

Enhanced Esports: Community Perspectives on Performance Enhancers in Competitive Gaming

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This work explores perceptions of performance enhancer usage in esports. Specifically, we explored the perception of: food and food supplements; non-medical use of prescription drugs; drugs with some social acceptance (e.g. alcohol, nicotine, cannabis); drugs with lower social acceptance (e.g., psychedelics, opioids); and non-invasive brain stimulation (e.g. transcranial direct current stimulation). A mixed-methods approach was used to triangulate findings around three data sets, including both prompted and unprompted online forum comments, as well as survey data. The studies evidence that players are willing to use or are already using enhancers to increase their in-game performance, and that players are generally concerned about the use of enhancers in professional esports contexts. Furthermore, the community perceives that a substantial number of e-athletes use enhancers. The core contribution of this work is a comprehensive investigation into perspectives of esports performance enhancement, which highlights the urgent need for further research, as well as regulation by esports leagues.

CCS Concepts: • **Human-centered computing** → **Empirical studies in HCI**; • **Applied computing** → **Computer games**; • **Software and its engineering** → **Interactive games**.

Additional Key Words and Phrases: esports, competitive gaming, performance, enhancement, food supplements, drugs, brain stimulation, content analysis, survey, mixed methods

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1 INTRODUCTION

The pressure for esports professionals to optimize their performance has reached new heights. The prize pools of world class sports competitions, such as the Wimbledon' tennis championship (\$48M [1]) and the Masters golf championship (\$11.5M [5]), are now comparable with the prize pools of esports competitions such as Dota 2's The International (\$40M [26]) and the Fortnite World Cup Finals (\$30.3M [104]). With prize money, college scholarship funding, celebrity status, and

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reputation at stake, professional players may feel pressured to explore opportunities that increase their performance—including avenues that may put their own health at risk.

Extant research indicates that professional athletes accept greater occupational and medical risk to facilitate their performance, and tend to be more willing to embrace novel methods of performance enhancement [22, 82, 118]. As with traditional sports, esports leagues and communities have valid concerns surrounding the use of performance enhancing drugs (PEDs). There have been disclosures of esports professionals using performance enhancers [66, 94], but the full range of enhancers being used in an esports context has not been established. Professional players have publicly disclosed using stimulants such as Adderall™ to increase their performance in tournaments [66], prompting esports organizations such as the Electronic Sports League (ESL) to randomly drug test players [99]. In addition, while there is some evidence that acute caffeine intake can increase hit accuracy and reaction time in first-person shooters [95], there is ongoing debate as to what constitutes a PED in the context of esports. In this work, we both include and extend beyond PEDs to examine a wide range of substances that may enhance performance—herein referred to as ‘performance enhancers’ (PEs).

While the use of PEs in esports have been reported anecdotally [25, 77] or in specific contexts like e-cycling [92], for the most part their use has not yet been examined empirically. The health risks associated with enhancers, particularly PEDs, create ethical and legal barriers to investigating their potential effects. Following this, the lack of empirical evidence on the benefits of stimulants has been used to justify their use in professional esports leagues. For example, one Overwatch League commissioner highlighted that Adderall is a legal prescription within the United States, and that there is no scientific data to support that Adderall is a performance enhancing drug in the context of esports [73]. It should be noted that medically unnecessary use of Adderall or similar pharmaceuticals such as Ritalin can lead to severe, negative psychological and physiological side effects such as nausea, loss of appetite, high blood pressure, and, in the worst case, death [65, 88, 89]. Despite this, esports professionals have disclosed non-medical use of prescription drugs (e.g., Adderall) to support performance in competitive gameplay [66], as well as disclosure of their experience with *other players’* usage—with some claiming widespread consumption at the professional level [102]. Allowable use of prescription stimulants, coupled with their ready availability for people who want a prescription [83], stands to obfuscate the prevalence of PE use in professional esports contexts. To further complicate the landscape of PEs in esports, legal stimulants in the form of food supplements or energy drinks are not only prevalent within competitive gaming culture, but also comprise some of the major sponsors of both tournaments and professional teams [27].

While the lack of transparency around prevalence of professional use of PEs is a noteworthy problem in and of itself, it also gives rise to a more pressing issue—unfalsifiable assumptions of use within the competitive gaming community. With the absence of visible drug testing protocols, and a scarcity of organisational and academic discourse on the subject, the speculation and discussion around PEs in esports is taking place mostly in online forums and social media sites. However, to date, no research has examined how online gaming communities discuss the use of PEs, presenting open questions around whether or not risky PE usage practices are being promoted and shared within these spaces.

The general lack of evidence and understanding in this new research space reveals shortcomings in the literature that should be urgently addressed. Importantly, the *perceived* reasons for PE usage, as well as the *perceived* prevalence of PE usage, are unknown at both professional and amateur levels. There are also general questions around both willingness to use PEs, and the circumstances under which people may justify PE use. Such knowledge would represent a useful contribution for both academic and organisational stakeholders as well as anti-doping agencies. By equipping esports

regulatory bodies with community perceptions of the use of PEs in competitive play, they may be able to engage more meaningfully with critical drug and performance enhancement legislature. We regard this as a critical contribution to the body of esports research: PE usage may represent an important variable to consider in study design and reporting; further, such knowledge may position further research on player wellbeing in esports.

2 BACKGROUND

2.1 Esports: High Performance in Competitive Gaming

The term ‘esports’ (electronic sports) refers to formalized, competitive computer gaming [103] or as “organized video game competitions” [57], and often involves expert players competing within various sporting contexts such as leagues, sponsored teams, or bracketed tournaments in the presence of spectators [35]. Global revenues from esports were estimated at \$24.9B USD in 2020 [2], and spectatorship is growing, with an expected 646 million esports viewers by 2023 [90]. Esports are not just played by professionals; similar to how people can engage in competitive play in physical sports as amateurs or professionals, recreational participation in esports is also growing, including through amateur tournaments [31, 105, 107]. To complement the professional and amateur scenes, there is now also a vibrant collegiate scene [75, 93, 110] that includes training, coaching, and lucrative scholarships. Finally, esports is not limited by hardware platform. While esports is often thought of as being PC based, gaming consoles and mobile devices are also being used to play at a professional level. In 2019, mobile esports viewership increased by over 600% [79].

2.1.1 Performance in Esports. Given the competitive nature of esports—alongside the prize money, sponsorships, celebrity, and improved social standing associated with winning—research into high-level performance among esports athletes is growing. This research interest extends across different disciplines. Psychologists have investigated performance facilitation, showing spaced practice [58, 84], and to an extent live streaming [71], may increase performance in esports. Similarly, on a physiological level, sleep can also affect performance [14, 15]. Given the importance of performing well, players and coaches alike are interested in methods and approaches that aid performance. Performing consistently well is especially critical in high-pressure situations, in which some players succumb to strong negative attitude swings resulting in poor performance and mental resignation [9, 63, 117]. Depending on a player’s ability to deal with the pressure, a player may either ‘clutch’ (i.e., perform well under pressure [80]) or ‘choke’ (i.e., fail to maintain performance under pressure [6]).

Groups that conduct drug testing, such as the Esports Integrity Commission (ESIC), have documented a list of prohibited substances, which is currently comprised of stimulants [30]. Notably, many of the drugs on the prohibited substances list are legally obtainable with a prescription, and the ESIC notes that the substances are prohibited unless the player has obtained a ‘therapeutic use exemption’. This therapeutic use clause is not without flaw, as there is evidence that prescriptions for enhancement rather than treatment can be easy to obtain [83]—with as many as 15 percent of medical students disclosing non-medical prescription drug use to increase their study efficiency [20]. More recently, a survey of 3,451 university students found that 12.5 percent ($n = 429$) disclosed current or previous non-medical use of prescription stimulants [48]. Additionally, past research shows that enhancement using transcranial direct current stimulation (tDCS) is potentially possible in games, sports, or settings resembling these application cases [37, 38, 40, 44]. Detection of tDCS use is impractical without establishing multiple baseline measurements as a comparison for potentially enhanced brain activity.

2.1.2 Improvement Strategies in Esports. Esports players engage readily and frequently with strategies explicitly intended to improve performance. In a survey of training and performance in esports, active training represented 38.5% of players' total playtime [76]. Visibly, players seek to improve their performance in games through practice, training, and gameplay analysis. Such training manifests in myriad ways: explicit actions towards performance improvement in esports consist of reviewing both the player's own gameplay, as well as other professional play; deliberate practice during gameplay; gameplay analysis, discussion, and theorising with peers; and engaging in physical exercise to improve cognition [62]. In team-based esports, a crucial component of training and performance improvement is 'scrimming' (i.e., having practice matches with) other teams, with professional players reporting engaging in scrims two – five times a week [86]. Finally, players will also seek external mechanisms for improving their performance: for first-person shooters, 'aim training' games (of which the sole purpose is to practice routines, or drills, intended to improve facets of a player's aim) are popular, with prominent titles including *Aim Lab* and *KovaaK 2.0*.

Given the centrality of explicit performance improvement in esports, and the pressures associated with achieving excellence in play, it stands to reason that players may also pursue less visible—and possibly precarious—methods for enhancing their abilities. As such, we examine the use of PEs such as supplements, substances, and stimulants in competitive gameplay.

