table A1 in the appendix.

On top of the playing phases and transition codes, further codes for violent interactions without a need to score were defined. Such interactions include for example committing suicide,

looting behavior, shooting at team members, shooting at hostages, or destruction of inventory. These actions differ from phase 6 through the absence of danger while displaying violence.

The coded phases represent the progression of playing in different modes based on the players' decisions and interactions within the game environment. Consequently, the coding scheme allows for microscopic description of the generated game content and the players' behavior.

Physiological measures

We recorded heart rate (HR) and skin conductance response (SCR) during game play. HR was extracted from peripheral pulseoxymetry (oxygen/pulse monitor; Nonin Medical Inc., Minneapolis, MN) that was mounted to the left index finger. Automatic pulse curves peak detection allowed the measurement of beat-to-beat interval and the calculation of instantaneous HR. SCR was measured at the left foot above the abductor hallucis muscle about midway between the proximal phalanx of the first toe and a point below the ankle medial to the sole of the left foot. Silver-silver chloride electrodes and unibase electrolyte were used. The signal was sampled with an ambulatory digital recorder (Vitaport II; Becker Meditec, Karlsruhe, Germany) at 80 Hertz. Data were bandpass filtered (cutoff frequencies, 0.05 and 10 Hz) to reduce signal drifts and artefacts. SCR was defined as squared fluctuations of the signal.

Playing procedure

The participants played the first-person-shooter game during a functional magnetic resonance imaging procedure (cf., Weber, Ritterfeld, & Mathiak, in press). A post-playing questionnaire indicated high means for compliance: (1) The study was fun ($M = 7.4$, $SD = 1.6$)¹; (2) The study was interesting ($M = 7.9$, $SD = 1.4$); (3) I felt bad during the measurement ($M = 2.2$,

¹ Scale from 1 “totally disagree” to 9 “totally agree”.

$SD = 1.5$); (4) I would participate in a similar study again ($M = 7.6, SD = 2.1$). Immersion in the game play was rated above scale mean: (5) I felt like I was acting in the environment rather than controlling a game ($M = 4.7, SD = 2.4$); (6) I felt present in the game environment ($M = 5.7, SD = 2.3$); (7) From time to time I was not aware of my real environment ($M = 5.6, SD = 3.5$); (8) The game required all of my attention ($M = 5.6, SD = 2.3$). Overall, the participants felt more or less comfortable playing the game in the scanner and could play the game like they would in their normal environment.

The participants spent 10-15 minutes in the scanner before they started to play the game for this study. During this time the MRI scanner and the physiological measures were set up, and the participants tested the video game controller and became used to the initially exceptional playing environment. While adapting to the MRI environment the participants showed slightly increased arousal levels.

Coder training & reliability

Two independent coders (male graduate students from the Annenberg School for Communication, University of Southern California) and a supervisor (RW) coded the recorded game play videos. The coders received a training of about 16 hours in which they discussed the different playing phases with experienced players of video games and learned to rate events and violent interactions according to the coding scheme provided. The training was based on one player's recorded game play video not used in the study. The entire coding procedure took about 120 hours per coder and yielded an overall inter-coder reliability of 0.85. Inconsistent codings were discussed with the coders after coding. Based on these discussions, the supervisor corrected inconsistent codes.

Results

In order to answer research questions one and two, we first identify various game playing patterns in an inter-player and intra-player analysis. We will then use the identified game playing patterns to examine differences in arousal responses between players and to answer research questions three and four.

Frequency and duration of game playing phases

Main playing phases and the one-action transitions over all players are analyzed separately for each player. The equipment phase 2 occurred in 10 % of all events and with duration of 14% of the total time played. Phase 3 (safe) was generated most frequently with 36% of all events, and accounted for almost half of the total time played (45%). Phase 4 (danger) showed the second most frequent occurrence (28 % of all events) but accounted for only 8% of the total time played. Phase 5 (combat) was generated in 15% of all events and represented 7% of the total time played; phase 6 (attack) occurred in 7% of all events and corresponded to only 1% of the played time. Even less frequently, phase 7 (dead) was generated in only 5 % of all events, but represented 26% of the time played. In sum, phases that were generated most frequently are *safe*, *danger*, and *combat*, whereas the phases *safe*, *dead*, and *equipment menu* accounted for the majority of time. We further analyzed percentages of playing time for each phase per each individual player (table 1).

