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Response-Inhibition: Gender-difference in the People with Epilepsy (Generalized and Partial Epilepsy)

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Abstract
Executive functions are considered as higher mental-processes involved in dealing with novel situations as in opposition to automatic-responses, which are habitual in nature and a result of learning and experience, moreover it is an umbrella-term, containing a number of cognitive-processes like planning, execution, problem-solving response-inhibition, working-memory, initiation and reasoning.
This research is an attempt to study the gender-difference in Response-Inhibition of people with Generalized and Partial epilepsy. Significant gender-difference was found in Response-Inhibition of the people with epilepsy. Moreover Deficit cases were also calculated for all the groups and a total of 18% deficit cases were found, in which 20% were among the males and 16% were among the females. More deficit cases were found in the people with Generalized epilepsy as compared to the people with Partial epilepsy. No significant difference in the means of Response-Inhibition of the two groups of type of epilepsy (Generalized and Partial) was found.
Key Words- Executive Functions, Response-Inhibition, Generalized and Partial Epilepsy

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I. INTRODUCTION

Executive functions an umbrella term for the management, regulation and control of cognitive processes (Elliott, 2003), these functions includes working memory, reasoning, task flexibility and problem solving executive-planning and execution (Chan, Shum Toulopoulou et al., 2008). The executive system is theorized in psychology as a cognitive system that controls and manages other cognitive processes. The prefrontal lobe is necessary but not sufficient for the execution of these functions (Alvarez & Eugene, 2006).

Executive functions are generally consist of-

(i) Flexibility in behavior, providing it adaptability,

(ii) Various problem-solving strategies, which are appropriate according to the requirement to maintain and update the goals,

(iii) Monitoring the consequences of one's actions,

(iv) Interpretation of future events by utilizing prior experience or knowledge (Miyake & Shah, 1999).

In general executive functioning, includes - (i) inhibition (ii) working memory (iii) strategic processing (iv) set shifting and (v) emotional regulation (Norman & Shallice, 1986; Shallice, Levin, Eisenberg et al., 1991; Baddeley, 1996; Goldman-Rakic, 1996; Smith & Jonides, 1999; Jonides & Smith, 1997; Miyake et al., 2000; Braver, Cohen & Barch, 2002; Diamond, 2002). In brief, executive functions allow humans to successfully deal with novelty. Executive functions make humans able to synthesize information coming from the external environment, as well as from memory stores in the brain, to generate, implement and correctly implement strategies necessary to accomplish various tasks (Goldberg, 2001; Manchester, Priestley & Jackson, 2004).

II. BRAIN BEHAVIOUR PERFORMANCE

Neural Constructs:	**Brain-Behavior Relationship**	**Behavioral Consequences**	**Daily Life-tasks**
Plasticity, Connectivity, Neural Processing, multimodal integration, Regional specializations	WORKING MEMORY: Attention, Awareness, Automaticity	Risk-taking, Reaction-time, Change sets, Distractibility, Failure to Inhibit, Impulsivity, Fatigue	Initiate, organize, sequence, judgment/ safety, Completion

Figure-1. Language of Executive Functions at Multiple Levels

RESPONSE-INHIBITION

The term inhibition broadly has three different meanings within the cognitive literature. Firstly, it can be taken as a description of the pattern of empirical findings. Specifically, inhibition stands in opposition to facilitation and refers to a level of performance that is below a certain baseline. For example, in the literature on spatial attention the term *inhibition of return* was indicated to describe a phenomenon of slowing when responding to the targets in a cued location compared to the baseline response time to the targets in an uncued location (Posner, Rafal, Choate et al., 1985). The term *inhibition* can refer to this pattern of slowing in responding, but can also serve as a description of a mechanism responsible for such slowing.