2.2 Performance Enhancers: Their Effects and Usage

Food and food supplements that may be considered PEs are on the rise. Arguably the most popular supplement used to enhance performance is caffeine, which can be consumed through various drinks (e.g., coffee and energy drinks) or as pills. Caffeine increases the excitability of the sympathetic nervous system [11, 46] and consequently is used to enhance alertness—although there are large individual differences with regards to the response to caffeine and its effect on cognition or physical performance [21, 23, 81]. However, there are many more foods and food supplements that potentially enhance performance—and the market for such products exceeds 100 billion USD, with an annual growth rate of 3–4% [87]. One such food supplement often hailed as a PE is tyrosine: a chemical precursor to dopamine and norepinephrine, which play crucial roles in cognition, sensory processing, and attentional control [34, 96]. In stressful situations or when cognitive effort is required, dopaminergic neurons show increased activity and it is assumed that tyrosine can be converted to dopamine to maintain an optimal performance level [59, 64]. In recent years, several studies have investigated the effects of tyrosine on cognition—but results are largely inconsistent [24, 45, 70].

Among the most popular pharmaceuticals used for performance enhancement purposes are amphetamine salts (commonly known as Adderall) and methylphenidate (commonly known as Ritalin), both of which are clinically used for the treatment of attention deficit hyperactivity disorder (ADHD). For example, methylphenidate increases dopamine and norepinephrine release, which in turn may lead to increased attention and wakefulness [68, 100]. The effect of such pharmaceuticals is also the reason for their appeal as a PE. These pharmaceuticals, amongst others, are frequently misused by students to enhance their academic performance [69, 72, 98]. Notably, these studies account for people who require certain medication for medical reasons—instead focusing on individuals who take a certain medication for the purpose of performance enhancement sans medical need. Prior work [108, 109, 113] has studied the use of performance enhancing drugs in the bodybuilding context and found that people disclose and discuss usage in online forums, suggesting that online communities may represent a useful resource for studying PE use in gaming.

Drugs are substances that have an impact on either an individual's physiology, psychology, or both—without providing any nutrition. Further, drugs can refer to legal or illegal substances that may cause addiction, habituation, or a marked change in consciousness [112]. Be it either by law or

culture, some drugs are more and some less accepted in the general populace [29, 111]. For example, the consumption of alcoholic beverages, or the smoking of tobacco and cannabis, is broadly socially accepted and not strictly regulated—or is legal altogether—in many countries. On the other hand, opioids, psychedelics, or stimulants such as cocaine are sometimes labelled as “hard drugs”, and their usage, possession, or distribution is typically heavily regulated or illegal. Regardless of their social acceptance and legality, some drugs have the potential to be used for performance enhancement purposes. For example, in a meta-analysis from 2010, nicotine was reported to enhance attention and memory [51]; however, this effect seems to be moderated by the intake dosage, the presence of a nicotine addiction, and the general performance level [33, 49, 78, 85].

Non-invasive brain stimulation, specifically transcranial electrical stimulation, is a method by which individuals may be able to enhance their performance in games and physical activities. Transcranial electrical stimulation is an umbrella term referring to methods such as transcranial direct and alternating current stimulation [12]. These brain stimulation methods rely on the fixation of one or multiple electrodes to the scalp via a conductive gel or headband. Electrical brain stimulation has been shown to potentially modulate cognitive processes such as working memory [41, 42, 56, 74] and response inhibition [37, 39, 40, 43]; however, large individual differences are observed [8, 67]. Importantly, recent technological advances make it possible for individuals to carry out brain stimulation sessions from the comfort of their own home with either commercially available or self-built devices [60, 115]. It should be noted that even though the devices may be perceived to be safe, the usage at home is completely unregulated and thus there is no control over whether or not people adhere to suggested safety parameters.

Taken together, there are many methods and substances that can potentially be used to enhance performance in games, with varying degrees of strength and consistency with regards to their effects on performance.

3 OUR APPROACH

To resolve gaps in the literature, we developed and addressed five exploratory research questions:

- RQ1. How do online communities discuss PEs in esports and gaming contexts?
- RQ2. Do users in online communities disclose using PEs to increase performance?
- RQ3. What are the perceived reasons for PE usage among top-level players?
- RQ4. What is the perceived prevalence of PE usage among top-level players?
- RQ5. How willing are players to use PEs, and under what circumstances?

With these questions in mind, we designed a set of mixed-methods studies that investigate the perceptions of PEs in esports from a variety of perspectives. A combination of naturalistic and survey data is used to investigate the perceptions and prevalence of enhancement from the standpoint of online gaming communities.

In our first step, reddit posts and comments were analyzed to investigate the discussion about PEs in the wild (hereafter: ‘reddit scraper’). Second, a survey about performance enhancement in esports was deployed to gather information about the perception of performance enhancement in gaming (hereafter: ‘survey’). This survey was advertised on reddit and via personal contacts. Third, we analyzed the reddit comments made under the survey advertisements to investigate a prompted discussion surrounding enhancers (hereafter: ‘ad comments’).

The combination of several streams of bottom-up data from the community results in a comprehensive dataset that joins qualitative and quantitative data. This approach ameliorates some disadvantages each approach would have on its own; for example, every survey must contend with social desirability bias, but in tailored subforums on reddit, people can participate in pseudonymous discussions without fear of judgement. Put differently, each data stream differs along the dimensions

of topic framing and whether or not the discussion was prompted. Specifically, the reddit scraper deals with unprompted and unframed data, the ad comments were prompted but unframed data, and the survey replies were prompted and framed with regards to the research topic.

This work makes landmark contributions to the games and play research area. We provide empirical insight into the perspectives of PE usage in gaming and esports contexts. The article contributes new understanding of how online communities discuss performance enhancers; the perceived reasons for performance enhancer usage; the perceived prevalence of performance enhancer usage; insight into the willingness to use performance enhancers; and insights into disclosure of use. These contributions serve as a necessary foundation from which a future research agenda around esports enhancement can be built.

4 METHODS

Data from each of the three aforementioned sources (i.e., reddit scraper, ad comments, and survey) are used to answer each research question. However, RQ1 relies heavily on the reddit scraper as well as the ad comments, whereas we posed specific questions in the survey to answer RQ2-5, and the interpretation of the survey replies are informed by the comments made on reddit.

There are myriad beliefs about how to enhance and modify performance. In this work, we focus on performance modifiers that have to be taken or administered, and are not inherent to the athlete. Thus, PEs such as breathing or relaxation techniques are beyond the scope of this research. Throughout this work, we focused on five different categories of PEs: (1) Food & Food Supplements (e.g., caffeine, tyrosine, sugar), (2) Pharmaceuticals (e.g., Modafinil, painkillers, benzodiazepines), (3) Drugs with some social acceptance (e.g., alcohol, nicotine, cannabis), (4) Drugs with lower social acceptance (e.g., psychedelics, opioids), and (5) Non-Invasive Brain Stimulation (e.g., transcranial direct current stimulation). We recognize that this classification system is not the only possible way of classifying performance enhancement methods. For example, a classification system that groups performance enhancing drugs into stimulants, depressants, cannabinoids, hallucinogens, hypnotics, and dissociatives would also be possible, though categorizations of this nature create undesirable ambiguities (e.g., both caffeine and methamphetamine are stimulants). Further, because this work was conducted in a global context, and not in a specific jurisdiction, classification related to legality was not appropriate as legalization and decriminalization of PEs varies between and within countries.

Our work was approved by the Behavioural Research Ethics Board at the university of the last author.

4.1 Content Analysis of Reddit Comments

Disclosure of performance enhancer use—particularly those that are in legal grey areas—may be difficult to ascertain in online communities, particularly in communities in which users are directly identifiable. To overcome the issue of willful disclosure of PE use, we conducted an inductive content analysis of reddit comments. While reddit has known demographic biases (e.g., majority male users from the United States), the pseudonymity of reddit's forums affords users a sense of privacy, and may afford increased willingness to disclose more than they normally would via the online disinhibition effect [101].

Reddit Scraper. We selected 31 enhancement-focused and 66 game-focused subreddits to analyze. The enhancement subreddits consisted both of forums devoted to specific PEs (e.g., r/steroids) as well as general enhancement forums (e.g., r/Drugs). For gaming based subreddits, we searched for reddit communities using reddit/t/ and the keywords 'esport' and 'game', as well as for specific gaming-themed subreddits that potentially contained discussion related to competitive gaming.

This list was amended with relevant subreddits known to the authors due to experience with competitive gaming (e.g., r/OverwatchUniversity—a subreddit dedicated to improving performance in *Overwatch*). The final list included subreddits with different focuses, such as general gaming (e.g., r/games), esports and speed running (e.g., r/esports and r/speedrunning), communities surrounding competitive play of specific games (e.g., r/competitiveoverwatch), communities about specific games in general (e.g., r/overwatch), and esports organizations (e.g., r/OpTicGaming). We scraped data from the top 500 posts from each subreddit with a Python scraper that we implemented based on the Python Reddit API Wrapper (PRAW) [13]. Data collection took place on the 19th November 2021. For a full list of subreddits, keywords, and search strings, please refer to the supplementary material. Then, we loaded all comments for each of the posts and saved all data. Using regular expressions, we searched for keywords (e.g., ‘enhancement’, ‘esports’) in the posts and corresponding comments using the specified search strings. The initial search resulted in 18513 hits in enhancement subreddits and 6464 hits in gaming subreddits. This data collection approach was taken with the understanding that data would need to be distilled into a relevant dataset.