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In the following, confidence intervals for each phase across the group with a confidence level of 95% (according to $1.96*SD$) serve as the criterion to report statistical different values between players. For example, player 1 showed an above average value for phase 5. Twelve percent of this player's playing time was spent in combat. On the other hand, this player showed below average values for phases 4 and 6 (being in danger and being attacked). The time this player spent in phase 7 (dead) was also below average. Thus, player one was involved in combats for long periods of his playing time, rarely attacked by opponents, and was only in the observational mode for short periods of time after being killed. This indicates a successful game player with no problems operating in the virtual environment provided by the game and effectively killing virtual opponents. On the contrary, player 2 displayed above average durations for phases 3 (safe), 4 (danger), as well as for phase 6 (being attacked) and the shortest duration for phase 7 (dead). Player 2 spent much time in the safe phase and little time in the combat or in the dead-mode phase. These results suggest that player 2 is an extremely cautious player. The third player showed the lowest values of the group for phases 2 (equipment) and 5 (combat), but the second highest value for phase 7 (dead). This player spent much more time in the dead-mode phase, but less time using the equipment menu or in combat and was rarely attacked, indicating that he played the game less effectively and generated only sparsely violent content. Likewise, all other players can be categorized.

These analyses suggest that although all players possess comparable FPSG playing experiences, individual playing styles or individually-generated content can vary.

Frequency and duration of game playing patterns

In order to examine patterns of game play, we computed progressions of phase and transition codes. The analysis of four consecutive transitions (four-action transitions) was found

to be optimal and revealed clear patterns of FPSG play. A five-action transition analysis appeared too specific and contained too many combinations to identify typical game playing patterns.

The following example explains the creation of four-action transitions: If transition 300 (see table A1 in the appendix) was followed by transition 200, then followed by transition 310 and finally by transition 400, we computed the code 300-200-310-400 as four-action transition. This four-action transition stands for the game playing pattern “safe after beginning of round – equipment menu – returning to safe – potentially dangerous character appears”.

Overall, 1,057 different four-action transitions were generated by the players. However, 50 % of the total time played can be explained by only 21 out of the 1,057 four-action transitions. For reasons of simplification, we concentrate this report on these 21 four-action transitions (see table 2).

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The code combination with the longest duration was 700-300-200-310, which accounted for 10% of the total playing time. This combination indicates that the player was shot, started the next round with phase three (safe), then activated the equipment menu (phase two) and returned back to phase three. Other four-action transitions can be identified accordingly (see table A1 in the appendix for a description of the transition codes).

Individual differences in game playing patterns

For intra-player analyses we used the 21 most important four-action transitions listed in table 2. Figures 1, 2, and 3 display the average durations for each player. (Data are split into three figures for better readability).

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The figures identify different and similar game playing patterns and confirm the observation that individually generated game content varies. A simple visual inspection suggests that player 1, 2, 3, 7, and 9 display rather distinct game playing patterns compared to the other players. Amongst those, player 7 and 9 demonstrate rather similar patterns.

In order to verify these results we conducted a hierarchical cluster analysis of players with the occurrence of the 21 four-action transitions over time as cluster variables. As result, players 1, 2, 3, and 6 form single clusters. One cluster is formed by players 7 and 9 and one cluster contains the players 4, 5, 8, 10, 11, 12, and 13 (see figure 4). Table A2 in the appendix

provides average durations of each of the 21 selected four-action transitions for each player cluster. Again, we computed two-sided confidence intervals for the mean of every four-action transition over all players. Afterwards we used these confidence intervals ($\text{mean} \pm 1.96 * \text{SD}$) to identify major deviations for each cluster. The labeling and interpretation of the clusters shall be exemplified by a few clusters:

Player one forms a single cluster and, therefore, generated game content that appears to be distinct from the other players. This player spent only a little time in phase 6 (attack) and 7 (dead). He spent more time than other players in phase 5 and an average amount of time in phases 2 to 4 (see table 1). This player is characterized by outlying means. Regarding combat, the duration of related four-action transitions was above average. It seems that this player often experienced several successful combats in one round. Further, this player apparently managed to survive much better in a round for a longer time than other players did. It is also remarkable that this player was never killed by his opponent immediately after being attacked. When he was attacked he always responded quickly by using his weapon – he never ran out of ammunition during combat. This cluster, respectively this player, is therefore labeled “Professional”. Corresponding interpretations of single player clusters lead to the identification of “cautious”, “daredevil”, and “advanced” players.

Another cluster (4) is constituted by player 4, 5, 8, 10, 11, 12, and 13. For most of these players, only minor deviations can be found between them. Therefore, we labeled this cluster “typical”.

