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TESTING LOGICAL MEMORY USING A COMPLEX PASSAGE : DEVELOPMENT AND STANDARDIZATION OF A NEW TEST

CHITTARANJAN ANDRADE, ARJUN P. MADHAVAN & M.L. KISHORE

ABSTRACT

Several passages are available to test verbal (logical) memory. Those standardized for use in India are, however, short and simple. As a result, limited dispersion of scores, or ceiling effects, are observed when these tests are administered to young and highly educated populations. This study presents an exercise in the development and standardization of a longer and more complex passage. The passage was administered to 121 residents of Bangalore and 92 residents of Cochin. Significant effects of age decade, gender, and city were observed on memory performances. Group data are presented for each decade of life; these have potential normative value. It is suggested that this test will be useful when assessing populations in whom the conventional passages fail to provide adequate dispersion, or result in ceilling effects.

Key words : Learning, memory assessment, verbal memory test, neuropsychological testing

Verbal learning and memory are tested in several ways, such as through the use of the sentence repetition test, paired associate learning test for similar and dissimilar pairs, and memory for a passage (Andrade,1999). The last-mentioned is also known as the logical memory test because it tests the recall of a brief story, the contents of which follow in logical sequence.

Several logical memory passages have been standardized for use in India (e.g Mukundan et al.,1983, 1991). An asset of these passages is that they are short and simple; they are therefore well-suited for use in the majority of clinical situations, in which poorly educated patients from lower to middle class backgrounds are examined.

The shortness and simplicity of these passages can, however, be a disadvantage when well-educated subjects from middle to upper socioeconomic strata are tested; in such situations, these passages result in poor dispersion of performances, and ceiling effects. As a result, effects of independent variables upon learning and memory cannot be sensitively discriminated (Nunnaly,1978).

There is therefore a need for the development of more complex verbal (logical) memory passages. This study presents an exercise in the development and standardization of one such passage.

MATERIAL AND METHOD

The senior author of this paper (CA) developed the complex passage that is presented in the Appendix. The passage contained exactly 50 memory units, and was made up of 4 long sentences each containing several descriptive clauses. Words and phrases were specially selected for difficulty.

The passage was administered (in accordance with the instructions detailed in the Appendix) to middle to upper middle class residents of Bangalore (n=121) and Cochin (n=92). These subjects were identified by systematic sampling from one residential area in each city. Door to door visits were made to recruit cooperative subjects who were in good physical

and mental health, who were fluent in English, who had good hearing, and who were not taking medications that might have influenced memory performances.

Three trials of immediate recall (T_1, T_2, T_3) and one of delayed recall (T_4) were conducted. Learning was expected to occur between the T_1 and T_3 trials, while forgetting was expected to occur between the T_3 and T_4 trials. The 28-item Goldberg General Health Questionnaire (GHQ; Goldberg,1972) was administered as a distractor task in between the third immediate recall trial (T_3) and the delayed recall trial (T_4).

The GHQ was scored as follows : items answered "same as usual" were assigned a score of 0, while item answered with any other choice were scored as 1. The total GHQ score was computed for each individual. The logical memory passage was scored as detailed in the Appendix.

Statistical analysis : The independent sample Student's t test was used to compare the means of two groups; when variances between groups was significantly heterogeneous, as determined using the F max test, the t test was applied with modified degrees of freedom. The Chi square test was used to compare proportions between groups; for 2x2 contingency tables, Yates' continuity correction was applied.

The Pearson's product moment procedure was used to derive correlation coefficients between quantitative variables.

Comparison of the means of memory performances across time was effected using two way repeated measures multivariate analysis of variance (RMANOVA) with Pillai's trace as the statistical criterion. In this analysis, groups such as site, sex, and age category were the between subjects factors, and memory trials were the within subjects factors.

All the tests of significance, wherever applicable, were two-tailed. Alpha for significance was set at $p < 0.05$.

RESULTS

Analysis across sites :

Data obtained from the Bangalore and Cochin sites are presented in table 1. The samples from the two sites were comparable in age. There was a small but statistically significant elevation of GHQ values in the Cochin sample as compared with the Bangalore sample.

TABLE 1
DATA OBTAINED FROM BANGALORE AND COCHIN SAMPLES*

Variable	Bangalore (n=121)	Cochin (n=92)
a. Age (years)	41.4 (16.5)	41.5 (12.3)
b. Sex : Male	61	45
Female	60	47
c. GHQ	19.0 (2.8)	20.1 (2.9)
d. Trial 1	21.6 (8.3)	19.6 (9.5)
Trial 2	28.6 (9.8)	27.9 (9.1)
Trial 3	33.7 (9.9)	34.1 (9.2)
e. Delayed recall	32.3 (10.2)	30.9 (9.7)

a. t=0.19, d.f.=211, p=0.93, NS

* Values are mean (standard deviation) for quantitative variables and frequency counts for qualitative variables.

b. X^2=0.01, d f =1, p=0.94, NS

c. t=2.48, d.f.=211, p=0.014

d. RMANOVA results for trials 1-3 : main effect for site, NS; main effect of trial, p<0.001; site x trial interaction, p=0 047.

e. RMANOVA results for trials 3-4 : main effect for site, NS; main effect for trial, p<0.001; site x trial interaction, p<0.001.

