

## Original Article

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# Visual Motor and Executive Functioning in Adult Patients with Primary Generalized Epilepsy: A Pilot Study

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**Background and Purpose:** Epilepsy is a neuropsychological disorder which can lead to various cognitive deficits of varying levels. Primary generalized epilepsy is characterized by bilateral ictal electroencephalography patterns and excessive neural activity found in both hemispheres of the brain. There is dearth of research on primary generalized epilepsy in adult population. The present study investigates the visual motor and executive functioning deficits in patients with primary generalized epilepsy.

**Methods:** Study was conducted on 30 participants (n=30) divided into target and normal control group. Target group consisted of patients diagnosed with primary generalized epilepsy with minimum 5 years of illness. Bender-Gestalt test (BGT) and Wisconsin's Card Sorting Test (WCST) was administered on both the groups.

**Results:** A significant difference was found between target group and control group's performances on BGT which indicates that visual motor functioning of control group was better than target group. A significant difference in executive functioning was found in performance of epilepsy patients and non-patients on the domains of WCST.

**Conclusions:** Both executive and visuomotor functioning are significantly affected in patients of primary generalized epilepsy in adult patients. **(2020;10:62-68)**

**Key words:** Epilepsy, Generalized epilepsy, Visual motor coordination, Executive functions, Cognitive dysfunctions

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## Introduction

Executive functions are the mental processes that enables an individual to perform tasks like paying attention, planning, organizing, reasoning, remembering, managing time and space, problem solving, and working memory. They include a group of interconnected functions that control purposeful, goal-directed, problem-solving behavior. Frontal lobe is associated with the executive functions we carry out. Different parts of frontal lobe are associated with corresponding cognitive functions. Dorsolateral prefrontal cortex is associated with verbal fluency, ability to maintain and shift set, response inhibition, organization, working memory, problem solving, reasoning and abstract thinking.<sup>1-4</sup> Anterior cingulate cortex is associated with decision making, motivation behaviors, emotional drives and inappropriate response inhibition.<sup>5-7</sup> Orbitofrontal cortex is concerned with maintaining set, controlling impulse, reinforcement on sensory stimuli and monitoring enduring and socially appropriate behaviors.<sup>8,9</sup> Brain is directly affected in individuals having epilepsy

which may be revealed as dysfunction or diminution in one or several cognitive functions.<sup>10,11</sup> Cognition comprises of the capacity of brain to process information accurately and to program adaptive behavior. Primary generalized epilepsy is characterized by bilateral ictal electroencephalography (EEG) patterns and excessive neural activity found in both hemispheres of the brain. Seizures can affect the neuro-cognitive functioning of an individual.<sup>12-14</sup> Hence, patients with epilepsy can have problems in their ability to learn and remember information, pay attention and focus, express themselves clearly, and etc. Recurrent seizures raise the chance of disturbance in brain functioning which can further lead to cognitive problems. Cognitive dysfunction and behavioral disorders are found more commonly in people with epilepsy.<sup>15</sup>

Impairment of sustained attention is most constantly designated in epilepsy.<sup>16</sup> Kälviäinen et al.<sup>17</sup> found that patients with epilepsy had difficulties in tasks that require memory, sustained attention even though they had normal attention span, normal psychomotor speed and normal speed of tracking. According to their study, memory difficulties can