The sixth cluster was formed by players 7 and 9. Like player 6, these players showed only minor deviations in the analysis of the main game playing phases (see table 1), but the visual inspection of figures 2 and 3 and the analysis of the average durations of selected four-

action transitions revealed that these players showed above average durations for the four-action transition 310-400-500-700 (being safe after returning from the equipment menu – danger – combat – dead). Thus, both players in this cluster showed this playing pattern as typical generated content during their game play. For other playing patterns, considerably shorter durations were found. These players seem to be focused on only a few typical game playing patterns. We therefore labeled this cluster “monotonous”.

In summary, different game playing patterns can be identified by the analysis of the durations of the four-action transitions. We identified professional, cautious, daredevil, typical, advanced, and monotonous FPSG players who differ in generated game content. Hereby, research questions one and two are answered.

Physiological responses to game events

In order to answer research questions three and four, we analyzed heart rates (HR) and skin conductance responses (SCR) as physiological indicators for arousal. We conducted two analyses of variance in a repeated measurement design (one for SCR and one for HR). We used time and game events as within-player factors. Regarding time, we compared the first four maps played by each player which covers approximately the first 40 minutes of playing time. Regarding game events, we used the phases and transition codes from the content analyses above. In order to facilitate the variance analyses, we reduced the number of transition codes from 18 to 13 by merging similar codes into a code which represents specific game events (for overviews on game events see table A3 in the appendix).

Heart rates and skin conductance responses were aggregated for 11 of the 13 players (two players had to be excluded because of errors in the measurement procedure), for the first four maps (sessions) played, and for the mentioned 13 game events (see table A3).

For SCR, the analysis did not reveal significant effects, which can be in part explained by the rather small sample size of 11 players. Nevertheless, over time (session/map), averages of SCR responses decreased (figure 4) with an effect size of 0.17 (partial eta squared; $F_{(1.2, 11.8)} = 2.09^2$, $p = 0.16$). The second within-player factor (game event) also missed significance ($F_{(2.4, 24.5)} = 1.18$, $p = 0.10$) with an effect size of 0.11 (partial eta squared).

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Despite the insignificant results, all players revealed SCRs that can be explained by game events. For example, peaks in SCR were found as responses to events 5 (player kills opponent), 10 (player runs out of ammunition), and 13 (player is attacked), indicating high arousal in these situations during game play (figure 5). Low SCR were found for event 2 (equipment menu) in particular and event 1 (player in dead mode after end of round).

Regarding HR of the players, the analysis revealed significant differences for both time and game events. Over time, HR averages decreased significantly ($F_{(1.9, 19.5)} = 8.56$, $p < 0.01$; figure 6) with an effect size of 0.46 (partial eta squared). The influence of game events on heart rates also reached significance, even in the small sample of 11 players ($F_{(3.4, 34.5)} = 3.08$, $p = .03$, eta squared = 0.24). Events with highest heart rates were 3 (player started round) and 10 (player ran out of ammunition); events with lowest heart rates were 8 (team member killed player's opponent) and 2 (equipment menu).

In summary, the results answer research question three and must be interpreted as a positive validation of the applied coding schema (research question four).

² Greenhouse-Geisser sphericity correction was applied for all F-Tests.

Discussion

The present study examined player generated content in a first-person-shooter game and physiological responses to game events over time. We conducted an event-related, high-resolution content analysis of 13 experienced first-person-shooter game players with 50 minutes of playing time per player on average. We analyzed frequency and duration of defined game phases and four-action transitions over all players (inter-player analysis) as well as for each player separately (intra-player analysis) in order to describe both general player generated content and specific individual game playing patterns. In a second step we combined game events derived from the content analysis and physiological data to examine arousal states in different game playing situations and to validate the applied coding scheme.

Our content analysis has two major limitations. At first, the coding scheme was mainly designed for an fMRI-study on first-person-shooter game playing (Weber, Ritterfeld & Mathiak, in press). Therefore the main goal of the content analysis was to differentiate between violent and non-violent game content. A more differentiated coding scheme considering the context of violence (cf., Smith, in press; Smith, Lachlan & Tamborini, 2003) might have revealed more information on player interactions.

Further, only 13 male players were content analyzed with a rather laborious content analysis procedure which clearly restricts generalizability. However, each player played about 50 minutes. Therefore, the study design provided enough information for a demonstration of an event-related, longitudinal content analysis with high temporal resolution and revealed insights in the way players generate individual content in a first-person-shooter game.

Our first research question was: What type and extent of violent content do experienced players of a first-person-shooter game generate over a typical time of game play? Surprisingly,

the players spent 26 % of their playing time in the dead mode, watching their team members or computer generated bots completing the mission without any possibility to interact, or exploring the game's environment looking for opponents. During this time, the players were not engaged in violent interactions and hardly in any interaction at all. Violent interactions in terms of use of weapon accounted for only 7% of the total playing time. One could assume that this is due to low player skills, but all players were experienced video game players and were given time to practice before their game play was recorded. Their expertise is also indicated through the result that phase 6 (where the player was attacked) accounted for only 1% of the total time played.

