CSCanada
Cross-Cultural Communication
Vol. 11, No. 8, 2015, pp. 81-87
DOI:10.3968/7254

ISSN 1712-8358[Print]
ISSN 1923-6700[Online]
www.cscanada.net
www.cscanada.org

Processing Speed Mediates Visual Attention in Patients With Remitted Major Depression

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Received 9 April 2015; accepted 25 June 2015
Published online 26 August 2015

Abstract

Information processing and attention in psychiatric patients have received limited research interests among neuroscientists. This has further limited clinical interventions in neuropsychological areas of psychiatric disorders. The present study was on processing speed and visual attention in patients with remitted major depression (RMD). Forty two participants were recruited for the study. Twenty one (21) of them were patients with RMD while the other 21 were healthy controls (HC). Four instruments were used to assess processing speed (TMT A and TMT B) and visual attention (Letter Cancellation TaskS (LCT): Coloured and black-white), while the between group quasi experimental design was used. The findings of the study showed significant differences between RMD and HC on time taken to complete TMT A: $F(1,35)=11.01$, TMT B: $F(1,35)15.50$; LCT (coloured) $F(1,35)=19.04$, LCT (Black-white) $F1(1,35)=29.65$ at $p < 0.05$ level of testing. Similarly the path model analysis showed that TMT B mediates significantly TMT A (overall processing speed) on time taken to complete LCT (Colored): $B=0.62$, and LCT (Black and White): $B=0.77$. The discussion of the study centered on the roles of the ability to shift the task in visual attention search and likely tendency that visual search has common neural circuitry pathway with ability to shift task.

Key words: Processing speed; Visual attention; Depression; Set shifting; TMT: A&B

Ucheagwu, V., Udoh, F., Ugokwe-Ossai, R., Ezeokana, J., & Osaai, J. (2015). Processing Speed Mediates Visual Attention in Patients With Remitted Major Depression. *Cross-Cultural Communication*, *11*(8), 81-87. Available from: http://www.cscanada.net/index.php/ccc/article/view/7254 DOI: http://dx.doi.org/10.3968/7254

INTRODUCTION

Major depression is associated with cognitive deficits including memory and executive functions (Veiel, 1997; Zakzanis, Leach, & Kaplan, 1998). These in turn have been linked to dysfunction of fronto-subcortical networks including the dorsolateral prefrontal cortex (DLPFC), the ventrolateral prefrontal cortex (VLPFC) the anterior cingulate cortex (ACC), the basal ganglia and the hippocampus (Brody, Barsom, & Bota Saxena, 2001). In major depression, attention is proposed to be one of the most impaired cognitive domains (Zakzanis et al., 1999). The attentional impairment is particularly apparent when the cognitive demands of the information processing increase (Hartlage et al., 1993). Information processing and visual attention search have been characterised as part of wider neuropsychological tests that assess executive functioning.

Information processing speed is the cognitive ability of an individual to analyse and react to external stimuli. This ability is viewed as a fundamental part of the architecture of the cognitive system (Kail & Salthouse, 1994; Fry & Hale, 2000) and is developmentally dependent upon age across the life span (Kail & Salthouse, 1994; Hale 1990). Cognitive processing has been implicated in cognitive deficits found in depression (Nebes et al., 2000). Nebes et al (2000) showed that elderly depressed patients performed significantly worse in measures of both processing speed and working memory. While performances on these measures improved in patients whose depression remitted, the amount of improvement was no greater than that seen in the controls with repeated testing. Hierarchical regression analyses showed that depression explained a significant amount of variance on the neuropsychological tasks. However, if the variance associated with processing resources was removed first, depression no longer accounted for a significant amount of neuropsychological variance. Such findings exalt the contributory role of cognitive processing in overall cognitive function/ performance of depressives. Other studies have further confirmed cognitive processing speed impairment in young and middle adult depressives (Hartog et al., 2003; Tsourtos et al., 2002) as well as caregivers with depressed mood (Vitaliano et al., 2009).