be due to attentional dysfunction, which leads to impaired or slowed initial encoding of memory trace, and deficit in storing process and hippocampal dysfunction. Gucuyener et al.,<sup>18</sup> Schubert,<sup>19</sup> Kwan and Brodie,<sup>20</sup> and Drane and Meador<sup>21</sup> in their research established that antiepileptic drugs have a negative effect on attention and concentration of the individual. Pulsipher et al.<sup>22</sup> in their research found impairment in executive functions in juvenile myoclonic subjects. Another study by Modi et al.<sup>23</sup> conducted a study to recognize executive functioning phenotypes in youth with epilepsy and to observe if there is a difference of phenotypes on psychosocial and medical outcomes. They identified four executive functioning phenotypes which included four groups. Group 1 with no executive functioning deficits (45% of sample), group 2 included global executive functioning deficits (29% of sample), group 3 included behavioral regulation and working memory deficits (8% of sample), and group 4 included metacognitive deficits (17% of sample). They found no significant executive functioning phenotype group differences for seizure characteristics. Which indicated phenotypic variability in executive functioning is considerably related to patient-reported outcomes they also concluded that executive functioning phenotypic variability impacts quality of life differentially and psychosocial functioning. Neurocognitive interventions need to be individualized and tailored for the remediation of executive function deficits developed on phenotypes. Gelžinienė et al.<sup>24</sup> conducted a study on 59 patients aged 14 to 17 years, meeting the diagnostic criteria for idiopathic generalized epilepsy and found the presence of executive dysfunction in patients with idiopathic generalized epilepsy. Similar findings were reported by Walsh et al.<sup>25</sup> in patients with purely drug-refractory juvenile myoclonic epilepsy. Swartz et al.<sup>26</sup> in his study found that patients with juvenile myoclonic epilepsy have impairment in visual working memory. Visual motor functioning is also affected in primary generalized epilepsy.<sup>27</sup> Research by Perrine et al.<sup>28</sup> indicates impact of epilepsy on psychomotor speed, verbal memory, which result in adversely affecting the quality of life of the individual. van Rijckevorsel<sup>13</sup> and Kälviäinen et al.<sup>17</sup> found that patients with epilepsy had difficulties in tasks requiring memory, sustained attention while they had normal attention span, simple psychomotor speed and simple speed of tracking. Research by Perrine et al.<sup>28</sup> and Elger et al.<sup>29</sup> concluded that visuomotor functioning is affected in patients of epilepsy and it supports present results. In the study by Lee et al.,<sup>30</sup> it is stated that visuomotor speed and perception is affected by antiepileptic. Stores et al.,<sup>31</sup> Levav et al.,<sup>32</sup> Pavone et al.,<sup>33</sup> Aldenkamp et al.,<sup>34</sup> and Gallassi et al.<sup>35</sup> found that psychomotor slowing is associated with epilepsy and antiepileptic drugs have an impact on visual motor and psychomotor

functioning.

The present study intends to investigate executive and visuomotor functioning in patients with primary generalized epilepsy. Impetus for taking up this investigation is availability of limited research on primary generalized epilepsy in adults, which elevates a need for further exploration of associated dysfunctions in primary generalized epilepsy. Most of the available researches are conducted on juvenile epilepsy. The findings of the research will be helpful in understanding the extent of impaired functionality in adults and a plan of cognitive remediation can be devised accordingly.

## Method

Total number of participants in the study were 30. Out of which, 15 participants were from a target group and another 15 from a control group. The target group consisted of patients diagnosed with primary generalized epilepsy with minimum 5 years of illness. In the control group, individuals with no psychiatric or neurological illness were taken. Both the groups were matched in characteristics, i.e., age, sex, education, socioeconomic status. The research sample was selected using purposive sampling as per inclusion and exclusion criteria. Fifteen participants in the target group were selected from the Outpatient Department of Psychiatry from Civil Hospital, Gandhinagar. Fifteen normal individuals were selected in the control group from the community. Age, education and socio-demographic status were matched of both the groups. Inclusion criteria of the target group were: 1) patients clinically diagnosed with primary generalized epilepsy by a psychiatrist/neurologist; 2) patients between the age ranges of 20 to 45; 3) patients of either sex and exclusion criteria included: 1) patients with history of substance abuse; 2) patients with diagnosed psychiatric illness; 3) patients with pre-existing psychiatric or organic conditions; 4) patients having epilepsy with mental retardation.

## Tools

### Bender-Gestalt test (BGT)

The BGT consists of nine designs, characterized by their gestalt, printed on a card. Each card is presented to the client and the client is instructed to copy each design on a paper. BGT is a test of perception and visuomotor functioning, which measures visual acuity and motor functioning. This test is most frequently used for brain dysfunction and can be used for child as well as adult population.

Test retest reliability score was found to be reliability coefficient of 0.71 as per study by Pascal and Suttell.<sup>36</sup> On retesting the subjects after a time interval between test and retest, they found the coefficient reliability of 0.63.

