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N – Back Task to Assess Sex Difference in Working Memory: A Pilot Study.

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ABSTRACT

Sex difference in cognitive, social and personal characteristics has been investigated over a century. Numerous empirical studies have been done on the differences between genders in specific cognitive skills. We have done a pilot study on girls and boys of late adolescent age group to assess sexual difference in the domain of working memory in terms of behavioural, using Letter N-Back-test with Computerized Neurocognitive Battery of University of Pennsylvania. We preferred the N- back task over traditional WM span tasks because we could assess the difference with respect to working memory load that is 'N' and in its response requirements. The results of our study indicated no significant difference between girls and boys in working memory.

Keywords: cognition, working memory, N back task, sex difference.

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INTRODUCTION

In our everyday life, use of memory is essential to run our daily errands like remembering a telephone number, a grocery list or directions to a new place. We may also need to engage in mental activities that require temporary storage and demanding cognitive processing as in the case of mental arithmetic to draw upon long term mathematical knowledge and to integrate the various pieces of information to arrive at a correct solution.

Working Memory (WM) may be defined as the system for the temporary maintenance and manipulation of information necessary for the performance of such complex cognitive activities such as comprehension, learning and reasoning. [1] Variations in the capacity of WM have been shown to explain individual differences in reasoning, problem-solving, reading and language comprehension, and Intelligent Quotient [2-5]

We have used the N- back task to assess the WM of girls and boys. The N back task is a WM task. It involves a set of information to be remembered along with a secondary processing task [2]. In this task, participants are presented with a series of visual stimuli and are asked to indicate whether the one currently displayed matches that seen in the previous 1, 2, or 3 trials. To administer this task we used Computerized Neurocognitive Battery CNB. The CNB yields measures of accuracy (number of correct responses) and speed {median response time (RT) for correct items} [6]. This feature permits evaluation of the individual differences in strategy pertinent to the speed-accuracy [7]. The n-back paradigm, has been extensively validated in functional neuroimaging studies [8-11].

WM deficits are central to a number of psychiatric and neurological conditions. To explore the sex differences in cognition may be an important variable for understanding the underpinnings of any such conditions.

Sex differences in cognition have been consistent over 40 years of research. The land mark review on sex differences in cognition, temperament, and social behaviour was by Maccoby and Jacklin [12]. Sex differences were found in verbal, language, and certain spatial skills, where girls tend to produce words at an earlier age, have a larger vocabulary, and show a higher level of language complexity beginning in early childhood and Boys excel girls in spatial skills like mental rotation [13-16].

MATERIAL AND METHODS

The study was carried out in the library of Sree Balaji Medical College. 18, right-handed subjects 9 girls and 9 boys aged 18 and 19 years were selected randomly for study with prior written consent after ethical clearance from Sree Balaji Medical College Institutional Review Board. Ethnicity was South Indians. Education level was same for all the participants. The subjects included for study had no history of any medical or neuropsychiatric illnesses, or a history of head injury and drug abuse. The blood pressure temperature and Pulse rate were normal.

Mini-Mental State Examination *(* MMSE) was administered to rule out the students for cognitive impairment. This consisted of a set of questions designed to elicit information about orientation, registration, attention, calculation, ability, recall language and praxis that could be answered in ten minutes. Scoring of MMSE consists of a total number of correct answers. The maximum is 30. A scope of 24-30 is generally classified as no cognitive impairment, 18-23 as mild cognitive impairment and 0-17 as a severe cognitive impairment.

To assess WM, Letter N-Back (LNB) test of CNB of University of Pennsylvania was used after obtaining prior permission from the University. It is a web based interface that was set up in Sree Balaji Medical College library with Brain and behaviour laboratory at the University of Pennsylvania. The choice of a computerized battery facilitated group administration of test. The LNB2 assesses attention and working memory. In this task, participants were asked to pay attention to flashing letters on the computer screen, one at a time, and to press the spacebar according to three different principles or rules: the 0-back, the 1-back and the 2-back. During the 0-back the participant must press the spacebar whenever the letter X appears on the screen. During the 1-back the participant must press the spacebar whenever the letter on the screen is the same as the previous letter

