

**ASSOCIATION OF COMPUTATIONAL ABILITY AND DIGIT SPAN IN SCHIZOPHRENIA PATIENTS**

**Sarwat Jahan Khanam\***

Institute of Clinical Psychology

**Anjum Ara**

University of Karachi

and

**Riaz Ahmad**

Institute of Clinical Psychology

**ABSTRACT**

*Present study is an endeavor to assess the relationship between computational abilities and digit span in patients of schizophrenia. Schizophrenia is characterized by various executive function disabilities; working memory is one of few very important aspects among these. The construct being very significant in understanding the cognitive deficits associated with the schizophrenia, has been reported to be well assessed by various indices. Present study is an endeavor to study the performance of patients of schizophrenia on two of them that is, an Arithmetic test and a Digit span measure. It was assumed that the two set of scores will be highly correlated in patients of schizophrenia. For the purpose 101 individuals were included as participants in the study, 57 of them were the diagnosed patients of schizophrenia while the remaining 44 were the controls selected from the community. Both of the groups were tested on Arithmetic and digit span tasks. Results reflect that scores of schizophrenia patients on both measures were found significantly correlated ( $r=.610, p<.001$ ), while in controls the association found was not significant ( $r=.169, p>.05$ ).*

**Key Words:** Arithmetic, Digit span, Working memory

---

\* Correspondence Address: Dr. Sarwat Jahan Khanam, Assistant Professor, Institute of Clinical Psychology (email:skhan\_icppsy@yahoo.com)

## **Khanam, Ara & Ahmad**

### **INTRODUCTION**

Patients of Schizophrenia demonstrate characteristics deficits in their cognitive abilities (Phillips, 2003; Heaton, Gladsjo, Palmer et al., 2001; Heinrichs & Zakzanis, 1998; Saykin, Shtasel, Gur, Kester, et al., 1994) with the executive functions reported being impaired (Levin et al., 1989; Mohamed et al., 1999), and specifically significant impairment found in working memory (Phillips, 2003; Goldman-Rakic, 1994). Saykin et al. (1994) documented evidence of deficits in attention, vigilance, and a range of other cognitive functions in schizophrenic patients, involving memory, processing speed and motor skills. Stone, Gabrieli, Stebbins and Sullivan (1998) found schizophrenic patients as impaired on tasks related to working memory. They discovered that working memory deficits in schizophrenia patients can not be explained by difficulties in verbal intelligence and immediate memory capacity. However he suggested working memory deficits as central to the cognitive profile of patients of schizophrenia.

There are number of indices familiar for the assessment of working memory. A most frequent difficulty encountered interpreting the results of various studies using different indices rests on the issue that performance on a measure can not be reliably attributed to a specific deficit, as the tests used may have factor loading of different abilities. Heinrichs and Zakzanis (1998) discussed in their quantitative review that neurocognitive tests probably measures several components at the same time. Performance may be subjected to various associated particular task demands. Hence, the final score or performance may reflect this complexity rather than just the preservation or impairment, of a supposed function. The only way to get the pure impression is to gather as many evidences by using multiple tasks, so as to assess the common deficit underlying the performance patterns. In the same context frequent studies are required to test the consistency of performance across various indices to see whether they share similar attributes in population of interest.

La Pointe and Engle (1990) considered digit and letter span tests as most appropriate measures of working memory. Researches reflect difficulties of verbal working memory of patients with schizophrenia as depicted through digit span test (Karatekin & Asarnow, 1997; Conklin, 2000). However the findings are less consistent across various studies. Few studies found patients of schizophrenia having difficulties on both forward and backward digit span tasks (Twamley, Palmer, Jeste, Taylor, & Heaton, 2006; Stratta, Daneluzzo,

## PAKISTAN JOURNAL OF PSYCHOLOGY

Prosperini, Bustini, Mattei, & Rossi, 1997; Stefansson & Jons dottir, 1996) while few found no difference between schizophrenia patients and controls on either task (Park & Holzman, 1992; Holzman, 1992). Conklin (2000) examines schizophrenia patients and their biological relatives on the digit span task. For forward digit span patients of schizophrenia showed impairment, however their non psychotic relatives performed as well as the control participants. While for backward digit span, a measure of verbal working memory, patients of schizophrenia and their relatives both showed impaired performance. Besides few inconsistencies patients of schizophrenia are widely reported to be less efficient on digit span tasks reflecting working memory deficits. Tulsky and Price (2003) reported identification of a factor combining attention and working memory in Wechsler Adult Intelligence Scale and Wechsler Memory Scale, in normal patients. The factor also includes subtests of arithmetic and digit span.

Keifer, Apel and Weisbrod (2000) analyzing the performance on arithmetic tests explored that if working memory demands are minimized from the tests of arithmetic, the patients of schizophrenia may perform equally well on the tasks as their controls. They also found forward digit span performance as preserved while deficit performance on backward digit span task.

