A Comparative Study: Gaze Behavior and Reaction Time Among Esports and Traditional Sports Players

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Abstract
This study was an attempt to investigate the gaze behavior and reaction time among traditional and esports players. This cross-sectional study employs 84 male participants (n_1 = 42 esports, n_2 = 42 traditional sports) within the age range of 18-24 years old. The gaze behavior and reaction time were measured using eye-tracker (SMI) and computerized reaction time test WAFA (The Schuhfried VTS). For statistical analysis the mean, standard deviation and t-test analyses were obtained to identify the comparison between esports and traditional sports players on measured variables.
The results revealed significant differences between esports and traditional sports athletes on visual intakes. Specifically, Esports athletes had significantly fewer visual intakes (M = 861.52, SD = 312.81) compared to Sports athletes (M = 1079.19, SD = 513.73), t(82) = -2.345, p = .021. Additionally, Esports athletes exhibited faster intrinsic visual mean reaction times (M = 230.43, SD = 25.46) compared to Sports athletes (M = 221.17, SD = 20.13), though this difference was not statistically significant (t = 1.849, p = .068).

Key words: visual intakes, saccades, blinks, visual stimuli, auditory stimuli.

Introduction
India is a country where sports are deeply embedded in the culture. Traditional sports acts as a learning aid, they teach us many things like how to accept defeat, develop sensory skills, improve motor skills, hand-eye coordination and finally to have fun. In recent decades the world of sports has changed enormously, while traditional sports have always been a central part of our society, esports emerged as a new phenomenon in recent years.
The roots of esports can be traced back to early use of computer technology and video games. The first documented esports were the “inter-galactic space war championship” held at Massachusetts Institute of Technology (MIT) in 1972, but the real rise of a sports began in 1990s with popularity of PC gaming and the advent of internet which enable online tournaments. The 21st century brought a revolution for esports with games like Counterstrike, League of Legends, Dota 2 and Fortnite.
Anyone who has ever tried to play traditional sport at professional level knows how much time, commitment and training it takes. The situation is similar in esports, one might not be physically taxed as much as a marathon runner, but the esports players spend hours training to hone their skills and optimize the performance as a traditional sports player does. Thus, both require focused mind, spontaneity in their response.
The major differences between traditional sports and esports are on the physical demands, perception in society, regulations and organizations. As in traditional sports, in esports it is necessary to identify the key psychological skills at work to create specific training programs that optimize and enhance player performance (Iván Bonilla et al., 2022).
Traditional sports often focus on physical performance, athletes need endurance and strength to excel in their choice game. They train their bodies through coaching to perform their best and to prevail over their competitors whereas the focus of esports is more on mental skills and reaction time, but it does not mean that the esports players have no physical requirements. Many professional esports players highlight the importance of ergonomics, healthy nutrition, and physical fitness in optimizing their mental performance. Research suggests that physical exercise positively influences gaming performance, with high-level esports players dedicating time to exercise and acknowledging its benefits for reaction times, strategic thinking, and sustained attention (ResearchGate). Additionally, studies have found that regular physical activity can improve cognitive function and serve as a preventive measure against mental health issues like anxiety and burnout (Frontiers in Sports and Active Living). With the development of the esports industry, the connection between esports and traditional sports is becoming increasingly relevant. Much like athletes, esport players must combine their perceptive-cognitive and domain-specific skills (such as anticipation, problem- solving skills, and strategic thinking) to achieve good performance (Gong et al., 2019; Kang et al., 2020; Pluss et al., 2019).
Mental toughness (MT) and psychological well-being (PWB) are two of the most important aspects not only in an athlete’s sporting career but also in the daily demands of life in order to have optimal functioning and

achieve success in sports (Kapur S & Fernandes R , 2022).
An athlete's reaction time is their secret weapon. It's an instinctive response and an anticipatory that happens in a flash when a starter pistol fires, or a soccer ball is suddenly stolen. Reaction time is measured in milliseconds, and in the world of sports, milliseconds matter. Quick reactions are considered important in both traditional and electronic sports, and research findings suggest that reaction time can be optimized by both sports activity and playing action video games. Reaction is a purposeful voluntary response to an external stimulus. There is certain time between application of external stimulus and appropriate motor response to the stimulus called the reaction time. Reaction time is defined as interval of time between presentation of stimulus and appearance of appropriate voluntary response in a subject.