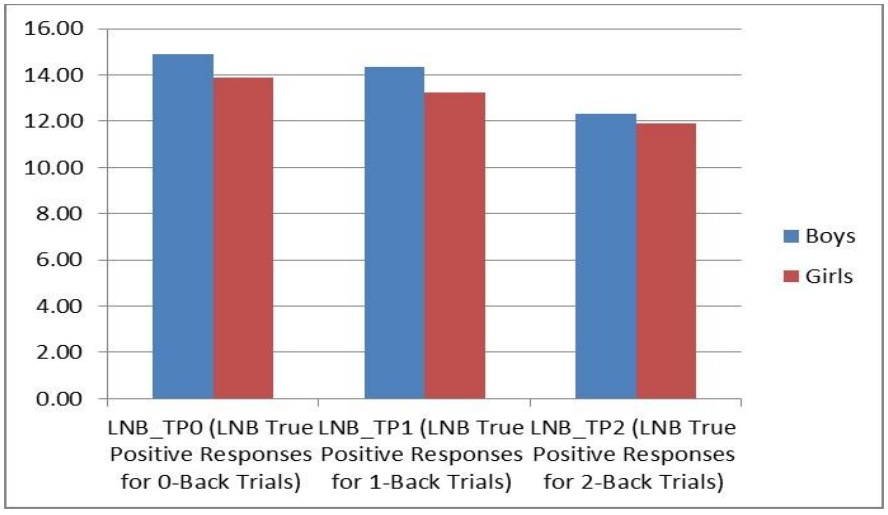
(i.e. in the series "T", "R", "R" the participant should press the spacebar on or immediately after the second "R"). During the 2-back, the participant must press the spacebar whenever the letter on the screen is the same as the letter before the previous letter (i.e. in the series "T", "G", "T", the participant should press the spacebar on or immediately after the second "T"). In all trials, the participant had 2.5 seconds to press the spacebar (each letter flashed for 500 milliseconds and was followed by a blank screen lasting for 2000 milliseconds). The participant practiced all three principles and mistakes were allowed during the practice sessions. Once all practice sessions were completed successfully, the tasks began. During the actual test trials, the participant did the 0-back, 1-back and 2-back three times each. No feedback was given in terms of correct or incorrect responses. Total number of true positive responses for each of the trails (0-Back, 1-Back, and 2-Back) and the reaction time for true positive responses on 0-Back, 1-Back and 2-Back trials were selected as performance measures.

RESULTS

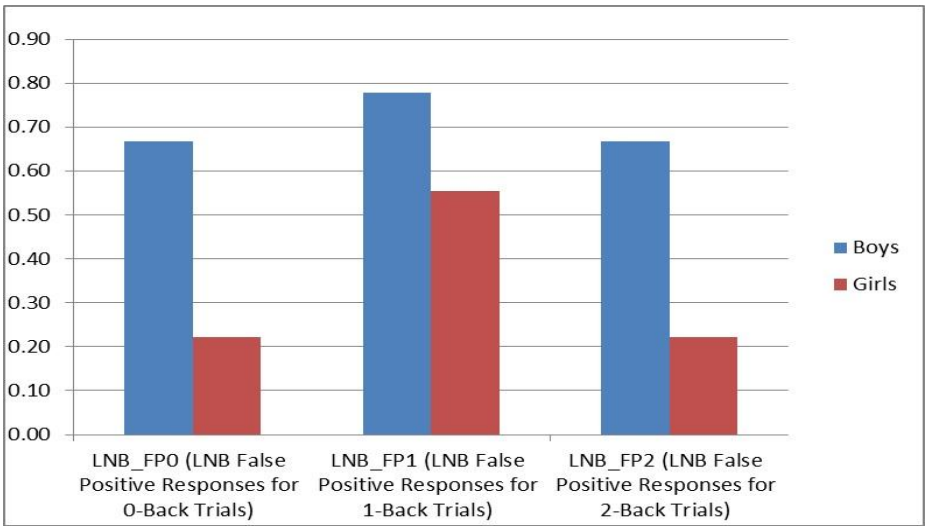
Both boys and girls scored 28 to 30 in MMSE indicating no cognitive impairment.

