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Habitual engagement with violent video games does not translate virtual aggression to real-world emotional processing: Insights from gaze behaviour metrics

Abstract

This study examined the effects of habitual violent video gaming on emotional processing, focusing on its impact on the recognition of positive and negative facial emotions. Sixty habitual gamers participated, which included violent video gamers (VVGs; *n* = 30, M_{age} = 20.03 years, *SD* = 0.92), who specifically engaged in playing first-person shooters (FPS), and non-violent video gamers (NVVGs; *n* = 30, M_{age} = 21.23, *SD* = 3.64). Participants completed an emotional go/no-go task requiring them to recognise five basic facial emotions (i.e., happiness, anger, disgust, fear, and sadness). The results showed no difference between VVGs and NVVGs in recognising happiness, with both groups demonstrating higher accuracy and quicker response times for happy faces on go trials and lower false alarm rates on no-go trials. Eye-tracking metrics corroborated this happy-face advantage, showing an enhanced perceptual salience for happiness in the mouth region. In contrast, the recognition capacity for negative emotions was substantially lower regardless of the gaming group. This reduced efficacy was mainly associated with a scattered gaze pattern rather than the desensitisation effects proposed by the General Aggression Model (GAM). Additionally, the study found lower aggression levels in VVGs, suggesting that habitual exposure to in-game violence is not associated with hostile information processing. Overall findings challenge the disproportionate emphasis placed on the negative effects of violent video games, asserting that broader psychosocial factors should be considered when evaluating their impact.

Keywords: violent video games, first-person shooters, the general aggression model, desensitisation, facial emotion recognition, eye-tracking metrics.

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Introduction

Background

Video games have surged in popularity since their inception in the late 20th century and have become an integral part of modern interactive media. Available across various platforms, including computers, gaming consoles, and everyday devices such as smartphones and tablets, video games encompass a broad spectrum of themes, ranging from casual to violent. This widespread availability and the diversity of content have sparked public and academic debate regarding their potential adverse effects. This issue has become particularly acute with violent video games due to their accessibility and the impact they generate on younger players (Scharrer et al., 2018). It has been argued that short-term and long-term exposure to in-game violence can trigger cognitive and emotional reactions in players that mirror the aggressive content of these games (Anderson et al., 2004). This association has been reported through several experimental (Carnagey et al., 2007; Hassan et al., 2019), cross-sectional (Li, 2022), and longitudinal studies (Anderson et al., 2008; Kühn et al., 2009).

The General Aggression Model (GAM; Bushman & Anderson, 2002) has been the most prominent theoretical framework for many of these investigations. According to this model, inherent tendencies and external circumstances influence an individual's current internal states, where cognition, affect, and arousal are intertwined. For example, playing violent video games (an external factor) can activate inherent aggressive thoughts, intensify hostile feelings, and raise levels of excitement. This altered internal state of gamers shapes their perception and interpretation of social interactions, ultimately guiding their responses in real-world situations (Anderson et al., 2008, 2010).

The GAM expands upon social cognitive theories of aggression by incorporating cognitive components of script theory (Huesmann, 1986) and affect-related desensitisation models (Carnagey et al., 2007; Funk et al., 2004). Advocates of the script theory posit that short-term exposure to in-game violence fosters the development of "hostile knowledge structures" such as scripts and schemata, thereby prompting individuals to process information aggressively (Bushman & Anderson, 2002). According to this perspective, violent video games often immerse players in environments where aggression is not only normalised but rewarded, facilitating the internalisation of hostile scripts and schemata (Allen et al., 2018; Anderson & Bushman, 2018). Once activated, these knowledge structures alter the processing of perceptual information, skewing attention towards cues that might signal social threats (Bushman & Anderson, 2002). As a consequence, predisposed aggression is posited to influence the perception of reality, wherein neutral or ambiguous social signals are more likely to be interpreted negatively (Bushman & Anderson, 2002). When exposure to in-game violence becomes habitual, it leads to the continuous buildup of aggressive thoughts and behaviours, numbing players' initial reactions to hostile situations. This reduction in emotional response to negative stimuli is referred to as "emotional desensitisation" (Carnagey et al., 2007; Funk et al., 2004).

Influence of violent video games on emotional information processing

The translation of in-game violence has been reported to occur in the form of altered emotional processing among violent video gamers. Early studies exploring this phenomenon employed "Emotional Stroop" tasks, where the participants had to recognise the colour of the words laden with emotional and non-emotional content. For instance, Kirsh et al. (2005) observed that violent video gamers experienced greater Stroop interference with negatively valenced words compared to neutral ones. Interestingly, such a trend was absent among non-violent video gamers. These findings suggest that violent video gaming primes a cognitive bias towards emotionally congruent stimuli, amplifying the salience of negative information. The resulting processing bias exacerbates the difficulty in diverting attention away from negatively valenced stimuli, potentially reinforcing the link between violent media consumption and aggression (Anderson et al., 2004; Bushman & Anderson, 2002). However, it is critical to note that in the Stroop task used by Kirsh et al. (2005), the emotional relevance of the words was incidental to the primary task of colour identification. Such an approach typically results in an indirect evaluation of processing bias. This methodological limitation necessitated a direct examination of emotional processing among violent video gamers.

To refine this approach, subsequent investigations introduced "facial emotion recognition" tasks, which typically offer precision in assessing processing bias and provide greater ecological validity (Kirsh et al., 2006; Kirsh & Mounts, 2007). These studies examined how exposure to virtual violence might affect the recognition of facial expressions and, consequently, real-world social interactions. Happiness is generally recognised more accurately and quickly than other basic emotions, suggesting a "happy-face advantage" (Beaudry et al., 2014; Calvo & Beltrán, 2013; Calvo et al., 2018; Kirita & Endo, 1995). However, Kirsh et al.

(2006) found that individuals with high consumption of media violence were faster at recognising angry faces relative to those of happy ones. A follow-up study by Kirsh and Mounts (2007) narrowed this investigation to the context of violent video gaming. They reported a reduced happy-face advantage among the participants who engaged in a violent video game for a brief period of 15 minutes. The observed attentional bias in their study was linked to increased activity in brain regions involved in aggressive scripting (Bushman & Anderson, 2002). Building on these insights, Bailey and West (2013) compared the outcomes of 10 hours of training with either a violent or a non-violent video game on an emotional search task. The results indicated that violent video gaming led to a reduction in the amplitude of event-related potentials (ERPs) associated with allocating attention to happy faces relative to pre-training conditions. However, this effect was not observed in recognising angry faces, suggesting biased attentional processing against positive emotions.

Although these studies strongly argue that exposure to in-game violence impairs the happy-face advantage, they mostly operate within the framework of script theory and explore the short-term effects of violent video gaming. Moreover, these studies evaluate emotional processing right after gameplay, inducing a mood-congruent effect (Kühn et al., 2019) that temporarily primes individuals towards aggressive behaviours (Bartholow et al., 2006; Bailey & West, 2013). As previously reported, such priming effects could have led to the reduced happy-face advantage (Bailey et al., 2011; Bailey & West, 2013; Kirsh & Mounts, 2007). Therefore, the impaired recognition of happiness in these contexts should not be solely attributed to violent video gaming.

Interestingly, contrary findings also emerge from investigations into the short-term effects of violent video gaming. For instance, Liu et al. (2017) reported no difference in the happy-face advantage between participants who engaged in a 25-minute session of violent video games and those who played non-violent games. There was no group difference in the facilitation task on response accuracy, reaction times, and N2pc amplitude. Similarly, in the disengagement task, no notable differences in response accuracy and reaction times were found between the groups. However, there was an absence of a significant N2pc response to angry faces in the violent and neutral video game groups, indicating that the difficulty in disengagement was not specifically associated with exposure to violent video games.

The evidence from both behavioural and psychophysiological findings remains ambiguous in supporting a reduced capacity to recognise happiness among violent video gamers. Thus, it becomes disproportionate and inconsistent to broadly apply the effects of violent video games to impaired emotional processing. Additionally, focusing primarily on immediate effects might neglect the possibility of long-term cognitive and emotional adjustments that could counterbalance or alleviate these early impacts.

Beyond the script theory, the desensitisation model suggests that long-term exposure to violent video games leads to a frequent accumulation of hostile scripts, eventually reducing emotional responses to aggressive situations (Funk et al., 2004). Proponents of this model argue that habitual exposure to in-game violence reduces sensitivity to negative emotional stimuli, making individuals less likely to perceive them as distressing or threatening (Carnagey et al., 2007; Engelhardt et al., 2015). This impaired sensitivity can lead to underestimating the severity of negative emotions and threats, which, paradoxically, could intensify aggressive behaviours (Denson et al., 2020). In the context of facial emotion recognition, it has been noted that habitual exposure to violent video games reduces the ability to recognise negative emotions (Diaz et al., 2016; Miedzobrodzka et al., 2021, 2022). These contrasting perspectives within the GAM framework highlight the necessity of conducting a detailed investigation to determine whether habitual exposure to violent video games impairs emotional processing or if, considering the limitations in previous studies, the adverse effects of such games have been overstated.