Ad Comments. Comments made on the survey advertisement posts in all subreddits were collected on 18th December 2021 using the same method as described above. In total, 294 comments were collected for further processing. Notably, these comments were limited to subreddits that approved the posting of the survey recruitment advertisement (see supplementary material).

4.1.1 Data Reduction.

Reddit scraper. Common and homonymic keywords, such as ‘play’, ‘LoL’, ‘dope’, and ‘speed’, were filtered from the data. Duplicate posts were also removed. After initial filtering, the dataset was reduced to 1715 comments in the gaming subreddits and 1815 comments in the enhancement subreddit. The word count was comparable between the two comment subsets; 145147 words (average number of words per comment = 84.6) drawn from gaming-related subreddits and 183040 words (average number of words per comment = 100.8) drawn from the enhancement-related subreddits. Subsequently, the datasets were further refined; for a comment to be included in the final dataset, it had to mention enhancement or performance modulations in a gaming context, or represent a reply to a comment that refers to those topics. For example, if a person asked how to keep their attention up while gaming, and another user suggests a certain PE because it works for them, both comments would be included. Comments were also excluded for irrelevancy (e.g., if a keyword was incidentally used in an idiom: ‘this is out of my league’). The final list of comments contains 65 items from gaming subreddits (average word length = 91, total word count = 5916) and 66 comments from enhancement subreddits (average word length = 109, total word count = 7552).

Ad Comments. Comments were excluded from analysis if one or more of the following criteria were fulfilled: (1) comment made by one of the authors in response to a question (e.g., asked to explain something about the raffle), (2) topic of comment was not relevant to the analysis (e.g., asking about an aspect of the survey such as proof of moderator approval), or (3) discussing something unrelated to the survey or the topic. After data reduction, 77 comments remained.

4.1.2 Analysis Procedure.

Reddit Scraper. The analysis process was split into 4 phases, combining inductive and deductive methods in a so-called abductive approach [17, 28, 47, 50, 106]. In our first phase, four raters (the first, second, third, and fourth authors of this paper) independently reviewed and coded all comment data, generating individual coding sheets. These initial coding sheets were based on the data but informed by the authors’ prior knowledge about the subject matter. In our second step, all raters met to compare individual codes and in an iterative process discussed their results until a consensus

about the codebook was reached. Following this, in a third step, two raters then re-coded the data for a second time using the collective codebook: this allowed both raters to further refine the codebook, merging relevant and similar codes into larger representative themes. This merger of themes was based on connections within the data as well as higher-level considerations. To ensure the final codebook was appropriate, the two raters undertook a final re-coding of all comment data using a constant comparative analysis approach. Both latent (i.e., interpreting the commenters' intended meaning) and semantic (i.e., the participant's words, verbatim) codes were generated. Responses could be assigned multiple codes, and the final themes are not exclusive: codes contribute to multiple themes simultaneously.

Ad Comments. For analysis of ad comments, the codebook established in the analysis on the reddit scraper comments was used as a baseline. Coding of each comment was iterated until authors arrived at consensus.

4.2 Survey about the Perception of Enhancements in Gaming

4.2.1 Data Collection. The survey was advertised on selected subreddits (that is, subforums) on the website reddit.com. Prior to advertising on a subreddit, the authors sought approval from subreddit moderators. The list of contacted subreddits is identical to the subreddits that were searched in the reddit scraper. In total, the survey was advertised on 27 subreddits (for a complete list, refer to the supplementary materials) between the 1st and 15th December 2021. All participants could opt into a raffle to win one of five \$100 USD Amazon gift cards. Overall, 664 participants completed the questionnaire.

4.2.2 Instruments. To assess overall perception of PEs in esports and the opinions about the topics of fairness, regulation, and usage, we used a combination of closed and open-ended questions¹. Participants were asked about basic demographic information as well as their self-identified gamer type (e.g., casual player, professional player, speedrunner) and the genre of games they typically play (e.g., strategy, arcade fighter, shooter). Participants were given a brief description of the five PE categories, including examples for each (e.g., for the category "Pharmaceuticals", amphetamines like Ritalin or Adderall). The survey was piloted internally to ensure ease of understanding and clarity. The survey consisted of a total of five blocks: the first four blocks focused on items concerning specific PEs, and the final block contained open-ended questions.

Reasons for PE Usage. Reasons for PE usage. For each of the PE categories, participants were asked about why they think certain performance enhancers may be used. The options were: "To stimulate the body", "To stimulate the mind", "To calm the body", "To calm the mind", "To enhance perception of in-game stimuli", "To reach a specific goal", "Encouragement from others or social pressure", "Curiosity", or "No opinion". Multiple selections were possible.

Perceived Prevalence. Participants were asked to indicate the ratio of top-level players that use PEs from each category on a scale from 1 to 100%.

Willingness to Enhance. In addition, we asked participants in an open question about their willingness to use PE methods in general. In detail, we phrased it as: "Would you be willing to use performance enhancing methods? If so, which would you use and why/why not?". Each statement was assigned a primary as well as potentially an additional classification. The three possible primary classifications were "willing to use enhancers", "not willing to use enhancers" and "conditionally willing to use enhancers". The primary rating was aimed at representing the

¹Please note that we collected additional data in this questionnaire. However, this data is beyond the scope of the present manuscript and will be reported elsewhere.

principal meaning of the reply. Further, a set of secondary classifiers was also developed and all replies rated independently by two authors. It should be noted that secondary classifiers could also state conditionals to the person's willingness to use PEs. For example, a fictional statement such as, "I'm willing to do anything to enhance my performance, as long as I do not harm my body", would be classified as willing to enhance, but also receive a secondary label that reflects the condition of not being willing to harm their health to do so.

4.2.3 Data Reduction. Participants were excluded from further analysis based on the following criteria: (a) time to completion was below 1.5 seconds per question; not counting the optional open questions, (b) implausible data entry, or (c) duplicate replies indicative of bot or script usage, specifically focusing on identical replies to open questions for multiple different questionnaire instances in a short amount of time. Based on these criteria, 98 participants were removed, leaving 566 participants.

4.2.4 Analysis Procedure. The analysis of the questionnaire data was twofold. First, the quantitative questionnaire data (i.e., responses to the closed questions) were analyzed in order to characterize the sample and report quantitative findings (details within results section). Second, the open-ended responses were analyzed using a thematic analysis approach in the same way as the reddit scraper (see Section 4.1.2), with the following differences: two coders created the initial codebook, and following independent coding, two coders discussed and resolved all discrepancies, resulting in full agreement.

4.3 Ethical Considerations

As this study deals with potentially sensitive subject matter, the safety of participants needs to be ensured. As previously mentioned, the present study comprises data gathered directly from reddit—on which people can post comments under a pseudonym—and survey data. Neither data stream gathered any personal information that may lead to the identification of the person. Further, given the ever-changing nature of reddit, and the fact that we report data from many subreddits and search results based on a multitude of keywords, it seems implausible that an individual statement could be traced back to a specific user on a reddit forum. Additionally, even if something were to be traced back to a reddit user, the specific person behind the reddit pseudonym would remain anonymous. Finally, in case questions and topics during the survey caused stress, participants were directed post-survey to pictures of baby animals to help alleviate negative emotions. Participants were also provided contact information for crisis help lines.

5 RESULTS

5.1 Content Analysis of Reddit Comments

Through our inductive content analysis, we developed six themes that relate to performance enhancer use in the context of gaming. The themes developed were *Health Concerns*, *Recommendation Seeking and Giving*, *Effect on Gameplay*, *Use in Professional Contexts*, *Joke Commentary*, and *Motivations for Use*. See Table 1 for an overview.

5.1.1 Health Concerns. Importantly, we observed comments that discuss fears of, or experiences with, performance enhancers' negative impact on physical and mental health. Here, the comments both sought information about potentially harmful side effects and relayed their own experiences with negative side effects (e.g., "*in 1 match of Overwatch, my high completely depleted and I felt like 10% of what I felt before. What's the reasoning behind this?*"), or divulged disharmonious use (e.g., "*Im a polysubstance abuser, and got semi-hooked on stimulants quite a while ago, and fully dependent on opioids not so long ago*").

	General Enhancement Subreddits	Gaming Subreddits	Both Subreddits (Sum)
Health Concerns	21 (36.8%)	9 (13.6%)	30 (24.4%)
Side Effects	15 (26.3%)	8 (12.1%)	23 (18.7%)
Disharmonious Use	6 (10.5%)	8 (12.1%)	23 (18.7%)
Recommendations	25 (43.9%)	33 (50.0%)	58 (47.15%)
Recommendations For Usage	7 (12.3%)	21 (31.8%)	28 (22.8%)
Recommendations Against Usage	2 (3.5%)	5 (7.6%)	7 (5.7%)
Information Seeking	9 (15.8%)	3 (4.5%)	12 (9.8%)
General Efficacy Discussion	7 (12.3%)	4 (6.1%)	11 (8.9%)
Effect on Gameplay	35 (61.4%)	16 (24.2%)	51 (41.5%)
Improvement on Performance	19 (33.3%)	11 (16.7%)	30 (24.4%)
Impairment to Performance	3 (5.3%)	2 (3.0%)	5 (4.1%)
Improvement on Play Experience	10 (17.5%)	3 (4.6%)	13 (10.6%)
Impairment to Play Experience	3 (5.3%)	0 (0.0%)	3 (2.4%)
Professional Contexts	0 (0.0%)	26 (39.4%)	26 (21.1%)
Discussion of Pro Player Usage	0 (0.0%)	15 (22.7%)	15 (12.2%)
Discussion of Regulations	0 (0.0%)	8 (12.1%)	8 (6.5%)
Moral Judgements	0 (0.0%)	3 (4.6%)	3 (2.4%)
Joke Commentary	0 (0.0%)	6 (9.1%)	6 (4.9%)
Motivations for Use	29 (50.9%)	2 (3.0%)	31 (25.2%)
Desire to Improve Performance	8 (14.0%)	2 (3.0%)	10 (8.1%)
Desire to Improve Experience	4 (7.0%)	0 (0.0%)	4 (3.3%)
Use Incidental to Gaming	17 (29.8%)	0 (0.0%)	17 (13.8%)

Table 1. Overview of the number and proportion of themes and subthemes across all collected comments, and by subreddit type. Under each subreddit column, the percentage represents proportion per that subreddit type. The 'Both Subreddits' column examines total number and percentage across all data.

