



# Perceptual Sensitivity of Psychogenic Nonepileptic Seizure (PNES) Patients

Priyesh Kumar Singh<sup>1</sup>

<sup>1</sup>Department of Cognitive Sciences and Psychology, School of Social and Behavioral Sciences, Amrita Vishwa Vidyapeetham, Kollam, Kerala, India

**Address for correspondence** Priyesh Kumar Singh, PhD, Department of Cognitive Sciences and Psychology, School of Social and Behavioral Sciences, Amrita Vishwa Vidyapeetham, Kollam 690525, Kerala, India (e-mail: priyeshr18@gmail.com).

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## Abstract

**Aim** The aim of the present study was assess the perceptual sensitivity of psychogenic nonepileptic seizure (PNES) patients. Secondly, we also aimed to replicate previous findings and explore whether PNES patients exhibit tendencies of preattentiveness in response to unpleasant stimulus.

**Method** A total of 56 individuals were selected for the present research, from which 28 were PNES patients and 28 healthy individuals. A  $2 \times 3$  design was used for the present study. The emotional-N-back paradigm was used for presenting stimuli. Perceptual sensitivity ( $d'$ ) was calculated on the basis of hits and false positives.

**Result** The result of analysis of variance (ANOVA) showed significant distinction between PNES and healthy individuals on perceptual sensitivity ( $d'$ ) measure ( $F(1, 50) = 19.11, p = 0.000$ ). Similarly, result of ANOVA ( $F(2, 100) = 63.64, p = 0.000$ ) for within-group valence showed a significant difference between pleasant, unpleasant, and neutral stimuli among PNES and healthy individuals ensuring a clear distinction between them.

**Conclusion** These findings suggest a notable disparity in perceptual sensitivity between PNES and healthy individuals, supporting the notion that individual with PNES experience emotional disturbance and possess a dysfunctional cognitive-affective system. Moreover, the result lends credence to the hypothesis that PNES patients are more responsive to unpleasant emotions than to pleasant or neutral ones.

## Keywords

- ▶ PNES
- ▶ perceptual sensitivity
- ▶ valence
- ▶ pathology
- ▶ IAPS

## Introduction

In the field of neurology one of the most intriguing pathologies that has gained significant attention in the past decades is psychogenic nonepileptic seizures (PNES), though its routes can be found during the time of Gower and Mandeville around 1730,<sup>1</sup> it gained significant attention in 1920 after the seminal work of Sigmund Freud on hystero-epilepsy. There are two contrary perspectives that have drawn a significant attention to the group of researchers who are

working to uncover the etiology of PNES. The first one is psychological perspective<sup>2</sup> and the second one is biological perspective. The wing of researchers who support the psychological perspective believe that seizures in PNES patients are mainly functional in nature, having a clear sign of behavioral maladjustment with psychological turmoil, as the prime causative factor. On the other hand, biological perspective advocates that seizures among PNES patients are caused by entropy or degeneration in particular brain regions such as orbitofrontal area, insular area, parietal

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area, frontal area, and somatosensory area, and the debate still continues.<sup>3-9</sup> Interestingly, amidst this dichotomy there is a paradigm that has gained less attention among researchers is the cognitive paradigm, where the pioneer of this paradigm believes, it has the capacity to bridge the difference between these (psychological and biological) two paradigms.

### Background of the Study

Till date majority of the researches that has been done considering cognitive perspective into account has succeeded in establishing the fact that PNES patients have deficit in various cognitive domain such attention, perception, memory (specifically working memory), learning, problem solving, and broadly speaking executive functioning.<sup>10</sup> In fact, measuring these cognitive attributes offers a clear picture of patient's mental as well as behavioral functioning. So among discrete cognitive attributes, working memory, which largely depends upon the perceptual sensitivity, is one such virtue that finds a special lead in every psychological and behavioral disposition. Therefore, in the present work it is aimed to investigate perceptual sensitivity, not yet discussed anywhere in available literature till date, to our best of knowledge. In addition, it was also aimed to reconfirm the discrepancy that still persist regarding preattentiveness of PNES individual that whether they are more inclined toward negative/unpleasant situation/stimulus or are more subconsciously avoidant toward negative/unpleasant situation/stimulus. One more reason to investigate about perceptual sensitivity of PNES patients was the underlying deduction that PNES patients are highly sensitive toward emotion-arousing situation. Therefore, there is a possibility that at cognitive level some missing elements are there

that need to be ascertained because we strongly believe some unknown element at cognitive level is causing problem and dysfunctional cognitive-affective system among individual with PNES.