Potential overemphasis on the negative impact of habitual violent video gaming

Several studies propagating the GAM have emphasised external, learned influences (e.g., violent media exposure) without adequately considering pre-existing levels of negative predispositions. Moreover, they have also failed to establish a direct association between aggression and violent media exposure (Kirsh et al., 2006; Kirsh & Mounts, 2007). Consequently, these studies have proposed that the effects of media violence are universal, affecting all individuals irrespective of their inherent tendencies. It is also imperative to observe that recent physiological investigations into emotional processing have not yielded consistent evidence of significant neural alterations following either brief or habitual exposure to in-game violence (Regenbogen et al., 2010; Szycik et al., 2017). Thus, scepticism is growing regarding the possible transfer of in-game violence to real-world aggressive behaviour or emotional processing. Even when a translation exists, it appears negligible or statistically inconsequential when broader developmental factors and other risk factors for violence are considered (Jerabeck & Ferguson, 2013; Ferguson, 2018). Furthermore, publication bias has been suggested as another possible reason for the overstated negative impacts associated with violent video games (Jerabeck & Ferguson, 2013; Ferguson & Wang, 2019).

As digital media becomes increasingly ubiquitous, evaluating them from a neutral perspective is crucial rather than exaggerating their adverse effects. In response to these concerns, the current study critically evaluates the GAM and explores multiple perspectives to examine how habitual violent gaming might not be linked with increased aggression or hostile emotional processing. Firstly, given the potential for gamers to become habituated to in-game violence, it is plausible that the initial aggressive priming does not necessarily represent the long-term cognitive and emotional impacts of such gaming practices (Ferguson & Dyck, 2012). Additionally, it is also important to note that habitual gamers might not be drawn to violent video games due to an affinity for aggression or violence. Instead, these individuals could choose such games for their mood-enhancing effects, serving as a strategy for emotional regulation rather than aggression incitement. This argument is supported by mood management theory (Zillmann, 1988), which proposes that individuals engage with preferred media to mitigate negative moods and sustain positive ones. Therefore, the habitual choice of violent games may reflect a method of mood improvement rather than an inclination towards aggression (Kersten & Greitemeyer, 2022). This perspective challenges the straightforward association between violent video gaming and aggressive behaviour, suggesting that game selection is more about mood management than fostering aggression.

In a related vein, advocates of the catharsis theory suggest that habitual engagement with violent video games may act as a mechanism for venting aggression, subsequently reducing hostile tendencies (Gentile, 2013; Kersten & Greitemeyer, 2022). Geen and Quanty (1977) provided a contemporary explanation of catharsis, describing it as a phenomenon that could follow aggressive behaviours and lead to decreased aggression. In the realm of media effects, they theorise that engagement with violent media (such as violent video games) can act as a release for aggressive impulses, possibly resulting in diminished aggressive behaviour after the interaction (Gentile, 2013). According to this view, playing violent video games allows for the expression of aggressive emotions, which are subsequently alleviated. Therefore, habitual engagement with violent video games does not necessarily lead to the development of hostile tendencies; rather, this engagement could be part of a daily routine.

Problematisation of the current study

While addressing the identified research gaps, this study aims to investigate whether long-term exposure to violent video games impairs emotional processing among habitual violent video gamers (VVGs). Specifically, it investigates whether such exposure results in a reduction in the ability to recognise both positive and negative facial emotions in comparison with habitual non-violent video gamers (NVVGs). The latter group serves as a control to assess the influence of in-game violence on emotional recognition.

Prior to examining emotional processing, the study measures aggression levels among participants to explore any potential correlations between violent gaming exposure and aggressive behaviours. Considering mixed results on the definitive connection between violent gaming exposure and aggression (Drummond et al., 2020; Ferguson, 2015; Ferguson & Wang, 2019; Hilgard et al., 2017), this study posits a foundational null hypothesis:

H1: There will be no statistically significant relationship between violent gaming exposure and aggression levels among participants.

At the core of this investigation, the current study explores emotional processing by positing a happy-face advantage, wherein happy faces are recognised with greater speed and accuracy. This assumption is supported by research indicating superior recognition efficacy for happiness compared to other basic emotions (Calvo & Lundqvist, 2008; Calvo & Beltrán, 2013;

Kirita & Endo, 1995). The study also examines the recognition efficacy of negative emotions, which are typically associated with low recognition rates (Beaudry et al., 2014; Calvo et al., 2018). Further, it compares the capacity to recognise happy and negative facial emotions between VVGs and NVVGs. Previous studies indicate that regular exposure to violent video games does not necessarily deteriorate the recognition of happiness (Diaz et al., 2016; Liu et al., 2017), nor does it affect the accuracy of recognising negative emotions (Pichon et al., 2021). Drawing on these observations, the study proposes the following hypotheses:

H2: The recognition capacity for happiness will be greater than negative ones, such as anger, disgust, fear, and sadness.

H3: VVGs will not show a reduced happy-face advantage compared to NVVGs.

H4: VVGs will not show impaired recognition capacity for negative emotions compared to NVVGs.

This study adopts an emotional go/no-go task paradigm, drawing on the works of Tottenham et al. (2011). Unlike methods that involve passive observation of emotions or focus on non-emotional aspects of stimuli, this task directly evaluates the capacity to engage with or disengage from pertinent emotional information. Numerous studies, including neuroimaging research, have validated this task to differentiate between top-down prefrontal cognitive systems and subcortical limbic regions involved in processing negative and positive emotions (Hare et al., 2008; Somerville et al., 2011).

In the current task, the recognition capacity of facial emotions is primarily measured by the percentage of correct responses (CRs) on go trials and the corresponding reaction times (RTs). However, relying solely on CRs could misleadingly suggest high accuracy due to a liberal response bias, where participants might press the response button for nearly any stimulus, regardless of its relevance. To reduce this bias, the percentage of false alarms (FAs) on no-go trials is also measured as an indicator of recognition capacity. By including FA rates, we can distinguish between genuinely high accuracy and a propensity for indiscriminate responding (Kestenbaum & Nelson, 1992; Tottenham et al., 2011; Tracy & Robins, 2008). In addition to response accuracy, FA rates help quantify how often participants incorrectly identify an emotion that is not present (no-go trials). A combination of low FA and high CR rates indicates an enhanced recognition capacity to discriminate emotional expressions. In contrast, high FA and low CR rates could suggest a liberal response bias, indicating that participants may be overly eager to respond.

Exploring facial emotional processing with the eye-tracking metrics

In its initial phase, the current study employs standard performance metrics, including CRs, RTs, and FAs, to evaluate the recognition capacity of facial emotions. Although these metrics effectively evaluate the happy-face advantage, they are insufficient for justifying potential desensitisation to negative emotions. This study incorporates eye-tracking metrics to overcome this limitation and explores the attentional mechanisms involved in facial emotion recognition. These metrics offer Supplemental evidence on visual attention patterns related to facial emotion recognition.

Research indicates that different facial regions provide varied levels of information essential for categorising emotions (Calvo et al., 2018; Smith et al., 2005). During facial emotion recognition, visual attention is selectively allocated to specific regions that are considered most “diagnostic” or “perceptually salient” for discerning specific emotions (Beaudry et al., 2014;

Calvo & Nummenmaa, 2008). This selective focus is often inferred from eye-tracking metrics such as fixations and saccades (Schurgin et al., 2014). Increased visual attention to perceptually salient facial features correlates with improved accuracy in emotion recognition (Wong et al., 2005). For example, happiness is often identified more accurately than other facial emotions, a phenomenon mainly attributed to the focused visual attention on the distinctively salient feature of a smiling mouth (Beaudry et al., 2014; Calvo & Nummenmaa, 2008, 2009; Calvo & Beltrán, 2013; Kirita & Endo, 1995). Conversely, other basic emotions, particularly negative ones, have lower recognition efficacy because visual attention is more scattered across multiple facial regions (Calvo & Nummenmaa, 2008; Calvo et al., 2018). Given these insights, this study postulates that greater perceptual salience on selected facial regions indicates more efficient emotional processing (Calvo et al., 2018). Investigating how perceptual salience influences facial emotion recognition not only enhances the comprehension of emotional processing but also sheds light on the cognitive cues that might affect the behaviours of violent video gamers in real-world scenarios.

The current study utilises three fixation metrics to assess attentional orientation and perceptual salience during facial emotion recognition. First, the time to the first fixation (TFF) measures the interval from when the stimulus is presented to the onset of the first fixation. TFF indicates the initial attractor points on the face, revealing which facial regions capture attention first and fastest. This rapid attraction to specific diagnostic areas can suggest innate or conditioned responses to particular facial emotions, providing a foundational measure of perceptual salience. After the initial fixation is established, the endurance of this fixation is measured by the first fixation duration (FFD). This metric captures how long the first point of focus is held, which can reflect the intensity of the facial emotion in the targeted facial region. A longer FFD indicates a deeper cognitive engagement with the facial regions that are initially deemed most relevant or expressive, suggesting that these areas may contain crucial information for facial emotion recognition. Complementing the TFF and FFD, the total fixation duration (TFD) accounts for the cumulative duration of all fixations on a specific area. This measure provides cumulative evidence of how much visual attention is devoted to a particular facial region, highlighting the areas that consistently draw and hold the viewer's attention. Prolonged TFD on specific regions can signal their ongoing relevance in the processing and interpretation of facial emotion.