### Wisconsin's card sorting test (WCST)

WCST was initially developed to measure abstract reasoning ability and the ability to shift cognitive strategies in reaction to altering environmental contingencies.<sup>37</sup> WCST is a measure of executive functioning of an individual. Executive function needs the ability to cultivate and conserve problem solving strategy across varying stimulus conditions in order to attain future goals.<sup>38,39</sup> WCST consist of 128 response cards that depict figures of various forms like cross, star, circles and triangles of color red, green, blue, and yellow. There are four stimulus cards and those are placed from left to right order, i.e., one red triangle, two green stars, three yellow crosses, and four blue circles. A client is given the deck of 64 response cards and instructed to match each consecutive card from the deck with one of the four stimulus cards, whichever card he thinks matches. The client is given a feedback about every card he matches. He is only told whether each response is right or wrong. There are three sorting categories which is not told to the client. These categories are: color, form, and number. Once the client makes 10 consecutive correct responses, the category is changed and the client has to shift his mental set and change the category. Patients having frontal lobe dysfunction have significant difficulty in shifting mental-set, management, planning, organization and etc. It can be used for clients in the age range of 6 and half years to 89 years of age.

### Procedure

Clearance from the ethical committee was taken for this research and informed consent was obtained by all the participants before the commencement of the research. Participants were selected from Civil Hospital, Gandhinagar and Hospital for Mental Health, Gandhinagar.

Participants of the control group were clinically diagnosed by psychiatrists. EEG reports were also obtained to verify the diagnosis. IQ reports were verified to rule out mental retardation with epilepsy. Participants of both the target group and control group were thoroughly explained about the nature and purpose of the study and they were explained about the rationale of neuropsychological testing. They were then assessed on neuropsychological tests, i.e., BGT and WCST. Appropriate instructions were given to the subjects and as-

**Table 2.** Characteristics of the participants of target and control group

Characteristic	Frequency
Sex	
Target group	
Male	7 (46.7)
Female	8 (53.3)
Control group	
Male	7 (46.7)
Female	8 (53.3)
SES	
Target group	
Low	11 (73.3)
Middle	2 (13.3)
Low-middle	2 (13.3)
High	-
Control group	
Low	7 (46.7)
Middle	4 (26.7)
Low-middle	4 (26.7)
High	-
Illness duration	
Target group	
>5 to 10 years	6 (40.0)
>10 years	9 (60.0)
Control group	-

Values are presented as number (%).  
SES, socioeconomic status.

**Table 1.** Characteristics of the participants of target and control group

Characteristic	Minimum	Maximum	Mean	Standard deviation
Target group				
Age	20.00	49.00	30.93	8.47
Education	5	12	8.46	2.64
Control group				
Age	20.00	45.00	33.33	10.01
Education	5.00	15.00	10.07	3.17

assessment was carried out in one to two sessions. Test atmosphere was calm and peaceful and distractions were avoided as far as possible. After administration, tests were scored as per the scoring procedure given in the test manual of respective tests.

**Results**

Mann-Whitney test was used for statistical analysis of data. Mann-Whitney test is a non-parametric test used on small sample when two groups are not in normal probability range. It compares two conditions and determines whether two samples are different in an independent group design. Kolmogorov Smirnov Z test was applied for determining the normal probability of data. Since data was skewed, Mann-Whitney test was applied. SPSS (ver. 17.0; SPSS Inc., Chicago, IL, USA) was used for the statistical analysis. The characteristics of the participants in the target and control group are given in Tables 1 and 2. In the target group there were eight females and seven males. Mean age was 30.93 years and standard deviation (SD) was 8.47. Mean education was 8.46 and SD was 2.64. Eleven participants were from low socioeconomic status, two from low middle and another two from low middle socioeconomic status. Eight participants had illness duration of 5 to 10 years and seven had more than 10 years. In the control group there were eight females and seven males. Mean age was 33.33 years and SD was 10.01. Mean education was 10.07 and SD was 3.173. Seven participants were from low socioeconomic status and four from middle and four from low middle