### Technical Vocabulary Used during Study

#### Perceptual Sensitivity

In the present study, perceptual sensitivity was measured through reaction time utilizing the metrics of hits and false positives (FAs). *Emotional valence*: emotional valence can be defined as the hedonistic continuum ranging from pleasant to neutral to unpleasant. In the present study, emotional valence picture was selected from the International Picture Affective System (IAPS), which has a predetermined value, for pleasant valence: the value is above than 6; for neutral values it ranges from 4 to 5; for unpleasant: values range from 1 to 3. Detailed description of the valence is given in ► **Table 1**.

#### Method

##### Sample

Fifty-six individuals, 28 with PNES and 28 healthy individual, with age range of 18 to 25 years (mean [M] = 21.30, standard deviation [SD] = 1.92) who were diagnosed by a neurologist, based on semiological history, postictal characteristics, and video-encephalography, were selected from the Outpatient Department (OPD) of the Neurology Department of Banaras Hindu University (BHU), Varanasi, Uttar Pradesh, India. An informed consent was taken from the participants and their attendant and approval from the Neurology Department, Institute of Medical Sciences, BHU.

**Table 1** Valence of three types of pictures taken from the International Affective Picture System (IAPS)

Pleasant		Unpleasant		Neutral	
Number	Valence	Number	Valence	Number	Valence
1441	7.97	1120	3.79	2383	4.72
1601	6.86	1300	3.55	2512	4.86
1630	7.26	3051	2.30	2595	4.88
1661	6.14	3195	2.06	2635	5.22
1750	8.28	6022	2.14	2661	4.90
1850	6.15	6230	2.37	2681	4.04
1920	7.90	6520	1.94	2695	4.01
2045	7.87	6550	2.73	2890	4.95
2071	7.86	9041	2.98	7004	5.04
5201	7.06	9172	4.01	7041	4.99
5390	6.59	9183	1.69	7053	5.22
5621	7.57	9253	2.00	7110	4.55
5629	7.03	9320	2.65	7175	4.87
5811	7.23	9405	3.71	7186	4.63
8205	6.62	9440	3.67	7205	5.56
5836	7.25	9623	3.04	7271	4.82

### Variables, Behavioral Measures, Design, and Stimulus Description

Perceptual sensitivity ( $d'$ ) was calculated on the basis of hits (accuracy) and FA. Hits and FA were taken as dependent behavioral measure whereas group and emotional valence were treated as independent. A 2 (group: PNES and healthy controls)  $\times$  3 (emotional valence: pleasant, unpleasant, and neutral) factorial design was used for the current study. Further, emotional valence and group was taken as within- and between-subject factor, respectively, in the present study. Forty-eight pictures, 16 each with pleasant, unpleasant, and neutral valence, were selected from the IAPS.<sup>11</sup> The details of the picture number and valence values are given in **Table 1**. Further an emotional-N-back task (E-N-back) shown in **Fig. 1** was used to manipulate the emotional valence among the subjects.