Conversely, attention refers to the selective allocation of neural processing resources to important information (Purves et al., 2008). Paclecke-Habermann, Pohl & Leplow (2005) showed significant deficits in attention (attention shift, stroop task and sustained attention) between euthymic patients with major depressive disorders and healthy controls. Other studies had also validated Paclecke-Habermann et al (2005) finding on the executive dysfunction (including attention) deficits in depressed groups (Fossati, Ergis, & Allilaire, 2002; Uamkar, 2014; Malhi et al., 2007).

The present study was on attention and processing speed in patients with remitted depression. Some studies have examined cognitive functions in remitted depression with more emphasis on healthy control comparisons. The present study proposed a meditational role for speed of processing and sustained attention in remitted depressives. The model of cognitive dysfunction in remitted depression appears to have been neglected by clinicians in recent past with strong emphasis on processing speed and sustained attention. This study therefore hypothesized that cognitive set shifting demands on information processing will mediate performances in sustained attention tasks. Secondly, healthy controls will differ significantly from remitted depressives on both processing speed and sustained attention tasks.

1. METHODS

Forty two participants were recruited for the study. They were divided into 2 groups: Remitted Major Depression (RMD) and Healthy Controls (HC). The RMD was made up of 21 participants selected from an inpatient community rehabilitation centre in Anambra state Nigeria. Their diagnoses were made by two Doctorate level Clinical Psychologists working in the centre. The criteria for diagnoses were based upon DSM IV TR diagnostic criteria. The bases for being included in the remission group were reduction in reported symptoms from Becks Depression Inventory II (BDI II) and Symptom Checklist 90R (SCL-90R), as well as DSM IVTR global assessment of functioning (GAF). The HC group was recruited from undergraduate student population in the department of psychology Madonna university Okija Anambra state controlling for gender in the PDR group. Tables 1 and 2 showed the demographic characteristics of the participants

Table 1
Demographic Profiles of the Participants

Demography	Group		*df*	*t*
	RMD	HC		
N	21	21		
Age rage	21–60	19–28		
Mean age	40.42	22.66	40	7.95*
Gender: Male	14	14		
Female	7	7		

Note. * Showed significance at P<.05 level of testing.

In Table 2, significant heterogeneity was seen in the groups. This is likely to be the result of age differences between the groups and within the groups (PDR) based on the standard deviation from the mean

Table 2
Homogeneity Profile of Samples

Source	*SS*	*df*	*MS*	*F*	Sig
Intercept	37254.29	1	37254.29	657.75	0.001
Gender	0.58	1	0.58	0.01	0.91
Group	2964.29	1	2964.29	53.77	0.001
Gender * Group	0.29	1	0.29	0.005	0.94

2. INSTRUMENTS

Trail Making Tests (TMT A and B) were used to assess visual processing speed in the participants. For a comprehensive description of TMT A and B see Lezak, Howieson, Bigler and Tranel (2013) and for its utility in Nigeria samples see Emejulu, Ugokwe-Ossai and Ucheagwu (2011). On the other hand Letter Cancellation tasks (LCT) used for the present study were based upon the adaptation of Uttl and Pilkenton- Taylor (2001) cancel H task. The LCTs were of 2 types: Cancel "T" task and the colour version of cancel "T" task.

The cancel 'T' task is made up of varied 150 letters using the upper case (letters included were: L, N, K, C, Z, H, T, A, B) and the participant is expected to cancel out only the letter "T" as fast as possible with minimal or no error. The colour version of the task was similar but the letter items were made up of different colours (Purple, Yellow, Red, Green). In this task the participant was asked to cancel out only the letter "T" with green colour. Cancellation tasks have been shown to have dual purposes. When given to elicit unilateral inattention they may be untimed or response speed may be secondary as