Our second research question was: Does individually generated violent content in a first-person-shooter game vary between players? The analysis of game playing phases per player showed interesting differences between the players. Even among a very small number of players who were more or less identical in terms of socio-demographic variables, differences in generated game content could be found. A cluster analysis revealed six distinct player clusters which can be labeled as *Professional*, *Cautious*, *Daredevil*, *Average*, *Advanced*, and *Monotonous*. This supports the assumption that FPSG (and most likely video games in general) provide a large variety of actions which may lead to quite different generated content and consequently, different experiences.

Our third and fourth research questions were: How do arousal levels of experienced first-person-shooter game players respond to individually generated game events over an extended time of game play, and can continuous arousal measurement serve as validation criteria for event-related, high-resolution content analyses? In order to answer these questions we measured heart rates and SCR responses as indicators for arousal and analyzed these measures for 11 of the 13 players over time and for different game events. In contrast to some previous studies, we

found decreasing arousal levels when playing a first-person-shooter game for an extended time, even though SCRs did not reach statistical significance. This finding supports Sherry's (2001) assumption of decreasing arousal after playing violent video games for extended (and common) playing times which, in turn, would restrict the generalizability of the excitation-transfer hypothesis.

Yet, summarizing the results that first-person-shooter game players generate only negligible amounts of violent content and decrease their arousal after prolonged game play and concluding that these results suggest less harmful effects of latest-generation FPSG cannot be justified. Event-related fMRI analyses of similar generated violent content have shown a link between brain activity patterns that can be considered as characteristic of aggressive cognitions and affects and even small amounts of violent interactions in a FPSG (Weber, Ritterfeld, & Mathiak, in press).

Regarding different game events we found clearly interpretable differences in heart rate as well as in skin conductance responses for 13 distinct events. We found the highest arousal levels when a player was forced to stop shooting because he ran out of ammunition. Arousal is rather low when a player used equipment menus or when team members killed an opponent. Overall, we found that the physiological measures provide decent validation criteria for event-related, longitudinal content analyses of first-person-shooter games.

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Table 1: Percentage of playing time by phase and player

		Player												
Phase	1	2	3	4	5	6	7	8	9	10	11	12	13	
2	14.5	12.1	4.7	12.8	11.4	17.8	13	12.5	14.2	21.8	13	14.5	15.5	
3	48.4	55.1	45.7	50.1	38.2	45.7	51.8	46.4	45.9	34.6	48.4	34.9	43.2	
4	5.8	9.0	7.0	7.2	4.6	8.1	8.1	6.8	8.7	8.4	6.1	6.4	10.2	
5	12.3	7.1	4.1	4.6	5.6	6.6	6.4	8.2	6.2	8.8	6.3	7.4	5.2	
6	0.5	1.4	0.8	1.1	0.9	1.3	1.2	0.7	1.4	1.2	1.4	1.1	1.4	
7	18.5	15.3	37.7	24.1	39.3	20.5	19.5	25.4	23.5	25.2	24.9	35.9	24.4	
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	

* Shaded cells mark values above the upper limit of confidence intervals across all players; framed cells mark values below the lower limit.

Table 2: Duration of four-action transitions of all 13 players

Four-action Transitions	Total playing time (sec)	Percent	Cumulative Percent
700-300-200-310	16,603.70	9.86	9.86
300-200-310-400	13,064.90	7.76	17.62
200-310-400-500	9,481.80	5.63	23.25
500-700-300-200	7,298.80	4.33	27.59
600-700-300-200	5,720.00	3.40	30.98
400-500-700-300	3,642.20	2.16	33.15
310-400-500-320	2,993.40	1.78	34.92
500-300-200-310	2,616.60	1.55	36.48
600-500-700-300	2,615.30	1.55	38.03
310-400-500-700	2,217.50	1.32	39.35
400-600-500-700	2,128.90	1.26	40.61
415-600-700-300	2,085.60	1.24	41.85
400-500-320-400	2,024.60	1.20	43.05
500-415-600-700	2,016.70	1.20	44.25
200-310-400-600	1,885.10	1.12	45.37
310-400-500-415	1,628.90	0.97	46.34
200-310-400-350	1,512.70	0.90	47.24
200-310-400-330	1,384.30	0.82	48.06
400-600-700-300	1,264.20	0.75	48.81
500-320-400-500	1,145.20	0.68	49.49
200-310-200-310	1,144.50	0.68	50.17
Total	84,474.90	50.17	50.17

