

## Research Paper

# Autonomic Activities in Cases of Post-traumatic Stress Disorder Through Virtual Reconstruction of Trauma



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## ABSTRACT

**Background:** In Iran, one of the main duties of forensic psychiatrists is to accurately diagnose post-traumatic stress disorder (PTSD). In order to achieve a more accurate diagnosis and reduce the possibility of deception, the autonomic reactions of patients with PTSD were investigated through virtual reconstructed trauma.

**Methods:** The autonomic activities of 80 patients who were diagnosed with PTSD by psychiatric interview based on the diagnostic and statistical manual of mental disorders, fifth edition (DSM-5) and PTSD checklist for DSM-5 (PCL-5) checklists, were recorded by an electronic wristband through virtual trauma exposure. Data were collected and analyzed by SPSS software, version 16.

**Results:** The galvanic skin response, heart rate, and body temperature can be the most reliable automatic reactions to diagnose true cases of PTSD.

**Conclusion:** The findings of this study along with psychometric tests can be used to distinguish between true cases of PTSD and fake cases.

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## Introduction

Post-traumatic stress disorder (PTSD) is of special importance in forensic studies due to the high probability of simulation or exaggeration of symptoms. The disorder may occur after exposure to actual or threatened events, such as a robbery attack or a severe car accident. According to the diagnostic and statistical manual of mental disorders, fifth edition (DSM-5), the duration of disturbance, including the main criteria is more than one month [1].

When an individual's claim is corroborated by a psychiatric report, it lends greater credibility in court. The diagnosis of PTSD primarily depends on psychiatric interviews and the self-reported symptoms of the individual, raising the possibility that some patients might exaggerate their symptoms or the severity of their condition, a concern that psychiatrists need to be mindful of [2].

It is more common for clients at certain medical centers, including those involved in legal medicine, to feign symptoms as a strategy to obtain financial and legal advantages. The fabrication of signs or symptoms of mental disorders could be seen among individuals from the lower socioeconomic levels of society aiming to gain more benefits. Typically, these individuals simulate straightforward symptoms such as behavioral, mood, and emotional disorders [3].

Currently, the diagnosis of PTSD relies on psychiatric interviews. However, given psychiatry's role in forensic medicine and the increased chance of clients feigning symptoms, there is a pressing need for more objective diagnostic methods beyond psychiatric interviews. PTSD is a disorder that is diagnosed based on the symptoms and is relatively easy to feign. For example, a study in the United States reported that symptoms were exaggerated by half of the 74 war veterans who were applying for service-related disability pensions [4]. Unfortunately, the exact prevalence of such cases is not known, as those who successfully feign symptoms are not usually detected. Also, people who pretend to have PTSD often have some kind of traumatic background [5]. In addition, significant criteria for PTSD diagnosis include the mental re-enactment of the traumatic event and the avoidance of memories, thoughts, and feelings associated with the incident [6], thus, they might convincingly present feigned symptoms as real.

A recent study found that forensic experts were suspicious about their ability to diagnose abusers, with

only 4% confident in their success rate. Hickling et al. arranged for actors to visit a specialized PTSD clinic and display fabricated symptoms of the disorder. In this study, it was found that none of the actors were identified as fraudsters [7].

The tendency of some individuals to feign the symptoms of PTSD, coupled with the professionals' cautious approach to diagnosing deception, fuels the belief that PTSD might be overdiagnosed, particularly within legal contexts [8]. When physicians trust these clinical diagnostic criteria, they detect only 20% of fraudsters. Some people may fake their symptoms, others may exaggerate existing complaints, and others may attribute the actual symptoms to the traumatic trauma [9]. These three forms of deception are commonly observed among those pretending to have PTSD.

Currently, there are some psychometric tools that may help to detect simulation or exaggeration of symptoms. These tools are collectively known as symptom validity tests. These tests typically involve straightforward memory or comprehension tasks requiring a choice between two options. Even individuals with significant neurological impairments can perform well on these tests, as random guessing can yield a correct answer rate of 50%. Therefore, scoring below 50% suggests a higher likelihood of deliberately incorrect responses [10]. Some researchers believe that using tasks that rely on reaction time, rather than tasks that rely on self-report, may help diagnose aggression [11].

When the assessment of the symptoms of PTSD is mainly based on the individual's report, simulation or fabrication of symptoms emerges as a significant concern. We need to determine the level of stress reactions in real cases of PTSD so that the level of these reactions in people who claim to have PTSD can be assessed. This approach will enhance diagnostic precision and provide more reliable expert opinions to the judicial system.

Many studies have been performed on autonomic activity in PTSD, yet none have explored this area within the Iranian population using virtual trauma reconstruction until now. This study aimed to assess the efficiency of technology in distinguishing between genuine PTSD cases and those that are imitated or simulated.