Integrating these fixation metrics offers insights into the perceptual salience of specific emotions within particular facial regions. For instance, a faster TFF coupled with a shorter FFD suggests rapid identification of facial emotion, primarily driven by its bottom-up characteristics (Theeuwes et al., 2000; Theeuwes, 2010). In contrast, a slower TFF followed by a shorter FFD may indicate that participants engage in more complex processing, perceiving the facial region as less informative for emotion recognition and thus assigning it lower perceptual significance. Consequently, a faster TFF, accompanied by longer FFD and TFD on a particular facial region, denotes enhanced perceptual salience of that region for a specific emotion.

The current study investigates whether the hypothesised happy-face advantage is reflected in an enhanced perceptual salience, indicated by shorter TFF, along with longer FFD and TFD, when accurately recognising happy faces in the mouth region. Additionally, it examines whether a reduced recognition capacity for negative emotions manifests as a scattered gaze distribution across the face, rather than focusing on a specific region during recognition. Thus, the study proposes that the previously observed lower efficiency in recognising negative emotions might primarily stem from reduced perceptual salience and not from the desensitisation effects as proposed by the GAM (Carnagey et al., 2007; Denson et al., 2020; Diaz et al., 2016; Funk et al., 2004). To investigate these propositions, the study presents the following hypotheses:

H5: The recognition capacity for happy faces will be higher, attributed to a faster TFF and prolonged FFD and TFD on the perceptually salient mouth region.

H6: The recognition capacity for negative emotions will be lower compared to happiness, attributed to a scattered gaze distribution across different facial regions.

H7: VVGs will show a comparable level of perceptual salience with the NVVGs while recognising happy facial emotions.

H8: VVGs will show a comparable level of perceptual salience with the NVVGs while recognising negative emotions.

Focus on the first-person shooters (FPS) genre

Despite there is extensive research discussing the effects of violent video games, a critical issue emerges from the prevalent oversimplification of this category. Many studies categorise violent video games as a homogeneous group, neglecting the distinct cognitive and emotional impacts produced by its sub-genres. In response to this concern and considering the magnitude of violence that manifests in first-person narratives (Schneider et al., 2004; Montag et al., 2012; Pötzsch, 2017), the current study narrows its focus on first-person shooters (FPS).

Originating with seminal titles such as *Wolfenstein 3D* (1992) and *DOOM* (1993), the FPS genre has evolved considerably in terms of graphics, gameplay mechanics, and narrative depth. Combat themes dominate FPS gameplay, which involves players navigating diverse environments, confronting enemies, and completing objectives to progress through missions, often using animated or realistic firearms. Given the inherently violent nature of FPS games, a focused analysis of this sub-genre becomes significant to understand its influence on the cognition, affect, and behaviour of gamers. Detailed information on participants' preferred FPS games and their perceived level of violence is available in the Supplemental Material.

Methods

Participants

The sample size for this study was determined using MorePower (version 6.0.4; Campbell & Thompson, 2012). The analysis showed that a minimum of 32 participants would be necessary to detect a medium effect size ($\eta^2 = 0.06$) at an alpha level of 0.05 (two-tailed), with 80% power, in a three-way mixed ANOVA. The final sample pool consisted of 60 adult students aged 18 years and above, which included an equal number of VVGs ($N = 30$, $M_{age} = 20.03$ years, $SD = 0.92$) and NVVGs ($N = 30$, $M_{age} = 21.23$ years, $SD = 3.64$).

Participants were recruited from a higher education institution in India through an interest survey disseminated via email advertisements. Prior to the experiment, participants were screened according to specific inclusion criteria for each gaming group. VVGs were required to have at least five years of experience playing video games. To maintain a "genre pure" policy, they were required to have exclusively engaged with FPS games for the last 12 months, with an average daily playtime of two hours in these games. Similarly, NVVGs were required to have a minimum of five years of overall gaming experience and to have strictly avoided FPS or any violent games during the last 12 months. NVVGs were also required to engage frequently in non-violent games for an average of two hours daily. Apart from these criteria, all participants were required to have normal or corrected-to-normal vision, as the experiment involved eye-tracking methodology. Initially, 42 individuals responded as VVGs. Of these, five were excluded from the experiment for playing genres other than FPS in the recent past. Seven were excluded due to insufficient gaze sampling (< 50%) during eye-tracking, resulting in a final dataset of 30 VVGs for analysis. On the other hand, among the 35 individuals who initially responded as NVVGs, three were excluded for insufficient gaze sampling, and two more (with the lower gaze sampling rates of 63% and 57%) were excluded to ensure comparable sample sizes, resulting in 30 NVVGs.

Questionnaire

Trait aggression

The 29-item Buss and Perry Aggression Questionnaire (BPAQ; Buss & Perry, 1992) was used to evaluate individual aggression levels. Participants indicated their level of agreement with each statement using a five-point Likert scale (1 = *does not describe me at all* to 5 = *describes me very well*). Sample item: "If somebody hits me, I hit back." The overall scale demonstrated excellent internal consistency, with a Cronbach's α of 0.86.

Violent gaming exposure

Violent gaming exposure was assessed using a 12-item modified Content-Based Media Exposure Questionnaire (CBMEQ; Den Hamer et al., 2017). The items were adopted to assess the consumption of violent content within gaming environments. Participants rated their frequency of exposure to different types of violent gaming content on a five-point Likert scale (1 = *never* to 5 = *very often*). Sample item: "How often do you watch people shoot at another person in your preferred video game?" The adapted scale showed excellent internal consistency, with a Cronbach's α of 0.85. In addition to the CBMEQ, three single-item measures assessed participants' gaming habits on a seven-point Likert scale (1 = *never* to 7 = *always*). These items evaluated perceived gaming frequency, in-game violence, and exposure to blood and gore during gaming, providing further insights into their gaming habits.

Stimuli

A total of 165 front-view colour photographs were utilised, sourced from the Karolinska Directed Emotional Faces (KDEF) dataset (Lundqvist et al., 1998). Fifteen emotional faces were used in a practice block to familiarise participants with the task. The main experiment consisted of 150 emotional faces presented in five blocks of 30 faces each. To control for sex-related differences, an equal number of male and female faces was included. Each picture had dimensions of 562 × 762 pixels and presented five distinct facial emotions: happiness, anger, disgust, fear, and sadness (see Fig.1a).

[insert Fig. 1 near here]

Procedure

Eye-tracking protocol

Eye movements were recorded using a Tobii TX300 eye tracker integrated into the lower portion of a 23-inch TFT display with a 1280 × 1024 pixel resolution (see Fig. 1b). The eye tracker setup was controlled by an Asus G750JX-T4191H computer, equipped with an Intel Core i7-4700HQ processor and 8GB of RAM. All stimuli were presented on the eye tracker display via Tobii Studio (version 3.3.2) at viewing distances ranging from 60 to 64 cm. The eye tracker was calibrated using nine standard points to ensure accurate tracking. Binocular tracking was conducted at a data sample rate of 300 Hz. A maximum dispersion threshold of 0.5 degrees and a minimum fixation period of 70 ms were set to register the valid fixations.

Task paradigm

The experiment was conducted in a semi-dark and soundproof laboratory setting. The performance in facial emotion recognition was assessed using an emotional go/no-go task (see Fig. 2). In the “go” trials, participants were required to press the left mouse button when a specific target (facial emotion) was presented. These go trials were intentionally frequent (60% occurrence) to enhance the participant’s tendency to respond quickly. On the other hand, during the “no-go” trials (40% occurrence), participants were instructed to refrain from clicking the left mouse button when a different facial emotion was displayed other than the target. The valence of the no-go stimuli was not disclosed to the participants. However, they were directed to abstain from responding to facial emotions other than the instructed target.

After successfully calibrating the eye tracker, participants received detailed instructions and were given a brief practice block of 15 trials to familiarise themselves with the experimental task. Five task blocks with 30 faces each were used to present the go and no-go trials. To avoid consecutive repetitions of no-go trials, the order of presentation was pseudo-randomised. Each facial emotion was displayed for a fixed duration of 1,000 ms. Subsequently, a fixation cross appeared, lasting 700 ms, following each face stimulus to provide a brief interval before the subsequent trial. On average, the participants completed the experiment in 20 to 25 minutes.