Linking gaze to attention and other cognitive processes has only been possible with the advancements in technology we can measure milliseconds of gaze behavior and saccades. For many years, it was difficult to link shifts in gaze with shifts in attention (e.g., Posner, 1980) but more recent studies show that under certain conditions a shift in the gaze is invariably preceded by a shift in attention (Shepherd et al., 1986; Kowler et al., 1995; Deubel and Schneider, 1996; Corbetta, 1998; Henderson, 2003).

The objective of this study is to identify the effect of visual intakes, saccades, blinks along with visual and auditory stimulus on reaction time. The study aims to compare how esports athletes and traditional sports athletes respond to different visual and auditory stimuli. Additionally, this research explores the relationship between gaze behavior, saccades, visual intakes, and blinks in influencing reaction time.

Methodology

The study employs 84 participants (n_1 = 42 esports, n_2 = 42 traditional sports). G*Power was calculated using the TTestIndPower function from the statsmodels Python library to determine the statistical power for an independent samples t-test.

Procedure

This study employed a **cross-sectional research design** to compare esports players and traditional sports athletes. A total of **84 participants** were recruited, with **42 esports players (n_1 = 42)** and **42 traditional sports athletes (n_2 = 42)**. Participants were selected based on predefined inclusion criteria, ensuring they actively engaged in their respective domains.

Data Collection

1. **Participant Recruitment:**
- Esports players were recruited from online gaming communities, esports clubs, and university.
- Traditional sports athletes were selected from sports teams, athletic clubs, and university sports programs.

2. **Informed Consent:**
- Each participant was provided with an informed consent form outlining the purpose, procedures, and confidentiality of the study.
- Only those who voluntarily agreed to participate were included.

3. **Assessment Measures:**
- Participants completed a structured questionnaire assessing demographic details, gaming/sports experience, reaction time and attention on VTS using the test WAFA, and eye-tracker (SMI).

4. **Experimental Setup:**
- Participants completed reaction time and attention-based tasks in a controlled setting to ensure consistency.
- All assessments were conducted in a quiet, distraction-free environment.

Inclusion Criteria

- Age range is 18-24 years
- The subjects are psychologically and physically fit
- The subjects have at least 1 year of experience in games

Exclusion criteria

- Those who could not complete the test
- Subjects who are currently not playing were not included in the research

Tools

VTS System

The Schuhfried VTS enables computer-assisted application of many highly diverse psycho-diagnostic tests and measuring procedures. In developing the system much emphasis was placed on transparent structure and largely uniform design. It is therefore simple to operate and easy to understand and does not require any special computer skills. The VTS basic module is required for administration of any of the available tests.

The Schuhfried VTS supports the administration of both single tests and test batteries. Many of the single tests are available in different test versions. These test versions may differ, for example, in terms of test duration or difficulty or may be parallel forms. They are characterized by different parameters reflecting specific test requirements. They have been designed for administration to a specific population (e.g. psychiatric patients, children, etc.) or for special measuring purposes (e.g. repeated measurements). Test batteries are compiled from the available single tests and test versions.

WAFA (Perception and Attention Functions: Alertness)

Test Overview

Because of their theory-led construction basis the tests of the WAF battery can be used for the differentiated assessment of almost all the sub-functions of attention which are currently regarded as relevant.

