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Research Paper

Executive Dysfunction in Chronic Schizophrenia

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ABSTRACT

Executive dysfunction is a core feature of schizophrenia. Executive function is an important cognitive domain crucial for an individual to achieve adaptive living. The present researchers undertook a neuropsychological assessment of executive function among Nigerian patients diagnosed with schizophrenia. The assessment tools employed were mini-mental status examination (MMSE), trail making test (TMT) parts A and B, fluency test and Stroop colour word test (SCWT), Working memory, inhibition, fluency and set shifting were the four component of executive function which were investigated. A total of ninety-seven participants consisting of patients diagnosed with schizophrenia (n=53, 26 females and 27 males); and a control group of 44 persons (21 females and 23 males) took part in the study. There were statistically significant differences between Schizophrenics and controls on all the parameters employed. Utilizing regression analysis, the most significant predictors of TMT part B parameter among cases were with general cognitive functioning (t= 3.03, P< 0.004) and current age (t= 2.54, P= 0.014). Schizophrenia cases, showed more executive function impairment than controls on the domains investigated.

Keywords: *Executive Function, General Cognitive Functioning, Executive Dysfunction, Chronic Schizophrenia, Mental Disorders, Neuropsychological.*

Executive function (EF) deficits have been known to occur in persons who have had severe brain injuries (Ratiu & Talos 2004; Goldstein, Naglieri, Princiotta & Otero 2014)) and chronic schizophrenia (Bhatia, Garg, Pogue-Heile, Nimgasonkar, & Deshpande, 2009; Snyder, Miyake, & Hankin, 2015). Executive dysfunction renders individuals unable to cope with the performance of a series of goal-motivated behavior necessary to achieve adaptive existence in an ecologically and psychologically evolving world. Such include the ability to generate thought and think flexibly, to update and manipulate information mentally, to inhibit what is undesirable or irrelevant to current goals, to self-regulate, and to plan and adjust behavior as appropriate to the current situation (Jurado & Rosselli, 2007). Miyake, Friedman, Emerson, Witzki, Howerter, & Wager, (2000), Wray, Kowalski, Mpondo, Ochaeta, Belleza, DiGirolamo, et al. (2020) agree that executive functions are cognitive control processes which facilitate decision making, planning and goal-driven behaviour. Intact executive functioning is critical to human

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existence. Yet there are lots of unresolved questions about EFs which demand urgent answers. The level and volume of creativity and innovation needed to position this generation and succeeding ones to meet the world's ever-increasing challenges vastly depend on intact EFs. (Diamond, 2012). Researchers report that individual differences in executive functioning are associated with many important aspects of human health and functioning, including academic and occupational functioning (García-Madruga, Gómez-Veiga, Vila, 2016; Best, Miller & Jones. (2009), interpersonal problems (Ozonoff & McEvoy 1994; Rabinovici, Stephens & Possin 2015), substance use (e.g., Mauri 2016; Ham, Kim, Chung, & Im 2017; Jatau, Sha'aban, Gulma, Shitu, Khalid, Isa, et al 2021), physical health (e.g. Rabinovici et al, 2015), and mental health (Bhatua et al., 2009; Snyder et al 2015).

The cognitive construct of executive functions was originally described in the 1970s based on patterns of deficits observed in patients with frontal lobe lesions. (Baddeley & Hitch, 1974; Stuss & Benson, 1986) Executive abilities evolve over childhood and adolescence but begin to wane from early old age. Furthermore, researches involving clinical and non-clinical populations have accumulated evidence of the high incidence of executive dysfunction to varying degrees, since the end of the Second World War e.g., Snyder et al 2015); Neuroimaging data from healthy individuals provide evidence that the frontal cortex supports the executive function of the updating mechanism (Narayanan, Prabhakaran, Bunge, Christoff, Fine, Gabrieli, 2005).

Research studies have reported that executive function deficits account for the bulk of psychopathologies that have been found in schizophrenia, with considerable effect sizes on neuropsychological measures of shifting, inhibition, updating, and other aspects of working memory (Rabinovici et al, 2015). Research evidence suggests that the various components of executive function may be distinct predictors of individual differences in clinically important behaviors and functional outcomes (Snyder et al (2015). Hence, the application of relevant and validated models of executive function to clinical research could help to provide much needed clarification on the nature, structure and organization of executive function in different neuropsychiatric conditions, as well as the relationship between executive function and deficits observed in different clinical populations (Berberian, Gadelha, Dias, Mecca, Comfort, Bressan et al. 2018).

HISTORICAL DEVELOPMENT OF EXECUTIVE FUNCTION THEORY

Two accidents gave impetus to the study and development of various theories and models of executive function. The first was the accident involving Phineas Gage in 1840. Working as a railroad foreman, Gage was pierced with a large piece of iron rod through his left eye that protruded out of his left frontal lobe (Ratiu & Talos, 2004). Consequently, a major portion of his frontal lobe was destroyed. Gage recovered physically from his brain injury but the same could not be said of his behavior and personality. Gage's post-recovery behavior and personality was described as 'disinhibitted' or 'hyperactive' suggesting a lack of inhibition, a condition found in persons with damage to pre-frontal cortex of the frontal lobe (Goldstein et al 2014). The second was the inadvertent surgical removal of the hippocampus of the subject H.M. It so happened that in 1953, William Scoville, a neurosurgeon performed surgery on the then popular patient H.M. The surgery on H. M involved the bilateral removal of his hippocampus. As a result, H.M. became amnesic of novel events- he could only remember events prior to the removal of his hippocampus. Scoville demonstrated once more that memory wasn't localized to a particular site of the nervous system after Karl Lashley had come to a similar conclusion in 1950. (Kolb & Whishaw, 2012). Thus grew the

interest and attention of psychologists and neuroscientists which broadened into wanting to establish a connection between the frontal lobes and intelligent behavior. Hence, the British psychologist Donald Broadbent in 1953 described differences between automatic and controlled processes. (Goldstein et al (2014).

Executive function research endeavours by psychologists and neuroscientists persisted into a second decade. Perhaps the 1960s could be called the Lurian decade of executive function research and theoretical development. It is noteworthy that Alexander Romanovich Luria, a Russian neuropsychologist laid the foundation for the theoretical and clinical development of executive function as a sub domain of cognitive functioning as well as pioneered the neuropsychological assessment of same. Luria proposed a neurodevelopmtal model in which he identified specific developmental stages which matched stages of higher cortical maturation. Luria suggested, in effect, that executive functioning research could rely on the unfolding of various stages of mental development encountered by children. Luria (1966), relying on Vygotsky's cultural and environmental theory of learning (Van de Veer & Valsiner, 1994), went further to postulate that certain stages responsible for neuropsychological functioning critical to intelligence and executive functioning are developed.

Luria (1966) postulated that higher cortical functions involving executive functioning demanded interaction of normal neurological development and specific environmental stimuli of a cultural, historical and social nature of development. In this regard, Luria postulates are quite consistent with current theory which suggests that particular phenotypes are shaped by environmental experience resulting in multi-finality or multiple endophenotypes. Thus, in relation to intelligence, executive functioning and other domains of cognitive functioning; optimal interaction of neurological development and environmental stimuli would produce more efficient cortical functioning. (Luria, 1963, 1966; Goldstien et al, 2014)

During the third decade of executive function research, Posner and Snyder (1975) built upon the findings of Broadbent, Luria and earlier researchers with their 'cognitive control' model. They extended the conceptualization of executive functioning to include the examination of the role of attention in higher level tasks such as visual searches. Similarly, Schiffrin and Schneider (1977) proposed a dual processing theory in which automatic processing activates a learned sequence of elements and proceeds automatically, whereas controlled processes involved a temporary activation of a sequence of elements that can be established rapidly without enlisting attention.