Keeping in view the significance of both tests present study is an endeavor to explore the relationship of performance on arithmetic and digit span tasks on both patients of schizophrenia and normal control. It also assesses the difference between the two groups on both tasks endorsing the deficits found in patients of schizophrenia.

## METHOD

### *Participants*

101 individuals were included as participants in the study, 57 of them were the diagnosed patients of schizophrenia while the remaining 44 were the controls selected from the community. The age of the participants ranges from 20 to 45, with minimum education of intermediate. All patients of schizophrenia were on medication, and were categorized as having various subtypes of schizophrenia including Paranoid, Disorganized, and Undifferentiated type. The controls were matched on variables of age, and education to the clinical participants.

## **Khanam, Ara & Ahmad**

### **Measures**

Measures selected to assess the participants for their computational ability and span for digit recall were digit span and Arithmetic subtests of WAIS R. The former involves simple task of repeating orally a backward and forward series of digits, with gradual increase in digits, till maximum of nine digits, while later comprised of 14 timed items arithmetic items, assessing both speed and accuracy.

### **Procedure**

Participants after getting the informed consent were individually administered an interview information form related to the personal, clinical and medication related information, followed by the arithmetic and digit span tests.

### **Statistical Analysis**

Pearson Product moment correlation was conducted to assess the relationship between the two constructs under study for both samples that is, patients of schizophrenia and control group. To assess the difference in the performance of these two groups, t tests were computed.

## **RESULTS**

**Table1**

*Pearson's correlation of arithmetic with digit span tests for patients with schizophrenia and normal participants*

<b>Measures</b>		<b>Patients with schizophrenia</b>		<b>Normal participants</b>	
		<b>r</b>	<b>sig</b>	<b>r</b>	<b>sig</b>
<b>Arithmetic</b>	Forward digit span	.305	.021	.069	.657
	Backward digit span	.768	.001	.205	.183

## PAKISTAN JOURNAL OF PSYCHOLOGY

**Table 2**

*Difference between patients with schizophrenia and normal participants on Arithmetic, forward digit span and backward digit span tests*

<b>Tests</b>	<b>Groups</b>	<b>Mean</b>	<b>S.D.</b>	<b>t</b>	<b>df</b>	<b>sig</b>
<b>Arithmetic</b>	Patients	6.8070	2.62841	-4.844	99	.000
	Normal	9.1136	1.99086			
<b>FDS</b>	Patients	7.0877	2.00250	.452	99	.652
	Normal	6.8864	2.47044			
<b>BDS</b>	Patients	4.5965	1.89793	-2.800	99	.006
	Normal	5.6818	1.97393			

FDS= Forward digit span, BDS= Backward digit span, Patients= patients with schizophrenia; normal=normal participants

## DISCUSSION

Results reflect significant relationship between performance of patients with schizophrenia on arithmetic test and both forward and backward digit span, reflecting a general similar underlying deficit across these two tests in these patients. Previous research findings suggest working memory deficits as the reason for the deficit performance of patients of schizophrenia related to both arithmetic and digit span task. However it is worth noting that in the present research patients of schizophrenia reported to perform significantly lower than normal participants on arithmetic and backward digit span, however, they have higher mean on forward digit span as compared to normal participants, besides difference being not significant.

Besides few past findings like Duffy and Carroll (1994) related to preserve forward digit span in schizophrenia patients which according to Chen, Chan, Chen, Nguyen, and Lam (1994) suggests preserved phonological loop function; findings warrant further study to highlight the role of medication in better performance of patient with schizophrenia on forward digit span as previous research (Cassens, Inglis, Appelbaum, & Gutheil, 1990 as cited in Zalewski) suggest positive effects of chronic administration of neuroleptics on sustained attention.

Present findings also endorsed that there is a non significant relationship between performance on the two tests that is digit span and arithmetic in control group which suggest that the two tests also are loaded on some unique

## **Khanam, Ara & Ahmad**

characteristics, which may not become central in response pattern of patients of schizophrenia as their working memory loss make the two tasks equally difficult for these patients.

Results offer further research endeavors to explore significance of computational difficulties as the indicator of disturbance in working memory in patients of schizophrenia.

## **REFERENCES**

Cassens, G., Inglis, A. K., Appelbaum, P. S., & Gutheil, T. G. (1990). Neuroleptics: Effects on Neuropsychological functions in chronic schizophrenia patients. In Zalewski, C., Johnson-Selfridge, M., Ohriner, S., Zarella, K., & Seltzer, J. (1998). A Review of Neurological Differences between Paranoid and Non paranoid Schizophrenia Patients. *Schizophrenia Bulletin*, 24 (1), 127-145.

Chen, E. Y.C., Chan, C. K.Y., Chen, R.Y.L., Nguyen, D.G.M., & Lam, L.C.W. (1994). Verbal Working Memory in Chinese Schizophrenic Subjects: A preliminary Report. *Journal of Hong Kong Coll. Psychiatry*, 4, 12-19.