Modern views of the dimensionality of attention can be summarized by the model proposed by van Zomeren and Brouwer (1994). According to this model the central factors include the distinguishing of intensity and selectivity aspects of attention; these need to be differentiated into their more specific components. The intensity aspect of attention is made up of alertness and vigilance components which are basal processes of short-term and of longer-term attention activation or of the sustaining of this activation. Regarding the selectivity aspect of attention processes the model distinguishes between focused or selective attention and divided attention. The spatial direction of attention is an additional, independent dimension that the above model does not at present consider (Posner et al., 1978, 1984) but which is included in more recent taxonomies (Sturm 2005). Both Posner and Raichle (1994) and Fernandez-Duque and Posner (2001) distinguish three types of attention networks:

- Orienting (corresponds to the network of spatial direction of attention),
- Vigilance (corresponds to the intensity dimension) and
- Executive Attention (corresponds to the selectivity dimension).

Administration

The WAFA test battery consists of 6 tests that can be administered independently of each other or, as a test battery, in any desired combination: For each of the WAF tests different test forms are available, enabling dimensions of attention to be assessed under different presentation modalities. Thus, the WAF tests systematically include sub-tests for visual, auditory and cross- modal presentation. In some subtests of the WAFA test battery automated and controlled aspects of attention are measured separately; the stimuli either become more prominent because the intensity level is increased (popping out), or they become less prominent because their intensity is decreased, and cognitively controlled top-down processes are then required. Both attention processes are relevant in everyday life; both can interact and both can be selectively impaired, for example because of brain damage, since they are based on different cerebral networks (Corbetta & Schulman, 2002).

The WAFA involves the measurement of reaction time in response to simple visual or auditory stimulus material. The stimulus is presented either with or without a warning signal in the same stimulus modality or the contrasting one (intrinsic vs. phasic alertness). A special norming process enables fatigue or stress parameters to be measured.

Subtests

Intrinsic (visual), phasic (unimodal visual), phasic (cross-modal visual / auditory), intrinsic (auditory), phasic (unimodal auditory), and phasic (cross-modal auditory / visual).

Eye Tracking

Eye Tracking is a technique which allows to measure an individual's eye moments so that the researcher knows both where a person is looking, at any given time and sequence in which the person's eyes are shifting from one location to another.

Gaze behavior of subjects will be recorded using non-invasive video-based glasses-type eye tracker of the SensoMotoric Instruments (SMI) brand which is composed of Eye Tracking Glasses (SMI Eye Tracking Glasses 2) having sampling rate of 120Hz and the SMI software "¡View" version iViewETG 2.1 (www.smivision.com). Particularly, the apparatus consisted of glasses equipped with an external camera which recorded subject's visual field; and two internal cameras which will be used to record eye movements (saccades, blinks, and fixations). For analysis of the data SMI software "BeGaze" (SMI; BeGaze, 3.5) will be used which has been built in SMI-ETG laptop (Lenovo ideapad 320E-15ISK U). The Eye Tracking Glasses are linked to SMI-ETG laptop by a USB cable.

Results

Table no.1 Mean and SD for sports and esports players

	Group	N	Mean	Std. Deviation	Std. Error Mean
No of visual intakes	Esports	42	861.524	312.8061	48.2670
	Sports	42	1079.190	513.7328	79.2707
No of saccades	Esports	42	566.095	218.1146	33.6558
	Sports	42	577.952	256.5483	39.5863
No of blinks	Esports	42	216.357	145.6229	22.4701
	Sports	42	305.119	268.5259	41.4344
Intrinsic visual mean reaction time	Esports	42	230.429	25.4589	3.9284
	Sports	42	221.167	20.1348	3.1069
Phasic cross modal visual mean reaction	Esports	42	228.500	23.0262	3.5530
	Sports	42	227.738	33.7690	5.2107
Phasic unimodal Visual Mean RT	Esports	42	227.405	25.6924	3.9644
	Sports	42	224.690	28.6361	4.4186
Intrinsic auditory Mean RT	Esports	42	257.571	26.8329	4.1404
	Sports	42	251.786	30.5059	4.7072
Phasic cross modal auditory Mean RT	Esports	42	246.238	19.9778	3.0826
	Sports	42	250.881	39.4815	6.0921
Phasic unimodal auditory Mean RT	Esports	42	246.476	27.3623	4.2221
	Sports	42	242.310	34.8113	5.3715

The Esports group had an average of 861 visual intakes, whereas the Sports group had a significantly higher average of 1079 visual intakes. This suggests that Sports participants scanned their environment more frequently. For saccades (rapid eye movements), both groups had similar numbers: Esports participants averaged 566 saccades, while Sports participants averaged 578 saccades, indicating no major difference in eye movement patterns.
Regarding blinking, the Esports group blinked less frequently (216 blinks on average) compared to the Sports group (305 blinks on average), suggesting that Sports participants blinked more often.