[insert Fig. 2 near here]

Design and variables

The study employed a 2 (Group: VVGs vs NVVGs) × 5 (Facial Emotion: Happiness vs Anger vs Disgust vs Fear vs Sadness) × 3 (Fixation Region: Eye vs Nose vs Mouth) mixed-factorial design, with the first factor as a between-subjects variable. This design allowed for a direct comparison of performance efficacy (i.e., CRs and RTs on go trials and FAs on no-go trials) and gaze behaviour across different facial emotions in two distinct gamer groups. Emotional stimuli were sourced from the KDEF dataset. Three broad areas of interest (AOIs) were identified as fixation regions (i.e., eyes, nose, and mouth) for evaluating participants' gaze behaviour (see Fig. 3).

[insert Fig. 3 near here]

Data analyses

All the analyses were conducted using IBM SPSS Statistics (version 27). Descriptive measures (*M* and *SD*) were used to explain the characteristics of the participants and game-related information. An independent samples *t*-test was conducted to assess the differences in aggression levels and violent gaming exposure between VVGs and NVVGs. The core analyses involved the evaluation of performance efficacy and gaze behaviour. Firstly, the performance efficacy of facial emotion recognition was measured through the percentage of CRs in go trials and corresponding RTs (time taken for the first mouse click), using 2 (Group: VVGs vs NVVGs) × 5 (Facial Emotion: Happiness vs Anger vs Disgust vs Fear vs Sadness) two-way mixed ANOVA with the first factor as a between-subjects variable and the second as a within-subjects variable. A higher percentage of CRs with shorter RTs would indicate better performance efficacy. Additionally, the rate of FAs was also assessed on no-go trials to evaluate the rate of response confusion in recognising facial emotions.

Further, the gaze behaviour was examined in terms of three fixation metrics (TFF, FFD, and TFD), measured separately using 2 (Group: VVGs vs NVGs) × 5 (Facial Emotion: Happiness vs Anger vs Disgust vs Fear vs Sadness) × 3 (Fixation Region: Eye vs Nose vs Mouth) three-way mixed ANOVA with the first factor as a between-subjects variable and the other two as within-subjects variables. The main effects assess gaze efficiency regarding facial emotions and fixation regions. Additionally, interaction effects between facial emotion and fixation region highlight the perceptual salience of specific facial emotions on specific facial regions. When a facial emotion is recognised, a faster TFF combined with prolonged FFD and TFD in targeted fixation regions indicates enhanced perceptual salience of that emotion in those areas.

Results

The study reports and discusses only the significant main and interaction effects on ANOVA, complemented by post hoc pairwise comparisons. Details of the pairwise comparisons for each dependent variable are provided alongside the corresponding tables in the Supplemental

Material. Given the risk of Type I errors arising from multiple comparisons, a Bonferroni adjustment was applied. The Greenhouse-Geisser correction was also employed to adjust the *F*-statistic values where the assumption of sphericity was compromised, as evidenced by Mauchly's test.

Characteristics of the participants and game-related information

Overall gaming experience and average daily playtime of the VVGs ($M_{experience}$ = 7.93 years, *SD* = 2.63; $M_{daily\ playtime}$ = 2.60 hours, *SD* = 0.77) and NVVGs ($M_{experience}$ = 6.87 years, *SD* = 2.18; $M_{daily\ playtime}$ = 2.33 hours, *SD* = 0.80) reflected their habitual exposure to video gaming. Among VVGs, *Valorant* was identified as the most preferred game, with approximately 36.66% of respondents expressing engagement at the time of the study. Conversely, NVVGs preferred less aggressive and more strategy or skill-based games. *EA Sports FIFA* was the leading choice among NVVGs, with about 20% of them engaging with it. The detailed breakdown of gaming habits, including frequency and duration of play sessions, as well as preferred gaming platforms, is further elaborated in the given Dataset.

Aggression and violent gaming exposure

The scores on the independent samples *t*-test, $t(58) = 4.22$, $p < 0.001$, showed that VVGs had significantly higher levels of violent gaming exposure (*M* = 31.70, *SD* = 9.78) compared to NVVGs (*M* = 22.83, *SD* = 6.05). NVVGs exhibited higher levels of aggression (*M* = 76.06, *SD* = 14.78) than VVGs (*M* = 64.80, *SD* = 13.06), with this difference also proving statistically significant on the independent samples *t*-test, $t(58) = 3.13$, $p < 0.05$.

Additionally, Pearson's product-moment correlation analysis revealed no significant correlation between exposure to violent video games and aggression levels ($r = 0.01$, $p = 0.92$).

Analysis of the performance efficacy

Percentage of correct responses (CRs) on go trials

The two-way mixed ANOVA yielded a marginally significant main effect of the group on the percentage of CRs on go trials, with $F(1, 58) = 3.71$, $p = 0.06$, $\eta_p^2 = 0.06$, indicating that VVGs were slightly more accurate than NVVGs, considering the overall emotion recognition accuracy (see Table 1). Similarly, there was a significant main effect of facial emotion on the percentage of CRs, $F(3.35, 194.43) = 82.13$, $p < 0.001$, $\eta_p^2 = 0.59$. The post hoc pairwise comparisons showed that the percentage of CRs was significantly higher for happiness ($p < 0.001$) compared to all other facial emotions, followed by disgust, sadness, anger, and fear (see Table 1). Details of these pairwise comparisons are further elaborated in Supplemental Table S1. No interaction effect was observed between the group and facial emotion on the percentage of CRs on go trials, $F(3.35, 194.43) = 0.45$, $p = 0.77$, $\eta_p^2 = 0.01$.

Reaction times (RTs) on correct go trials

There was no significant main effect of the group on the RTs for the corresponding CRs, $F(1, 58) = 1.20$, $p = 0.32$, $\eta_p^2 = 0.02$. This outcome indicates that VVGs and NVVGs performed comparably in terms of the time taken to accurately recognise facial emotions (see Table 1). There was a significant main effect of facial emotion on the RTs, $F(3.47, 201.14) = 52.61$, $p < 0.001$, $\eta_p^2 = 0.48$. The post hoc pairwise comparisons showed that the RTs were significantly faster while recognising happiness ($p < 0.001$) compared to all other facial emotions, followed by sadness, disgust, anger, and fear (see Table 1). Details of these pairwise comparisons are further elaborated in Supplemental Table S2. No interaction effect was observed between the group and facial emotion on the RTs, $F(3.47, 201.14) = 1.39$, $p = 0.24$, $\eta_p^2 = 0.02$.

Table 1

Percentage of CRs on go trials, the corresponding RTs, and the percentage of FAs on no-go trials during the facial emotion recognition task.

	% of CRs	**RTs (in ms)**	**% of FAs**
	Mean (S.E.)	**Mean (S.E.)**	**Mean (S.E)**
Group			
VVGs	73.33 (2.27)	716.54 (12.91)	5.72 (0.77)
NVVGs	67.15 (2.27)	734.97 (12.91)	5.61 (0.77)
Facial Emotion			
Happiness	92.50 (1.60)	645.15 (12.89)	0.97 (0.40)
Anger	65.28 (2.46)	739.77 (9.56)	5.42 (1.03)
Disgust	75.46 (2.47)	729.29 (10.68)	12.36 (1.26)
Fear	45.83 (2.60)	786.60 (10.95)	4.72 (0.78)
Sadness	72.13 (2.31)	727.98 (11.09)	4.86 (0.78)

Note: $N = 60$; Values represent estimated marginal means. Standard errors (S.E.) of the estimated marginal means are in parentheses

Percentage of false alarms (FAs) on no-go trials

There was no significant main effect of the group on the percentage of FAs on no-go trials, $F(1, 58) = 0.01$, $p = 0.92$, $\eta_p^2 = 0.001$. The findings indicate that VVGs and NVVGs performed comparably in terms of recognising certain emotions (by clicking the mouse) when they were not supposed to during no-go trials (see Table 1). There was a significant main effect of facial emotion on the percentage of FAs, $F(3.19, 200.08) = 26.75$, $p < 0.001$, $\eta_p^2 = 0.32$. The post hoc pairwise comparisons showed that the percentage of FAs was significantly lower for happiness ($p < 0.001$) compared to all other facial emotions, followed by fear, sadness, anger, and disgust (see Table 1). Details of these pairwise comparisons are further elaborated in Supplemental Table S3. No interaction effect was observed between the group and facial emotion on the percentage of FAs on no-go trials, $F(3.19, 200.08) = 1.02$, $p = 0.39$, $\eta_p^2 = 0.02$.