### Experimental Task

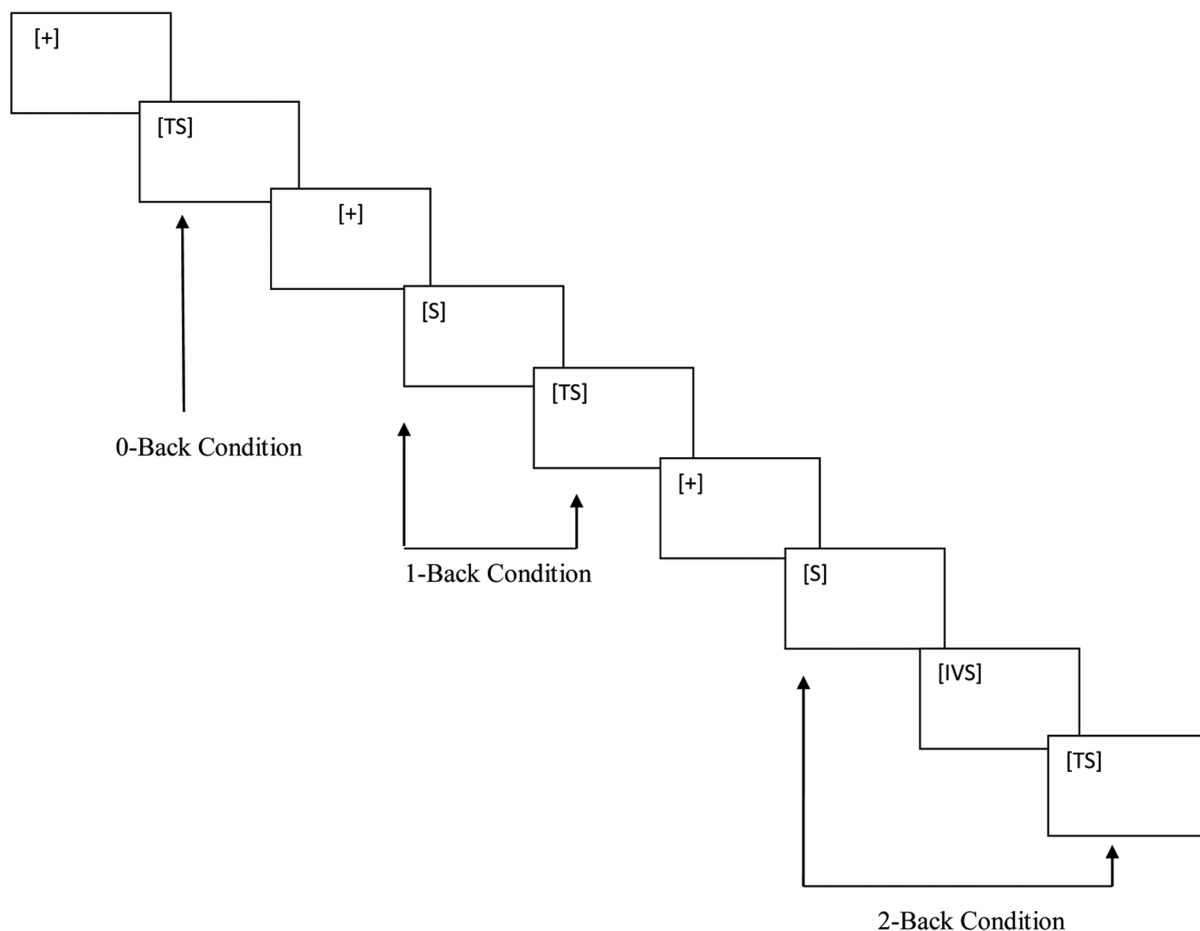
In the present study, the N-back paradigm was employed to assess the perceptual sensitivity of the individual with PNES, though originally the N-back paradigm is mainly used for assessing the working memory. In this context, calibration has been implemented within the N-back paradigm, transforming it into the emotional N-back task (E-N-back) to better align with our objectives.<sup>12</sup> The E-N-back task

(**Fig. 1**) used in the present study consisted of emotional pictures with pleasant, unpleasant, and neutral valence. Task was designed on Superlab software (Cedrus, Version 4.5) and pictures were displayed on 15.6" color monitor of i3 Intel processor computer with refresh rate of 60 Hz. In the present study, the stimulus has been presented for 1,250 ms, which is very peculiar in itself because in available literature maximum limit of stimulus presentation is 300 to 500 ms, which is noteworthy at methodical verge.

The experimental procedure consisted of a demo and practice session of 1 minute 4 seconds followed by main session of 3 minutes 48 seconds. Total slides of 60 pictures in each block condition were used and the ratio of target and nontarget pictures was 1:3. Pictures were displayed at the center of the monitor screen. The display of the task trial started with a fixation (+ sign) for 1,000 ms followed by stimuli for 1,250 ms.

### Procedure

Prior to the experiment, all the participants were asked to fill a biographical information form. A written informed consent was obtained from each participant. Participants were randomly assigned into three different experimental conditions with 28 participants in each group. The following instructions were given to all the participants before the start of experimental session:



**Fig. 1** Flowchart of the experimental task, that is, 0-back, 1-back, and 2-back task condition. TS, target stimulus; +, fixation; S, stimulus; IVS, intervening stimulus.