socioeconomic status. On BGT, significant values were found on dysfunction rating (target group mean rank, 11.70; control group mean rank, 19.30; Mann-Whitney  $U=55.50$ ;  $Z=-2.54$ ;  $p\leq 0.05$  level; Table 3), indicating that there was a significant difference in visuomotor functioning of normal individuals and epileptic patients. On Wisconsin's card sorting test, as shown in Table 4, there was a significant difference between the total number of errors of the target group and control group (target group mean rank, 8.00; control group mean rank, 23.00; Mann-Whitney  $U=0.00$ ;  $Z=-4.67$ ;  $p\leq 0.001$  level) and in percent errors (target group mean rank, 8.80; control group mean rank, 22.20; Mann-Whitney  $U=12.00$ ;  $Z=-4.18$ ;  $p\leq 0.001$  level). There was also a significant difference between the target group and control group in: perseverative responses (target group mean rank, 9.73; control group mean rank, 21.27; Mann-Whitney  $U=26.00$ ;  $Z=-3.62$ ;  $p\leq 0.001$ ); percent perseverative responses (target group mean rank, 9.93; control group mean rank, 21.07; Mann-Whitney  $U=29.00$ ;  $Z=-3.49$ ;  $p\leq 0.001$  level); and perseverative errors (target group mean rank, 8.60; control group mean rank, 22.40; Mann-Whitney  $U=9.00$ ;  $Z=-4.35$ ;  $p\leq 0.001$  level). There was a significant difference in set task shifting ability of the target group and control group in percent perseverative errors (Mann-Whitney  $U=52.00$ ,  $Z=-2.00$ ,  $p\leq 0.01$ ), attention between the target group and control group in non-perseverative errors (target group mean rank, 11.50; control group mean rank, 19.50; Mann-Whitney  $U=26.00$ ;  $Z=-3.62$ ;  $p\leq 0.01$ ), capacity of abstraction in the target group and control group in percent conceptual level response (target group mean rank, 2.00; control group mean rank, 9.00; Mann-Whitney  $U=15.00$ ;  $Z=-4.57$ ;  $p\leq 0.001$  level), set shifting and ability to complete categories between the target group and control group in number of categories completed (target group mean rank, 10.00; control group mean rank, 21.00; Mann-Whitney  $U=30.00$ ;  $Z=-3.98$ ;  $p\leq 0.001$  level), conceptualization abilities between the target group and control group in trials to complete first

**Table 3.** Mann-Whitney *U* test values for Bender-Gestalt test

	Dysfunction rating
Mann-Whitney <i>U</i>	55.50*
Z	-2.54
<i>p</i> -value	0.016

\*Level of significance at 0.01 level.

**Table 4.** Mann Whitney *U* test values for Wisconsin's card sorting test

	Total No. of errors	% errors	Perseverative responses	% perseverative responses	Perseverative errors	% perseverative errors	Non perseverative errors	% non-perseverative errors	% conceptual level	No. of categories completed	Trials to complete 1st category	Failure to maintain set	Learning to learn
<i>U</i>	0.00*	12.00*	26.00*	29.00*	9.00*	34.00*	52.50*	69.00	15.00*	30.00*	58.50 <sup>†</sup>	100.5	40.50*
Z	-4.677	-4.18	-3.624	-3.499	-4.354	-3.302	-2.491	-1.806	-4.574	-3.985	-2.369	-0.713	-3.501
<i>p</i> -value	0	0	0	0	0	0.001	0.011	0.074	0	0	0.023	0.624	0.002

\*Level of significance at 0.001 level.

<sup>†</sup>Level of significance at 0.05 level.

category (target group mean rank, 14.70; control group mean rank, 16.30; Mann-Whitney  $U=58.50$ ;  $Z=-2.36$ ;  $p \leq 0.05$  level), and efficiency to change categories between the target group and control group in learning to learn (target group mean rank, 10.70; control group mean rank, 20.30; Mann-Whitney  $U=40.50$ ;  $Z=-3.50$ ;  $p \leq 0.001$  level).

## Discussion

Epilepsy is associated with several cognitive dysfunctions which can add to the distress of the patients. It is hence helpful to understand the associated cognitive dysfunctions in order to plan and provide focused intervention. As per the results of the study, following outcomes were observed.