In the fourth decade, researchers Baddely and Shalice, separately conceptualized a model that could be referred to as 'controlled attentional system' of executive functioning. Baddely (1986) conceptualized executive functioning in terms of time-sharing, selective attention, temporary activation of long-term memory and switching of retrieval plans while Shallice (1988) emphasized the controlling mediator of inhibition of competing actions in the selection of an action to be performed.

Central executive hypothesis proposed by Baddeley and his colleagues formed the dominant view of executive functioning in the fifth decade of its development. Baddeley, Sala and Robbins (1996) central executive hypothesis built upon Baddeley's previous version of controlled/supervisory attentional system. They viewed executive functioning as a unified system having multiple functions that controls the phonological loop, visuospatial sketchpad

and an episodic buffer. Another important contribution of this decade was made by J.M. Fuster. Fuster (1997) proposed a 'cross-temporal synthesis based on interference control, planning and working memory. His theory identified the goal of executive functioning to be the organization of behavior.

The sixth decade of executive functioning theoretical development could be termed an era of near-maturity. Goldstien et al, (2014) termed Miller and Cohen's (2001) model of executive functioning as 'Integrative Model'. Miller and Cohen (2001) were the first to propose a model that conceptualized the top-down nature of executive functioning system. In this model, executive functioning is viewed as promoting interaction between sensory and motor processing areas while selective signals direct activities along the neural pathways.

The major contribution to executive functioning theoretical development in its seventh decade came from R.A. Barkley. In his work entitled 'Executive functioning and self-regulation: Integration, extended phenotypes and clinical implications', Barkley (2011) summarized executive function with the single concept of self-regulation composed of (i) working memory (ii) Management of emotions (iii) Problem solving (iv) Analysis and synthesis into new behavioral goals. Additionally, he identified the processes associated with executive functioning to include working memory, planning, problem solving, self-monitoring, interference control and self-motivation (Barkley, 2011). The foregoing models of executive functioning tend to mix up underlying mental processes with behavioral outcomes and identify a limited number of the former. These drawbacks have rendered assessment tools selection and their efficacy problematic. Accurate and valid assessment of executive function is therefore compromised, (Stuss & Benson, 1986; Shallice, 1988; Damasio, 1995; Stuss, 2005); and notably, damage to any component process is difficult to be fully ruled out following the onset of brain lesions or psychopathologies. (Chan,Shum, Toulopoulou & Chen 2007). There is therefore, the need for new model (s) that take into account the need to target relevant mental processes. This is our focus in the next session.

The four-factor model of Executive Functioning

Executive function refers to the mental processes required to initiate, perpetuate and complete series of goal-motivated behaviours which make adaptive living a possibility. We align with Rabinovici et al, (2015) that from a clinical perspective, it is useful to split executive functions into specific components that can be separately affected in individual patients. In this regard we identify four components that make distinct clinical contributions to executive function. These are: working memory (information updating and monitoring), inhibition (of prepotent responses), set shifting (mental set shifting), and fluency. (Miyake, Friedman, Emerson, Witzki, Howerter, Wagner 2000; Fisk, & Sharp, 2004; Rabinovici et al, 2015). These processes are mediated by neural pathways reliant on the neurochemical environment which utilizes the complex networks encompassing the cortical and sub cortical structures controllable by the frontal lobes. It is hoped that such categorization may ease early diagnosis, treatment planning, intervention and rehabilitation involving executive dysfunction in several neurotic and psychotic disorders. Neuroimaging studies show overlapping activations in these regions are seen in paradigms that engage working memory, set shifting, response inhibition, fluency, and planning. Hence, data from functional brain imaging studies are consistent with data from structural brain imaging studies. For instance, neuroimaging in patients with OCD has produced converging data implicating altered functioning in the neurocircuitry between orbitofrontal cortex, caudate and thalamus. Positron emission tomography (PET) studies have shown increased activity (e.g., metabolism and blood flow) in the frontal lobes, the basal ganglia (especially the caudate)

and the cingulum of mental disorder patients. (Sadock, Sadock & Ruiz 2015). The four-factor model represents a successful attempt at fractionating the executive system into more specific components of executive function (Shallice, 1988; Shallice & Burgess, 1991; Posner & Raichle, 1994) It has the potential to overcome the crudeness, under specification of component processes and lack of sensitivity associated with some of the current conventional executive function tests used by clinicians and neuropsychologists. (Burgess, 1997; Chan, Chen, Cheung, Chen, & Cheung, 2006; Chan, Chen, & Law, 2006).

These components underlie most of the higher cognitive/executive functions and are more associated with psychopathology as accumulated data show (Rabinovici, et al 2015). A brief discussion of these four components of executive function follows.

Working Memory

Working memory is a limited capacity system that enables us to temporarily process, store, and manipulate information in conscious awareness. Updating consists of actively monitoring and codifying information or perceptual input, reviewing items that are being sustained within the working memory buffer, contrasting previous information patterns with novel input and, finally, replacing information that has become irrelevant (Berberian, Gadelha, Dias, Mecca, Comfort, Bressan, et al, 2018). Patients with working memory deficits may report absentmindedness and trouble focusing. Intact working memory is crucial to higher-level tasks including planning and decision making as it allows us to actively keep track of all of the necessary information. (Rabinovici et al, 2015). An earlier model proposed by Baddeley and Hitch, (1974) split working memory into a phonologic loop that maintains auditory and verbal information and a visuospatial sketchpad that maintains visual information. This model has gained credence from functional neuroimaging studies showing left-lateralized activations when performing verbal working memory tasks and right lateralized activity in response to visually oriented tasks. (Snyder et al, 2015)

Working memory can be further divided into tasks that require simple maintenance of information (eg, forward digit span, which is a task that requires repeating a chain of numbers) and those that require active manipulation of information (eg, backward digit span, in which numbers are repeated in reverse order). Either spelling WORLD backward or performing serial 7s on the Mini-Mental State Examination (MMSE) are examples of working memory tests that require information manipulation.

Inhibition

Inhibition is the ability to hold back a predominant, automatic, or previously learned response that may be inappropriate or irrelevant in the present situation. (Rabinovici, Stephens and Possin, 2015) Certain stimuli are loaded to stimulate an automatic behavioral response due to either familiarity or immediate reward. (Friedman & Miyake, 2004). However, adaptive behavior may require inhibition of the prepotent (ie, automatic or habitual) response in order to meet the current goal.

Patients who are cognitively disinhibited have difficulty actively ignoring irrelevant or even penalizing stimuli. They may appear easily distracted, stimulus bound, and impulsive. In advanced cases, patients exhibit utilization behavior (picking up and using objects they observe for no clear purpose), echolalia (involuntarily repeating what is heard), or echopraxia (involuntarily imitating actions). (Rabinovici et al, 2015)

Set Shifting

Set shifting involves disengaging from an irrelevant task set to actively engage in a relevant task set (Berberian, Gadelha, Dias, Mecca, Comfort, Bressan, et al, 2018). Set shifting also reflects the ability to modify attention and behavior in response to changing circumstances and demands. Set shifting inherently relies on working memory (in order to keep in mind the current goals) and response inhibition (in order to ignore a previously relevant goal or focus of attention), illustrating the interdependence of different components of executive function. Patients with deficits in set shifting may report difficulties with multitasking and appear rigid in their thinking. On clinical evaluation, they may exhibit perseverative thoughts or behaviors. The Luria manual sequencing task, in which patients are asked to alternate sequentially between three hand positions (closed fist, fingers extended parallel to the ground, and fingers extended perpendicular to the ground), is a useful bedside test of set shifting. Trail-making tasks are often employed on neuropsychological testing (Rabinovici et al, 2015.