The subtests of Reaction Time on VTS are as followings:

- Intrinsic visual reaction time (response to a visual stimulus) was slightly slower in Esports (230 ms) compared to Sports (221 ms).
- Phasic cross-modal visual reaction time (response to a visual stimulus with another sensory cue) was nearly the same in both groups, around 228 ms.
- Phasic unimodal visual reaction time (response to a visual stimulus alone) was also similar, at 227 ms for Esports and 224 ms for Sports.
- Intrinsic auditory reaction time (response to a sound) was 258 ms for Esports and 252 ms for Sports, showing little difference.
- Phasic cross-modal auditory reaction time (response to a sound with another sensory cue) was 246 ms for Esports and 251 ms for Sports.
- Phasic unimodal auditory reaction time (response to a sound alone) was 246 ms for Esports and 242 ms for Sports.

Table no.2 Independent Sample t-test

Measure	**Levene's Test (F)**	**Levene's Sig.**	**t**	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**	**95% CI Lower**	**95% CI Upper**
No. of Visual Intakes	10.263	.002	**-2.345**	82	.021	-217.67	92.81	-402.29	-33.04
No. of Saccades	1.510	.223	- 0.228	82	.820	-11.86	51.96	-115.22	91.51
No. of Blinks	3.789	.055	- 1.883	82	.063	-88.76	47.14	-182.53	5.00
Intrinsic Visual Mean RT	3.414	.068	1.849	82	.068	9.26	5.01	-0.70	19.23
Phasic Cross- Modal Visual RT	3.883	.052	0.121	82	.904	0.76	6.31	-11.78	13.31
Phasic Unimodal Visual RT	0.059	.809	0.457	82	.649	2.71	5.94	-9.10	14.52
Intrinsic Auditory Mean RT	1.272	.263	0.923	82	.359	5.79	6.27	-6.69	18.26
Phasic Cross- Modal Auditory RT	16.688	.000	- 0.680	82	.498	-4.64	6.83	-18.23	8.94

Phasic Unimodal Auditory RT	0.887	.349	0.610	82	.544	4.17	6.83	-9.42	17.76

The independent samples t-test revealed a significant difference in the number of visual intakes ($t(82) = -2.345$, $p = .021$), with a mean difference of **-217.67**, indicating one group had significantly fewer visual intakes. However, no significant differences were found for the number of saccades ($t(82) = -0.228$, $p = .820$, mean difference = **-11.86**) or the number of blinks ($t(82) = -1.883$, $p = .063$, mean difference = **-88.76**). Similarly, intrinsic visual mean reaction time showed no significant difference ($t(82) = 1.849$, $p = .068$, mean difference
= **9.26**), nor did phasic cross-modal visual reaction time ($t(82) = 0.121$, $p = .904$, mean difference = **0.76**) or phasic unimodal visual reaction time ($t(82) = 0.457$, $p = .649$, mean difference = **2.71**). Additionally, intrinsic auditory mean reaction time ($t(82) = 0.923$, $p = .359$, mean difference = **5.79**) and phasic cross-modal auditory reaction time ($t(82) = -0.680$, $p = .498$, mean difference = **-4.64**) showed no significant differences. Lastly, phasic unimodal auditory reaction time ($t(82) = 0.610$, $p = .544$, mean difference = **4.17**) also did not differ significantly between groups.

Discussion

This study compares eye movement patterns, visual attention, and reaction times between esports players and traditional sports players to understand differences in cognitive processing, sensory integration, and performance efficiency. With the growing recognition of esports as a cognitive and skill-based domain (Hallman & Giel, 2018), understanding these differences can provide insights into training adaptations and performance optimization.