Table 3
Descriptive Statistics for Response Variables and Participants

	Gender	Grouptd	Mean	Std	*N*
TMT A	Male	HC	50.43	14.99	14
TIME (Secs)		RMD	132.36	59.12	14
		Total	91.39	59.43	28
	Female	HC	51.71	18.27	7
		RMD	126.00	28.96	5
		Total	82.67	44.16	12
TMT B	Male	HC	91.71	28.69	14
TIME (secs)		RMD	217.00	75.83	14
		Total	154.35	85.05	28
	Female	HC	101.00	26.49	7
		RMD	210.80	81.75	5
		Total	146.75	77.52	12
TMT A	Male	HC	0.29	0.83	14
Error		RMD	0.43	0.65	14
		Total	0.36	0.73	28
	Female	HC	1.14	1.86	7
		RMD	0.80	1.10	5
		Total	1.00	1.54	12
TMT B	Male	HC	1.43	1.40	14
Error		RMD	1.71	2.13	14
		Total	1.57	1.77	28
	Female	HC	2.14	2.19	7
		RMD	2.00	1.22	5
		Total	2.08	1.78	12
LCCT	Male	HC	24.79	15.37	14
Time(secs)		PDR	50.07	25.40	14
		Total	37.43	24.29	28
	Female	HC	23.43	9.03	7
		RMD	62.00	31.04	5
		Total	39.50	28.10	12
LCCT	Male	HC	0.5	1.40	14
Error		RMD	0.07	0.27	14
		Total	0.29	1.01	28
	Female	HC	0.14	0.38	7
		RMD	1.00	2.24	5
		Total	0.50	1.45	12
LCCT	Male	HC	1.43	2.17	14
Omission		PDR	0.29	1.07	14
		Total	0.86	1.78	28
	Female	HC	0.29	0.76	7
		RMD	0.00	0.00	5
		Total	0.17	0.58	12
LCT	Male	HC	34.14	8.86	14
Time(secs)		RMD	83.57	31.15	14
		Total	58.86	33.15	28
	Female	HC	38.00	10.36	7
		RMD	85.80	19.56	5
		Total	57.92	28.35	12
LCT	Male	HC	0.00	0.00	14
Error	RMD	0.00	0.00	14	
		Total	0.00	0.00	28

To be continued

Continued

	Gender	Grouptd	Mean	Std	*N*
	Female	HC	0.00	0.00	7
		RMD	0.00	0.00	5
		Total	0.00	0.00	12
	Gender	**Grouptd**	**Mean**	**Std**	***N***
LCT	Male	HC	1.93	3.12	14
Omission		RMD	0.21	0.43	14
		Total	1.07	2.36	28
	Female	HC	2.29	1.79	5
		RMD	1.20	1.95	12
		Total	1.83	1.95	12

Table 4
Multivariate Analysis of Covariance of Gender and Group on Response Variables

Source	Dep. variable	SS	*df*	MS	*F*	Effect size	Observe power
Age	TMTA TIME	785.99	1	785.99	0.52	0.02	0.11
	TMT B TIME	3.86	1	3.86	0.001	0.00	0.05
	TMTA ERROR	0.03	1	0.03	0.03	0.001	0.05
	TMTB ERROR	5.36	1	5.36	1.65	0.05	0.24
	LCCT TIME	1355.15	1	1355.15	3.28	0.09	0.42
	LCCTERROR	0.07	1	0.07	0.05	0.001	0.06
	LCCT OMMISSION	4.70	1	4.70	2.20	0.06	0.30
	LCT TIME	709.87	1	709.87	1.65	0.05	0.24
	LCT ERROR	0.00	1	0.00	–	–	–
	LCT OMMISSION	1.02	1	1.02	0.22	0.006	0.07
Gender	TMT A TIME	8.98	1	8.98	0.01	0.00	0.05
	TMT B TIME	16.67	1	16.67	0.01	0.00	0.05
	TMT A ERROR	2.95	1	2.95	2.58	0.07	0.35
	TMT B ERROR	1.15	1	1.15	0.35	0.01	0.09
	LCCT TIME	89.95	1	89.95	0.22	0.01	0.07
	LCCT ERROR	0.72	1	0.72	0.54	0.02	0.11
	LCCT OMISSION	2.90	1	2.90	1.35	0.04	0.20
	LCT TIME	21.56	1	21.56	0.05	0.001	0.06
	LCT ERROR	0.00	1	0.00	–	–	–
	LCT OMISSION	4.23	1	4.23	0.89	0.03	0.13
Group	TMT A TIME	16655.65	1	16655.65	11.01**	0.24	0.90
	TMT B TIME	51549.39	1	51549.39	15.50**	0.31	0.97
	TMT A ERROR	0.004	1	0.004	0.003	0.00	0.05
	TMT B ERROR	3.45	1	3.45	1.06	0.03	0.17
	LCCT TIME	7857.98	1	7857.98	19.04**	0.35	0.99
	LCCT ERROR	0.05	1	0.05	0.03	0.001	0.05
	LCCT OMMISSION	8.89	1	8.89	4.15*	0.11	0.51
	LCT TIME	12793.33	1	12793.33	29.65**	0.46	1.00
	LCT ERROR	0.00	1	0.00	–	–	–
	LCT OMMISSION	11.82	1	11.82	2.49	0.07	0.34
Gender * Group	TMT A TIME	42.20	1	42.20	0.03	0.001	0.05
	TMT B TIME	495.34	1	495.34	0.15	0.004	0.07
	TMT A ERROR	0.51	1	0.51	0.45	0.01	0.10
	TMT B ERROR	0.93	1	0.93	0.29	0.01	0.08
	LCCT TIME	172.59	1	172.59	0.42	0.01	0.10
	LCCT ERROR	3.47	1	3.47	2.57	0.07	0.35
	LCCT OMISSION	2.40	1	2.40	1.12	0.03	0.18
	LCT TIME	41.36	1	41.36	0.10	0.003	0.06
	LCT ERROR	0.00	1	0.00	–	–	–
	LCT OMISSION	0.10	1	0.10	0.23	0.01	0.08
Error	TMT A TIME	52936.07	35	1512.45			
	TMT B TIME	116377.79	35	3325.08			
	TMT A ERROR	39.91	35	1.14			
	TMT B ERROR	113.78	35	3.25			
	LCCT TIME	14443.85	35	412.68			
	LCCT ERROR	47.21	35	1.34			
	LCCT OMISSION	75.01	35	2.14			
	LCT TIME	15100.07	35	431.43			
	LCT ERROR	0.00	35	0.00			
	LCT OMISSION	166.49	35	4.75			