Secondly, the term inhibition is used to describe the specific mechanism that is thought to account for some pattern of empirical data. In the case of inhibition of return it has been postulated that the aforementioned pattern of slowing in responding stems from a process which tags previously attended locations and prevents the return of attention to these locations (e.g. Rafal, Egly, & Rhodes, 1994). However, it has been pointed out that such an inhibitory account of the observed pattern of results is not the only possible one and other non-inhibitory mechanisms, like the ballistic nature of attentional sweep, have also been proposed (Pratt, Spalek, & Bradshaw, 1999). The inhibition of return is thus an example in which the term inhibition can be used in two of its primary functions, as a description of a phenomenon and as a description of a mechanism of this phenomenon (MacLeod, Dodd, Sheard et al., 2003).

Thirdly, it may also refer to mechanisms of interference resolution. In this case inhibition is not just a particular pattern of below-baseline performance in a certain task or to a quite specific mechanism responsible for a particular pattern of results, but rather a general class of processes that are responsible for dealing with all kinds of interference and helping to guide goal-oriented actions in the face of multiple distracters. A well-known example could be the framework proposed by Hasher and Zacks (1988) and Lustig, Hasher and Zacks, (2007) to account for cognitive decline in old age. This inhibitory framework of age differences in cognition postulates that resolving the competition from distracters is more challenging for older than young adults, resulting in impaired performance on a variety of cognitive tests. Such impaired performance in the presence of distractions is observable in a wide variety of tasks and thus can be assigned to a single factor of decline in inhibitory functions. However, both the tasks which produce results used to substantiate this claim and the cognitive processes responsible for performance in those tasks vary greatly and hence the overarching term of inhibition used in relation to the effects in these tasks serves a descriptive rather than explanatory function.

According to Berkley's model(1997b) Self-regulation is a major element of executive functioning , self-regulation can be defined as any response set designed to alter the probability of the individual's subsequent response to an event and in doing so functions to alter the probability of a later consequence related to that event." Thus the self-regulation includes the majority of the key components of executive function including goal-directed behavior; devising plans to achieve future-oriented goals; utilization of self-directed speech, rules and plans and impulse control. A prerequisite for executive or self-regulatory processes is intact behavioral inhibition. Behavioral inhibition is something which is multidimensional and comprises three interrelated processes: (1) inhibition of a dominant response; (2) discontinuation of a specific response pattern in order to allow time to react and (3) interference control which protects this delay period and executive processes from distracting events and responses.

III. METHOD

OBJECTIVES

1. To examine the gender differences in Response inhibition in the people with epilepsy.
2. To compare the means of two groups of the people with Generalized and Partial epilepsy, in terms of Response inhibition.

HYPOTHESES

1. There would be significant Gender differences in response inhibition in the people with epilepsy.
2. There would be a significant difference in the means of two groups of the people with Generalized and Partial epilepsy, in terms of Response inhibition.

Inclusion Criteria

1. Diagnosed as epileptic by the neurologist
2. Between the age-range of 16-65 years

Exclusion Criteria

1. Persons with pseudoseizures
2. Persons with epilepsy of less than 16 and more than 65 years

Sample / Participants

A purposive sample of 125 male and 125 female subjects with epilepsy were drawn selected from Jaipur Hospital, Jaipur (Rajasthan) and Meerut Neurology Centre and E.E.G. Lab of Dr. Vinod Arora, Meerut (Uttar-Pradesh). Out of total 250 subjects, 130 were the people with Generalized epilepsy and 120 were with Partial epilepsy.

Research Design

Within Group Randomized design was used, as there is no Control-Group in the study and deficit cases were analyzed on the basis of the cut-off score provided in the NIMHANS Neuropsychological Battery-2004 manual.

Measures

1. Case History Record
2. Ishihara's Test for Colour-Deficiency to check the colour-blindness (Dr. Shinobu Ishihara, 2012)
3. The Stroop Test, NIMHANS (National Institute of Mental Health and Neurosciences-Banglore) Version-2004.