We are conducting an experiment to study your perceptual sensitivity. It will help us to dive more deep in your mental status. You are requested to perform the task. First of all you will be given demo and practice session of approx. 1 minute 4 seconds followed by the main task of 3 minutes 48 seconds. Individual with PNES were given special instruction that “It is very important for knowing your problem and it will help us to know your problem more deeply. If you will do the task it will give information about your disease and help in the treatment of your problems.” At the end of the experimental session feedback of the participants was obtained and they were thanked for their participation and cooperation.

**Result**

**Perceptual Sensitivity (*d'*)**

Mean perceptual sensitivity (*d'*) scores and SDs for different experimental conditions presented in ►Table 2 revealed that the performance of PNES participants on perceptual sensitivity (*d'*) was better ( $M = 1.19, SD = 0.90$ ) in comparison to healthy individuals ( $M = 1.06, SD = 0.55$ ). The results of analysis of variance (ANOVA) presented in ►Table 3 clearly indicate that perceptual sensitivity (*d'*) between groups is found to be significant,  $F(1, 50) = 19.11, p = 0.000$ , which shows that individuals with PNES are more sensitive in comparison to healthy individual and is illustrated in ►Fig. 2.

Further, the main effect of emotional valence on perceptual sensitivity (*d'*) performance of the PNES and healthy individuals was also found to be statistically significant,  $F(2, 100) = 63.64, p = 0.000$ . Mean perceptual sensitivity (*d'*) scores presented in ►Table 2 clearly indicate that perceptual sensitivity (*d'*) performance of the participants was better for

**Table 2** Mean and standard deviation scores of groups on various valence

Variable	Mean	SD
Group		
Health controls	1.06	0.55
PNES	1.19	0.90
Emotional valence		
Pleasant	0.79	0.83
Unpleasant	1.57	0.94
Neutral	0.28	0.90

Abbreviations: PNES, psychogenic nonepileptic seizure; SD, standard deviation.

unpleasant ( $M = 1.57, SD = 0.94$ ) in comparison to pleasant ( $M = 0.79, SD = 0.83$ ) and neutral ( $M = 0.28, SD = 0.90$ ) valence of pictures. These mean scores have been graphically presented in ►Fig. 3.

Mean perceptual sensitivity scores (*d'*) and variation presented in ►Tables 4 and 5 as well as graphically displayed in ►Fig. 4 revealed that PNES participants has more sensitivity for unpleasant pictures ( $M = 1.33, SD = 01.00$ ) in comparison to healthy control participants than pleasant ( $M = 1.83, SD = 0.84$ ).

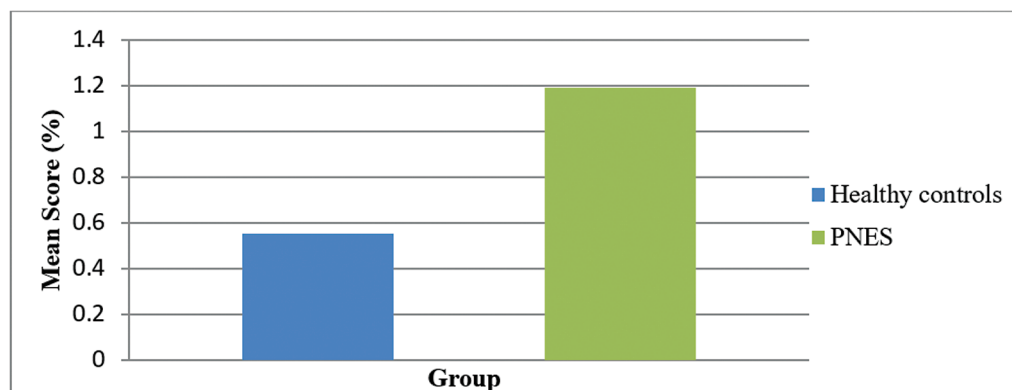
**Discussion**

The main objective of the present research was to examine the perceptual sensitivity of PNES patient as compared with healthy individual. The second objective of this study was to