5.1.2 Recommendation Seeking and Giving. Within the dataset, we observed comments that both seek and provide information about performance enhancers, specifically relating to their use in video game contexts. This theme includes general information seeking on usage (e.g., “*How does Huperzine A feel, and does it really make you play better while you are on it*”), recommendations given for and against PE usage (e.g., “*I would say yes it [tDCS] should be able to help improve FPS gaming precision*”, and, “*In short: No, Huperzine-A won't make you play CoD better*”), and a general discussion about PE efficacy (e.g., “*Caffeine can increase reaction time*”).

5.1.3 Belief of Effect on Gameplay. This theme describes the effect of PEs on gameplay experiences. These comments are often firsthand descriptions of perceived effects, and describe effects on both performance and play experience. Comments discussing the influence of PEs on their performance describe both positive and negative outcomes—for example, one user writes that, “*I'm on adderall, controlled meth is op for keeping you focused*”; in contrast, another user states that, “*But no, I actually play noticeably worse on it*” [Adderral], “*and really any other drug as well, alcohol and weed included.*” Likewise, comments describing play *experiences* reported both positive (e.g., magnifying ‘fun’ or entertainment value) and negative (e.g., listlessness, or lack of interest) consequences of PE use. For example, one users writes, “*Speed and weed for great gaming experience.*”; in contrast, another user writes, “*i just wasn't enjoying myself. Every game felt like a task i had to complete.*”

5.1.4 Discussion of Use in Professional Contexts. In this theme, comments discuss the ethics, regulations, and usage of PEs in esports. In particular, comments speculated as to professional usage (e.g., “*Adderall and other stuff has been used in e-sports forever, you’d be surprised the lengths people will go to win*”), discussed PE regulation in esports (e.g., “*Esport Cheaters, they lose nothing from a 12 month ban, they can go back to their day job.*”), and passed ethical and moral judgements relating to PE use (e.g., “*wtf are you on mate. Of course competitive cheaters should be shunned by society????*”).

5.1.5 Motivation for Use. We also observed a set of comments that disclose a motivation or rationale for using PEs. In particular, we observed a desire to improve performance, a desire to improve player experience, and a belief that PE use will help to make up for a perceived performance limitation. When discussing desire to improve their performance, commenters would disclose this when either seeking recommendations or reporting their own experience—e.g., “*With the Halo Sport 2 shutting down [...] I find myself looking for a new tDCS headset with the intention of improving at eSports.*” and “*I’m currently on vyvanse and I’ve been awake for 19 hours. I’m playing an FPS gaming tournament \$1000 prize pool.*” In regards to improving experience, comments were more interested in fun or enjoyability: “*Is gaming on acid fun? Not too long ago a friend and I tried playing dark souls (he was on acid and I was on 2C-B) and it went about as horrible as you’d expect. However I wonder if more casual/easier games are doable?*”. Finally, overcoming limitations was a substantial motivator for use, with participants describing both cognitive and physical obstacles to high performance: “*I’ve recently started using Tdcs [...] to try to rein in my ADHD and improve my gaming, because I’m convinced that my ADHD is actively preventing me from getting better competitively.*”, and “*I’ve damaged my right hand and arm nerve and I think it’s in the later stages of the disease [...] it’s heavily impacting my gaming performance [...] Looking for a stack or anything to help heal nerves, especially in the right arm.*” We also see some disclosure of incidental PE use in game contexts, where altering performance or player experience is not a deliberate or intended outcome, but occurs anyway.

5.1.6 Joke Commentary. Within the content analysis data, we observed a culture of jokes relating to stimulant use. These comments are often tongue-in-cheek accusations or recommendations (e.g., “*Take Adderall, try again*” in response to players complaining about poor in-game performance). While the recommendations and accusations are largely sardonic, it does potentially belie an underlying belief that PEs are thought to influence player performance.

5.2 Ad Comments

Based on the inductive content analysis of reddit comments, the 77 ad comments were categorized and divided into different categories. Note that in total 294 comments were made on our ad postings, however most of those discussed things unrelated to the topic of interest. For example, many commentators asked questions about the lottery (e.g., *does the fulfillment of all the survey questions contribute to a higher chance to win a code?*). For a detailed overview see Table 2.

Broad Category	Specific Topic	Count	Proportional Weight
factual focus on performance enhancers	effectiveness discussion	18	23%
	brain stimulation	1	1%
fairness	call for harsher regulations	4	5%
	general comment on regulations	6	8%
	moral disapproval	2	3%

side effects	no side effects	2	3%
	negative physical	2	3%
	negative mental	3	4%
	disharmonious use	2	3%
unrelated usage	incidental to gaming	6	8%
	overcoming some limitation	5	6%
impact on gaming	improved experience	3	4%
	improved focus	3	4%
	general improvement	2	3%
	no effect on performance	2	3%
personal usage	general comment	25	32%
	pro-player usage	2	3%
	tournaments & competitive	3	4%
pro play usage	general prevalence	18	23%
	focus on the individual	2	3%

Table 2. The table shows the categorization as well as the number of ad comments that fall into each category. Additionally, the proportional weight shows how many comments (out of the analyzed 77) mentioned a certain theme. Note that one comment could discuss multiple themes.

5.2.1 Personal Usage. Participants made the most comments in relation to personal usage ($n = 30$) with comments such as (e.g., *“I can safely say MDMA isn’t going to boost your performance playing games. [...] Although stimulant highs often have the problem of making you *feel* like you’re doing things better without necessarily improving your performance.”*). Some commentators state that they use PEs playing professionally (e.g., *“Been making some cash as a semi competitive e-sports athlete playing on LAN events. Traveling to other countries you don’t really have access to anything but energy drinks.”*) or in tournaments (e.g., *“I like to take 10 mg adderall before comp[petition] it helps me”*). Note that the disclosure of personal usage was unprompted.

5.2.2 Usage in Professional Play. Participants discuss PE usage in professional play ($n = 20$). This takes the form of comments speculating about the general prevalence of performance enhancement (e.g., *“From what I’ve heard from some pro players, this is a big issue tbh. In OWL [Overwatch League] it’s been rumored that a large number of players [...] use PEDs [Performance Enhancing Drugs]. Ketamine in particular was a common culprit to enhance players’ awareness and reaction.”*) or a focus on a specific player that is known or rumored to have used PEs (e.g., *“Coldzera who was the #1 player in CSGO for 2 years in a row took 500mg test for an unknown amount of time [...]”*).

5.2.3 Factual Focus on performance Enhancers. Some comments objectively discussed PEs ($n = 19$); mostly with a focus on general effectiveness (e.g., *“Tbh steroids can help as well. Gaming is a lot of mental. If you’re tired you’re gonna play like a grandpa. If you’re enhanced you’re gonna play like an energized youngster who’s motivated to get that win”*). However, one comment specifically discusses non-invasive brain stimulation in detail (i.e., *“That’s [brain stimulation] actually something I really don’t know anything about, but hear there is actually a bunch of peer review about the concept and trials using these devices actually doing something (personally they strike me as nonsense, but this is due to my ignorance). When controlled for placebo, e-sports or not.. have these things actually been shown to have any sort of effect as a performance enhancer of any sort?”*)

5.2.4 Fairness of performance Enhancers. Comments also discussed fairness and regulations ($n = 12$) (e.g., *“I will say it’s hard to draw a line, but I believe any PED [performance enhancing drugs] or*

stimulant related to competition should be banned as it gives an unfair advantage to the team using it, even if it's just slight.”). Further, people made general comments on the difficulties of regulating PEs (e.g., *“And whats to happen with the likes of clay who gets it prescribed because he needs it?”*) and some showed moral disapproval of PE use (e.g., *“literal cheat code for gamers”*).