True positive response (TP), False Positive response (FP), Reaction time (RTC) for 0 back, 1 back and 2 back were recorded.(Graph 1, Graph 2 and Graph 3). LNB Efficiency for Correct 1-Back and 2-Back was calculated using the formula LNB_MCR/log(LNB_MRTC) (Table 1)

Graph 1: Means of boys and girls for true positive responses in 0 back, 1 Back and 2 Back



Graph 2: Means of boys and girls for False positive responses in 0 back, 1 Back and 2 Back



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Graph 3: Means of boys and girls for Median Response time in 0 back, 1 Back and 2 Back

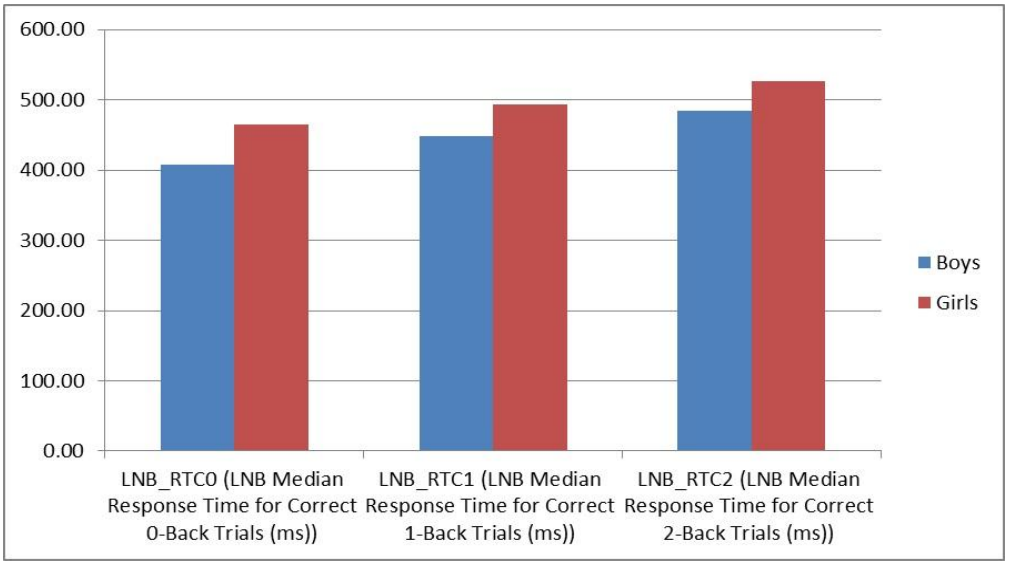

Table 1: Letter – N Back Test – 2 Back version scores.

S.No	SCORE NAME	MALES (Mean)	FEMALES (Mean)
1	LNB True Positive Responses for 1-Back and 2-Back Trials (max -30)	26.67	25.11
2	LNB Mean of Median RT for True Positive Responses for 1-Back and for 2-Back Trials (ms)	466.25	510.11
3	LNB Efficiency for Correct 1-Back and 2-Back = LNB_MCR/log(LNB_MRTC)	4.35	4.04

DISCUSSION

In our study, we examined Sex differences in working memory using the N-back sequential letter task. The task was used at three levels of difficulty by increasing the load that is "N" (0 back, 1 back and 2 back).It was a visual verbal task. When comparing the means with respect to true positive response and reaction time (Graph 1 and 3) the boys seem to perform better and with respect to false positive response boys have made more false positive responses compared to girls (Graph2). The reaction time also increased with an increase in difficulty level in both boys and girls. Further we performed Student t test to compare the means of Letter-N-Back efficiency for correct 1-back and 2 – back (Table 1) and found that the difference between the two means were insignificant. Thus we may infer that there exists no sex difference in WM using LNB task.

Very few studies have looked at gender differences in verbal working memory. The earliest study was by Speck et al. they used the N-back working memory task where women were found to have longer reaction times but higher accuracy than men in task performance[17] Our results do not support their findings. It has been documented by Schmidt et al that gender differences do not seem to be present in verbal working memory, where men and women seem to use the same brain regions and perform equally well [18] This similar to our report on behavioural similarities on WM task.

Gender differences seem to get smaller during adolescence [13]. Our study comprised of late adolescent group and this may account for no significant difference observed between girls and boys.

Further over a century ago in a developing country like India gender-related beliefs and behaviours was present, that is only boys or only girls should do a certain task. Over the years this has gradually decreased due to education and now there are more realistic and flexible beliefs that either sex can do anything. This may be the cause for decrease in gender differences.

In our studies we did not avoid the confounders with respect to hormones as there is evidence for hormonal influence on brain activity with increased levels of progesterone reducing functional asymmetries during task performance. [19, 20]

In future the neural and genetic basis in the domain of cognition in Indian population is warranted as genetics of a population may vary and sex differences are also influenced by society and environment apart from biological underpinnings.

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