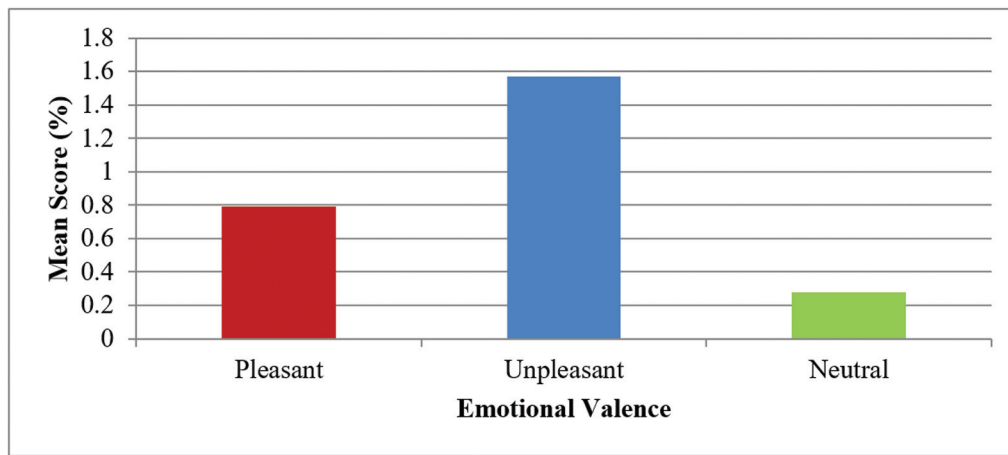
**Table 3** Summary of 2 × 3 analysis of variance for the measure of perceptual sensitivity (*d'*) scores

Source of variation	df	SS	MS	F	Sig.
Between-subject					
A (Group)	1	21.05	21.046	19.11	0.000
Within-subject					
C (Valence)	2	56.54	28.27	63.64	0.000

Abbreviations: df: degree of freedom; F: Fisher's value; MS: mean sum of squares; Sig, significant; SS, sum of squares.



**Fig. 2** Mean perceptual sensitivity (*d'*) scores of healthy control and psychogenic nonepileptic seizure (PNES) individuals.



**Fig. 3** Mean of perceptual sensitivity ( $d'$ ) scores under three emotional valence conditions.

determine the emotional valence to which PNES patients were most attentive. From the results it can be observed that the mean sensitivity score of PNES patient was better and statistically significantly differed from healthy individuals. This provides a clear insight into the fact that PNES patients are more sensitive and readily identifies the emotional laden stimulus. The present study finds its support from the study of Bakvis et al and Gul and Ahmed,<sup>13,14</sup> where they found PNES patient's executive function in comparison to epileptic patients on E-N-back task. Similar results were also observed by other pioneer researchers like Moore and Baker, Robert et al, Black, and Bakvis et al,<sup>2,14-18</sup> where they discovered that PNES patients performed differently from their counterparts in several cognitive domains specifically attention, working memory, and executive functioning. Further, this study strongly denies the preestablished notion that PNES patients are faking subconsciously. So it can be concluded that patients with PNES are genuinely experiencing distress and should be treated with respect. This is particularly important as stereotypical perceptions, often unconsciously held, can negatively impact the diagnosis and treatment of these patients.

Further, from the result of the mean score presented in **Table 1** and ANOVA in **Table 3**, it can be inferred that PNES patient are more quick at identifying unpleasant stimu-

lus and statistically differed from healthy individuals, respectively. Therefore, from this finding again it can be inferred that PNES patient are preattentive and vulnerable to unpleasant situation/stimuli and one must try to keep the PNES patient as much away from stressful situation while rehabilitating them. Current finding also find support from the work of Bakvis et al, Roberts et al, and Singh et al,<sup>14,17,18</sup> where all these researchers found similar result in which individual with PNES were hypervigilant to unpleasant stimulus or pictures. However, the present study gets refuted by the work of Bakvis et al,<sup>16</sup> where they found that PNES patients are avoidant toward unpleasant pictures and took more time to respond.