* See table A1 in the appendix for transition codes description

Figure 1: Average duration of 21 four-action transitions for player 1-4

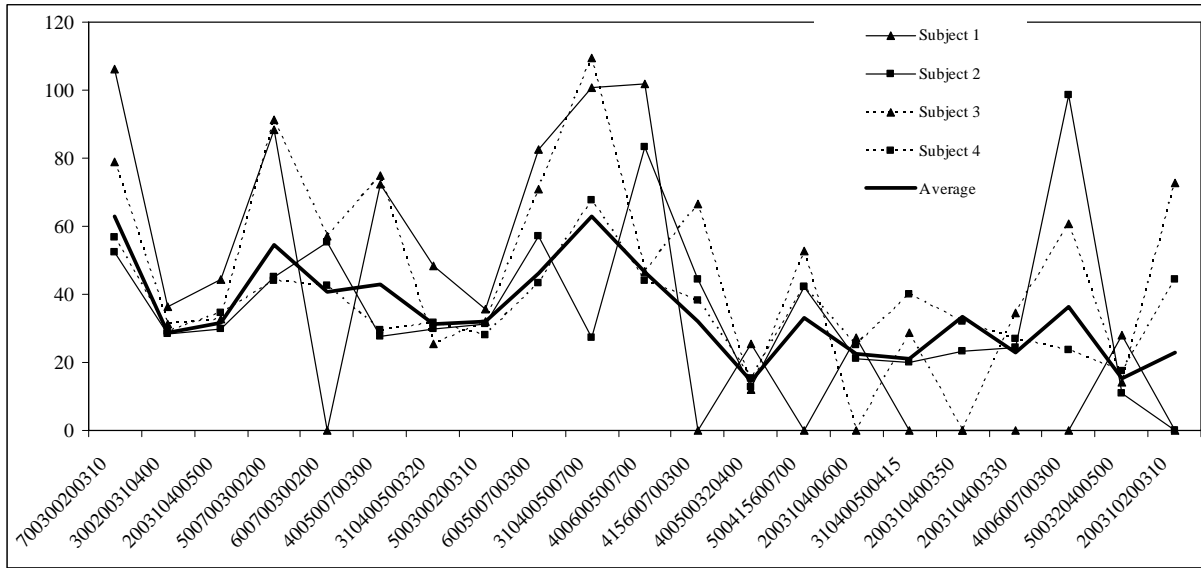


Figure 2: Average duration of 21 four-action transitions for players 5-8

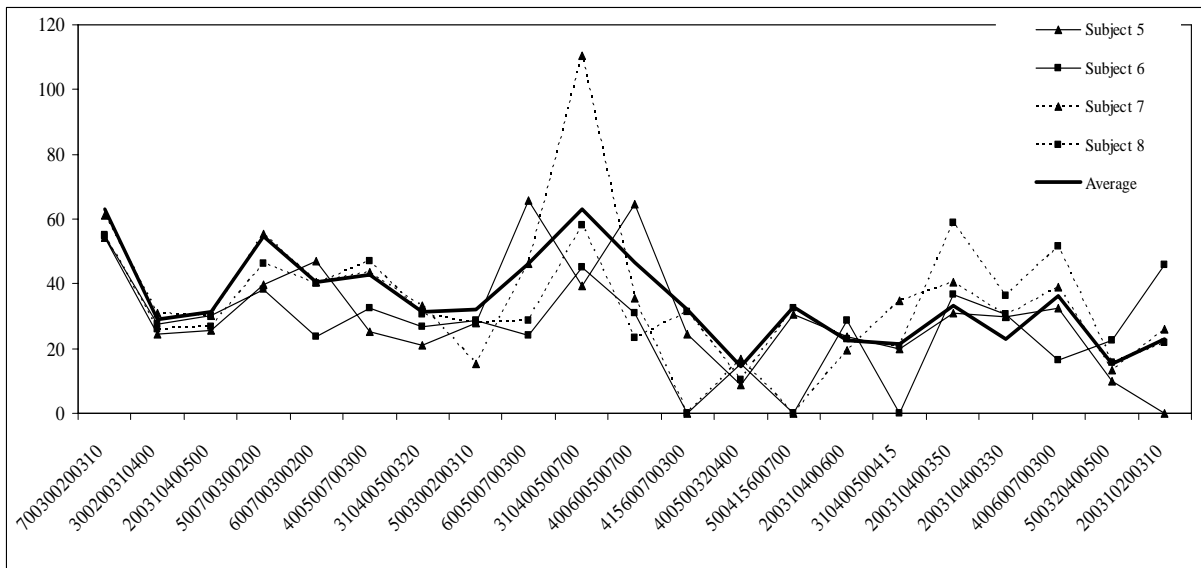