Note. **=Significance at $P \leqslant .01$, *=Significance at $P \leqslant .05$.

the examiner looks for the location and number of omissions and errors (Lezak et al., 2013). However for the present study, cancellation task was timed, thus reflecting visual selectivity and attention at fast speed with a repetitive motor response (see Lezak et al., 2013 for a comprehensive description of cancellation tasks).

3. PROCEDURE

The RMD group was tested at the community rehabilitation centre where they were inpatients as at the time of the study. Three trials were administered for each instrument and performances were timed to obtain the average response time for the trials. The same was done for the healthy controls. The study was part of the ongoing clinical study on the evaluation of emotions and executive functions in psychiatric patients in Anambra state Nigeria.

4. DESIGN

Between Group quasi experimental design was used for the between group difference analysis while path analysis model design was used to examine the causal paths. The multiple analysis of covariance and multiple linear regressions was used for data analysis.

5. RESULT

The descriptive statistics for response variables and participants are shown in Table 3, while the multivariate linear model analysis is shown in Table 4.

Table 4 show significant differences between the RMD group and the HC group on the time taken to complete the TMT A and B as well as time taken to complete the letter cancelation tests (Colored and ordinary). It also showed significant differences between the two groups on omission in the letter color cancellation test alone. However, no significant interaction effect was shown in the table. In addition, age as a covariate was not significant in any of the dependent variables tested.

6. CAUSAL MODEL OF PROCESSING SPEED ON VISUAL ATTENTION IN PARTICIPANTS WITH REMITTED MAJOR DEPRESSION

The path models propose that causal attributions of attention domains studied are possible through the indirect effects of shift in task (TMT B) more than direct effects of processing speed (TMT A) in remitted major depression (see Figures 1-5 and Table 5)

The causal model above showed the direct and indirect causal paths of processing speed (TMT A) on visual attention.

Table 5 showed summary table of causal paths studied. The table showed little or no significant contributions from the primary processing speed (TMT A) on visual attention. However, TMT B showed significant contributions on the reaction time in visual attention.