Moreover, the present findings also provide an encouraging speculation about the conviction where it is assumed that PNES patients are less responsive and withdrawn from their current situation. So from the current research this notion gets startled and we see that PNES patients are very apprehensive about their environment and current demand of the situation, which is obvious by their sensitiveness toward pictures. Also, this result opens up the possibilities that while diagnosing any PNES patient one must venture the personality characteristics because rarely the psychological personality profile of the patient is sought while diagnosing.<sup>18-20</sup>

### Conclusion

In conclusion, from the findings of the present study it is evident that perceptual sensitivity of individuals with PNES

**Table 4** Mean perceptual sensitivity ( $d'$ ) scores and SDs of healthy control and PNES participants under three emotional valence conditions

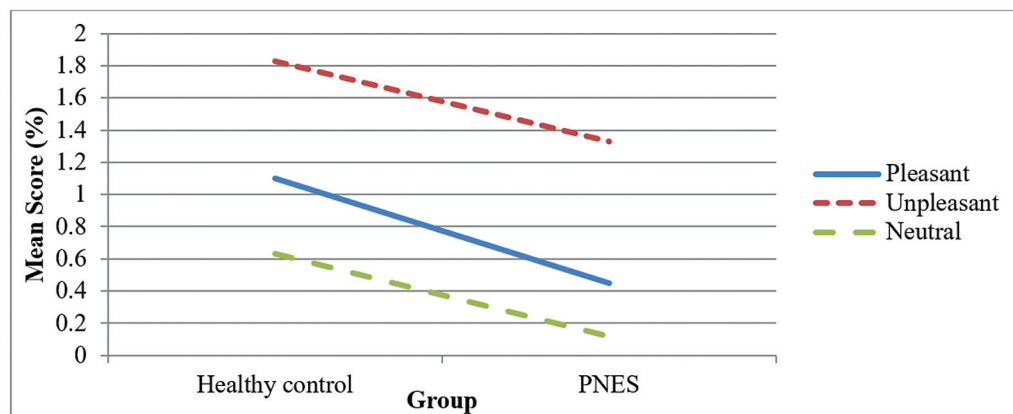
Variable	Emotional valence		
	Pleasant	Unpleasant	Neutral
Group			
Healthy control	1.10 (0.79)	1.83 (0.84)	0.63 (0.67)
PNES	0.45 (0.73)	1.33 (1.00)	0.12 (0.91)

Abbreviations: PNES, psychogenic nonepileptic seizure; SD, standard deviation.

**Table 5** Variability ratio of PNES and healthy individuals in relation to pleasant, unpleasant, and neutral valences

Coefficient of variation		
	PNES	Healthy Individuals
Pleasant	162.22	71.81
Unpleasant	75.18	45.90
Neutral	758.33	106.34

Abbreviation: PNES, psychogenic nonepileptic seizure.



**Fig. 4** Group and emotional valence for perceptual sensitivity.

is more as compared with healthy individuals and are more preattentive toward unpleasant stimulus or situation. In addition, by the findings of the present study we can theoretically (deduction based) ascertain that this trait is a curse for the PNES patients because it predisposes them, and makes them vulnerable, to dysfunctional cognitive-affective system.

### Implication and Future Suggestions

The present study, in broader sense, is helpful for professionals like neurologists, psychiatrists, psychologists, and health workers who are dealing with such type of population where the assessment of patient sensitivity is desirable. Therefore, measuring the perceptual sensitivity can aid in the precise diagnosis of PNES. In future, prospective studies can be done for evaluating the personality and locus of control of PNES patients to probe and know the cognitive underpinnings of sensitivity among individuals with PNES.

### Highlights of the Manuscript

- The current investigation indicates that individuals diagnosed with PNES exhibit heightened perceptual sensitivity in comparison to their healthy counterparts.
- This research corroborates earlier studies that suggest patients with PNES demonstrate increased preattentive responses to negative stimuli.
- These results may assist professionals in formulating treatment strategies from an intervention perspective.

#### Biographical Statement

Dr. Priyesh Kumar Singh has been working as an Assistant Professor in Amrita Vishwa Vidyapeetham and is a registered counselor at the National Career Service (NCS), MHRD Government of India. His doctoral research work has been a collaborative study with Department of Neurology, Institute of Medical Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India. He has published several articles in journal of repute. His research area includes health psychology and cognitive psychology. He has more than 10 publications to his name indexed in

Scopus and Web of Science. Link of his two best publications are provided below:

**Paper 1:** <https://www.sciencedirect.com/science/article/pii/S2772632024000242>

**Paper 2:** <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9357501/#:~:text=Conclusion%20Conclusively%2C%20the%20finding%20of,are%20poor%20at%20emotional%E2%80%93cognitive>

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#### Conflict of Interest

None declared.

#### Acknowledgment

None.

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