Analysis of the gaze behaviour

Time to first fixation (TFF)

There was no significant main effect of the group on TFF, $F(1, 58) = 1.96$, $p = 0.17$, $\eta_p^2 = 0.03$, indicating that the visual attention mechanisms guiding the initial gaze response were comparable between VVGs and NVVGs. There was a significant main effect of facial emotion on TFF, $F(3.41, 198.03) = 5.86$, $p < 0.001$, $\eta_p^2 = 0.09$. The post hoc pairwise comparisons showed that TFF was faster for happy faces than all other facial emotions (Table 2). However, while this fixation speed was significantly quicker than angry and sad faces, it was statistically similar to those expressing disgust and fear. This finding indicates that although happiness prompted a rapid response, the initial gaze towards happy faces was not uniquely fast compared to all the examined negative emotions. Details of these pairwise comparisons are further elaborated in Supplemental Table S4. Additionally, there was a main effect of fixation region on TFF, $F(1.62, 93.83) = 44.79$, $p < 0.001$, $\eta_p^2 = 0.44$, with the post hoc pairwise comparisons showing that participants took less time to first fixate on the nose region compared to the eye and mouth regions. Details of these pairwise comparisons are further elaborated in Supplemental Table S5.

Furthermore, there was a significant interaction effect between facial emotion and fixation region on TFF, $F(8, 464) = 3.86$, $p < 0.001$, $\eta_p^2 = 0.06$. The post hoc pairwise comparisons indicated that TFF was uniquely faster in the eye region for faces expressing disgust than all other emotions (see Table 3). In contrast, TFF for fearful faces was faster in the nose region, although this fixation speed was similar to those expressing disgust and happiness. Notably, happiness showed a markedly faster TFF in the mouth region than all other emotions, highlighting the smiling mouth as a critical region for recognising positive emotional expressions. There was no significant three-way interaction between the group, facial emotion, and fixation region on TFF, $F(8, 464) = 0.65$, $p = 0.74$, $\eta_p^2 = 0.01$, indicating that the efficacy of perceptual salience concerning TFF was comparable between VVGs and NVVGs.

Table 2

Main effects of the group, facial emotion, and fixation region across eye-tracking metrics.

	TFF (in ms)	**FFD (in ms)**	**TFD (in ms)**

	Mean (S.E.)	Mean (S.E.)	Mean (S.E.)
Group			
VVGs	346.20 (11.87)	266.87 (10.95)	407.40 (10.91)
NVVGs	322.664 (11.87)	248.94 (10.95)	397.18 (10.91)
Facial Emotion			
Happiness	309.12 (11.68)	281.52 (12.97)	422.25 (13.42)
Anger	349.53 (11.31)	248.97 (8.30)	388.48 (8.77)
Disgust	316.61 (9.46)	263.84 (8.77)	401.86 (8.69)
Fear	334.50 (12.29)	242.82 (8.22)	401.98 (10.22)
Sadness	362.39 (13.54)	252.36 (8.25)	396.88 (8.29)
Fixation Region			
Eye	280.74 (21.05)	240.02 (10.87)	409.45 (24.32)
Nose	215.91 (21.50)	276.90 (12.78)	493.84 (25.04)
Mouth	506.64 (18.61)	256.78 (9.73)	303.62 (11.70)

Note: $N = 60$; Values represent estimated marginal means. Standard errors (S.E.) of the estimated marginal means are in parentheses

Table 3

Interaction effects between facial emotion and fixation region across the eye-tracking metrics.

Fixation Region	Facial Emotion	TFF (in ms) Mean (S.E.)	FFD (in ms) Mean (S.E.)	TFD (in ms) Mean (S.E.)
Eye	Happiness	295.50 (30.17)	252.29 (18.43)	409.79 (27.53)
	Anger	263.21 (25.00)	243.96 (13.30)	414.61 (28.15)
	Disgust	243.95 (22.21)	251.29 (11.08)	393.10 (22.97)

	Fear	278.11 (25.91)	225.56 (11.40)	422.56 (29.27)
	Sadness	322.94 (28.89)	227.01 (12.29)	406.95 (27.71)
Nose	Happiness	207.31 (25.01)	301.35 (21.31)	508.59 (30.38)
	Anger	222.94 (26.21)	259.28 (11.89)	470.48 (25.99)
	Disgust	206.83 (21.55)	280.44 (15.28)	505.12 (27.95)
	Fear	203.73 (26.67)	262.20 (12.53)	498.96 (26.05)
	Sadness	238.77 (29.85)	281.22 (16.41)	486.07 (27.52)
Mouth	Happiness	424.55 (20.78)	290.91 (15.61)	348.37 (18.84)
	Anger	562.45 (21.83)	243.66 (11.56)	280.35 (13.20)
	Disgust	499.05 (21.10)	259. 78 (11.79)	307.34 (13.41)
	Fear	521.65 (25.82)	240.71 (13.45)	284.43 (15.19)
	Sadness	525.47 (26.37)	248.84 (11.31)	297.61 (15.59)

Note: $N = 60$; Values represent estimated marginal means. Standard errors (S.E.) of the estimated marginal means are in parentheses

First fixation duration (FFD)

There was no significant main effect of the group on FFD, $F(1, 58) = 1.34$, $p = 0.25$, $\eta_p^2 = 0.02$, indicating that VVGs and NVVGs performed comparably in maintaining their gaze stability after their initial fixation. There was a significant main effect of facial emotion on FFD, $F(2.20, 127.35) = 6.20$, $p < 0.001$, $\eta_p^2 = 0.10$. The post hoc pairwise comparisons showed that FFD was significantly longer for happy faces than those expressing anger, fear, and sadness (see Table 2). However, this fixation duration was similar to those expressing disgust. Details of these pairwise comparisons are further elaborated in Supplemental Table S6. Additionally, there was a main effect of fixation region on FFD, $F(2, 116) = 3.47$, $p < 0.05$, $\eta_p^2 = 0.06$, with the pairwise comparison showing that participants spent longer on their first fixation in the nose region, compared to the eye and mouth regions. Details of these pairwise comparisons are further elaborated in Supplemental Table S7.

There was no significant interaction effect between facial emotion and fixation region on FFD, $F(5.65, 327.83) = 1.05$, $p = 0.40$, $\eta_p^2 = 0.02$. However, the results showed that FFD was somewhat longer for fearful faces when participants fixated on the eye region. Similarly, FFD was longer for happy faces when fixated on the nose and mouth regions (see Table 3). There was no significant three-way interaction between the group, facial emotion, and fixation region on FFD, $F(5.65, 327.83) = 0.51$, $p = 0.79$, $\eta_p^2 = 0.09$, indicating that the efficacy of perceptual salience concerning FFD was comparable between VVGs and NVVGs.

Total fixation duration (TFD)

There was no main effect of the group on TFD, $F(1, 58) = 0.44$, $p = 0.51$, $\eta_p^2 = 0.01$, indicating that VVGs and NVVGs displayed comparable levels of engagement in terms of the total time spent fixating on facial emotions.

There was a significant main effect of facial emotion on TFD, $F(2.77, 160.70) = 2.98$, $p < 0.05$, $\eta_p^2 = 0.05$. The post hoc pairwise comparisons showed that while TFD was generally longer for happy faces, this difference was statistically significant only when compared with angry faces (see Table 2). Details of these pairwise comparisons are further elaborated in Supplemental Table S8. Additionally, there was a significant main effect of fixation region on TFD, $F(1.58, 91.59) = 15.43$, $p < 0.001$, $\eta_p^2 = 0.21$, with the post hoc pairwise comparisons showing that TFD was significantly longer in the nose region, compared to the eye and mouth regions. Details of these pairwise comparisons are further elaborated in Supplemental Table S9.

There was also a significant interaction effect between facial emotion and fixation region, $F(6.60, 382.70) = 1.97$, $p < 0.05$, $\eta_p^2 = 0.03$. The post hoc pairwise comparisons showed that although TFD was longer for fearful faces when participants fixated on the eye region, this pattern was similar to that observed for all other facial emotions (Table 3). TFD was notably longer for happy faces in the nose region, comparable only with those expressing disgust and fear. Similarly, TFD for happy faces was significantly longer in the mouth region than all other facial emotions. This outcome highlights a unique perceptual salience for happiness in this region, reflecting the prominent visual cues associated with smiling expressions that are primarily centred around the mouth, making it a focal point for recognising happiness. Furthermore, there was no three-way interaction effect between the group, facial emotion, and fixation region on TFD, $F(6.60, 382.70) = 1.12$, $p = 0.35$, $\eta_p^2 = 0.02$, indicating that the efficacy of perceptual salience concerning TFD was comparable between VVGs and NVVGs.

Discussion

A considerable body of literature grounded in the GAM suggests a link between violent video gaming and increased aggression, often observed as impaired emotional processing in gamers. Within this framework, script theory argues that exposure to in-game violence induces a processing bias towards negative emotions, resulting in a reduced happy-face advantage (Kirsh et al., 2006; Kirsh & Mounts, 2007). Conversely, the desensitisation model contends for the decreased responsiveness to hostility, leading to a blunted recognition of negative emotions (Bartholow et al., 2006; Carnagey et al., 2007; Funk et al., 2004). While many studies support both claims individually, the results are largely inconsistent. Moreover, there is growing scepticism concerning publication bias and possible exaggerated negative impacts of violent video games, which demands the need for further investigations in this area (Ferguson, 2007; Ferguson & Dyck, 2012; Ferguson & Wang, 2019). In this context, the current study investigated whether habitual exposure to violent video games (specifically FPS) affects the ability to recognise facial emotions.