IV. RESULTS

Response-inhibition

Response-inhibition or Stroop-effect was measured, in terms of seconds. Entire score was converted into seconds (from minutes and semi-seconds) and t-test and ANOVA (one-way) was used for analysis.

Table-1 Showing Gender-difference in Response-inhibition

Variables	N	Mean	S.D.	Df	t-Value
Males	125	115.39	62.58	224.262	2.391**
Females	125	98.95	44.65		

From the table-1, showings Mean, S.D. and t-values of Gender- differences in Response Inhibition. Mean and S.D. value of the Male subjects were 115.39 and 62.58 of the Female subjects were 98.95 and 44.65 and the t-value was found to be 2.391, ($p<0.01$), so significant Gender level differences in Response Inhibition was found and Males were found to be better at inhibiting a response.

Table-21 Showing Deficit Cases in Response - inhibition in terms of Gender

Variables	N	% of Deficit cases
Males	125	20
Females	125	16
Total	250	18

From the above Table 21-showing Deficit Cases in Response – Inhibition in Males & Females, 20% deficit in Males and 16% in Females and a total 18% of deficit cases were seen. Thus deficit-cases were more in Males than in Females.

Table-3 Showing Type of Epilepsy difference in Response-inhibition

Variables	N	Mean	S.D.	Df	t-Value
Generalized	130	106.16	47.14	248	0.636
Partial	120	110.90	69.39		

From the table-3, showing Mean, S.D. and t-values in Response Inhibition, of the people having different types of epilepsy (Generalized and Partial). Mean and S.D. value of the people with Generalized epilepsy were 106.16 and 47.14, while of the people with Partial epilepsy were 110.90 and 69.39 and the t-value was found to be 0.636 ($p>0.05$), so insignificant difference in terms of type of epilepsy in Response Inhibition was found.

Table-23 Showing Deficit Cases in Response – inhibition in terms of Type of epilepsy

Variables	N	% of Deficit cases
Generalized	130	20
Partial	120	12.5
Total	250	16.4

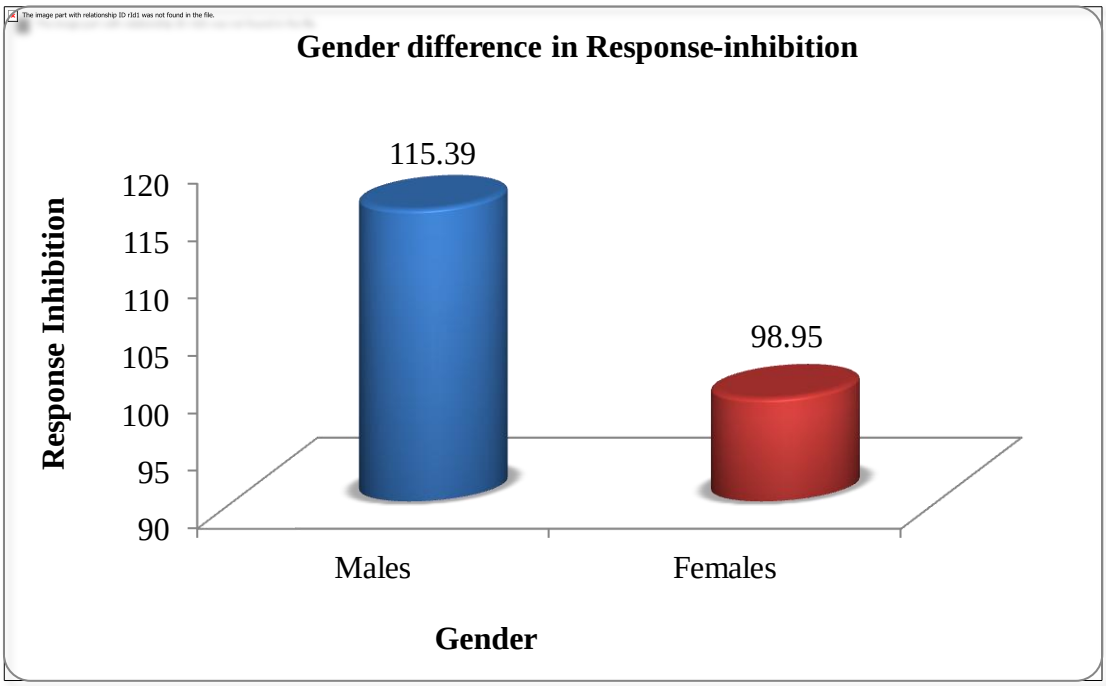
From the above table 23, out of total 16.4% of deficit-cases, 20% deficit cases is seen in the people with Generalized and 12.5% in people with Partial epilepsy. Thus deficit cases were more in the people with Generalized epilepsy.