In recent years, 3D digital technologies have been used to create scene reconstruction. The adoption of computer animation techniques for reconstructing crime scenes is becoming more popular in criminal investigations today, replacing traditional methods [12]. In such cases, the re-

**Table 1.** Characteristics of reconstructed virtual trauma

Virtual Trauma	Neutral duration (m)	Duration of stress (m)	Description
Car accident	1	4	The subject is placed inside a virtual car that crashes several times with objects and other cars.
War	1	5	The subject is placed as the first person in a battleground that includes shooting and explosions.
Quarrel	1	3	The subject is placed in a virtual environment where several people are fighting and are beaten several times as the first person.
Falling from a height	1	5	The subject looks down from the point of view of a person who is climbing a telecommunication tower.

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construction of the crime scene and observation of the defendant's behavior play crucial roles in the criminal investigation process.

The goal of the study was to find a more accurate instrument to detect true cases with PTSD and simulated ones, thereby moving beyond reliance on psychiatric interviews for expert opinions. Despite psychiatrists' focus on accuracy and reliability, these interviews are sometimes questioned by the public and courts.

## Materials and Methods

At baseline, virtual stressful traumas were designed in a virtual reality device to resemble real trauma. The characteristics of virtual traumas are mentioned in [Table 1](#).

The study participants were people referred by the judicial system to the Legal Medicine Office, to confirm their PTSD claims, from December 2018 to February 2021.

Typically, the most common cases referred to forensic psychiatrists at the [Legal Medicine Research Center](#), in order of frequency, include car accidents, fights, falls from heights, sexual assaults, and military incidents. Due to the ethical considerations in creating a virtual space for rape cases, we practically excluded these cases from the study. Each participant was evaluated only in environments that replicated the alleged incident and were exposed to a specifically prepared virtual trauma reflecting that incident.

The inclusion criterion, regardless of gender, was people between the ages of 18 and 48 years. The diagnosis was made by an expert psychiatrist based on a psychiatric interview and the PTSD Checklist for DSM-5 (PCL-5) checklist, which was developed by the National Veterans Affairs Center for PTSD [13]. The control group was selected from students, staff, and companions of clients

who exhibited neurotic symptoms but did not fulfill the PTSD criteria according to the comprehensive psychiatric interview and PCL-5 questionnaire. They were matched with the study group regarding demographic characteristics. Exclusion criteria were a history of brain injury, seizures, high blood pressure, or heart disease.

Both groups signed the written informed consent and entered the study. Then, they were exposed to a virtual space similar to the real traumatic event and at the same time, their galvanic skin response, heart rate response, respiratory reaction, temperature changes, and muscle tone reaction were recorded by the EMPATICA-E4 sensitive wristband and recorded in the corresponding software. Six participants withdrew before completing the exposure due to significant stress.

The results obtained in this research were collected in the Excel software and then analyzed by SPSS 16 software.

## Results

[Table 2](#) shows the changes in the reactions of the two groups through exposure to the virtual trauma.

The skin's reaction to virtual trauma, determined by the system's sensitivity to skin perspiration, was measured. A t-test was conducted to statistically analyze the differences between the two groups. The analysis revealed a significant difference in the average galvanic skin response between the PTSD and non-PTSD groups. ( $P=0.029$ ), indicating that the skin reaction level could serve as a critical diagnostic marker ([Table 2](#)).

The skin temperature changes were statistically analyzed by a t-test, revealing a significant difference in mean skin temperature between the two groups ( $P=0.011$ ). This finding means that skin temperature dur-

**Table 2.** The Mean±SD of the studied variables in the two groups

Variables	Groups	No.	Min	Max	Mean±SD	P
Galvanic skin response	Non-PTSD	80	0.00	1.61	0.438±0.623	0.029
	PTSD	80	0.00	2.24	0.484±0.574	
Temperature	Non-PTSD	80	22.56	34.38	31.097±2.127	0.011
	PTSD	80	25.24	34.43	30.159±2.458	
Muscle tone	Non-PTSD	80	10.43	41.55	19.777±13.427	0.218
	PTSD	80	26.00	57.40	18.758±19.105	
Heart rate response	Non-PTSD	80	70.86	88.02	78.071±4.926	0.00
	PTSD	80	95.10	140.00	118.648±11.227	
Breathing	Non-PTSD	80	0.03	1.71	0.434±0.500	0.907
	PTSD	80	0.04	1.62	0.442±0.411	

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ing exposure to virtual trauma can be used as an indicator to confirm the diagnosis.

Also, a statistical analysis comparing the two groups found no significant difference in the mean muscle tone response between individuals with and without PTSD (P=0.218).