5.2.5 Side Effects. There are discussions surrounding side effects ($n = 9$) in the comments on the survey ad. Side effects include physical (e.g., *“Traveling to other countries [for LAN events] you don't really have access to anything but energy drinks. The urge to piss between each round sucked and the extra anxiety while playing in front of a crowd doesn't help either.”*), mental (e.g., *“Modafinil gave me the worst kind of brain fog out there, it was also terrible for my productivity since I was too dumb to do anything. Amphetamines clear my brain entirely and makes me productive af. Also doesn't dehydrate me like Modafinil does”*) and other reports of disharmonious use (e.g., *“Cheat code, yes. But people should be very careful going this route. As someone who briefly struggled with it, Adderall is an extremely addictive substance and a lot of people aren't the same on it. Even worse, I have a friend who takes competitive gaming a lot more serious than most and lost damn near everything over his Adderall addiction just to win some fucking Overwatch and Siege games.”*). However, some people indicate they have no side-effects (e.g., *“Tried addy and moda while in college, moda does not compare to amphetamines. Significantly way more wired on adderall. Feel no sides on modafinil but it also gave me none of the benefits”*).

5.2.6 Unrelated performance Enhancer Usage. There were comments that report the usage of potential PEs that are used not with the intent of enhancing gaming performance ($n = 11$). Some people report incidental usage (e.g., *“I've exclusively played games stoned for the last decade but I do think it helps me concentrate”*) and other report that they want to overcome a certain limitation (e.g., *“This is something that hits close to home for me, as someone who NEEDS Adderall for daily living, including gaming (prescribed). My Adderall brings me to the level of everyone else playing, and provides in my opinion zero competitive edge.”*).

5.2.7 Impact on Gaming. Some individuals disclosed that a PE may have an impact of their gaming performance or experience ($n = 10$). Some report an improved gaming experience (e.g., *“THC [Tetrahydrocannabinol]. Doesn't enhance my gameplay but it helps me not get angry when i play”*), improved focus (e.g., *“Not gonna lie I use cannabis to focus sometimes. I find my win rate goes way up with the right cultivar.”*) or a general improvement (e.g., *“I'll be honest though [...] having tried playing fighting games at high level comparing with and without, on adderall it makes a very noticeable difference. Not trying to promote usage or anything but I'm sure its used a lot more than most people think.”*). However, there are also reports of no impact on performance or experience (e.g., *“I still suck ass, but I can break my controller in half”*).

5.3 Survey About the Perception of Enhancement in Gaming

5.3.1 Characterizing the Sample. Participants were able to self-identify their gender: 477 identified as men, 65 as women, 11 as non-binary, 8 preferred not to disclose and 4 preferred to self-describe (e.g., trans woman). The mean age was 25.88 years ($SD = 6.59$, median = 25.00). With regards to gamer identity, in descending order participants identified as competitive gamers ($n = 325$, 57.4%), casual gamers ($n = 121$, 21.4%), amateur esports athletes ($n = 74$, 13.1%), part-time esports athletes ($n = 26$, 4.6%), full-time esports athletes ($n = 12$, 2.1%), and speedrunners ($n = 8$, 1.4%). Participants were asked what genre of games they played competitively; participants reported playing the following genres in descending order competitively: shooters ($n = 421$), MOBA games ($n = 190$), strategy ($n = 179$), MMO ($n = 139$), racing ($n = 93$), fighting ($n = 75$) and sports games ($n = 43$). Note that it was possible for participants to indicate multiple genres.

5.3.2 Reasons for performance Enhancer Usage. Participants reported the perceived reasons for using different enhancement methods, in a check-all-that-apply question (see Table 3). Overall, regardless of the PE type, participants thought PEs were most likely to be used to stimulate or calm the mind or body as well as using them to enhance perception. Notably, stimulating the mind is perceived as the most likely reason for PEs to be used. This makes sense in the context of esports as it is more a mental and not so much a physical sport. Nevertheless, stimulating the body (e.g., maybe to be more awake?) or calming the mind and body (e.g., to combat stage fright and its effects?) also seem to play a role. Although this pattern of results is observed when averaging across all PEs and is especially pronounced in the Food & Food Supplements category, other PEs are perceived differently. Both categories of Drugs—socially broadly accepted vs. not accepted—are comparable in most categories, though in general, participants perceive drugs with less social acceptance as being less likely to calm the body and mind, as compared to socially accepted drugs. Further, the number of participants having no opinion on the topic of not accepted drugs is about 3.5 times larger compared to other drugs. In contrast to other PEs, participants believe that drugs are more likely to be taken due to social pressure or curiosity. With regards to Brain Stimulation, participants may not have a strong understanding of this PE type as indicated by the comparatively high “no opinion” ratings. This is contrasted by almost half of all participants indicating that brain stimulation can be used to stimulate the mind, which suggests that participants may have made assumptions about what it can be used for based on its label. A further nuance is added to the data by evaluating the overall sum of responses for each PE as well as each response option. For example the number of responses in the PE categories Food & Food Supplements, Drugs (accepted) and Pharmaceuticals is noticeably higher compared to the other two categories; even when considering the “no opinion” responses. This could hint toward the fact that survey respondents have formed a stronger opinion about those PE categories already. For more details see Table 3.

	Food & Food Supplements	Brain Stimulation	Drugs (accepted)	Drugs (not accepted)	Pharmaceuticals	Overall Reasons for usage [sum]
Stimulate Body	370 (65.4%)	114 (20.1%)	133 (23.5%)	157 (27.7%)	233 (41.2%)	1007
Stimulate Mind	411 (72.6%)	255 (45.1%)	173 (30.6%)	185 (32.7%)	292 (51.6%)	1316
Calm Body	123 (21.7%)	84 (14.8%)	344 (60.8%)	176 (31.1%)	266 (47.0%)	993
Calm Mind	120 (21.2%)	119 (21.0%)	338 (59.7%)	176 (31.1%)	249 (44.0%)	1002
Enhance Perception	224 (39.6%)	157 (27.7%)	141 (24.9%)	159 (28.1%)	223 (39.4%)	904
Reach Goal	105 (18.6%)	119 (21.0%)	85 (15.0%)	100 (17.7%)	161 (28.4%)	570
Social Pressure	83 (14.7%)	42 (7.4%)	248 (43.8%)	184 (32.5%)	92 (16.3%)	649
Curiosity	75 (13.3%)	121 (21.4%)	163 (28.8%)	211 (37.3%)	100 (17.7%)	670
No Opinion	20 (3.5%)	201 (35.5%)	38 (6.7%)	122 (21.6%)	58 (10.2%)	439
Total number of votes [sum]	1531	1212	1663	1470	1674	

Table 3. Participants’ perceptions of the reasons why a certain PE is used with the sum of all cells in a row or column added. The percentages in brackets indicate how many participants had this opinion, when considering the whole sample. This makes a comparison across PEs possible. Note that for each PE type, the selection of multiple fields was possible, the sum of all percentages does not equal 100.

5.3.3 Perceived performance Enhancer Usage. To gauge perceived prevalence among professional players, participants were asked to specify the percentage of top-level players taking certain performance enhancers, using a slider from 0–100. In order to test whether the perceived prevalence of different PE types in pro-play is different between PEs, we conducted a repeated measures ANOVA. The results show an overall main effect of PE type ($F_{4,565} = 607.02$, $p < .001$, $\eta_p^2 = .52$). Descriptively, food supplements are perceived as being used the most (81.29%), followed by accepted

drugs (49.06%) and pharmaceuticals (48.92%). Brain stimulation (26.62%) and not-accepted drugs (21.72%) were perceived as least likely to be used. Subsequently, all likelihoods were rank-ordered and post-hoc repeated contrasts calculated. Analysis revealed a difference between all PEs except between accepted drugs and pharmaceuticals ($p = .92$). See Figure 1 for a visualization of results. To briefly foreshadow the interpretation of results, this shows that in the public eye the majority of professional players are perceived to use some form of PE, with approximately half of the players using socially accepted drugs and pharmaceuticals. Further, although not potentially problematic at first glance, the intake of energy drinks may negatively impact e-athlete health, especially in situations where an esports team is sponsored by the company producing such drinks.

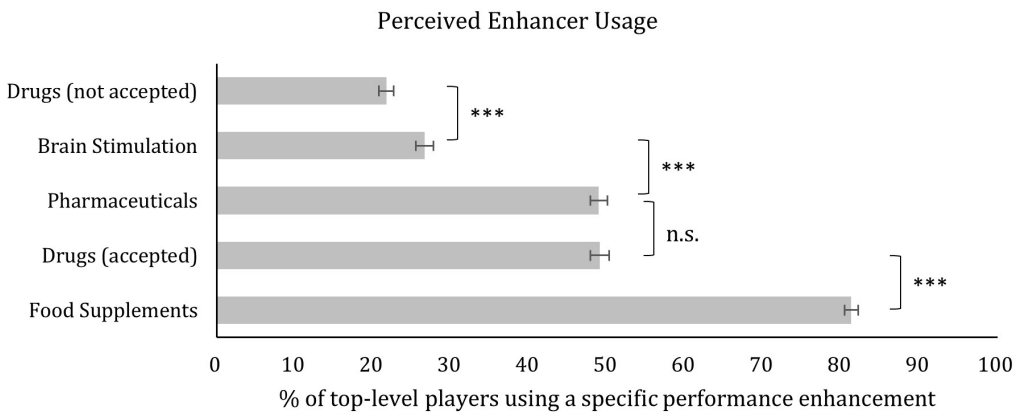


Fig. 1. Visualization of the perceived PE usage in professional play in percent split by PE type. *** = $p < .001$. Error bars represent standard error of the mean. For ease of understanding significance is only indicated for subsequent PE categories, and all PEs are rank ordered with regards to their perceived usage.