Fluency

Fluency represents the ability to maximize the production of verbal or visual information in a specific time period, while avoiding repeating responses. The three most common types of fluency tasks are category, letter, and design. (Rabinovici et al, 2015)

Executive dysfunction in chronic Schizophrenia

Chronic schizophrenia is defined as a chronic stage in the development of a schizophrenic illness in which there has been a clear progression from an early stage to a later stage characterized by long- term, though not necessarily irreversible, "negative" symptoms, e.g. psychomotor slowing; under activity; blunting of affect; passivity and lack of initiative; poverty of quantity or content of speech; poor nonverbal communication by facial expression, eye contact, voice modulation and posture; poor self-care and social performance. (WHO ICD-10 Version, 2016 F20.5).

Schizophrenia manifests generally in the mid to late teens and presents with often uncontrollable executive dysfunctions. The disorder ranges from mild, moderate, acute to chronic in its stages of manifestation. Periods of acute schizophrenia could occur repeatedly in the course of the psychosis. Schizophrenics in an acute episode of the illness experience some variation of hallucinations, delusions, and thought disorder. These are the "positive symptoms" of schizophrenia as they are in addition to the person's usual repertoire of feelings. Following an acute episode, some patients experience remission or cessation of symptoms, whereas, others enter into a lengthy period of chronic illness characterized mostly by "negative symptoms". These are subtractions from the normal repertoire of feelings, such as loss of interest and energy, loss of warmth and humour, and loss of ability to feel empathy (Andreason & Olsen, 1982). These are cognitive deficits range over a broad spectrum of severity that impact on a person's functioning in adaptive living. Problems such as attention and memory disorders, problem solving difficulties, and perceptual problems are evidences of underlying cognitive deficits characterize the disorder. (Levin, Yurgelin-Todd & Craft, 1989).

In totality, schizophrenia has no established causes, yet possess multiple symptoms, courses and outcomes. And it is characterized by its episodic, heterogeneous nature. Patients with chronic symptomatology and corresponding cognitive dysfunction have significant problems coping with demands of daily living and expectations. Some brain imaging studies (e.g.Suddath, Christison, Torrey, Casanove, & Weinberger, 1990) suggest the anterior

hippocampus as a lesion site in the brain of schizophrenics. They also suggest the possibility that schizophrenics may have a unique brain deficit that has not yet been identified.

An approach that could address some of the confounding factors which could influence executive function performance is to examine the neuropsychological profile of patients at the chronic stage of schizophrenia. Rabanea-Souza (2019) examined 72 remitted and 42 nonremitted schizophrenia patients and 119 healthy controls and found that executive function deficits are present in chronic schizophrenic patients. However, a notable drawback of the study is the failure to identify and differentiate between the components of executive functioning and the higher order cognitive functions they predict. Sabhesan & Parthasarathy (2005) examined 31 schizophrenia patients at various levels of recovery and found that the dimensions of executive functions did not show any significant relationship with age or duration of illness. However, the sample size is rather small and failure to isolate chronic cases meant that confounding factors that could influence neuropsychological test performance were ignored.

Savla, Twamley, Delis, Roesch, Jeste, Palmer, (2012) conducted a study that included 145 community-dwelling individuals with schizophrenia. Executive functions were measured with the Delis-Kaplan Executive Functioning System (D-KEFS). They conducted an exploratory factor analysis (EFA) with principal axis factoring, as well as parallel analyses to examine the latent constructs underlying the D-KEFS tasks, a second EFA on weighted residuals of the D-KEFS tasks (after accounting for processing speed measured with the Digit Symbol task), and bivariate correlations to examine relationships between the D-KEFS components and relevant demographic and clinical variables, crystallized verbal knowledge, and functional capacity. The study had appreciable sample size but imprecise number of executive functioning components could have compromised its results.

A large body of evidence suggests that executive function deficits are core features of mental disorders such as schizophrenia as a result of altered neural mechanisms related to its etiology and onset. (Berberian, Gadelha, Dias, Mecca, Comfort, Bressan, et al. 2018) The effects of various confounding variables on executive and cognitive functioning need to be investigated further and to be controlled before a definite conclusion can be made. Additionally, extant studies have mostly been restricted to the global north- more advanced countries. However, there is a paucity of studies, simultaneously examining executive dysfunction involving the aforementioned four components of executive function in chronic schizophrenia in Nigeria.

METHODOLOGY

The method adopted for the present study titled 'Executive Function Dysfunction in Chronic Schizophrenia is considered under the following subheads:

- Objectives of the study
- Research questions
- Hypotheses
- Samples
- Instruments
- Procedure
- Ethical consideration
- Statistical analysis

Objectives of the Study

Executive function dysfunction is a core feature of chronic schizophrenia (Goetghebeur & Dias, 2009; Hosenbocus, & Chahal 2012). The purpose of the present study is thus the neuropsychological assessment of executive dysfunction in chronic schizophrenia.

The following are the specific objectives for this research:

- To examine the level of executive function deficits` in chronic schizophrenia patients;
- To examine the degenerative pattern of executive functioning in chronic schizophrenia s;
- To explain the influence of various patient clinical and demographic characteristics on the disorder;
- To compare mean differences in group outcomes of executive dysfunction in chronic schizophrenia patients and controls.

Research questions

The broad research question is do executive dysfunction influence adaptive behavioural outcome in chronic schizophrenia and drug induced mental disorder patients?

1. Do general intelligence scores of chronic schizophrenia patients fall below those of control group?
2. Do chronic schizophrenia patients perform worse than controls on tests of inhibitory control?
3. Are there differences in group outcomes of executive function deficits in chronic schizophrenia and controls?
4. Do assessment scores of these psychotic patients reflect impaired behavioural outcome and adaptive living

Hypotheses

- General cognitive functioning scores of chronic schizophrenia patients will fall below those of control group;
- Chronic schizophrenia patients will perform worse than controls on tests of inhibitory control;
- There will be differences in group outcomes of working memory deficits in chronic schizophrenia and controls;
- Assessment scores of the psychotic patients will reflect impaired performance on fluency tasks as compared to the control group;
- Chronic schizophrenia patients will perform worse than controls on set shifting tasks.

Sample

A total of 97 participants (n=25 females and n=72 males were included in the study. This included a sample consisting of fifty-three chronic schizophrenia patients aged between 18 and 68 years selected after consent was obtained at the In-Patient and Out-Patient departments of Federal Neuropsychiatric Hospital, Benin City, Nigeria There was a control group of forty-four volunteers aged between 18 and 68 years. The control group was drawn largely from religious communities with a demonstrable aversion to smoking, alcohol and drug use. Subjects in both cases and control groups had the mini mental status examination (MMSE), modified version of Stroop Colour Word Interference Test from subtests of the Delis-Kaplan Executive Function System (D-KEPS), the Trail Making Test (TMT) from the D-KEPS, and Fluency tasks, individually administered to them

Instruments

Four instruments were used in this study

MINI-MENTAL STATE EXAMINATION (MMSE) According to Mental Health Assessment Tools, second edition (2012). Laois OffalyLongford Westmeath Mental Health Services. Jansen online resource, the Mini-Mental State Examination is a 30-point questionnaire used to detect cognitive impairment, assess its severity and to monitor cognitive changes over time. Authors are Marshal F. Folstein, MD, Susan E. Folstein, MD, Paul R. McHugh, MD. Copyright ©_ 1975, 1998. Although older adults are at higher risk than the rest of the population, changes in cognitive function often call for prompt and aggressive action. In older patients, cognitive functioning is instrumental in identifying early changes in physiological status, ability to learn, and evaluating responses to treatment.