Figure 3: Average duration of 21 four-action transitions for players 9-13

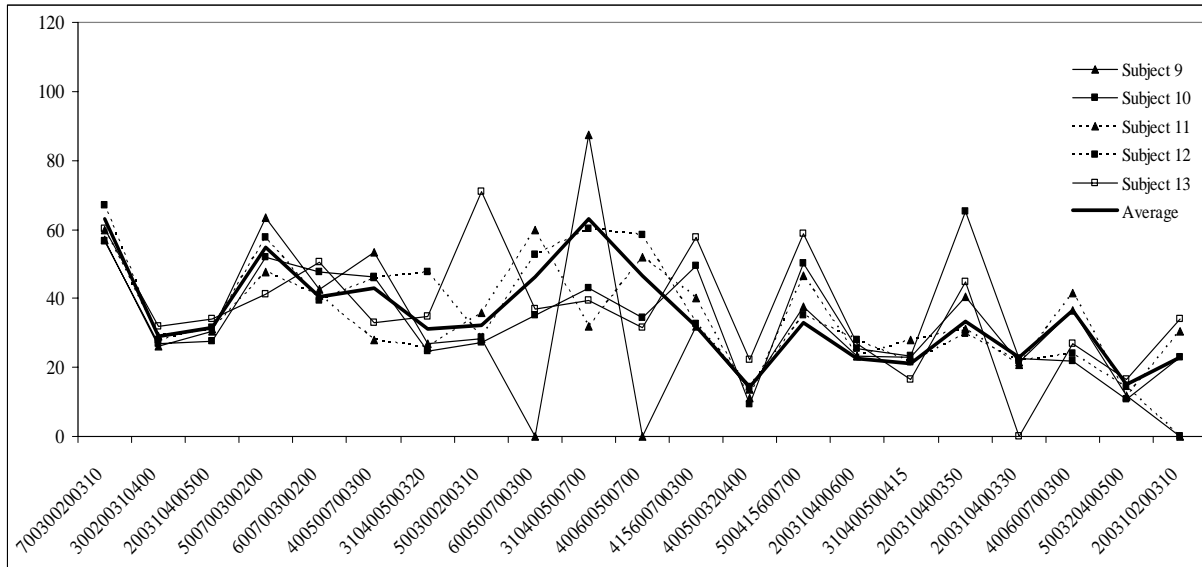


Figure 4: Skin conductance response by time

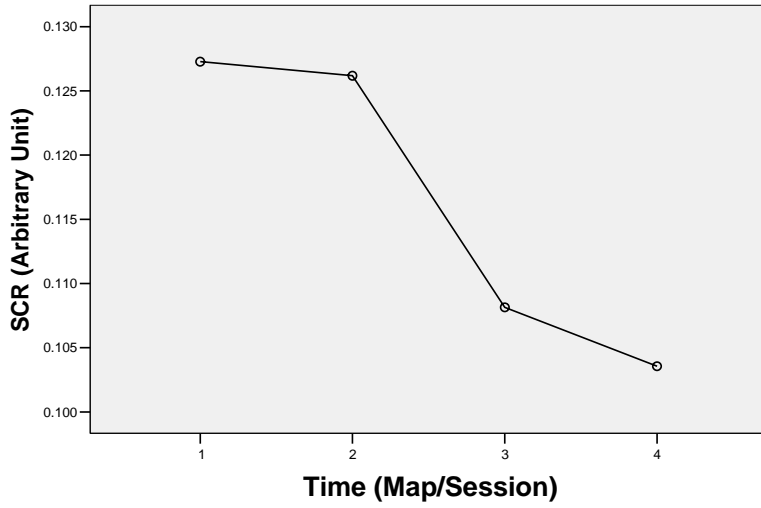


Figure 5: Skin conductance response by game events.