5.3.4 Willingness to Use. Out of 566 participants, 195 (34%) left the response field empty and 8 comments were unintelligible responses. Through iterative coding, the remaining 363 comments were grouped into three broad subcategories: (1) willing to use PEs ($n = 218, 39\%$), (2) not willing to use PEs ($n = 127, 22\%$) and (3) conditional and context-specific willingness to use PEs ($n = 18, 3\%$). We also identified secondary classifiers to the open question responses that characterized specific details (e.g., only caffeine or food supplements), justifications (e.g., because of potential side-effects), or further clarifications (e.g., “I have a prescription that is medically necessary”). For details on the comment frequency based on the categories see Table 4.

Willing to Use. Over 2/3 of participants that reported a willingness to use PEs chose to elaborate the reason(s) for their willingness. Most commonly participants said that they would be willing to only enhance using caffeine, food (supplements) or other “natural” substances (e.g., “I would use the enhancer ‘food and food supplements’, since I take them in everyday life anyway.”). Others stated that they would be willing to use PEs within limits, although the limits varied among responses (e.g., “I refuse to do anything with a needle or snorted due to addiction risk”; “cocaine: yes, meth: no.”). That specified limit sometimes related to the legality of the substance (e.g., “I would not use illegal or banned substances.”). Participants naturally made a distinction between certain enhancers and felt that PEs can be characterized along a spectrum.

Further, some participants said they would be fine with using PEs if the side effects were manageable (e.g., *“but only caffeine or perhaps amphetamines if they didn’t produce a negative reaction (paranoia, shaking, etc.)”*), with these described side effects often relating to their gaming performance (e.g., *“About 10 years ago I used time-release Adderall capsules and found that they hurt my ability to multi-task in Starcraft 2, but helped my reflexes and attention in shooter games.”*). In addition to general side effects, participants also placed limits specifically based on the risk to their health (e.g., *“I would be willing to try any that did not risk a long term impact on my health if tried in moderation.”*). The responses suggest that participants perceive PEs to have different risks and side effects attached, but also that many participants would be willing to use enhancers if the risks were manageable.

Many participants volunteered that PEs should be used if medically prescribed to them (e.g., *“I would yes. I have ADHD and would struggle to compete without access to ritalin/adderall. I believe it would be unfair for me to be on a lower level of play because of that.”*), or others (e.g., *“Those who medically require an enhancer to lead a “normal” life should be allowed. They’re already at a disadvantage, it would level the playing field.”*). Participants tended to make a distinction between medically necessary usage and usage for enhancement with reference to the unfair disadvantage it would give players with prescriptions; however, there were also comments made about the complexity of this distinction (e.g., *“I am prescribed adderall due to my ADHD but I try not to use it for playing games due to the stigma of performance enhancing drugs. It allows me play and think like a “normal” person but I can play decent without it as well.”*).

Willing to Use Conditionally, Based on Context. In addition to the caveats described above, there were contextual or situational influences on willingness to use PEs. A number of participants noted that they would use PEs, but not in tournaments or regulated play (e.g., *“In regulated play, no, never. Even though I’m prescribed modafinil, I still avoid it during regulated competitive play (and practice). However, for fun in casual competitive play, I commonly run modafinil (for narcolepsy), and maybe a bit of caffeine late at night. I’ve no issues with this, as it doesn’t hurt others - I play for fun, and am happy to let others win if I feel that my advantage takes away from their experience.”*, *“Maybe but not in an official match, so yes in scrim once or twice”*). Further, participants also mentioned that they would use a PE if everyone else was using it (e.g., *“I heard that in proplay many players use such substances and otherwise id not be able to keep up.”*, *“In high stakes scenarios, I think I would be more willing to test the limits allowed by a tournament, especially if it’s well documented that other players would be using them as well.”*). This shows that the willingness to use a specific enhancer may not always be just a choice made by a person in isolation, but also by other factors, such as the context or the choices of their peers.

Not Willing to Use. People who are not willing to use PEs often cite health reasons, because either they worry about the risk of addiction (e.g., *“I just don’t like getting addicted to stuff. Especially if it had a positive effect on my performance, I know I would spend far too much money on it.”*) or they say that their body is a temple (e.g., *“I have never used anything - even the socially acceptable - enhancers before. I firmly think my state of mind is my own and not one of a plant/drug/medicine.”*). Further, participants were concerned with the negative effects on their gaming performance (e.g., *“Nothing more than food, and painkillers. Anything else I’ve used has acted detrimental to performance.”*). Many of these responses implied that they have used PEs in the past, but are no longer willing.

Participants noted that PEs would reduce their enjoyment of victories because their wins should be based on skill (e.g., *“I want to know that what gave me the win was myself and not the drug I did or the stimuli I used”*). Another common avoidance reason is because they are considered as unfair (e.g., *“I wouldn’t be willing to use performance enhancing methods with the exception of food/drink, because in I see them as an unethical and unfair advantage.”*), or even as cheating (e.g., *“No. If you*

Additional classifiers	Willing to use enhancers		Not willing to use enhancers		Conditionally willing to enhance	
	count	%	count	%	count	%
Caffeine, food, supplements or "natural"	86	23.7%	0		0	
If medical prescription	24	6.6%	1	0.3%	0	
Within limits	27	7.4%	0		0	
If legal (in tournaments)	9	2.5%	0		7	1.9%
If everyone else was using it	5	1.4%	0		2	0.6%
If there was no harm to my health	12	3.3%	0		2	0.6%
If side effects were manageable	6	1.7%	0		0	
Competition only	0		0		5	1.4%
Not in tournaments	2	0.6%	0		4	1.1%
If it had benefits beyond gaming	1	0.3%	0		2	0.6%
Not now, but when I was younger I would have	1	0.3%	2	0.6%	0	
Unfairness	7	1.9%	15	4.1%	2	0.6%
My body is a temple	3	0.8%	16	4.4%	0	
Addiction	5	1.4%	3	0.8%	0	
Success would not feel the same	0		19	5.2%	1	0.3%
Negative effects on gaming	0		4	1.1%	0	
Gaming is not worth it	8	2.2%	13	3.6%	0	
Enhancer usage incidental to gaming	4	1.1%	4	1.1%	0	
no additional qualifier & unrestricted	63	17.4%	60	16.5%	0	

Table 4. Participants were asked to indicate their willingness to use enhancers in general. The table displays the frequency of replies that fell into certain categories. Additional classifiers were used to further describe the responses; for example, a person not willing to use PEs may state that the reason for this is, that they consider performance enhancement unfair. Consequently, the secondary classifiers give nuance to the primary meaning of a persons response to the question. For example, a person replying to the question with “yes, but ...” would be classified as willing to enhance with a secondary classifier representing the stated conditional, whereas a reply starting with “if I were to be a professional player, and if ...” would receive the primary classification of conditionally willing to enhance.

Note that one response may be coded with more than one additional classifier. The percentage is defined by the ratio of replies that fit that category divided by the total number of non-blank responses.

cheat once, you should be banned for life. I know people who have microdosed EPO and I have never looked at them the same way.”).

Finally, participants noted that taking PEs may not be worth it due to their general skill level or the lack of interest to play competitively (e.g., “*Not really. I’m not a very competitor gamer and tend to play more casually, so I am not looking to purchase enhancers or supplements for the purpose of increasing my success in games.*”). Some reported having done so in their youth, but that they had outgrown the desire to do so (e.g., “*I’m not sure I’d try too much these days as I don’t think my body would handle it, but when I was younger I would have tried anything that was tournament legal.*”). Additionally, comments referred to recreational PE usage as acceptable, but just not in a gaming context (e.g., “*I’ve done a lot of drugs tho just not for performance.*”).

6 DISCUSSION

6.1 How do online communities discuss performance enhancers in esports and gaming contexts? (RQ1)

When examining both sets of unframed data (that is, the ‘scraper’ and ‘ad’ datasets) within the online communities, two contexts of rhetoric were evident: discussion about self-usage, and discussion about professional usage.

6.1.1 Self-Usage. One prominent context of discussion largely concerned information seeking, exchange, and discussion—as described in the *Recommendation Giving and Seeking* scraper theme, and the *Factual Focus on Enhancers* ad theme. As many forums and online gaming communities are pseudonymous, users may feel empowered to openly exchange information on which illegal drugs and pharmaceuticals fit perceived needs. Further, the scaffolding of online communities allows users to easily identify spaces that may be less hostile to, or altogether welcoming of, this discussion—encouraging candid discussion.

This may also be parallel to a “code of silence” that has been observed in PE usage of bodybuilders. Prior work [91] found that bodybuilders who use anabolic steroids are less willing to disclose usage outside of the scene (e.g., with non-bodybuilding family members or friends), while they are open to talking about it with others inside of the scene. Specifically, this often involves discussions with like-minded individuals on focused online forums [7, 91]. Partially, this behavior is associated with being viewed negatively by outsiders, media highlighting usage as negative, and fear of more stringent regulations. Thus, discussion around enhancement usage in esports may be subject to similar fears (e.g., game companies that already are under scrutiny worrying about being associated with drug use). Future work may be beneficial to explore if such a “code of silence” also exists for performance enhancements in esports.

Further to this, the pseudonymous and tailored nature of online communities may have facilitated user openness in the discussion of personal experiences and uses (as evidenced in scraper themes *Belief of Effect on Gameplay* and *Motivations for Use*, and ad themes *Personal Usage* and *Impact on Gaming*). While some users recounted neutral or negative effects on gameplay, many others reported performance and experiential improvements. It is possible that such discussion begets further usage, contributing to the high frequency of people who disclosed a willingness to take PEs to give themselves a competitive edge in our survey study.