### Visuomotor functioning

A significant difference was found between the target group and control group's performances on the BGT, which indicates that visuomotor functioning of the control group was better than the target group. Research by Perrine et al.,<sup>28</sup> Elger et al.,<sup>29</sup> Lee et al.,<sup>30</sup> Stores et al.,<sup>31</sup> Levav et al.,<sup>32</sup> Pavone et al.,<sup>33</sup> Aldenkamp et al.,<sup>34</sup> and Gallassi et al.<sup>35</sup> also found impact of epilepsy on visuomotor and psychomotor functioning, which supports our study results. Although studies, e.g., Lee et al.,<sup>30</sup> Levav et al.,<sup>32</sup> and Pavone et al.<sup>33</sup> found the association of antiepileptic drugs and visual motor functioning and it needs to be kept in consideration as antiepileptic drugs may be associated with the visuomotor deficits.

### Executive functioning

Results reveal that the control group performed better than the target group. A significant difference was found between performance of epilepsy patients and that of non-patients on the domains of WCST.

Total number of errors, percent errors, perseverative responses, percent perseverative responses, perseverative errors, percent perseverative errors, non-perseverative errors, percent conceptual level responses, number of categories completed, trials to maintain first category and learning to learn scores were found highly significant indicating substantial difference in performance of both groups on WCST, which indicates dysfunction of task shifting ability, attention, abstraction ability, conceptualization, and ability to change and complete categories. The normal control group performed better than the target group. Examining the mean ranks of conceptual level re-

sponses, it is observed that performance of the target group is higher than the normal control group and the reason is that conceptual level responses indicate the inability to maintain and complete category. Hence it can be stated that executive functioning of epileptic patients is affected.

Hamed,<sup>40</sup> Devinsky et al.,<sup>41</sup> and Piazzini et al.,<sup>42</sup> in their research found that problems in executive functions are associated with epilepsy, which supports our results. Horner et al.<sup>43</sup> in their research found high scores on perseveration indices in patients of epilepsy, which indicates inability to shift set, and is suggestive of dysfunction of prefrontal lobe, which is also in accordance to our research.

### Conclusion, limitations and future directions

The study was conducted on a small sample as a pilot study. A larger sample will lead to better generalization and understanding of the dysfunctions. Another limitation of the study was that all the characteristics of the sample could not be matched since the data was collected in a limited period of time in a clinical setup. The major difference in the baseline characters was of socio economic status, while education is matched. Socio economic status alone can't affect cognition. Difference in socio economic status with similar years of education can attribute to differences in attitude and cultural practices or life style and other aspects of behavior with no impact on cognition or neuropsychological functioning. Determining the dysfunction associated with the type of primary generalized epilepsy can provide better outcome in terms of understanding the impairment due to epilepsy which could not be done in the present study due to small sample size. The tests used were mainly descriptive of functional ability or neuropsychological dysfunction. Additionally, assessments like the Benton judgement of line orientation test can be administered, determining visuo-perceptual functioning and dysfunction along with the BGT that assesses the visuomotor dysfunction.

Tests that assess on localization of the brain like Luria Nebraska Neuropsychological battery or other neuropsychological batteries simultaneously administered with EEG recording can be more thorough and helpful in understanding of neuropsychological functioning in patients of epilepsy.

Severity of epilepsy can be taken into consideration and compared with related neuropsychological functioning. Lastly, the difference in education was determined in the target group and control group and the IQ differences were not observed, which could provide more appropriate and confirmatory results.

As per the findings of the current study, it can hence be concluded

that both executive and visuomotor functioning are affected in patients of primary generalized epilepsy. However, further research is needed to generalize results. Neuropsychological assessments precisely assess the localization, lateralization and functioning of the brain, and the areas affected due to any brain insult or the involvement of the brain area in epilepsy. Assessment of patients with epilepsy on specific domains using neuropsychological tests can be further helpful in establishing a holistic management plan or providing the required support in case of any existing deficits and also help a person's function up to the maximum capacity.<sup>44</sup>

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