Conklin, H.M., Curtis, C.E., Katsanis, J., & Lacono, W.G. (2000). Verbal working memory Impairment in Schizophrenic patients and their first-degree relatives: Evidence from the digit span task. *American Journal of Psychiatry*, 157, 275-277.

Duffy, L. & O'Carroll, R. (1994). Memory Impairment in Schizophrenia: a comparison with that observed in the alcoholic korsakoff syndrome. *Psychological Medicine*, 24 (1), 155-166.

Goldman-Rakic, P.S. (1994). Working Memory dysfunction in Schizophrenia. *The Journal of Neuropsychiatry and Clinical Neuroscience*, 6 (4), 348-357.

Holzman, P.S. (1992). Schizophrenics show spatial working memory deficits. *Archives of General Psychiatry*, 49(12), 975-82

## PAKISTAN JOURNAL OF PSYCHOLOGY

Heaton, R.K., Gladys, J.A., Palmer, B.W., Kuck, J., Marcotte, T.D., & Jeste, D.V. (2001). Stability and Course of Neuropsychological deficits in Schizophrenia. *Archives of General Psychiatry*, 58 (1), 24-32. <http://archpsyc.ama-assn.org/cgi/content/abstract/58/1/24?ck=nck>

Heinrichs, R.W., & Zakzanis, K.K. (1998). Neurocognitive deficit in schizophrenia: A quantitative review of the evidence. *Neuropsychology*, 12 (3), 426-445.

Karatekin, C. & Asarnow, R.F. (1998). Working memory in childhood-onset schizophrenia and attention-deficit/hyperactivity disorder. *Psychiatry Research*, 80 (2).165-176. doi:10.1016/S0165-1781(98)00061-4

Kiefer, M., Apel, A., & Weisbrod, M. (2000). Arithmetic Fact Retrieval and Working Memory in Schizophrenia. *Schizophrenia Research*, 53 (3), 219-227.

La Pointe, L.B., & Engle, R.W. (1990). Simple and Complex Word Spans as measures of working memory capacity. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 16 (6), 1118-1133.

Levin, S., Yurgelun-Todd, D., & Craft, S. (1989). Contributions of Clinical Neuropsychology to the study of schizophrenia. In Wexler, B.E., & Bell, M.D. (2005). Cognitive Remediation and Vocational Rehabilitation for Schizophrenia. *Schizophrenia Bulletin*, 31 (4), 931-941.

Mohamed, S., Paulsen, J., O'Leary, D., Arndt, S., & Andreasen, N. (1999). Generalized cognitive deficits in schizophrenia: a study of first episode patients. *Archives of General Psychiatry*, 56 (8), 749-754.

Park, S., & Holzman, P.S. (1992). Schizophrenics show spatial working memory deficits. *Archives of General Psychiatry*, 49, 975-982

Phillips, W. A. (2003). Convergence of biological and psychological perspectives on cognitive coordination in schizophrenia. *Behavioral and Brain Sciences*, 26 (1), 65-82.

## **Khanam, Ara & Ahmad**

Saykin, A.J., Shtasel, D.L., Gur, R.E., Kester, D.B., Mozley, L.H., Stafiniak, P., & Gur, R.C. (1994). Neuropsychological deficits in neuroleptic naive patients with first-episode schizophrenia. *Archives of General Psychiatry, 51*(2), 124-131.

Stefansson, S. B., Jonsdottir, T. J. (1996). Auditory event-related potentials, auditory digit span, and clinical symptoms in chronic schizophrenic men on neuroleptic medication. *Biol Psychiatry, 40*, 19–27

Stone, M., Gabrieli, J.D., Stebbins, G.T., & Sullivan, E.V. (1998). Working and strategic memory deficits in schizophrenia. *Neuropsychology, 12* (2), 278-88

Stratta, P., Daneluzzo, E., Prosperini, P., Bustini, M., Mattei, P., & Rossi, A. (1997). Is Wisconsin Card Sorting Test performance related to "working memory" capacity? *Schizophrenia Research, 27*, 11–19

Tulsky, D.S., Price, L.R. (2003). The joint WAIS-III and WMS-III factor structure: development and cross-validation of a six-factor model of cognitive functioning. *Psychological Assessment, 15*, 149– 162.

Twamley, E.W., Palmer, B.W., Jeste, D.V., Taylor, M.J., & Heaton, R.K. (2006). Transient and Executive function working memory in Schizophrenia. *Schizophrenia Research, 87* (1), 185-190.

Zalewski, C., Johnson-Selfridge, M., Ohriner, S., Zarella, K., & Seltzer, J. (1998). A Review of Neurological Differences between Paranoid and Non paranoid Schizophrenia Patients. *Schizophrenia Bulletin, 24* (1), 127-145.