The study initially evaluated aggression levels and the extent of exposure to violent video games among participants. As anticipated, the degree of exposure to in-game violence was substantially higher among VVGs compared to NVVGs. In contrast, aggression levels were greater among NVVGs than VVGs. The analysis also revealed no significant correlation between violent gaming exposure and aggression among participants, thereby supporting Hypothesis 1 (H1). These findings strongly suggest that it is overly simplistic to attribute aggressive behaviour solely to violent gaming, as claimed by the GAM and related studies. Instead, it is important to consider a broad range of environmental and individual factors, such as family environment, domestic violence, mental health, and even personality traits, as potential risk factors for increased aggression (Addo et al., 2021; Ferguson, 2018; Jerabeck & Ferguson, 2013). Furthermore, these findings are noteworthy as they contradict previous research that has indicated a direct relationship between violent video gaming and increased aggression (Anderson et al., 2010; Prescott et al., 2018). Recent meta-analyses support this contradiction, indicating that the connection between violent gaming exposure and increased aggression levels in gamers is either nonexistent or too weak to assert causality (Drummond et al., 2020; Hilgard et al., 2017). Our study further explored this association by investigating whether there is any impairment in facial emotional processing among gamers.

The happy-face advantage was evaluated using performance and eye-tracking metrics. Participants exhibited greater efficiency in recognising happy faces than other facial emotions. This was evidenced by higher CRs and faster RTs in go trials. Additional analysis revealed a higher rate of FAs for negative emotions on no-go trials. This pattern suggests that negative emotions are generally more challenging for participants to distinguish accurately, and the chances of response confusion are high. In contrast, the rate of FAs was significantly lower for happiness. The overall results supported Hypothesis 2 (H2), emphasising that the happy-face advantage was clearly demonstrated not only by the response accuracy during go trials but also by a reduced rate of FAs in no-go trials. The results also indicated comparable performance between VVGs and NVVGs in overall facial emotion recognition. Although VVGs were slightly more accurate in recognising happiness, both groups demonstrated similar efficiency in RTs. This finding supports Hypothesis 3 (H3), suggesting that the happy-face advantage is mutually exclusive of the gaming experience. Additionally, VVGs and NVVGs performed comparably in recognising negative emotions, supporting Hypothesis 4 (H4).

Concerning the happy-face advantage, the findings are consistent with the recent research by Diaz et al. (2016) and Pichon et al. (2021), which suggests that the short-term effects on emotion recognition observed in earlier studies (Bailey et al., 2011; Bailey & West, 2013; Kirsh et al., 2006; Kirsh & Mounts, 2007) do not necessarily translate into long-term impacts of habitual violent video gaming. Additionally, our analysis found no significant differences in recognising negative emotions between VVGs and NVVGs, thus challenging the notion of emotional desensitisation supported by previous studies (Bailey et al., 2011; Bartholow et al., 2006; Denson et al., 2020; Engelhardt et al., 2011; Miedzobrodzka et al., 2021, 2022).

In addition to performance metrics, the fixation patterns reflected enhanced happy-face advantage among gamers. Prior research into gaze behaviour has shown that happiness is more readily identified due to its greater perceptual salience in the mouth region (Calvo & Nummenmaa, 2008; Calvo et al., 2018). The results supported Hypothesis 5 (H5) as the participants exhibited a relatively quicker TFF with a prolonged FFD and TFD in the mouth region when recognising happy faces. These findings align with prior research, suggesting enhanced visual attention towards the perceptually salient mouth region while recognising happiness (Beaudry et al., 2014; Calvo et al., 2018).

Furthermore, the recognition utility for negative emotions conformed to the conventional pattern observed in the general population, with notably lower performance efficacy for fear (Beaudry et al., 2014). Complementing this result, the fixation metrics revealed that, irrespective of the specific type, the negative faces required a longer time to capture initial visual attention. This was evidenced in the prolonged TFF. Furthermore, the FFD on these negative emotions was less stable, indicating that participants frequently shifted their focus away from the initially fixated regions. This gaze behaviour suggests that the participants did not obtain sufficient diagnostic information from the initial focus area and felt compelled to search other regions of the face to identify the emotion accurately. This pattern was further supported by a relatively shorter TFD, reflecting a more distributed attentional strategy, where participants scan multiple facial features to gather emotional cues.

The gaze patterns for negative emotions contrast markedly with those observed for happy faces. While happy faces captured attention quickly and maintained it in specific regions like the mouth, the attention for negative emotions was not as focused. Instead, it was more scattered across various facial features, thereby supporting Hypothesis 6 (H6). This distributed gaze pattern implies that the cues for recognising negative emotions may be spread across the face, requiring a more comprehensive visual assessment to interpret these emotions accurately. It is crucial to observe that the gaze patterns in this study align with existing research (Beaudry et al., 2014; Calvo & Nummenmaa, 2008; Calvo et al., 2018), suggesting that reduced performance efficacy for negative emotions is primarily attributed to scattered perceptual salience rather than to desensitisation, as explained by the GAM. Furthermore, the three-way interaction effect supported Hypotheses 7 (H7) and 8 (H8), showing no significant difference in the perceptual salience between VVGs and NVVGs in recognising positive and negative facial emotions, respectively. These findings collectively indicate that habitual exposure to violent games (such as FPS) does not lead to an attention bias against recognising positive stimuli, nor does it induce desensitisation towards negative emotions.

The current study explores several reasons why habitual exposure to violent FPS games did not impair emotion recognition among gamers. One key observation is that the aggression levels among VVGs were comparatively lesser than the control group, which could have regulated the development of hostile cognitive scripts. Previous research aligned with the GAM has postulated that exposure to aggressive content within violent video games can escalate aggression (Anderson et al., 2008; Bartholow et al., 2006; Bushman & Anderson, 2002). However, the current findings contradict these results by indicating that habitual violent gaming did not lead to heightened aggression among the participants. Consequently, this lack of increased aggression may have precluded any adverse impact on attention orientation concerning positive emotions.

This observation also raises the possibility of “aggression catharsis” as a factor that mitigates the translation of virtual in-game violence into real-world hostility. Greitemeyer and

Mügge (2014) provide empirical support for this concept, demonstrating that habitual gamers often believe in the aggression-reducing effects of violent games more than non-gamers or non-violent gamers do. Such cathartic processes could serve as a psychological buffer, enabling habitual gamers to rationalise their consumption of in-game violence as a mood regulation strategy. Interestingly, this catharsis might not only prevent the accumulation of negative emotions but also reduce the reinforcement of aggressive scripts, altering the gamers' responses to emotional stimuli. Therefore, the overall cathartic effect of violent video games might paradoxically enhance the recognition of positive emotions and optimise the detection of negative emotional cues, as evidenced in this study.

Significance of the current study

This study challenges the widespread notion that violent video games directly cause or significantly contribute to aggressive behaviour. This is particularly relevant in public debates and policy discussions where violent games are often singled out as a key factor in societal aggression. Further, violent gamers are often stigmatised as more prone to aggression or desensitised to violence. By showing that habitual violent gaming does not necessarily translate into impaired emotional recognition or higher aggression, the study helps to combat stereotypes surrounding the "typical gamer." This can contribute to a more balanced public perception of gamers and the gaming community, reducing unwarranted fear or moral panic.

Additionally, most of the early studies had either broadly considered the violent gaming category or had taken a major sub-genre (e.g., action-based violent video gaming) in explaining the impact of in-game violence on emotional processing. Our study is significant in exploring this phenomenon in a specialised cohort of FPS gamers. This study also expanded the methodological toolkit beyond traditional metrics such as CRs and RTs by incorporating eye-tracking metrics. This allowed us to measure where and for how long participants focused their gaze during facial emotion recognition. By analysing the fixation patterns, we assessed perceptual salience and explored whether there are biases in how visual attention is directed towards certain facial features or emotional expressions.

Furthermore, the results found no substantial negative effects on the ability of FPS gamers to process emotional information, provided they do not have predispositions like trait aggression. This suggests that negative impacts associated with violent video games might be more closely tied to individual predispositions rather than the content of the games themselves. Thus, the current study argues that violent video gaming should be viewed within the broader context of media engagement. Similar to how exposure to different genres of movies or books affects individuals variably based on personal traits, the impact of video games is also modulated by individual differences. This perspective highlights the importance of considering both the media content and the characteristics of users in understanding the psychological effects of media exposure.

Limitations and scope for future research

One important limitation is the use of non-violent gamers as a control group. While this comparison helps distinguish the effects of violent content from general gaming effects, it also introduces potential confounds. For example, gamers across genres, whether they play violent games or not, often share certain skills, such as enhanced reaction times, decision-making abilities, competitiveness and engagement levels in gaming (Barlett et al., 2009; Kearney, 2005). This overlap could reduce the effectiveness of the comparison, potentially leading to a null effect when testing specific variables. Also, this overlap makes it difficult to pinpoint whether differences in hostile emotional processing are due specifically to exposure to violent content or gaming more broadly.