DISCUSSION

Attention generally refers to the selective allocation of neural processing resources to important information at any level of arousal (Purves, Brannon, Gabaza, Huethel, LaBar, Platt & Woldorff, 2008). Selective attention further refers to the allocation of processing resources to the analysis of certain stimuli or aspects in the environment generally at the expense of resources

Table 5
Summary Table of Path Analysis of the Model Studied

	Bivariate Relation of concern	X_2, X_1	X_{3a}, X_1	X_{3b}, X_1	X_{3c}, X_1	X_{3d}, X_1	X_{3e}, X_1	X_{3f}, X_1
(A)	Original Covariate *rij*	0.90**	0.65**	0.04	0.19	0.80**	-	0.25
(B)	Bi: Causal–direct	0.90[a]	0.65[a]	0.04[b]	0.19[b]	0.80[a]	–	0.25[b]
		R^2=0.80	R^2=0.42	R^2=0.005	R^2=0.04	R^2=0.64	–	R^2=0.06
		e=0.20	*e*=0.58	*e*=0.95	*e*=0.96	*e*=0.46	–	*e*=0.94
	b2: Causal - Indirect	0.00	0.62	0.04	0.19	0.77	–	0.18
	Total causal (*Cij*)	0.90	1.27	0.08	0.38	1.57	–	0.43
	Non causal=A–B *rij-Cij*	0.00	0.62	0.04	0.19	0.77	–	0.18
			X_{3a}, X_2	X_{3b}, X_2	X_{3c}, X_2	X_{3d}, X_2	X_{3e}, X_2	X_{3f}, X_2
(A)	Original Covariation *rij*		0.69**	0.04	0.21	0.85**	–	0.20
(B)	bi: Causal – direct		0.69[a]	0.04[b]	0.21[b]	0.85[a]	–	0.20[b]
	b2: Causal - Indirect		R^2=0.48	R^2=0.002	R^2=0.04	R^2=0.72	–	R^2=0.04
			e=0.52	*e* =0.98	*e*=0.96	*e*=0.28	–	*e*=0.96
			0.00	0.00	0.00	0.00		0.00

Note. ** = Significance at $P \le 0.001$
a =Anova Model Significance at $P \le 0.001$
b = Anova not significance at $P \le 0.05$

X_1 = TMT A (TIME)
X_2 = TMT B (TIME)
X_{3a} = LCCT (Time)
x_{3b} = LCCT (Error)
X_{3C} = LCCT (Omission)
X_{3d} = LCT (Time)
X_{3e} = LCT (Error)
X_{3F} = (Omission)

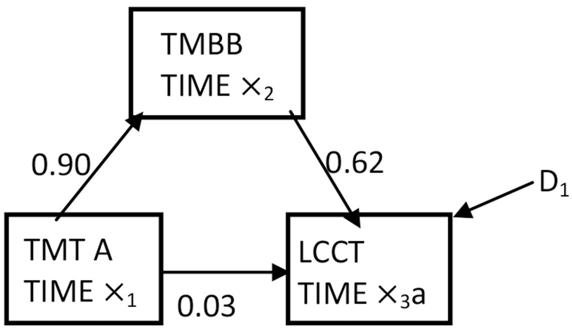

Figure 1
Causal Model of Processing Speed LCCT
dfM ≥ 0 (*dfM* = Model degress of freedom)

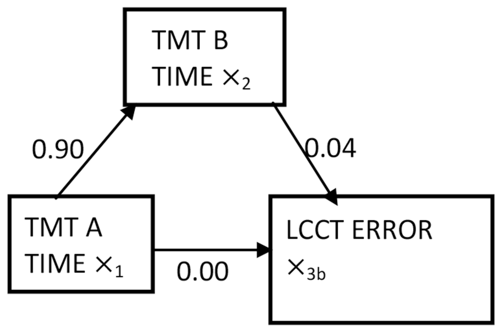

Figure 2
Causal Model of Processing Speed LCCT Error
dfM ≥ 0 (*dfM* = Model degress of freedom)

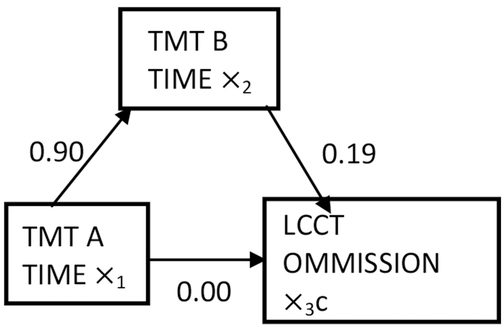

Figure 3
Causal Model of Processing Speed LCCT
dfM ≥ 0 (*dfM* = Model degress of freedom)