The purpose of this study was to examine the response inhibition in epileptic patients, belonging to different groups of gender, and type of epilepsy. In the research, deficit cases, were also calculated on the basis of cut-off scores, provided in the NIMHANS Neurological Battery-2004 manual.

V. DISCUSSION

Response-inhibition

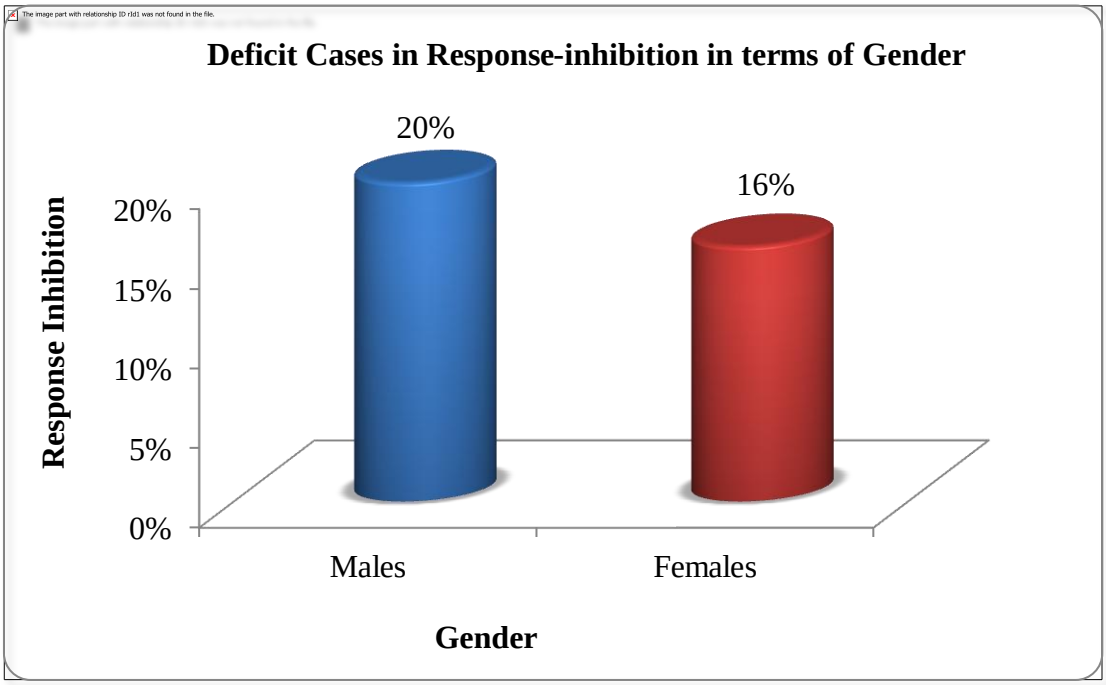
Significant gender-difference was found in Response-Inhibition of the people with epilepsy. Males were found to be better at inhibiting the response, as compared to the females.



Graph-1

Thus the hypothesis (Hypothesis No. 1), that there would be a significant difference in the means of the two groups of gender (male and female) was accepted.