The Mini Mental State Examination (MMSE) is a tool that can be used to systematically and thoroughly assess mental status. It is an 11-question measure that tests five areas of cognitive function: orientation, registration, attention and calculation, recall and language. The MMSE takes 5-10 minutes to administer and is therefore practical to use repeatedly and routinely. The MMSE is effective as a screening tool for cognitive impairment with older, community dwelling, hospitalized and institutionalized adults. Assessment of an older adults cognitive function is best achieved when it is done routinely, systematically and thoroughly.

Validity/Reliability Since its creation in 1975, the MMSE has been validated and extensively used in both clinical practice and research.

Strengths and Limitations the MMSE is effective as a screening instrument to separate patients with cognitive impairment from those without it. In addition, when used repeatedly the instrument is able to measure changes in cognitive status that may benefit from intervention. However, the tool is not able to diagnose the case for changes in cognitive function and should not replace a complete clinical assessment of mental status. In addition, the instrument relies heavily on verbal response and reading and writing. Therefore, patients that are hearing and visually impaired, have low English literacy, or those with other communication disorders may perform poorly even when cognitively intact.

MMSE Scoring guide: a)25-30 suggests a normal scoring range b)18-24 suggests a mild to moderate impairment of cognitive functioning c)Scores under 17 suggests a severe cognitive impairment.

Trail Making Test (TMT): This test was used to assess mental set shifting (Arbuthnott, K. & Frank J., 2000). The outcome variable was the mean of the total time taken to complete the first two conditions (one condition required participants to draw lines to connect circled numbers in a numerical sequence, and the other condition required them to connect circled letters alphabetically), minus the total time taken to complete the final phase of the task, which required the participant to connect circled numbers and letters in an alternating numeric and alphabetic sequence.

The trail making test was authored by R.M. Reitan. The test was used in 1944 for assessing general intelligence, and became popular for its use as was part of the Army Individual Test of General Ability. (Tombaugh, 2004). But in the 1950s researchers began using the test to assess cognitive dysfunction stemming from brain damage, and it has since been incorporated into the Halstead-Reitan battery. (Reitan,.1955; Reitan,.(1958). The Trail Making Test is now commonly used as a diagnostic tool in clinical settings. Poor

performance is known to be associated with many types of brain impairment, in especially frontal lobe lesion.

Type/Purpose of Test: The purpose of the TMT is to test for the presence of brain injury. The TMT is a measure of attention, speed, and mental flexibility. It also tests spatial organization, visual pursuits, recall, and recognition. Part A requires the individual to draw lines to connect 25 encircled numbers distributed on a page. Part A tests visual scanning, numeric sequencing, and visuomotor speed. Part B is similar except the person must alternate between numbers and letters and is believed to be more difficult and takes longer to complete. Part B tests cognitive demands including visual motor and visual spatial abilities and mental flexibility. Both sections are timed and the score represents the amount of time required to complete the task.
Population: Persons 15 to 89 years of age in a variety of settings suspected to have cognitive deficits, particularly after a TBI
Time required to administer: 5-10 minutes

Practical Administration
Ease of Administration: Easy to administer, requires no training

Fluency
Fluency represents the ability to maximize the production of verbal or visual information in a specific time period, while avoiding repeating responses. The three most common types of fluency tasks are category, letter, and design. Verbal fluency tasks are often included in neuropsychological assessment, in clinical practice, and in research The popular use of the verbal fluency tasks most likely stems in part from their face validity as tests of both verbal ability and executive control (Shao, Janse, Visser, & Meyer 2014). Subjects are required to retrieve words of their language, which undoubtedly requires them to access their mental lexicon. They need to focus on the task, select words meeting certain criteria, avoiding repetition, which certainly involves executive control processes (Fisk and Sharp, 2004). Serious deficits in either verbal ability or executive control should manifest themselves in poor performance in the fluency tasks.

The validity of the fluency tasks as a measure to assess verbal ability, specifically lexical access ability, has been confirmed in numerous studies comparing groups of participants that would be expected to differ in this ability. Salthouse (1991, 1996) found that participants with smaller vocabularies produced fewer words than did participants with larger vocabularies. Similarly, children with Specific Language Impairment or dyslexia, who often have word finding difficulties (e.g., Snowling, Van Wagtendonk & Stafford 1988; Seiger-Gardner, & Brooks, 2008), have been shown to have deficits in verbal fluency performance compared to typically developing children (Cohen, Morgan, Vaughn, Riccio, & Hall 1999. Weckerly, Wulfeck & Reilly 2002). Therefore, the fluency tasks can be used as an efficient screening instrument of general verbal functioning (Rabinovici, et al 2015).

Design Fluency Test (DFT), also known as “figural” or “nonverbal” fluency represents a method of assessment of executive functioning, commonly used in research and clinical practice. Examinees are instructed to draw as many different designs as possible in one minute, while avoiding repeating previous designs. There are now several versions of DF tests, most of which require that designs be drawn by connecting dots in a series of five-dot matrices, using four lines (Suchy, Kraybill, & Larson, 2010; Rabinovici et al 2015).

Stroop colour word test

The Stroop Color and Word Test (SCWT) is a neuropsychological test extensively used for both experimental and clinical purposes (Scarpina & Tagini (2017)). It assesses the ability to inhibit cognitive interference, which occurs when the processing of a stimulus feature affects the simultaneous processing of another attribute of the same stimulus (Stroop 1935).The purpose of the stroop colour word test (SCWT) is to assess the ability of the individual to inhibit a habitual response for one that is less readily available. Multiple versions of the Stroop Test have been developed. Earlier versions such as the 5 × 20 grid version was chosen for standardization (Golden & Freshwater, 2002) because impaired individuals had difficulty reading across the rows, tending to lose their place. The Color-Word component consists of color words, but each one is printed in a color that differs from the written word (e.g., the word "red" will be printed in green or blue, but not in red). (Rozenblatt.2011)

Numerous studies have validated the MMSE in Nigeria (e.g. Imam, Onifade, Durodoye, Aje, Sogaolu, Kehinde, Ogunniyi,. 2003; Onwuekwe, 2012; Ogurel 2015; Abdullah, Umar, Abdulkadir, Bmr, & Danladi 2019) Several studies have also validated subtests of D-KEFS among African populations in Morocco, North Africa (Oumellal, El Alaoui Faris, & Benabdeljlil, 2018), Cameroon, Central Africa (Kanmogne,, Fonsah., Tang, 2018) and Ghana, West Africa (Adjorlolo 2016) countries with close cultural affinity with Nigeria (Miles 2015; Amunts, Camilleri, Eikhoff 2020). Notably, language is the most significant cultural component to be considered jn cross cultural application of neuropsychological tools (Bezdicek, Moták, David Schretlen, Preiss, Axelrod, Nikolai, Peña, Ojeda & Růžička 2016; Vissoci, de Oliveira, Gafaar, Mvungi & Mmbaga 2019) However, absence of validation of executive function tests in a specific territory may cast a shadow over generalizability of research findings (Cavaco et al 2013).