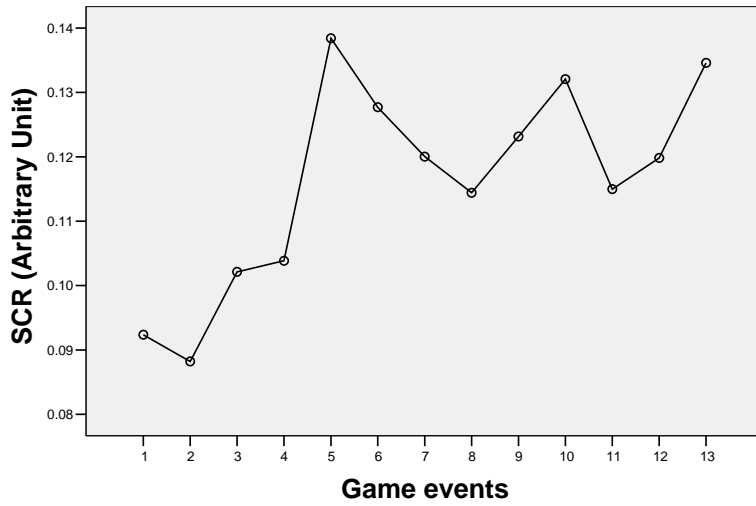


Figure 6: Heart rate by time

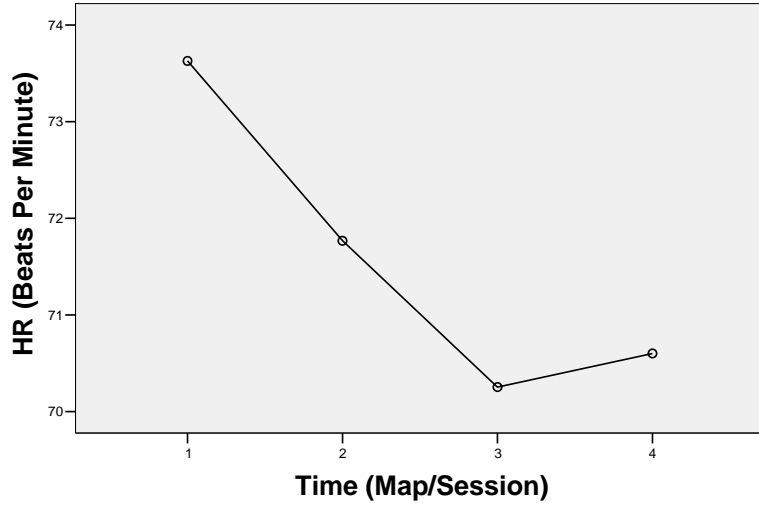
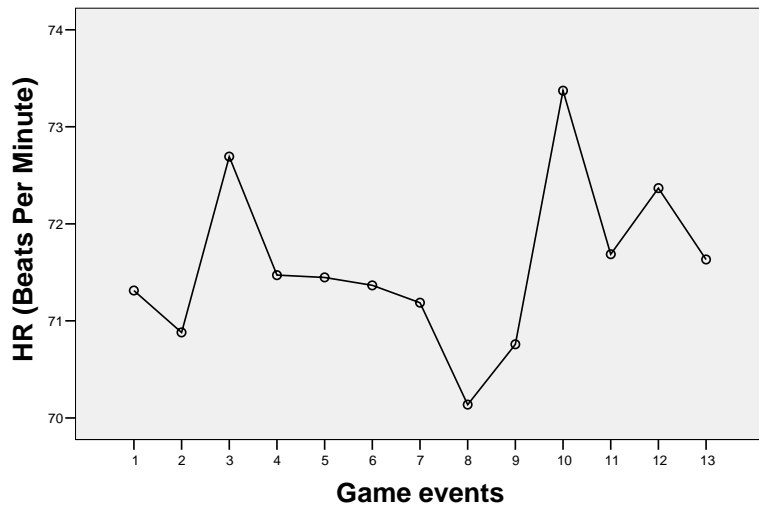


Figure 7: Heart rate by game events



Appendix

Table A1: Description of one-action transition codes

Transition	Description
200	Player starts phase 2 by opening the equipment menu. Phase 2 can follow phase 3 and phase 4
300	Player starts a round with phase 3 (safe)
310	Player starts phase 3 (safe) after having completed phase 2 (use of equipment)
320	Player starts phase 3 (safe) after having killed an opponent in phase 5 (combat) before. The player does not pay attention to the killed opponent
322	Player starts phase 3 (safe) after having killed an opponent in phase 5 (combat) before. The player pays attention to the killed opponent (shooting the dead body again, observing the dead body for several seconds etc.)
324	Player starts phase 3 (safe) after phase 5 (combat) if the attacking opponent disappears from the player's visual field
330	Player starts phase 3 (safe) after phase 4 (danger) if the opponent disappears from the player's visual field without having attacked the player
340	Player starts phase 3 (safe) after phase 4 (danger) by disappearing from the opponents visual field.
350	Player starts phase 3 (safe) after phase 4 (danger) by identifying a potentially dangerous character as a team member
360	Player starts phase 3 (safe) after phase 4 (danger) by identifying a potentially dangerous character as a hostage
370	Player starts phase 3 (safe) after phase 4 (danger) or phase 5 (combat) because a team member had killed the opponent.
400	Player starts phase 4 (danger) because a potentially dangerous character appears in the player's visual field
410	Player starts phase 4 (danger) after withdrawing from phase 5 (combat) if he stops shooting without having killed the opponent
415	Player starts phase 4 (danger) after phase 5 (combat) if he stops shooting because of a lack of ammunition
416	Player starts phase 4 (danger) after phase 5 (combat) if the opponent withdraws from combat but is still in the player's visual field
500	Player starts phase 5 (combat) by using weapons. Phases before can be 4 or 5.
600	Player starts phase 6 (attack) if he is attacked by an opponent, no matter whether the player did or did not notice the opponent before.
700	Player starts phase 7 (dead) if he is killed during a round and the first person perspective switches to a third person perspective.