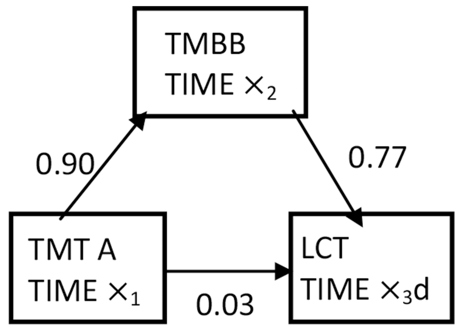

Figure 4
Causal Model of Processing Speed LCT Time Omission
dfM ≥ 0 (*dfM* = Model degress of freedom)

allocated to other stimuli or aspects. Similarly, the speed/reaction time over which the selective attention is performed is regarded as the psychological refractory period (PRP).

The first part of this study examined differences in selective attention and processing speed of two groups studied. The findings showed that the remitted major depression (RMD) showed significant high reaction time in the tests assessing processing speed (TMT A and B) and the tests assessing attention (LCCT and LCT). However no differences were seen between the two groups on error and omission but LCCT omission. The effect sizes of the significant variables further showed the relevance of the variables to the groups studied. Many studies have been done on the roles of attention on processing speed with very limited studies focusing on the depressives in remission. The essence of studying the depressives in remission is to have a clear understanding of the latent cognitive variables of attention and processing speed in this group. Such an understanding will enhance deep knowledge about depressive disorders and cognitive statuses. The present study showed that even in the absence of significant symptoms, the RMD still showed increased reaction time in tests of attention and processing speed. However, the errors committed by

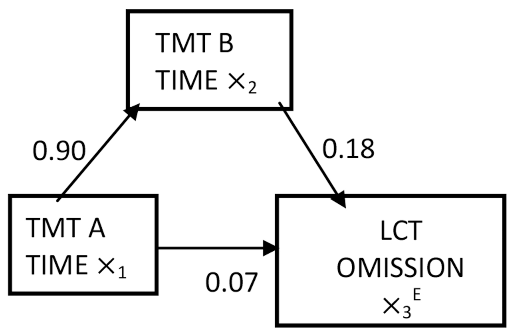

Figure 5
Causal Model of Processing Speed LCT Omission
dfM ≥ 0 (*dfM* = Model degress of freedom)

the two groups were not significantly different. The present findings are in line with other studies showing that depressives do manifest deficits in attention and processing speed when compared with normal controls (Veiel, 1997; Brody et al., 2001). However, the RMD showing attention and processing speed time deficits links such deficits as likely deficits to be seen in prodromal depressives. Further well developed studies are needed to tilt out these complications. The questions to be probed are: (i) Are deficits in reaction time on attention and processing speed an inherent problem prior to symptomatic depression or (ii) Are they the outcome of the depressive disorder.

The second part of the study was on the causal paths through which processing speed links to attention. Researchers have long tried to tease out the domains assessed by the Trail Making tests A and B. Although the common factor was on processing speed (Lezak et al., 2013), we believe that the two tests follow different trajectories to visual selective attention. The findings of the present study showed that the direct contributions of TMT A to reaction time in tests of attention were all spurious. In other words such contributions were through the indirect effect of the TMT B. Ideally TMT B has been shown to measure ability of an individual to set shift (Emejulu et al., 2011). In set shifting, it requires the individual to switch attention from one set of variable to another still being conscious of speed. The results of the present study therefore argue that general processing speed do not tap or contribute to visual search/attention in RMD. On the other hand, the processing speed is to be combined with capacity to set shift.

The present study had some limitations. The first was that age disparities significantly existed between two groups. Although this was controlled by introducing age as a covariate, interpretations of the results should be done with caution. Similarly, in the model of causation examined in the study, statistical modulations to determine the model's fit were not employed. This raised doubts on the fitness of the model as an important ingredient in path analytic works.

Overall this study was part of the contribution in studying psychotic depressives in remission. The findings showed that attention and processing speed reaction time deficits are found in this group. Furthermore, that set shifting task is a major factor to reaction time in visual attention among major depressions in remission.

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