Another potential limitation lies in the relatively narrow selection of FPS games played by our participants. Many of them, such as Valorant or BGMI, feature stylised rather than graphically realistic depictions of violence. As the gaming industry continues to develop more lifelike representations of violence, it would be worthwhile to explore whether our findings extend to gamers exposed to hyper-realistic content. To that end, future investigations can incorporate a broader spectrum of FPS games, ranging from heavily stylised to highly realistic portrayals, thereby introducing greater variability into the research. We also recommend extending the current paradigm to encompass genres beyond violent FPS games. For instance, titles such as the *Dishonored* or *Deus Ex* series offer different mechanics and goal structures, while narrative-based games like *The Remains of Edith Finch* largely eschew violence. A wider range of gaming experiences would allow researchers to draw broader conclusions about the potential influence of video game content on emotional processing and help mitigate concerns that the negative effects of violent video games may be overstated in the literature.

Further, although the current results did not show a translation of in-game violence to impaired facial emotion processing, these findings cannot be generalised across individuals with higher levels of trait aggression. It is plausible that individuals with inherent aggressive tendencies might experience an amplification of hostility due to in-game violence. There is also a call for future studies to examine various other personal dispositions, such as personality traits, gender, and age, along with broader developmental and environmental factors, such as family upbringing and exposure to real-life violence. These elements provide deeper insights into how different personal and situational factors might influence or modify the relationship between exposure to violent gaming and emotional processing.

Conclusion

Overall, the findings of this study demonstrate that habitual exposure to violent video games does not impair the ability to recognise facial emotions. Performance metrics indicated a pronounced efficiency in recognising happy faces, further supported by fixation patterns. This suggests that the distinctive visual characteristics of happy faces, especially around the mouth region, remain readily perceptible even after exposure to violent content. Therefore, these findings reveal no negative bias in processing information related to positive emotions, challenging the assumptions made by script theory. Conversely, the recognition of negative emotions was characterised by reduced performance efficacy, aligned with patterns observed in the general population. Eye-tracking metrics provided additional insights, showing that the negative emotions required longer initial fixations and shorter durations of visual attention on perceptually salient regions, indicating a more dispersed focus. Thus, the reduced recognition utility for these emotions is attributed to scattered gaze patterns and may not be influenced by desensitisation from violent video games. By analysing the processing of positive and negative emotions, this study offers a comprehensive evaluation of the GAM. Importantly, participants in this study did not exhibit elevated levels of trait aggression despite their exposure to violent video games. This observation underscores the need to consider individual traits and contextual factors when assessing the effects of violent video games. This study does not entirely refute the foundational principles of the GAM; instead, it provides a critique of how script theory and desensitisation models may have overstated the negative impacts of violent video games.

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Disclosure statements

Competing interests

The authors declare that they have no competing financial interests or personal relationships that could have influenced the work reported in this paper.

Data availability

All data generated or analyzed during the present study are provided as supplemental materials under the file titled *Dataset*.

Ethical approval

This study was approved by the Institutional Human Ethics Committee (IHEC) of the Indian Institute of Technology Indore (IIT Indore), India, following review at the committee meeting held on 21 December 2022 (approval ID: PAPER-04/BSBE/IITI/IHEC-08/2022). All procedures involving human participants were conducted in accordance with the ethical standards of the IHEC and with the principles of the Declaration of Helsinki and its subsequent amendments. Participants were adults aged 18 years and above, with an age range of 18–30 years (M_{age} = 20.63 years, SD = 2.70). All participants, including those who completed only the interest survey, received non-monetary compensation for their participation.

Informed consent

Written informed consent was obtained from all participants prior to their participation in the study. Data collection began on 3 February 2023, and consent was obtained individually by the investigators on the day of testing, immediately before the commencement of the experimental procedures. The consent covered voluntary participation, permission to collect and analyse behavioural and eye-tracking data, and consent for anonymised data to be used for research dissemination, including publication in scientific journals. Participants were informed of their right to withdraw from the study at any time, without penalty or need to provide a reason. All data were anonymised at the point of collection and stored securely in accordance with institutional data protection guidelines. Participants were adults aged 18 years and above and were fully informed about the purpose of the research and any foreseeable risks associated with participation. No vulnerable populations or minors were involved in the study.

Author contributions

Both authors share equal contributions.

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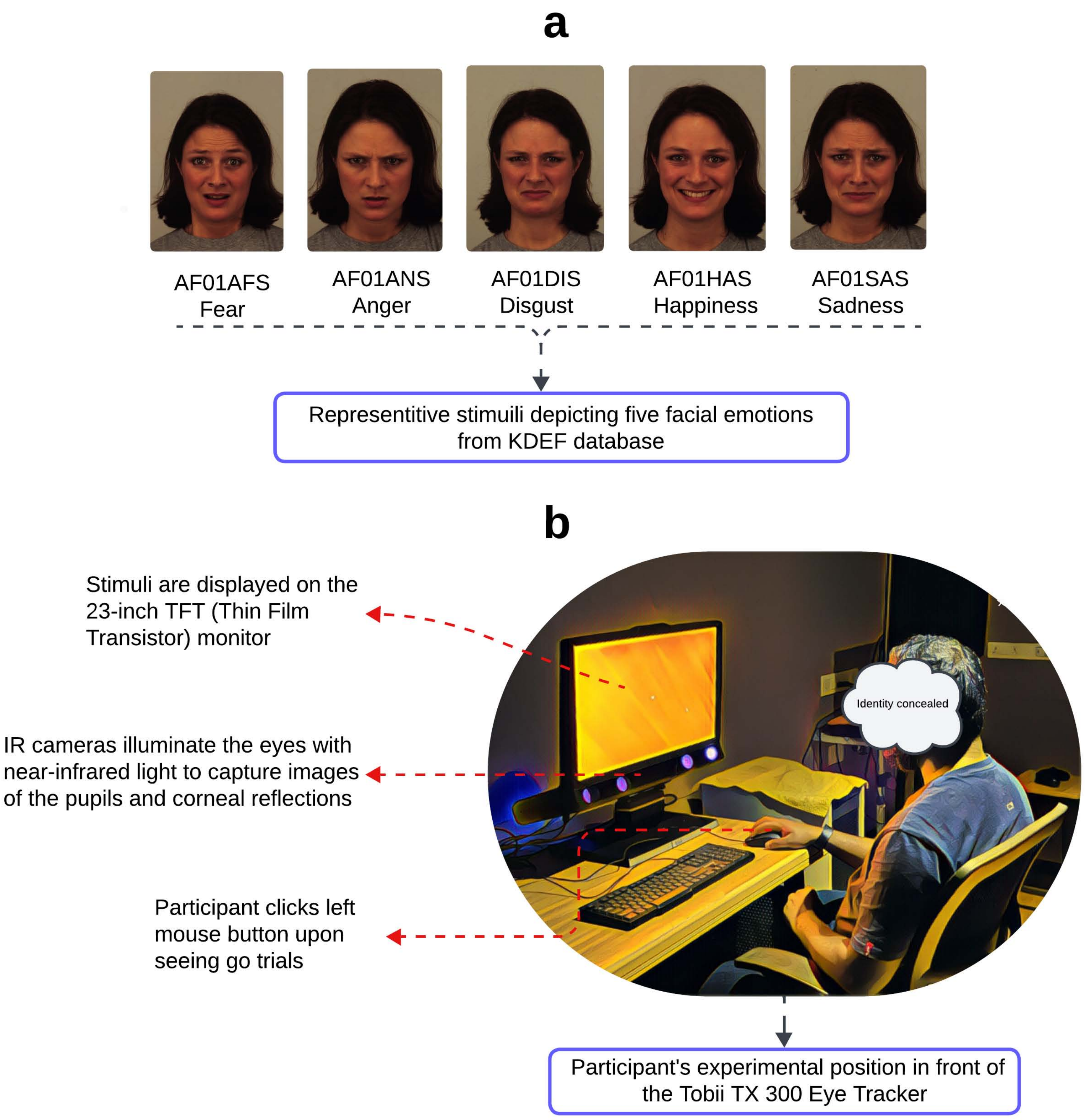
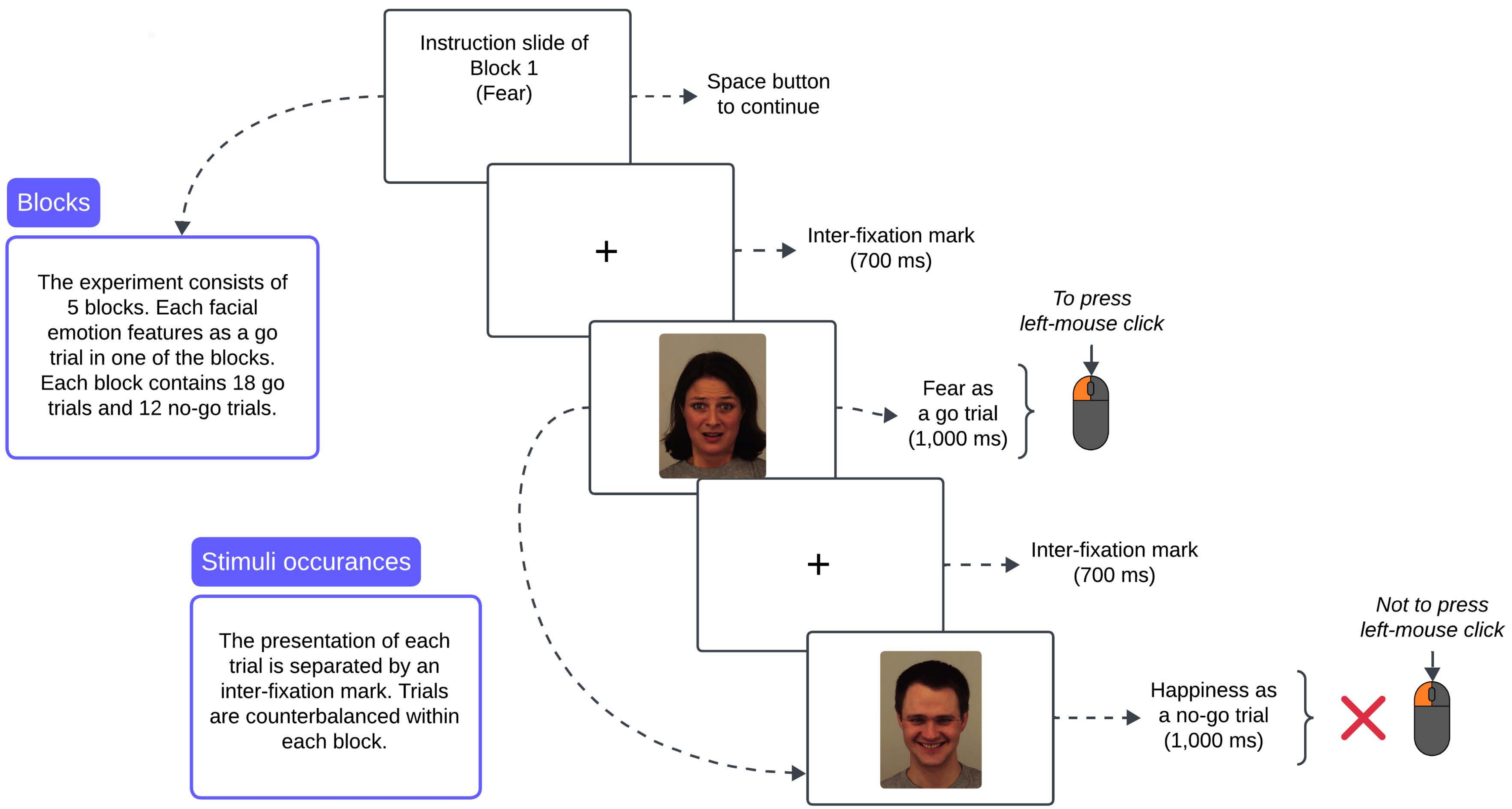
Figure legends