Table A2: Average duration of 21 four-action transitions by clusters

Four-action transitions	Cluster									
	1	2	3	4	5	6	All players			
	Professional (Player 1)	Cautious (Player 2)	Daredevil (Player 3)	Typical (Pl. 4, 5, 8, 10,11,12,13)	Advanced (Player 6)	Monotonous (Pl. 7, 9)	(N = 13)			
	<i>M</i>	<i>M</i>	<i>M</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
700300200310	106.10	52.41	78.99	58.50	4.39	54.79	58.94	3.02	63.05	14.70
300200310400	36.47	28.51	31.25	27.83	2.41	27.55	28.41	3.35	28.88	3.15
200310400500	44.37	29.99	32.76	30.20	3.59	30.02	30.47	0.21	31.50	4.68
500700300200	88.45	44.92	91.18	46.94	6.23	38.34	59.56	5.69	54.66	17.24
600700300200	0.00	55.27	57.26	43.97	4.31	23.80	41.68	1.41	40.58	14.77
400500700300	72.25	27.62	74.75	36.37	9.61	32.62	48.50	6.73	42.99	16.27
310400500320	48.39	29.70	25.40	30.79	8.73	26.92	30.03	4.35	31.23	8.31
500300200310	35.50	31.23	31.90	35.22	16.09	28.82	21.78	9.35	32.12	12.73
600500700300	82.60	56.95	71.05	45.99	13.81	23.94	23.09	32.65	46.36	22.04
310400500700	100.60	27.30	109.30	48.45	13.32	45.25	98.90	16.12	63.03	29.63
400600500700	101.90	83.20	46.40	44.03	15.02	31.05	17.72	25.05	46.63	26.36
415600700300	0.00	44.38	66.47	39.10	11.32	0.00	15.92	22.51	32.03	21.48
400500320400	25.51	12.73	12.10	13.06	4.74	15.36	15.23	2.43	14.43	4.89
500415600700	0.00	42.14	52.80	42.24	10.24	0.00	18.82	26.62	32.94	20.39
200310400600	27.10	21.05	0.00	25.03	1.83	28.48	21.40	2.50	22.66	7.29
310400500415	0.00	20.14	28.65	24.22	7.83	0.00	28.98	8.38	21.25	11.47
200310400350	0.00	23.15	0.00	41.83	14.81	36.80	40.55	0.16	33.38	18.85
200310400330	0.00	24.23	34.65	22.62	11.34	30.68	25.85	6.11	23.05	11.37
400600700300	0.00	98.70	60.56	31.71	11.05	16.40	37.80	1.56	36.40	24.30
500320400500	27.86	10.80	14.17	13.76	3.00	22.60	12.69	1.12	15.17	5.15
200310200310	0.00	0.00	72.90	21.95	16.77	46.03	12.99	18.37	22.97	22.93

* Shaded cells mark values above the upper limit of confidence intervals across all player, framed cells mark values below the lower limit.

Table A3: Description of merged transition codes (game events)

Event	Description
1	Phase 7, player in dead mode after end of round
2	Phase 2, player in equipment menu
3	Phase 3, safe, after beginning of round
4	Phase 3, safe, after returning from equipment menu
5	Phase 3, safe, after player killed opponent
6	Phase 3, safe, after player hid from opponent or opponent from player
7	Phase 3, safe, after player identified character as team member or hostage
8	Phase 3, safe, after team member killed player's opponent
9	Phase 4, danger, potentially dangerous character appears in player's visual field
10	Phase 4, danger, player had to end combat phase because of lack of ammunition
11	Phase 4, danger, player or opponent stops shooting, but opponent is still in player's visual field
12	Phase 5, combat, player uses weapon
13	Phase 6, player is attacked

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