Procedure

Cases were individuals diagnosed with chronic schizophrenia and participants of our ongoing PhD research, recruited after ethical clearance from the Federal Neuropsychiatric Hospital, Benin City, Nigeria Ethics Committee was received. The said Committee also vetted our consent form. Their treating psychiatrists were contacted initially and generally, after preliminary information and verbal consent, they referred willing subjects to the researcher for interview. All referred subjects who met inclusion criteria were recruited, though a few patients still opted out in the process of tests administration. Cases and controls were personally and individually administered the mini mental status examination (MMSE), TMT Parts A and B, SCWT and Fluency tasks between the months of April and August, 2021. Time taken to complete all parts of the test and scores were recorded. Demographic details (gender, age, education etc) were also recorded for all participants. For category fluency (also known as semantic fluency), subjects were asked to generate as many words as possible from a specified category, in this case animals. With respect to letter fluency (also referred to as phonemic fluency), subjects were asked to generate as many words as possible that start with a specified letter G, excluding names of people and places or grammatic variants of previous responses. For design fluency, subjects were asked to generate as many designs as possible while using only four lines to connect the dots.

Ethical Consideration

Study was approved by Research Ethical Committee of Federal Neuropsychiatric Hospital Benin City, Edo State, Nigeria.

Statistical Analysis

The above neuropsychological tests were administered, scoring done according to the standard procedure as prescribed in the manuals. All data were evaluated on required statistical techniques with descriptive details. All statistical analysis were conducted using IBM SPSS Statistics version 20.0 (IBM, Armonk, NY, USA)

RESULTS AND DISCUSSION

Table No.1 Mean (M) and Standard Deviation (SD) for Study Variables with N=53 (Schizophrenia Clinical Group) and N= 44 (Control Group)

	Clinical Group		Control Group	
Variables	**M**	**SD**	**M**	**SD**
MMSE	20.16	6.78	25.11	4.5
TMT Part A	132.52	85.32	54.59	18.82
TMT Part B	243.77	111.76	98.95	40.45
SCWT	1.60	1.88	3.09	2.11
Fluency	15.73	9.22	30.38	10.94
Age	39.41	11.12	31.90	14.46
School Years	13.61	2.03	13.43	1.96
Duration of illness	3.91	7.46	Not Applicable	Not Applicable

Demographic characteristics: The mean ages of chronic schizophrenia patients and controls were 39.41 (SD=11.12) and 31.90 (SD=14.46) years respectively. Gender-wise distribution of the sample was 49.06% females, 50.94% males among schizophrenics and 47.7% females, 52.3% males among controls.

The mean years of education were comparable: schizophrenics 13.61 (SD=2.03) years and controls 13.43 (SD=1.96) years. There was no significant difference between schizophrenics and controls on education (Table1)

Table No.2 Comparison of means for Schizophrenia and Control Group MMSE scores

Test Value = 25.11					
t	**df**	**Sig. (2-tailed)**	**Mean Difference**	**95% Confidence Interval of the Difference**	
				Lower	**Upper**
-5.322	52	.000	-4.95906	-6.8288	-3.0893

MMSE scores of schizophrenics and controls were 20.16 (SD=6.78), 25.11 (SD=4.45) respectively [Table 1]. Controls had significantly higher MMSE score than schizophrenics (t=5.32, $P<0.001$) [see Tables2]

Schizophrenics versus controls: There were significant differences between schizophrenia cases and controls on Part A of the TMT (t=6.65, $P<0.001$) [see Table 3]. On Part B of the TMT, schizophrenics 243.77 (SD=111.76) secs took significantly more time than controls 98.95 (SD=40.45) secs (t = 9.43, $P<0.001$) [see Table 4]. Number of females was not significantly more in schizophrenia cases than in controls. Schizophrenics performed significantly worse than controls in both Stroop colour word interference test and fluency tasks (semantic fluency +polemic fluency +design fluency) (t=5.74, $P<0.001$) and (t=11.56, $P<0.001$) respectively [Tables 5 and 6]

Table No.3 Comparison of means for Schizophrenia and Control Group TMT Part A scores

Test Value = 54.59					
t	**df**	**Sig. (2-tailed)**	**Mean Difference**	**95% Confidence Interval of the Difference**	
				Lower	**Upper**
6.650	52	.000	77.93830	54.4194	101.4572

Table No.4 Comparison of means for Schizophrenia and Control Group TMT Part B scores

Test Value = 98.95					
t	**df**	**Sig. (2-tailed)**	**Mean Difference**	**95% Confidence Interval of the Difference**	
				Lower	**Upper**
9.433	52	.000	144.82358	114.0163	175.6309

Table No.5 Comparison of means for Schizophrenia and Control Group Stroop colour word test scores

Test Value = 3.09					
t	**df**	**Sig. (2-tailed)**	**Mean Difference**	**95% Confidence Interval of the Difference**	
				Lower	**Upper**
-5.741	52	.000	-1.48623	-2.0057	-.9668

Table No.6 Comparison of mean scores for Schizophrenia and Control Group Fluency tasks

Test Value = 30.38					
t	**df**	**Sig. (2-tailed)**	**Mean Difference**	**95% Confidence Interval of the Difference**	
				Lower	**Upper**
-11.561	52	.000	-14.64415	-17.1860	-12.1023

Table No. 7 Regression Analysis showing age and general cognitive functioning as positive predictors of TMT Part B (Dependent variable) performance of Schizophrenics

Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	(Constant)	233.406	67.246		3.471	.001
	Duration of Illness OF schizophrenics in years	-.837	2.132	-.056	-.393	.696
	Total MMSE Score of schizophrenics	-6.292	2.072	-.382	-3.036	.004
	age of schizophrenics in years	3.563	1.399	.355	2.546	.014

Analyses among patients: Regression analyses were performed to test for effects of different clinical and demographic variables on TMT, MMSE, SCWT and Fluency tasks among the clinical groups. Variables selected for analysis included age, school years, and

duration of illness. There were statistically significant differences between the duration of illness for schizophrenics On Part B, the main correlates were general cognitive functioning and older age both clinical groups: Schizophrenics (t=3.03, *P=0.004*) (t=2.54, *P=0.14*) [Table 7]

The major finding of this study is that schizophrenia patients performed worse than controls. To our knowledge, this is one of the first reports of inhibitory control, working memory, set shifting and fluency components of executive function, among schizophrenia patients in Nigeria. We found that Nigerian subjects diagnosed with schizophrenia performed worse than controls on Parts A and B of the TMT, assessing inhibitory control, working memory and set shifting components of executive ability; SCWT assessing working memory and inhibitory control; fluency tasks assessing fluency and working memory components of executive functions; and MMSE assessing working memory and general cognitive functioning. Our findings are consistent with those of Rabanea-Souza (2019). Age has been found to adversely affect executive function, but the effect was pronounced among schizophrenic cases more than controls.

The cases took more time to complete Part B of TMT than normal subjects, in agreement with other studies (Bhatia, et al 2009). Age was an important predictor of TMT performance in our cases. Our results are consistent with those by Sabhesan & Parthasarathy (2005) and Bhatia, et al (2009). Cognitive abilities were adversely affected by psychotic symptoms (Bhatia et al, 2009). The subjects with higher general cognitive functioning scores took less time on all parts of the TMT. This finding is consistent with Giovagnoli et'al (1996) study on Italian subjects, in which the TMT was affected by age, education and general intelligence. All the measurement tools utilized in this study involves knowledge of English alphabets and numbers. Therefore, literacy affects performance on these tests. Participants in this study were drawn from South South and South Eastern parts of Nigeria where the use of English language in academics and socio-economic transactions start very early in an individual's life.