Heart rate response to stress is a crucial marker of vitality and autonomic activity. A t-test conducted between the two groups showed a significant difference in heart rate response (P=0.000). This means that the increase in heart rate in the group of people with PTSD following exposure to virtual trauma increased significantly.

There was a significant difference in galvanic skin reaction, skin temperature, and heart rate response between the groups, but the difference in the mean respiratory response between the two groups was not significant. (P=0.907)

The chi-square test was used to examine the relationship between the main variables of age and sex. The results showed that age did not significantly affect galvanic skin response (P=0.686), body temperature (P=0.739), and heart rate response (P=0.595) in people with PTSD. Conversely, gender significantly impacted the galvanic skin response (P=0.015), temperature (P=0.000), and heart rate response (P=0.001) in individuals with PTSD, as shown in Table 3.

Galvanic skin reaction, temperature, and heart rate response were significantly higher in men than in women. (P=0.015) Also, the galvanic skin response varies with occupation, education level, and marital status among individuals with PTSD, with significant differences as detailed in Table 4.

## Discussion

PTSD can develop after a traumatic event and is characterized by four clusters of symptoms: Recurrent distressing memories, avoidance, negative changes in cognition and mood, and marked changes in arousal and reactivity [14].

In legal contexts, the potential for individuals to feign mental disorders and deceive evaluators, particularly those referred for psychiatric evaluations, must always be considered by assessors.

In court, verification of a mental disorder claim can serve as a mitigating factor (for defendants) or as grounds for compensation (for trauma victims). Therefore, a forensic psychiatrist plays an important role in detecting simulation, exaggeration, or faked symptoms from true symptoms, but little is known about the most common symptoms imitated by patients. In a society where litigation is common, psychiatrists may need to assess the authenticity of psychiatric or behavioral symptoms claimed to result from trauma, be it psychological or physical. The actual incidence of malingered psychological symptoms after a physical injury is unknown, but one study

**Table 3.** Mean±SD of galvanic skin response, heart rate response and temperature in patients exposed to virtual trauma according to age and sex

	Parameters	No.	Min	Max	Mean±SD	P
Galvanic skin response	Age groups (y)	18-25	8	0.13	1.61	0.774±0.617
		26-33	18	0.01	1.50	0.294±0.475
		34-41	28	0.00	2.24	0.564±0.653
		41-48	26	0.00	1.25	0.439±0.530
	Sex	Male	56	0.00	2.24	0.453±0.561
		Female	24	0.01	1.61	0.558±0.608
Heart rate response	Age groups (y)	18-25	8	108.73	127.95	119.938±7.690
		26-33	18	99.11	134.00	115.001±11.181
		34-41	28	98.99	138.00	120.676±10.508
		42-48	26	95.10	140.00	118.576±13.019
	Sex	Male	56	95.10	140.00	119.613±11.167
		Female	24	99.11	138.00	116.394±11.275
Temperature	Age groups (y)	18-25	8	22.56	32.52	29.56±0.721
		26-33	18	25.24	34.40	30.81±0.303
		34-41	28	25.51	34.38	30.54±0.307
		42-48	26	25.85	34.43	30.94±0.362
	Sex	Male	56	22.56	34.43	30.37±0.251
		Female	24	25.25	34.38	31.00±0.266

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found that 48 out of 50 cases of post-accident neurosis resolved within two years after the legal claim was settled. Furthermore, a U.S. General Accounting Office study reported in 1980 found that approximately 40% of individuals deemed totally disabled had no disability one year later. Such findings imply a high incidence of exaggerated symptoms and highlight the importance of considering malingering in these evaluations [15].

Some studies have been conducted to identify the true causes of PTSD, and some of these studies have highlighted the difficulty of identifying the real cases, especially when it comes to claiming financial compensation. Freeman et al. [4], Guriel and Fremouw [5], Hickling Hickling [7], Resnick [9], and McNally and Frueh [16] are among those who have confirmed this in their studies. Some have suggested psychological tests and some noted monitoring the persistence of symptoms to deal

with this problem. Norte et al. found that both PTSD patients and individuals exposed to trauma but without PTSD exhibited a significant heart rate increase upon exposure to their personal traumatic events. However, while PTSD patients maintained this elevated heart rate, the control group's heart rate returned to baseline levels. In PTSD patients, sustained heart rate was positively associated with re-experiencing symptoms [17]. Paulus et al. studied patients referred to the outpatient psychiatric services of war-injured patients. They found that patients with PTSD had higher systolic and diastolic blood pressure and heart rate than those without PTSD. Then, they measured the effect of trauma on blood pressure and found that the difference between the two groups was significant. They suggested that the cardiovascular system is more susceptible to PTSD [18]. Dibajnia and Zahiruddin found significant increases in blood pressure, heart rate, and the number of complications in patients