Moreover a total of 18% deficit cases were found, in which 20% were among the males and 16% were among the females.



Graph-2

The facts that males are better at inhibiting the response at the same time have more deficit cases, when we compare both the genders, gives a clear indication of greater sensitivity of males regarding this specific executive function, in the sense either they perform worst or marvelous, as the standard deviation was also found to be 62.58, which is quite high.

Review of literature demonstrates some inconsistency in the results, as some studies give males an upper hand, while others to females. The reasons may lies in the variation in ways and the conditions in which the researches are conducted. As in one study Berlin, Bohlin and Rydell (2004) examined whether inhibition measured as early as preschool can predict more general executive functioning and Attention-Deficit Hyperactivity Disorder (ADHD) symptoms at school age.

The study focused specifically on ADHD symptoms rather than general disruptive behavior problems, and boys and girls were studied separately. The main result was that inhibition was strongly related to ADHD symptoms both in school and at home for boys, but only in the school context for girls.

Early inhibition was also significantly related to later executive functioning, and concurrent relations were found between executive functioning and ADHD symptoms, although in both cases only for boys. Besides this, inhibition added significantly to the variance, beyond that of executive functioning, which meant that for boys, inhibition and the other executive functioning explained about half the variance in inattention problems. The stronger relation between inhibition, executive functioning and ADHD symptoms for boys compared to girls could suggests that either the predictors of ADHD are different for the two sexes, or girls are more often equipped with some factor that protects them from developing ADHD symptoms, despite poor executive functioning. However, it is also possible that relations are just harder to demonstrate for girls due to their lower incidence of disruptive problem behaviors.

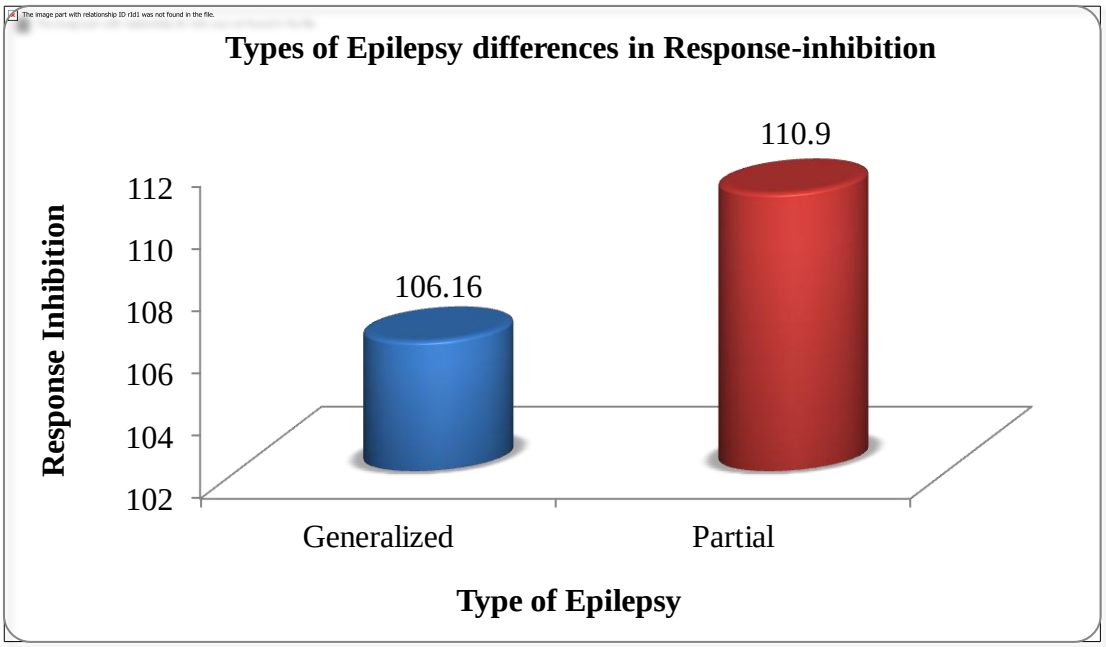
Li, Huang, Constable and Sinha (2006) examined the neural correlates of response-inhibition, during a stop-signal task. They used functional resonance imaging to examine the gender-difference and found greater activation in men, compared to women, in a wide array of cortical and subcortical areas, including the globus pallidus and motor thalamus during stop signal inhibition. In contrast, no brain regions demonstrated greater activation in women, even at a lower statistical threshold. Moreover, while men activated the medial superior frontal and anterior cingulate cortices, women activated the caudate tail to mediate response inhibition. These results extended gender differences in regional brain activation to response inhibition during a cognitive motor task. Men activated the motor circuitry while women appeared to involve visual association or habit learning during stop signal performance.