CONCLUSION

We report a fairly large Nigerian sample of Schizophrenia patients performed worse than controls on MMSE tasks, Part A and Part B of the TMT, Fluency tasks, and SCWT. Hence schizophrenia subjects recorded dysfunction in the four components of executive function investigated.

The results support the study hypotheses that:

- Schizophrenics will perform worse than controls on tests of general cognitive functioning (measured by MMSE);
- Schizophrenia subjects will perform worse than controls on tasks assessing working memory;
- Schizophrenics will perform worse than controls on tests measuring set shifting;
- Schizophrenics will perform worse than controls on tasks assessing inhibitory control;
- Schizophrenics perform worse than controls on fluency tasks.

The cases performed worse than the controls, suggesting that schizophrenia patients are more vulnerable to executive dysfunction than the general population. Duration of chronic schizophrenia illness did not affect performance on tests which may suggest that with timely

intervention, proper treatment planning and management, the patient can engage in activities of daily living and achieve wholesome adaptive existence. Education positively predicted performance in executive function tests. This may suggest that training and re-training programmes should be provided using the language best understood by patients. MMSE positively predicted performance in other tests of executive functioning. This may be a pointer to its efficacy as an assessment tool to monitor the progress of neurotic and psychotic patients.

REFERENCES

Abdullah, A., Umar, A., Abdulkadir, M., Bmr, M., & Danladi, J. (2019). Relationship between Post-Stroke Cognitive Impairment and Functional Activity of Stroke Survivors in Maiduguri, Borno State Nigeria. Advances in Physical Education, 9, 8-22. doi: 10.4236/ape.2019.91002.

Adjorlolo, S. (2016). Ecological validity of executive function tests in moderate traumatic brain injury in Ghana. Clin Neuropsychol Jan-Dec 2016;30(sup1):1517-1537. doi: 10.1080/13854046.2016.1172667. Epub 2016 Apr 13.

Amaral, D. G. (2002). The primate amygdala and the neurobiology of social behavior: implications for understanding social anxiety. Biol Psychiatry. 2002; 51:11–17. doi: 10.1016/S0006-3223(01)01307-5. [PubMed] [CrossRef] [Google Scholar].

Anett, A. J., & Labovitz, S. S. (1995). "Effect of physical layout in performance of the Trail Making Test". Psychological Assessment. 7 (2): 220–221. doi:10.1037/1040-3590.7.2.220. ProQuest 614331919.

Aron, A. R., Robbins, T. W., & Poldrack, A. R. (2004). Inhibition and the right inferior frontal cortex. Trends Cogn Sci. 2004; 8:170-7.

Baddeley, A. D., & HITCH, G. J. (1974). Working memory. In: Bower G, ed. Recent advances in learning and motivation. London: Academic Press, 1974: 47– 90. [Google Scholar].

Baddeley, A.D.; Della Sala, S.; Robbins, T. W.; Baddeley, A. (1996). "Working memory and executive control". Philosophical Transactions of the Royal Society. 351 (1346): 1397–1404. doi:10.1098/rstb.1996.0123. PMID 8941951.

Barkley, R. A. (1997). Behavioral inhibition, sustained attention, and executive functions: Constructing a unifying theory. Psychological Bulletin, 121, 65–94. PubMed CAS Google Scholar.

Barkley, R. A. (2001). The Executive Functions and Self-Regulation: An Evolutionary Neuropsychological Perspective. Neuropsychol Rev 11, 1–29 (2001). https://doi.org /10.1023/A:1009085417776.

Beberian, A. A., Gadelha, A., Dias, N. M., Mecca, T. P., Comfort, W. E., & Bressan, R. A. (2018). (n.d.). Component mechanisms of executive function in schizophrenia and their contribution to functional outcomes. braz J psychiatry. 2018; 00:000-000. http://dx.doi.org/10.1590/1516-4446-2018-0021.

Best, J. R., Miller, P. H., & Jones, L. L. (2009).). Executive function after age 5: changes and correlates. Dev. Rev. 29, 180–200. 10.1016/j.dr.2009.05.002 [PMC free article] [PubMed] [CrossRef] [Google Scholar].

Bezdicek, O., Moták, L., David, J., Schretlen, D. J., Preiss, M., Axelrod, B. N., … Růžička, R. (2016). Sociocultural and Language Differences on the Trail Making Test Archives of Assessment Psychology, Vol. 6, No. 1, (33-48) © 2016 American Board of Assessment Printed in U.S.A. All rights reserved.

Bhatia, T., Garg, K., Pogue-Heile, M., Nimgasonkar, V. L., & Deshpande, S. N. (2009). Executive functions and cognitive deficits in schizophrenia: Comparisons between probands, parents and controls in India. J Postgrad Med 2009; 55:3-7.

Blair, C. (2016). Developmental Science and Executive Function Curr Dir Psychol Sci. 2016 Feb 1; 25(1): 3–7. doi: 10.1177/0963721415622634 PMCID: PMC4789148 NIHMSID: NIHMS741195 PMID: 26985139.

Braver, T. S., Barch, D. M., & Cohen, J. D. (1999). Cognition and control in schizophrenias: A computational model of dopamine and prefrontal function. Biological Psychiatry,46:312-328.

Bragrad, A., Schelstraete, M. A., Snyers, P., & James, D. G. (2012). Word-finding intervention for children with specific language impairment: a multiple single-case study. Lang. Speech Hear. Serv. Sch. 43, 222–234. doi: 10.1044/0161-1461(2011/10-0090)

Burgess, P. W. (1997). Theory and methodology in executive function research. In P. Rabbitt (Ed.) Methodology of frontal executive function (pp. 81–116). Hove, East Sussex: Psychology Press. Google Scholar.

Burgess, P. W., Alderman, N., Evans, J., Emslie, H., & Wilson, B. (1998). The ecological validity of tests of executive function. Journal of the International Neuropsychological Society 4: 547–558. Google Scholar.

Cavaco, S., Goncalves, A., Pinto, C., Almeida, E., Moreira, J., & Teixeira-Pinto, A. (2013). Trail Making Test: Regression-based Norms for the Portuguese Population: egression-based Norms for the Portuguese Population Archives of Clinical Neuropsychology, Volume 28, Issue 2, March 2013, Pages 189–198, https://doi.org/ 10.1093/arclin/acs115.

Cahn, D. A. (1995). "Detection of dementia of the Alzheimer type in a population-based sample: Neuropsychological test performance". Journal of the International Neuropsychological Society. 1 (3): 252–260. doi:10.1017/s1355617700000242.

Cahn-Weiner, D. A., Boyle, P. A., & Mallow, P.F. (2002). Tests of executive function predict instrumental activities of daily living in community-dwelling older individuals. Appl Neuropsychol 2002; 9 (3): 187– 191. doi:10.1207/S15324826AN0 903_8. [PubMed] [Google Scholar].

Chan, Y. (2019). Validation of the Delis-Kaplan Executive Function System (D-KEFS) in participants with Traumatic Brain Injury University of Birmingham Research Archive e-theses repository online resource 16/8/2021.

Cohen, J. M., Morgan, A. M., Vaughn, M., Riccio, C. A., & Hall, J. (1999). Verbal fluency in children: developmental issues and differential validity in distinguishing children with attention-deficit hyperactivity disorder and two subtypes of dyslexia. Arch. Clin. Neuropsychol. 14, 433–443. doi: 10.1093/arclin/14.5.433 Pubmed Abstract | Pubmed Full Text | CrossRef Full Text.

Crone, E. A., Wendelken, C., Donohue, S. E., & Bunge, S. A. (2005). Neural evidence for dissociable components of task-switching. Cereb Cortex. 2005; 16:475-86.