Users also broadly engaged in conversation about health concerns—in particular, fears concerning and disclosure of negative side effects, the risk of addiction, and mental and physical drawbacks (such as fatigue, decreased motivation, and decrements to wellbeing). These points of discussion were identified in both the *Health Concerns* scraper theme, and the *Side Effects* ad theme. This is supported by the survey data, in which participants who indicated that they were not willing to use PEs largely cited health reasons. As such, despite a general perception of the widespread prevalence of enhancement usage in competitive gaming, players remain hesitant to engage themselves—and will seek advice about these concerns, or will disclose personal negative experiences. Such disclosures may be motivated by a desire to warn others about the usage of specific enhancers, or to seek reassurance and empathy from peers. Interestingly, in contrast, questions of legality did not appear to motivate concerns about PE usage.

In the unprompted data, the most frequently occurring health concern related to caffeine addiction’s prevalence within the gaming community. While caffeine addiction is likely a concern in the general population, it is worth highlighting that many energy drink vendors have advertisements targeted at esports players, in addition to tournament sponsorship. Further, there is evidence that acute caffeine intake may increase performance in first-person shooting games [95], which may motivate caffeine use among esports players. Future research should further explore the use of caffeine within the gaming community, particularly with regards to health concerns, caffeine consumption rates, the influence of energy drink sponsors, and prevalence of caffeine addiction. A potential PE that will probably be on the rise in the next years is non-invasive brain stimulation and transcranial direct current stimulation specifically [60, 115]. However, even if results show that performance enhancements are possible the inter-individual differences are large, and there is a lot of research needed before tailor-made stimulation protocols are developed [10]. Ideally, brain stimulation may be used in a safe environment in order to enhance training effects and aid people

in overcoming certain limitations (akin to how pharmaceuticals may be used to treat ADHD for example). Future research should further investigate the effect of such tools on gaming performance and game practice. However, there are also potential drawbacks to using such technology. Apart from the obvious health risk and the uncertainty of results, it is also important to acknowledge that such technology is potentially very expensive. Thus, this will inherently favor esports teams and athletes which have more funding at their disposal, which again is a potential risk to fairness. With that being said our data hints towards that, at large, non-invasive brain stimulation is not yet wildly known or understood in the esports community.

Finally, as evidenced by scraper theme *Use Incidental to Gaming* and ad theme *Unrelated Enhancer Usage*, users would also discuss the effects of enhancements on games in passing—that is, the unintended and incidental influence of their PE usage on gameplay. This is likely because a significant contingent of enhancement users may be using enhancements for different, or more general, purposes (e.g., to study, or for improving overall productivity), and it is only when prompted that they may reflect on the influence of the enhancement on gaming.

6.1.2 Professional Usage. When discussing professional play, one prominent mode of conversation concerned the perceived frequency of PE usage in professional esports contexts. As evidenced in scraper theme *Professional Contexts* and ad theme *Usage in Professional Play*, this discussion took form both speculatively and matter-of-factly; commenters would either speculate as to individual or general usage (i.e., conjecture about a specific player, or about widespread usage in professional play or tournaments), or would reflect on confirmed cases of use in esports. Commenters were largely of the opinion that PE usage was widespread in esports. This is supported by scraper data's *Humour* theme, in which users would frequently make sardonic or tongue-in-cheek comments situating PE usage as an 'open secret'. As such, it would appear that popular perception of PE usage in professional esports play is that it is common, or standard practice.

These results fit with the quantitative results from the survey question about the perceived PE usage in professional play. The survey results revealed that it is perceived that 50% of top-level players use pharmaceuticals or socially accepted drugs. In contrast, brain stimulation and socially not accepted drugs are perceived to be used by approx. one in five to one in four players. Food and food supplements are perceived to be used by 80% of all top-level players. While this unregulated usage of freely accessible substances may seem fine at first glance, it may have unintended negative consequences. For example, the consumption of high-sugar, caffeinated drinks with increased frequency can be detrimental to athletes' health [3, 18], and this issue may further be compounded when the esports team is sponsored by an energy drink company.

Interestingly, discussions of morality, fairness, and regulations were limited to professional play in the unframed comment data—although, when prompted directly in the survey, players who self-described as *'Not Willing to Use'* did also cite concerns about fairness, or hollow victories. As such, it may be that those who openly divulge or discuss personal usage, especially in public fora, are unconcerned by questions of fairness (or do not consider their own personal usage problematic). When discussing professional use in scraper theme *Usage in Professional Play* and ad theme *Fairness of Enhancers*, commenters were concerned about regulations and discipline (often calling for PEs to be regulated against, and users of PEs to be disciplined), and morality and fairness (largely suggesting that PE use is akin to cheating). It should be noted that this discussion was usually in the context of PED and stimulant usage, e.g., Adderall; other PEs, such as tDCS or caffeine, were typically omitted (if not explicitly) from this conversation.

The community discussions surrounding the topic of (illicit) performance enhancement in the scientific literature have so far not been in the spotlight, even though scandals and discussions about performance enhancement are a common occurrence. Allegedly, the use of some specific PEs

such as Adderall is so wide-spread that professional athletes in interviews either have admitted to it openly or state that everybody is using it. For example, in 2015 a Counter Strike athlete named Semphis said in an interview with VICE “I don’t even care. We were all on Adderall.” and in 2020 the former Call of Duty World Champion KiLLa stated “Nobody talks about it because everyone is on it.” The esports lifestyle and the way the industry is structured may further incentivize PE abuse. Only the top few percent of players in a small subset of competitive games are able to make a living wage in esports and consequently, it may even be perceived to be worth the risk to get caught cheating or give in to an unhealthy esports lifestyle to reach the top [61, 97]. As pointed out by our commenters as well as researchers, there is another problem with pharmaceuticals such as Adderall that are legitimately prescribed to individuals if medically necessary. Allowing therapeutic use exemptions could potentially threaten the whole drug testing system as it can be taken advantage of [53].

6.2 Do Users in Online Communities Disclose Using Enhancers to Increase Performance? (RQ2)

Yes. The content analysis of unprompted reddit comments evidences disclosure of PE usage in online forums. We also received a set of highly relevant comments on the survey recruitment posts. A large number of comments (30 out of 77) disclosed the use of some form of PE without being prompted to do so. Across each data set, comments included disclosures of pharmaceutical, drug, and food supplement use, with the specific goal to enhance performance.

In both the reddit scraper data and the survey data, we observed disclosures from people claiming to play at a competitive or professional level (e.g., participation in tournaments with prize pools). Due to the stakes of disclosure, we had initially considered willful disclosure of PE use by professionals to be somewhat unlikely to occur. These disclosures evidence that content analysis can serve as a valid method of gaining in-the-wild insight into PE use in the context of esports, even at professional levels. Perhaps more consequentially, it also suggests that the barriers surrounding willful disclosure of PE use can be sidestepped through assurances of anonymity, and recruitment on pseudonymous platforms.

This also touches on the usage of PEs, specifically pharmaceuticals, as a form of medically necessary treatment. Commentators discuss whether or not, for example pharmaceuticals such as Adderall, are truly unfair if a person with ADHD is prescribed the drug. This raises the broader question whether or not performance enhancement, in general, should be allowed or not to level the playing field in terms of neurophysiological measures. From an ethical standpoint, enhancement to overcome a prior disadvantage is different compared to performance enhancement without such a prior disadvantage. Whereas technological PEs are comparatively simple to control for and enforce, enhancers such as brain stimulation or certain pharmaceuticals are difficult to detect, track, and enforce. Another problem pointed out by commentators is the large inter-individual variability in PE usage and that using an enhancer does not necessarily directly lead to a tangible performance improvement.

6.3 What Are the Perceived Reasons for Enhancer Usage Among Top-Level Players? (RQ3)

Generally speaking, participants in the survey believed that PEs are most likely used to stimulate or calm the mind and body as well as enhance perception. However, there are nuances in the perceived reasons for PE usage that differ based on the type of enhancer being discussed.

Unsurprisingly, survey participants believe that pharmaceuticals are being used for the purpose of performance enhancement. Several of the top-level players disclosed using PEDs in tournament contexts, supporting the idea that performance pressures are a major factor of pharmaceutical

use. Several people highlighted that they would be willing to take PEs if they knew that their competition were using them. Adding to this idea, the perceived social pressure to take drugs is higher compared to other forms of enhancement. There is a general perception that people may feel forced to use drugs that they do not feel comfortable with.

Comparing the pattern of results for food supplements and brain stimulation, there is a marked contrast in perceptions of use. Due to the high familiarity with food supplements, many people form a clear opinion about their use, with only 3.5% of all replies being “no opinion”. On the flipside, for brain stimulation, 35.5% of all answers fell into the “no opinion” category. This indicates a poor understanding of this enhancement method in the wider population, which is something regulators and gamers alike need to be cautious of. Commercial devices for at-home usage can be bought and unregulated usage of such devices could not only potentially benefit players but also in the worst case be detrimental for player health and esports integrity. One reason for the increased perception of the use of more common PEs in pro-play (e.g., food supplements) may be a higher degree of familiarity (see also mere exposure effect [16]).