**Table 4.** Mean±SD of galvanic skin response, in patients exposed to virtual trauma according to the job, education and marital status

Parameters		No.	Min	Max	Mean±SD	P	
Galvanic skin response	Job	Self-employed	6	0.13	1.61	0.912±0.664	0.002
		Clerk	14	0.00	0.02	0.435±0.382	
		Worker	24	0.01	2.24	0.610±0.759	
		Unemployed	26	0.00	0.97	0.272±0.331	
		Housewife	10	0.01	1.25	0.548±0.596	
	Education	Primary school	8	0.02	1.40	0.980±0.596	0.000
		High school	10	0.01	0.51	0.189±0.217	
		Diploma	38	0.00	2.24	0.460±0.628	
		Academic	24	0.00	1.61	0.480±0.495	
	Marital status	Married	42	0.00	1.25	0.352±0.415	0.020
		Single	30	0.01	1.61	0.545±0.557	
		Divorced or widow	8	0.00	2.24	0.949±1.027	

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with PTSD by recalling the incident [19]. A review of existing literature indicates that while these changes have been primarily assessed through mental imagery and event perception, less research has been conducted using virtual reconstruction.

The application of 3D space-making technologies for crime scene simulation has, in some instances, provided new avenues for solving criminal puzzles. Recently, the use of computer animation techniques to reconstruct crime scenes instead of traditional methods, images, and oral or written explanations has increased the use of these techniques in forensic research [12]. The virtual reconstruction of trauma, especially in cases where individuals claim PTSD amidst criminal matters, should become a focal point for forensic psychiatrists in Iran.

In this study, the use of virtual reconstruction of trauma to determine the level of autonomic reactions and its differences in patients with PTSD with those without the disorder was considered. The findings highlighted the significance of the gender variable in influencing the occurrence of critical-level reactions. Reviewing the published scientific literature on the role of virtual trauma reconstruction in the diagnosis and treatment of PTSD suggests that this technique can effectively differentiate between individuals with the disorder and those without it. This method could be helpful along with various psy-

chological tests. By integrating multiple psychological tests and considering that a patient might report exaggerated symptoms in only two or more tests, the likelihood of false positives is reduced to below 5% [11]. Therefore, combining the findings of this study with psychometric tests could be an effective strategy for distinguishing between genuine and feigned cases.

The findings of this study showed that the most reliable autonomic reactions are changes in galvanic skin response, heart rate response, and body temperature. The findings of this study are consistent with those of Norte et al. [17], Paulus et al. [18], and Dibajnia et al. [19]. Paulus et al. found that patients with PTSD had higher blood pressure and heart rate than those without the disorder [18]. In this study, the respiratory rate and muscle tone did not show significant changes. The short duration of the test (due to the short duration of the virtual trauma display to prevent adverse events for the subjects) likely influenced the results.

## Conclusion

In cases involving claims of mental harm due to trauma, judges seek to ascertain the authenticity of PTSD claims and the extent of emotional damage incurred. Courts generally place greater trust in psychiatric diagnoses informed by or the use of psychological or

biological instruments than those based solely on interviews. Monitoring autonomic responses by immersing PTSD claimants in virtual trauma scenarios can yield data that is more dependable than that obtained through traditional face-to-face interviews. Thus, adopting such diagnostic approaches can help to clarify uncertainties and resolve doubts among legal professionals and insurance evaluators.

### Limitations

During the course of the study, the coronavirus disease pandemic and concerns regarding the use of oculus devices on the heads and eyes of participants, due to the potential for viral transmission, resulted in a several-month delay. However, thanks to the diligent efforts of the experts at the [Legal Medicine Research Center](#), the research was able to proceed and was ultimately conducted in early 2021. This study can be a guide for more complete research in the future. Future endeavors in this field may include the development of a broader array of virtual traumas and the creation of more conducive research conditions for a larger and more diverse cohort of patients, including war victims, those affected by terrorist acts, and natural disaster survivors.

### Ethical Considerations

#### Compliance with ethical guidelines

This cross-sectional descriptive study was conducted at the Central Office of [Iranian Legal Medicine Organization](#) of Tehran Province and the [Legal Medicine Research Center](#), (Ethical Code: IR.LMO.REC.1396.24). Also the participants signed written informed consent to confirm ethics approval and consent to participate.

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#### Authors' contributions

Study design: Davood Mirtorabi and Ali Yoonessi; Implementation the project: Seyed Mehdi Saberi and Armindokht Ahmadi; Data analysis: Rahmanian and Armindokht Ahmadi; Writing the manuscript: Seyed Mehdi Saberi.

#### Conflict of interest

The authors declared no conflict of interest.

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