Delis, D., Kaplan, E., & Kramer, N. (2001).). Delis–Kaplan executive function system. Odessa, FL: Psychological Assessment Resources. Google Scholar.

Delis, D. C., Kramer, J. H., Kaplan, E., & Holdnack, J. (2004). Reliability and validity of the Delis-Kaplan Executive Function System: An update. Journal of the International Neuropsychological Society, 10(2), 301–303. https://doi.org/10.1017/S1355617704 102191

Diamond, A. (2000). Close interrelation of motor development and cognitive development and of the cerebellum and prefrontal cortex. Developmental Psychology 71: 44–56. Google Scholar.

Diamond, A. (2012). Executive Functions Published online 2012 Sep 27. doi: 10.1146/annurev-psych-113011-143750 PMCID: PMC4084861NIHMSID: NIHMS6 02706.

Diamond, A., & Lee, K. (2011). Interventions shown to aid executive function development in children 4 to 12 years old. Science. 2011;333(6045):959–964. [PMC free article] [PubMed] [Google Scholar] in Blair, C. (2016) Developmental Science and Executive Function Curr Dir Psychol Sci. 2016 Feb 1; 25(1): 3–7. doi: 10.1177/0963721415622634 PMCID: PMC4789148 NIHMSID: NIHMS741195 PMID: 26985139.

Diller, L. (1987). Neuropsychological Rehabilitation. In Neuropsychological Rehabilitation, Meier MJ,Benton LA, Diller L. (Eds.). Edinburgh, Churchill Livingstone 1987.Ekman, P.; Friesen, W.V.; and Ellsworth, P. Emotions in the Human. Elmsford, NY: Pergamon Press, 1972.

Emmelkamp, P. M. G., David, D., Beckers, T., Muris, P., & Veryliet, B. (2014). Advancing psychotherapy and evidence-based psychological interventions. Int. J. Methods Psychiatr. Res. 23, 58–91. doi: 10.1002/mpr.1411; PubMed Abstract | Full Text | CrossRef Full Text | Google Scholar.

Ferguson, H. J., Brunsdon, V. E. A., & Bradford, E. E. F. (2021). The developmental trajectories of executive function from adolescence to old age. Sci Rep 11, 1382 (2021). https://doi.org/10.1038/s41598-020-80866-1.

Fiorentini, A., Vonloteri, L. S., Dragogna, F., Roveraa, C., Maffini, M., Mauri, C. M., & Altamum, C. A. (2011). Substance-Induced Psychoses: A Critical Review of the Literature December 2011 Current Drug Abuse Reviews 4(4):228-40 DOI:10.2174/1874473711104040228 Source PubMed.

Fisk, J. H., & Sharp, C. A. (2004). Age-related impairment in executive functioning: updating, inhibition, shifting, and access. J. Clin. Exp. Neuropsychol. 26, 874–890. doi: 10.1080/13803390490510680 Pubmed Abstract | Pubmed Full Text | CrossRef Full Text.

Fuster, J. M. (1995). Memory and Planning: Two temporal perspectives of frontal lobe function. In Jasper, H. H., Riggio, S., and Goldman-Rakic, P. S. (eds.), Epilepsy and the Functional Anatomy of the Frontal Lobe, Raven, New York, pp. 9–18. Google Scholar.

Fuster, J. M. (1997). The Prefrontal Cortex: Anatomy, Physiology, and Neuropsychology of the Frontal Lobe (3rd Ed.), Lippincott-Raven, Philadelphia. Google Scholar.

García-Madruga, J. A., Gómez-Veiga, I., & Vila, J. (2016). Executive Functions and the Improvement of Thinking Abilities: The Intervention in Reading Comprehension Front Psychol. 2016;7: 58. Published online 2016 Feb 4. doi: 10.3389/fpsyg.2016.00 058 PMCID: PMC4740460 PMID: 26869961.

Giovagnoli, A. R., Del-Pesce, M., Mascheroni, S., Simoncelli, M., Laiacona, M., & Capitani, E. (1996). Trail making test: Normative values from 287 normal adult controls. Ital J Neurol Sci 1996;17:305-9. [PUBMED] in Bhatia T, Garg K, Pogue-Geile M, Nimgaonkar V L, Deshpande S N. Executive functions and cognitive deficits in schizophrenia: Comparisons between probands, parents and controls in India. J Postgrad Med 2009; 55:3-7.

Golden, C. J., & Freshwater, S. M. (2002). Stroop color and word test: A manual for clinical and experimental uses. Wood Dale, IL: Stoetling Company.Google Scholar.

Goldstein, S., Naglieri, J. A., Princiotta, D., & Otero, T. M. (2014). Introduction: A History of Executive Functioning as a Theoretical and Clinical Construct. In: Goldstein S., Naglieri J. (eds) Handbook of Executive Functioning. Springer, New York, NY.

Hosenbocus, S., & Chahal, R. (2012). A Review of Executive Function Deficits and Pharmacological Management in Children and Adolescents J Can Acad Child Adolesc Psychiatry. 2012 Aug; 21(3): 223–229. [PubMed] [Google Scholar.

Imam, I., Onifade, A., Durodoye, M. O., Aje, A., Sogaolu, A. O., Kehinde, O., & Ogunniyi, A. (2003). Performance of normal Nigerian students on the mini-mental state examination Niger J Med Jul-Sep 2003;12(3):126-9 https://pubmed.ncbi.nlm.nih.gov PMID: 14737981

Jurado, M. B., & Rosselli, M. (2007). The elusive nature of executive functions: a review of our current understanding. Neuropsychol Rev 2007; 17 (3): 213– 233. doi:10.1007/s11065-007-9040-z. [PubMed] [Google Scholar].

Kanmogne, G. D., Fonsah, J. Y., & Tang, B. (2018). Effects of HIV on executive function and verbal fluency in Cameroon. Sci Rep 8, 17794 (2018). https://doi.org/10.1038 /s41598-018-36193-7.

Kazdin, A. E. (2007). Mediators and mechanisms of change in psychotherapy research. Annu. Rev. Clin. Psychol. 3, 1–27. doi: 10.1146/annurev.clinpsy.3.022806.091432; CrossRef Full Text | Google Scholar.

Kim, N., Kim, J., Wolters, M. K., MacPherson, E. S., & Park, J. C. (2019). Automatic Scoring of Semantic Fluency Front. Psychol., 16 May 2019 | https://doi.org/10.338 9/fpsyg.2019.01020 Kulhalli V, Isaac M, Murthy P.(2007) Cannabis-related psychosis: Presentation and effect of abstinence. Indian J Psychiatry 2007; 49:256-61.

Klingberg, T. (2016). Training and plasticity of working memory. Trends in Cognitive Sciences. 2010;14(7):317–324. [PubMed] [Google Scholar] in Blair, C. (2016) Developmental Science and Executive Function Curr Dir Psychol Sci. 2016 Feb 1; 25(1): 3–7. doi: 10.1177/0963721415622634 PMCID: PMC4789148 NIHMSID: NIHMS741195 PMID: 26985139.

Kolb, B., & Wishaw, I. Q. (1990) Fundamentals of Human Neuropsychology. W. H. Freeman and Company, New York.

Melby-Lervag, M., & Hume, C. (2013). working memory training effective? A meta-analytic review. Developmental Psychology. 2013;49(2):270. [PubMed] [Google Scholar].

Mental Health Assessment Tools Second edition (2012) https://www.drugsandalcohol.ie › MentalHealthAsses. (2012).