On the contrary, Liu, Xiao and Shi (2013) examined response-inhibition, pre attentive-processing and sex-difference in young children, with the help of a Go/No go task. The behavioral results showed that girls

committed significantly fewer commission error rates, which showed that girls had stronger inhibition control abilities than boys. Girls also achieved higher d' scores in the Go/No go task, which indicated that they were more sensitive to the stimulus signals than boys.

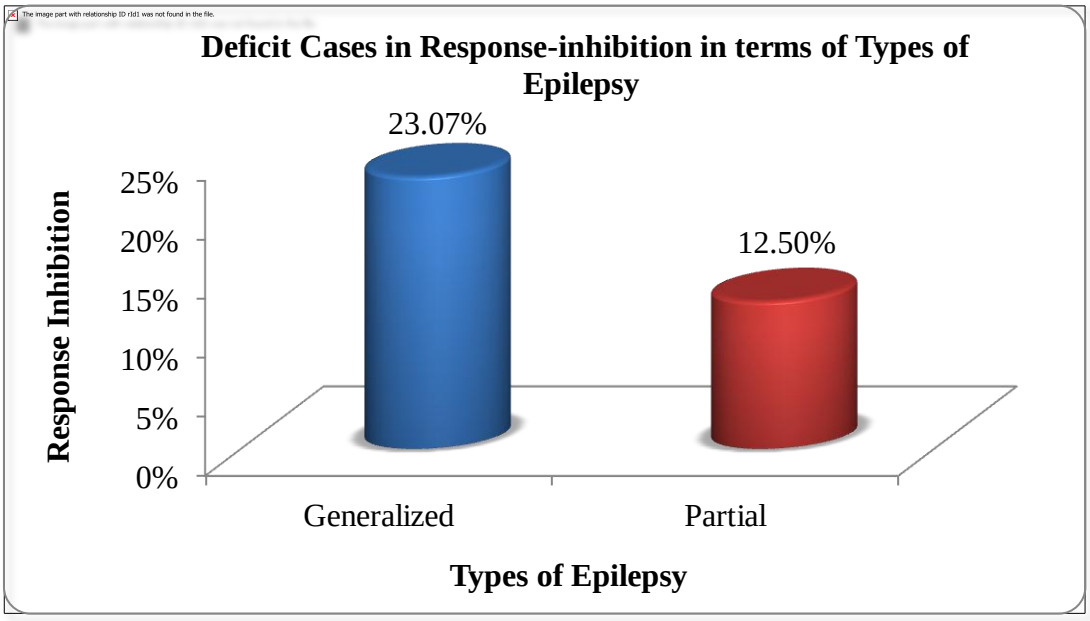
Nederkoorn, Baltus, Guerrieri and Wiers (2009) found that heavy drinking is associated with deficient response-inhibition in women but not in men. They used a Stop-Signal task and found that both male and female heavy drinkers appeared to make rash decisions in a performance task (committed more errors). However, especially women who drink excessively appear to have poor inhibitory control.

On the basis of type of epilepsy, no significant-difference in Response-Inhibition was found, in the people with epilepsy.