6.4 What Is the Perceived Prevalence of Enhancer Usage Among Top-Level Players? (RQ4)

Based on our observations of the survey data, there is a perception that PE usage is relatively widespread. On average, participants estimated that 48.92% of top-level players are using pharmaceuticals as PEDs. With regards to pharmaceuticals, this high level of perceived use is indicative of a general lack of trust in the drug testing processes that exist at professional levels. While we stress that the gap between perceived use and actual use is unclear, this perception of use likely informs willingness to use enhancers—if players perceive that their opposition is using enhancers, it may encourage them to take enhancers to remain competitive. Notably, survey participants estimate that 81.29% of all professional players use food supplements. This likely reflects the concerns of caffeine addiction’s prevalence observed in the reddit scraper data. Participants estimate that 81.29% of all professional players use food supplements, and that every other professional player uses accepted drugs like alcohol, nicotine and cannabis (49.06%) or pharmaceuticals such as methylphenidate or amphetamine salts (48.92%). This reflects a perception of rampant enhancer usage. This problem only gets amplified when other enhancers are also considered. The commenters on reddit also share this general sentiment that enhancer usage among top-level players is pervasive (e.g., *“This generation literally might as well call it [Adderall] water. [...] I would guess the numbers are insane now unfortunately.”*). Consequently, the perceived integrity of esports and player achievements will be scrutinized and the pressure to enhance in order to stay competitive will rise.

6.5 How Willing are Players to Use Enhancers, and Under What Circumstances? (RQ5)

Despite the prevalence of health concerns outlined in the reddit scraper data, the survey data shows that between 50–60% of respondents would be willing to use performance enhancers to various degrees.

Some survey responses gave very clear recommendations for use (e.g., specific drugs for specific modes of games). It is likely safe to assume that participants offering recommendations of this nature are willing to use enhancers. More typically, participants disclosed their willingness to use PEs if the cost-benefit ratio was favorable (e.g., *“I would be willing to try any that did not risk a long term impact on my health if tried in moderation.”* or *“If the benefits outweighed the risks”*) or if the game was important enough (e.g., *“largely yes, I would use enhancers if something was important enough”*).

Some of the participants that indicated that they would not take PEs conceded that the only thing inhibiting them is the legality of enhancer use. Several went on to say that they would take PEs in order to keep up with the competition if they were also using PEs.

6.6 Implications for Regulators and Perspectives on Fairness

We observed players at all skill levels being aware of PE usage. First, various PEs are perceived to be used in all levels of play. Many participants chose to disclose their own enhancer usage, evidencing that PE use is not just being perceived, but is actually occurring at all levels. Second, participants seem to be aware of the inherent health risk certain PEs pose. Third, as evidenced by the discussions surrounding fairness, the community seems to be concerned about the potential impact illicit performance enhancement may have on esports. Consequently, it is important to consider whether or not certain PEs should be allowed and if so, which and why?

The state of regulation is partially guided by whether or not the wider player base, consumers of esports, and esports athletes recognize illicit enhancement as a problem. By demonstrating that players are concerned about the use of PEs in esports, this work helps to path the way for additional regulation by esports leagues. This aligns with previous work on traditional sports, evidencing that people tend to favor stronger, as compared to weaker, regulations [98, 116]. Future research should aim to understand how enhancement with regards to fairness and its regulation in esports is perceived.

Researchers in governance and the legal field suggest that a centralized and effective regulation is necessary for esports to be legitimized alongside traditional sports [19, 54, 99]. However, currently, the governance structure in esports is still forming and in constant change with regards to policies against illicit performance enhancement [4, 32]. This is also complicated by the fact that game publishers are the biggest players in esports and, as they are competing businesses, it may be difficult to unite all publishers under one banner. Nevertheless, some tournament organizers such as the Electronic Sports League (ESL) have stated that they view doping similarly to other cheating practices such as match-fixing and that they will punish players accordingly if caught [55]. In a 2021 article, Fashina investigated the possibility of adapting WADA guidelines in esports [32]. According to the author, a PE needed to be regulated if it has the potential to boost performance, it poses a health risk to athletes and if it violates the spirit of the sport. However, even though organisations like the Esports Integrity Commission (ESIC) are trying to establish a anti-doping code, the infrastructure necessary (e.g., testing facilities) is not available yet. One possible way to facilitate this process would be for ESIC to become a WADA signatory, which would in turn allow ESIC to access WADA resources.

On a more practical and directly actionable level, two PEs are arguably the most prominent in esports: Adderall (and similar ADHD medications such as Ritalin) as well as energy drinks. If overused, both are bad for the athletes' health [3, 18] and both pose problems for regulators. Regulating ADHD medication is faced with the abuse of the therapeutic use exemption problem as well as the possibility that testing procedures are insufficient [53]. Energy drinks may seem less problematic at first glance, but the connection of energy drink companies and esports is a special case to consider as the continued partnership may be harmful to esports in the long run [36]. Frias (2022) argues that the relationship between energy drink companies and esports organisations undermines the foundations of any potential anti-doping policy [36]. The author argues that the aggressive marketing of energy drinks towards gamers, coupled with a sedentary lifestyle and the pressure to succeed creates a potentially large public health risk (see also [52, 55]).

Another possibility is the implementation of an esports equivalent of the WADA's biological passport for every athlete. WADA continuously monitors primarily an athlete's blood and their steroid levels as well as their performance over time. A similar procedure could be adapted for

esports, wherein an athlete's performance together with urine, blood or saliva samples to detect misuse of certain pharmaceuticals such as Adderall [114]. Apart from the technical and logistical difficulties this approach also has other problems. For example, if an indication for forbidden performance enhancement was a peak in performance on a specific day, that does not allow for people performing exceedingly well under pressure [80] and, in a more general sense, performance variance across time needs to be expected.

In sum, we echo past research, and recommend that esports teams, game developers, esports organization, and researchers engage in an ongoing dialogue to better establish effective regulations and legitimate use cases of performance enhancers.

6.7 Limitations

6.7.1 Reddit Scraper. Multiple terms used in the reddit scraper's keyword search proved to be terms with additional meaning in the context of certain games or esports communities, which led to a sizable number of false positives. To achieve a high data quality, we applied various filters and restrained our search to the top 500 posts and the top 500 comments (see Method section for details). While we believe that our data sample was sufficient for thematic saturation, there are likely some nuanced perspectives that this data set does not represent.

6.7.2 Survey. Beyond the typical limitations of survey methodology, we note several limitations and areas for future work. We maximized inclusion of professional players by recruiting from subreddits dedicated to esports, including esports teams (which are predominantly men). This has several implications on the demographics of the work. First, performance level in the sample ranges substantially, ranging from self-identified professionals to self-identified casual players. Second, the gender distribution of the survey is skewed towards men, limiting the range of perspectives disclosed. Future research and governing efforts, should aim to further investigate women's perspective on the topic of esports enhancement, as women may have different risk tolerances or health concerns. In addition to demographic limitations, we opted to use broad categories of PEs. This approach focused on breadth rather than depth. As there are many pharmaceuticals and drugs available that may impact the individual in different ways (e.g., stimulants vs. depressants vs. psychedelics), future work with a focus on pharmaceuticals and drugs should use a more fine-grained approach. Another important limitation is the self-selection that may have taken place. Potentially only those with concerns or personal use of PEs participated in the survey. With regards to the question about the perceived prevalence of PEs in professional play, there is a possibility of a regression to the mean, and as a consequence the absolute values of the perceived prevalence may not be fully accurate. Nevertheless, there is a statistically significant difference between the PEs and as each enhancer was evaluated by every survey respondent, the relational values are more credible.

6.7.3 Ad Comments. The sample that we draw from for our ad comments observations is limited in size and it is possible that a vocal minority is over-represented in the data. While we endeavoured to filter out irrelevant and untruthful comments, the pseudonymous nature of Reddit increases the likeliness of fabricated disclosures being erroneously included. Future research should aim to complement our in-the-wild data by conducting interviews with a few, trusted individuals.

6.8 Conclusion

This work is the first detailed investigation into the perceptions of performance enhancer usage in esports contexts. Our findings were triangulated around three data sets, including both prompted and unprompted reddit comments, as well as survey data. Through a mixed-methods approach, we answer five exploratory research questions. First, we evidence that users in online communities

disclose using performance enhancers to increase performance. Second, we contribute new understanding into how online communities discuss performance enhancers in esports and gaming contexts. Specifically, we describe a set of six themes that are further discussed in the context of self-usage and professional usage. Third, we provide evidence that some typical members of the esports community would be willing to use performance enhancers—particularly caffeine, food supplements, and PEs that are considered ‘natural’—and describe several circumstances under which PE usage may be considered justified (e.g., if there is no risk to health; if legal in tournaments; if medically prescribed). Notably, although not asked about personal usage of performance enhancers, many individuals disclosed the use of PEs both in a casual and a highly competitive setting. Fourth, we discuss the perceived reasons for enhancer usage among top-level players. Fifth, the data reveals a tangible consensus in the community, that professional esports athletes enhance their performance on a regular basis. This suggests a lack of trust in current drug testing practices.

Cumulatively, the core contribution of this work is a comprehensive investigation into community perspectives of performance enhancer usage in competitive gaming and esports. By evidencing that players are using PEs, and that players are concerned about the use of PEs in professional contexts, this work highlights the urgent need for further research, as well as regulation by esports leagues.

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