Mental Health Assessment Tools, second edition (2012). Laois OffalyLongford Westmeath Mental Health Services. Jansen.

Miller, E.K. & Cohen, J.D (2001) An Integrative Theory of Prefrontal Cortex Function Annual Review of Neuroscience Vol. 24:167-202 (Volume publication date March 2001) https://doi.org/10.1146/annurev.neuro.24.1.167. (n.d.).

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., HOWERTER, A., & Wager, T. D. (2000). The Unity and Diversity of Executive Functions and Their Contributions to Complex "Frontal Lobe" Tasks: A Latent Variable Analysis. Cogn Psychol [Internet]. 2000;41(1):49–100. Available from: pmid:10945922 PubMed/NCBI [Google Scholar].

Narayanan, N. S., Prabhakaran, V., Bunge, S. A., Cristoff, K., Fine, E. M., & Gabrieli, J. D. (2005). The role of the prefrontal cortex in the maintenance of verbal working memory: an event-related FMRI analysis. Neuropsychology. 2005; 19:223-32.

Ogurel, T. (2015). Mini-mental state exam versus Montreal Cognitive assessment Niger J Clin Pract, Official publication of Medical and Dental Consultants' Association of Nigeria,Nigeria https://www.njcponline.com.

Onwuekwe, I. (2012). Assessment of Mild Cognitive Impairment with Mini Mental State Examination Among Adults in Southeast Nigeria July 2012 Annals of Medical and Health Sciences Research 2(2):99-102 DOI:10.4103/2141-9248.105653 PubMed Google Scholar.

Oumellal, A., El Alaoui Faris, M., & Benabdeljlil, M. (2018a). The Trail Making Test in Morocco: Normative Data Stratified by Age and Level of Education. Open Journal of Medical Psychology, 7, 1-12. doi: 10.4236/ojmp.2018.71001

Rabanea-Souza, T. (2019). Neuropsychological correlates of remission in chronic schizophrenia subjects: The role of general and task-specie executive processes. core.ac.uk online.

Rabinovici, G. D., Stephens, M. L., & Possin, K. L. (2015). Executive Dysfunction Continuum (Minneap Minn). 2015 Jun; 21(3 Behavioral Neurology and Neuropsychiatry): 646–659. doi: 10.1212/01.CON.0000466658.05156.54.

Ratiu, P., & Talos, I. F. (2004). Images in clinical medicine: The tale of Phineas Gage. New England Journal of Medicine, 351(23), e21.PubMedCrossRefGoogle Scholar.

Reitan, R. M. (1958). "Validity of the Trail Making test as an indicator of organic brain damage". Percept. Mot Skills. 8 (3): 271–276. doi:10.2466/pms.1958.8.3. 271.

Rozenblatt, S. (2011). Stroop Color Word Test (adult). In: Kreutzer J.S., DeLuca J., Caplan B. (eds) Encyclopedia of Clinical Neuropsychology. Springer, New York, NY. https://doi.org/10.1007/978-0-387-79948-3_660:

Sadock, B. J., Sadock, A. V., & Ruiz, P. (2015).) Synopsis of psychiatry: Behavioural sciences and Clinical psychiatry (pp 302-303; 418-419), 11th edition, 2015, Wolters Kluwer, New Delhi.

Salthouse, T. A. (1991). Mediation of adult age differences in cognition by reductions in working memory and speed of processing. Psychol. Sci. 2, 179–183. doi: 10.1111/j.1467-9280. 1991.tb00127.

Salthouse, T. A. (1996). The processing-speed theory of adult age differences in cognition. Psychol. Rev. 103, 403–428. doi: 10.1037/0033-295X.103.3.403.

Scarpina, F., & Tagini, S. (2017). The Stroop Color and Word Test Front. Psychol. 8:557. doi: 10.3389/fpsyg.2017.0055.

Savla, G. N., Twamley, E. W., Delis, D. C., Roesch, C., Jeste, D., & Palmer, B. (2012). Dimensions of Executive Functioning in Schizophrenia and Their Relationship with Processing Speed Schizophrenia Bulletin, Volume 38, Issue 4, 18 June 2012, Pages 760–768, https://doi.org/10.1093/schbul/sbq149.

Seiger-Gardner, L., & Brooks, P. J. (2008).*). Effects of onset- and rhyme-related Sdistractors on phonological processing in children with specific language impairment. J. Speech Lang. Hear. Res. 51, 1263–1281. doi: 10.1044/1092-4388(200 8/07-0079)*.

Shallice, T. (1988). From neuropsychology to mental structure. Cambridge University Press. https://doi.org/10.1017/CBO9780511526817. (n.d.).

Shallice, T., & Burgess, P. (1991). Higher-order cognitive impairments and frontal lobe lesions in man. In H. S. Levin, H. M. Eisenberg, & A. L.

Benton (Eds.), Frontal lobe function and dysfunction (pp. 125–138). Oxford University Press.

Shao, Z., Janse, H., Visser, K., & Meyer, A. S. (2014). What do verbal fluency tasks measure? Predictors of verbal fluency performance in older adults Front. Psychol., 22 July 2014 | https://doi.org/10.3389/fpsyg.2014.00772.

Snowling, M. J., Van Wagtendonk, B., & Stafford, C. (1988). Object naming deficits in developmental dyslexia. J. Res. Read. 11, 67–85. doi: 10.1111/j.1467-9817.1988.tb00152.x.

Snyder, H. R., Miyake, A., & Hankin, B. L. (2015). Advancing understanding of executive function impairments and psychopathology: bridging the gap between clinical and cognitive approaches. Front. Psychol. 6:328. doi: 10.3389/fpsyg.2015.00328.

Spaulding, J. T. (2010). Investigating mechanisms of suppression in preschool children with specific language impairment. J. Speech Lang. Hear. Res. 53, 725–738. doi: 10.1044/1092-4388(2009/09-0041).

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. J. Exp. Psychol. 18, 643–662. doi: 10.1037/h0054651 CrossRef Full Text | Google Scholar.

Stuss, D. T., & Benson, D. F. (1986). The Frontal Lobes. New York, NY: Raven Press, 1986.

Suchy, Y., Kraybill, M. L., & Larson, G. C. J. (2010). Understanding design fluency: Motor and executive contributions Journal of the International Neuropsychological Society (2010), 16, 26–37. Copyright © INS. Published by Cambridge University Press, 2009.doi:10.1017/S1355617709990804.

Vissoci, J. R. N., de Oliveira, L. P., Gafaar, T., Mvungi, & Mmbaga. (2019). Cross-cultural adaptation and psychometric properties of the MMSE and MoCA questionnaires in Tanzanian Swahili for a traumatic brain injury population. BMC Neurol 19, 57 (2019). https://doi.org/10.1186/s12883-019-1283-9.

Von Hippel, W. (2007). Aging, executive functioning, and social control; Current Directions in Psychological Science, 16(5), 240-244. Online resource 29/10/2019.

Weckerly, J., Wulfeck, B., & Reilly, J. (2001). Verbal fluency deficits in children with specific language impairment: slow rapid naming or slow to name? Child Neuropsychol. 7, 142–152. doi: 10.1076/chin.7.3.142.8741

WHO ICD-10 Version, 2016

Wray, C., Kowalski, A., Mpondo, F., Ochaeta, L., Belleza, D., & DiGirolamo, A. et'al. (2020). Executive functions form a single construct a and are associated with schooling: Evidence from three low- and middle- income countries. PLoS ONE 15(11): e0242936. https //doi.org/10.1371/journal.pone.0242936.

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