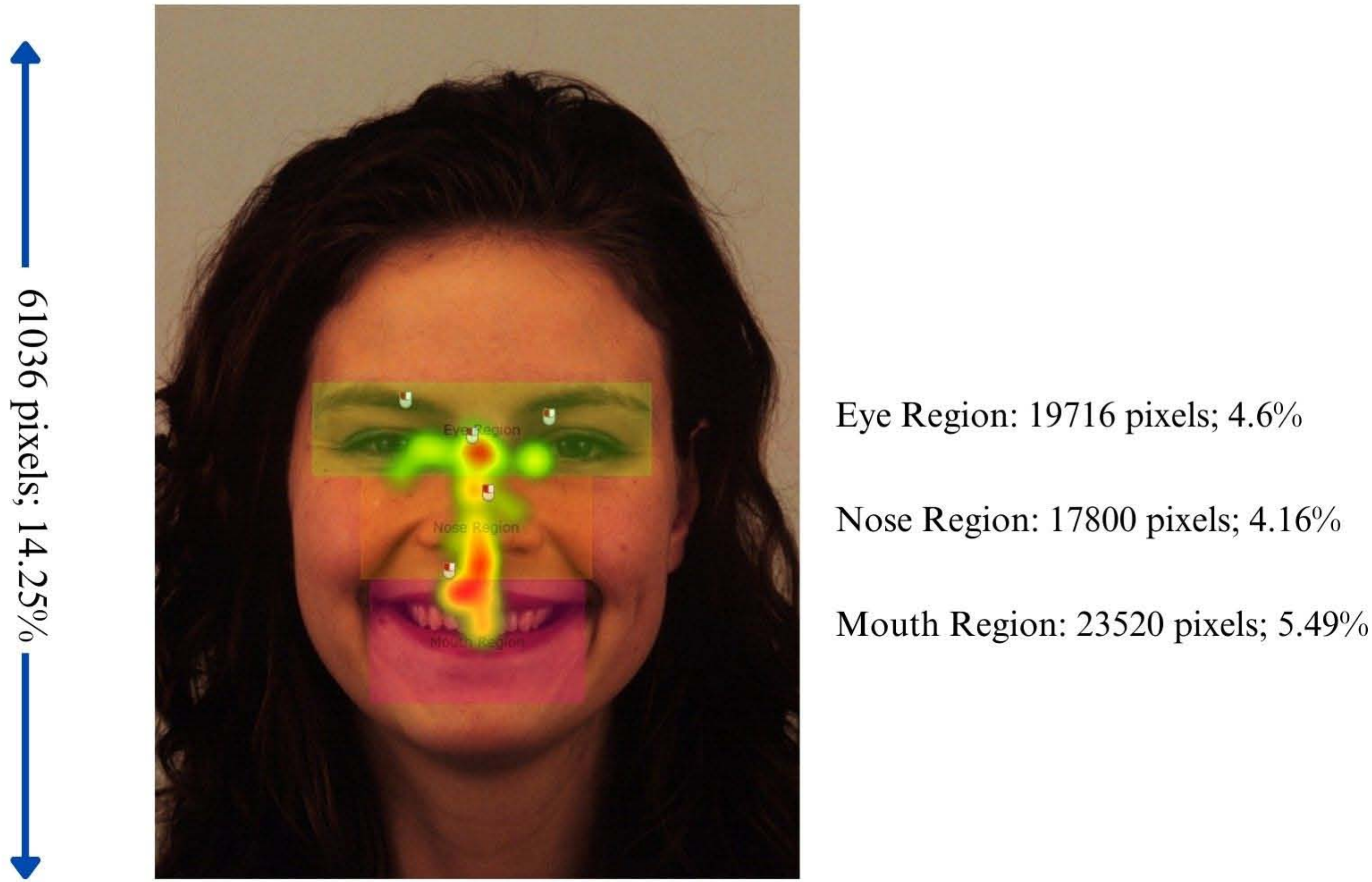
Figure 1. Emotional stimuli and experimental setup. (a) Five representative facial emotional stimuli from the Karolinska Directed Emotional Faces (KDEF) database; (b) Participant positioning in front of the Tobii TX300 Eye Tracker. All stimuli are used with permission from the Psychology Section at Karolinska Institutet for research purposes.

Figure 2. The emotional go/no-go task paradigm. This figure is covered by the Creative Commons Attribution 4.0 International License. Representative stimuli (AF01AFS and AM26HAS) are used with permission from the Psychology Section at Karolinska Institutet for research purposes.

Figure 3. Heat map displaying three examined fixation regions (Eye, Nose, and Mouth).


a
AF01AFS
Fear
AF01ANS
Anger
AF01DIS
Disgust
AF01HAS
Happiness
AF01SAS
Sadness
Representitive stimuili depicting five facial emotions from KDEF database
b
Stimuli are displayed on the 23-inch TFT (Thin Film Transistor) monitor
IR cameras illuminate the eyes with near-infrared light to capture images of the pupils and corneal reflections
Participant clicks left mouse button upon seeing go trials
Identity concealed
Participant's experimental position in front of the Tobii TX 300 Eye Tracker


Instruction slide of Block 1 (Fear)
Space button to continue
Blocks
The experiment consists of 5 blocks. Each facial emotion features as a go trial in one of the blocks. Each block contains 18 go trials and 12 no-go trials.
Inter-fixation mark (700 ms)
To press left-mouse click
Fear as a go trial (1,000 ms)
Stimuli occurances
The presentation of each trial is separated by an inter-fixation mark. Trials are counterbalanced within each block.
Inter-fixation mark (700 ms)
Not to press left-mouse click
Happiness as a no-go trial (1,000 ms)


61036 pixels; 14.25%
Eye Region
Nose Region
Mouth Region
Eye Region: 19716 pixels; 4.6%
Nose Region: 17800 pixels; 4.16%
Mouth Region: 23520 pixels; 5.49%