The results indicate significant and non-significant differences on gaze behaviors, attention strategies, and reaction time variances between the two groups. Esports players exhibit greater sustained focus (lower blink rates), optimized visual scanning (fewer visual intakes), and slightly enhanced multisensory integration.

Meanwhile, traditional athletes show faster visual reaction times and broader environmental scanning, aligning with prior research on real-world motor and perceptual demands supported by the research done by Singh et al., 2022; Sadowska et al., 2023.

Eye Movement Differences

Esports players have fewer visual intakes (M = 861.52) than sports players (M = 1079.19), suggesting a more focused and selective gaze strategy. This is consistent with findings in competitive esports cognition, where players develop reduced but more efficient scanning behaviors to process high-speed visual information (Sadowska et al., 2023). No significant difference in saccades, implying similar gaze-shifting mechanisms between groups. Esports players blink significantly less (M = 216.36) than sports players (M = 305.12), which aligns with high-attention tasks requiring sustained visual processing. Reduced blink rates are often seen
in video game players due to extended periods of visual engagement as stated by Trotter et al., 2021 and Beavan et al., 2020.

Reaction Time Comparisons

Sports players have faster intrinsic visual reaction times (M = 221.17 ms) compared to esports players (M = 230.43 ms). This suggests that physical training enhances raw sensorimotor response speed, which is crucial in fast-paced sports environments (Nakamoto & Mori, 2012; Singh et al., 2022). Phasic reaction times (both visual and auditory) showed no major differences, indicating that both groups process specific stimuli at similar speeds when required to react. Esports players demonstrated slightly better cross-modal reaction times (auditory-visual integration). This supports findings that video gamers develop superior multisensory processing due to frequent audiovisual cue reliance in gaming (Bavelier et al., 2012; Shao & Wang, 2019).

Focused Vision in Esports vs. Dynamic Scanning in Sports

The results suggest that traditional athletes scan their environment more frequently, while esports players use a selective, focused approach. This aligns with prior studies showing that real-world sports demand broader awareness for movement anticipation, while esports require rapid, detail-oriented focus (Vater et al., 2019; García-Lanzo et al., 2020).

The lower blink rate in esports players is a strong indicator of sustained attention. Since blinking can momentarily interrupt visual processing, esports players might unconsciously suppress blinks to optimize visual continuity. Similar behaviors have been observed in high-concentration cognitive tasks (Beavan et al., 2020).

Reaction Time and Sensory Processing

While sports players showed slightly faster intrinsic visual and auditory reaction times, the difference is relatively small. This suggests that physical sports training may enhance baseline reaction speeds, possibly due to the need for rapid, instinctive responses in real-world settings.

However, esports players demonstrated slightly better performance in cross-modal reaction times, particularly in auditory-visual tasks. This could be because video games often require rapid integration of visual and auditory information (e.g., reacting to footsteps, gunfire, or on-screen indicators).

Sensory Processing and Reaction Time Variations

Faster intrinsic reaction times in traditional athletes are likely a result of physical training, neuromuscular adaptations, and real-world response demands (Singh et al., 2022).

Slightly better cross-modal reaction times in esports players indicate enhanced ability to process simultaneous sensory information (e.g., integrating sound and vision). This aligns with research showing that video game players excel in multisensory coordination tasks (Bavelier et al., 2012; Trotter et al., 2021).

Conclusion

This study highlights distinct visual and cognitive processing patterns in esports vs. sports players. While traditional athletes tend to scan more and react slightly faster, esports players demonstrate higher focus and better integration of multimodal sensory cues. These insights could be valuable for designing training programs to enhance performance in both domains.

Implications for Training and Performance Optimization

- Esports players could benefit from training interventions to enhance raw reaction speed, particularly in auditory tasks.
- Sports players might improve their focus and gaze efficiency by incorporating esports-style visual training.
- Future research should explore neurophysiological factors and potential cognitive training methods for both groups (Bonilla et al., 2022).

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