Graph-3

Deficit cases were found to be more in people with Generalized epilepsy. More than 10% difference in deficit cases with no significant-difference between the two groups indicates variability of the scores obtained. **So the hypothesis (Hypothesis No. 3), that there would be a significant difference in the means of Response-Inhibition of the two groups of type of epilepsy (Generalized and Partial) was rejected.**



Graph-4

Though Partial epilepsy involves the isolated areas (one of the four lobes) of the brain while Generalized epilepsy involves the entire brain (all the four lobes), but brain is a complex organ with immensely interconnected regions and the problem in one region of the brain, affects not only that particular region, but also contribute to the malfunctioning of the other regions of the brain.

A number of studies have shown that cognitive control or Response-inhibition is supported by a cortical network involving the dorsolateral prefrontal cortex (DLPFC), the ventrolateral prefrontal cortex (VLPFC), the dorsal cingulate (dACC), and the parietal cortex (PC) (Desimone & Duncan, 1995; Miller & Cohen, 2001; Corbetta & Shulman, 2002; Aron et al., 2004). Some of these studies have suggested functional specialization within this network. In particular, activity in DLPFC and in PC has been associated with control implementation and top-down modulation of attentional processes (Desimone & Duncan, 1995; Miller & Cohen, 2001), while VLPFC engagement has been associated with suppression of irrelevant responses (Aron et al., 2004). Finally, activity in the cingulate cortex has been linked with conflict detection and monitoring (Botvinick et al., 2004).

Converging evidence from lesion and neurophysiological studies in non-human primates (Kubota & Komatsu, 1985; Kurata &Tanji, 1985; Watanabe, 1986; Sakagami & Niki, 1994) and in humans (Pfefferbaum et al., 1985; Kok, 1986; Gemba & Sasaki, 1989; Sasaki et al., 1996; Aron et al., 2003) suggests that the dorsolateral prefrontal cortex, the ventrolateral prefrontal cortex and the supplementary motor area (SMA) play a significant role in inhibitory control.

More recent evidence from neuroimaging studies with BOLD functional magnetic resonance imaging (fMRI) suggests that, in addition to the above regions, the dorsal cingulate (dACC) and parietal cortex (PC) are also implicated in inhibitory control (Casey et al., 1997a; Garavan et al., 1999; Konishi et al., 1999; de Zubicaray et al., 2000; Braver et al., 2001; Liddle et al., 2001; Menon et al., 2001; Rubia et al., 2001; Bunge et al., 2002; Durston et al., 2002; Garavan et al., 2002; Mostofsky et al., 2003; Rubia et al., 2003).

And the prefrontal cortex is highly interconnected with much of the brain, including extensive connections with other cortical, subcortical and brain stem sites. (Alvarez & Emory, 2006). The dorsal prefrontal cortex is especially interconnected with brain regions involved with attention, cognition and action, (Goldman-Rakic, 1988). While the ventral prefrontal cortex interconnects with brain regions involved with emotion. (Price, 1999). The prefrontal cortex also receives inputs from the brainstem arousal systems, and its function is particularly dependent on its neurochemical environment (Robbins & Arnsten, 2009). Thus the Response-inhibition may not be impaired only in the people with Partial, but also in people with Generalized epilepsy.

Pulliainen, Kuikka and Jokelainen (2000) assessed the motor function, attention and memory of fifty-two consecutive newly diagnosed adult patients with partial or generalized seizures, prior to the administration of antiepileptic drugs, with the help of neuropsychological tests. As a result they found that Patients with Partial onset of seizures did not differ from patients with Generalized seizures in tests of motor function or attention, nor in tests of learning and memory. Compared to controls patients with epilepsy performed significantly worse on visual motor tasks, mental flexibility and in delayed visual memory. Within the patient group as a whole lower education, higher age and symptomatic epilepsy with more abnormal CT scan findings tended to associate with worse performance in tests of concentration and mental flexibility and tests of memory.

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