TABLE 2
DATA OBTAINED FROM MALE AND FEMALE SUBJECTS*

Variable	Males (n=106)	Females (n=107)
a. Age (years)	40.6 (14.4)	42.3 (15.2)
b. GHQ	19.7 (2.9)	19.2 (2.9)
c. Trial 1	21.4 (8.9)	20.1 (8.9)
Trial 2	30.0 (9.3)	26.6 (9.5)
Trial 3	35.4 (9.0)	32.4 (10.0)
d. Delayed recall	33.1 (9.5)	30.2 (10.3)

a. t=0.87, d.f.=211, p=0.39, NS

* Values are mean (standard deviation) for quantitative variables and frequency counts for qualitative variables.

b. t=1.10, d f.=211, p=0.27, NS

c. RMANOVA results for trials 1-3 : main effect for sex, p=0 032, main effect for trial, p<0.001; site x trial interaction, p=0.022

d. RMANOVA results for trials 3-4 : main effect for sex, p=0.032, main effect for trial, p<0.001; sex x trial interaction, NS.

The immediate learning (T_1-T_3) and delayed recall (T_4) trials were analysed separately. For T_1

to T_3, the main effect for site was not significant ($F=0.46$, d.f.=1,211, $p=0.50$). This indicates that the learning scores in the two cities did not differ, overall. The main effect for trial was significant (Pillai's trace=0.78, $F=381.13$, d.f.=2,210, $p<0.001$), indicating that significant learning occurred accross trials. The site x trial interaction was also significant (Pillai's trace=0.03, $F=3.11$, d.f.=2,210, $p=0.047$), indicating that the Cochin sample showed significantly greater learning across trials.

For T_3 to T_4, the main effect for site was not significant ($F=0.16$, d.f.=1,211, $p=0.69$). This indicates that the T_3 and T_4 scores in the two cities did not differ, overall. The main effect for trial was significant ($F=95.94$, d.f.=1,211, $p<0.001$), indicating that significant forgetting occurred at T_4. The site x trial interaction was also significant ($F=13.41$, d.f.=1,211, $p<0.001$), indicating that the Cochin sample showed significantly greater forgetting in the delayed recall trial.

Analysis between sexes :

The data from the males and females in the sample are presented in table 2. Males and females did not differ significantly in either age or GHQ scores.

For T_1 to T_3, the main effect for sex was significant ($F=4.65$, d.f.=1,211, $p=0.032$). This indicates that the learning scores were overall higher in males. The main effect for trial was significant (Pillai's trace=0.78, $F=371.51$, d.f.=2,210, $p<0.001$), indicating that significant learning occurred across trials. The sex x trial interaction was also significant (Pillai's trace=0.04, $F=3.90$, d.f.=2,210, $p=0.022$), indicating that males showed significantly greater learning across trials.

For T_3 to T_4, the main effect for sex was again significant ($F=4.68$, d.f.=1,211, $p=0.032$). This indicates that the T_3 and T_4 scores were higher in males. The main effect for trial was significant ($F=75.38$, d.f.=1,211, $p<0.001$), indicating that significant forgetting occurred at T_4. The sex x trial interaction was, however, not significant ($F=0.10$, d.f.=1,211, $p=0.75$), indicating that the degree of forgetting was comparable in males and females.

Analysis for GHQ effects :

Correlation coefficients were computed to assess the relationship between the GHQ scores and the T_1 to T_4 scores. The coefficients obtained ranged from 0.09 to 0.18; no coefficient reached statistical significance. Thus, mental health status, as determined by the GHQ, did not correlate significantly with learning and recall performances.

Analysis for decade of life : Learning and recall scores for each decade of age are presented in table 3. Since subjects below the age of 20 and above the age of 79 were too few in number to form independent groups, their data were combined with those of subjects in the adjacent age decade. The seventies decade was omitted from the RMANOVA analyses because the sample in this group was too small.

TABLE 3
DATA OBTAINED FROM DIFFERENT DECADES OF LIFE*

Decade	T_1	T_2	T_3	T_4
Twenties	11-38	14-47	17-49	17-50
(16-29)	25.8	32.7	38.2	36.8
n=55	(7.1)	(7.7)	(7.2)	(7.1)
Thirties	7-39	17-48	21-49	17-49
(30-39)	23.2	32.1	38.6	36.3
n=45	(8.5)	(7.2)	(5.6)	(7.2)
Forties	5-36	11-42	16-46	14-49
(40-49)	19.4	28.7	34.7	31.6
n=44	(8.7)	(9.4)	(8.9)	(9.5)
Fifties	4-35	9-40	15-49	11-47
(50-59)	16.6	23.5	28.5	25.5
n=40	(7.7)	(9.4)	(10.0)	(10.0)
Sixties	2-31	13-36	14-40	13-41
(60-69)	16.7	23.1	27.2	26.2
n=23	(7.6)	(7.3)	(7.6)	(7.7)
Seventies	2-18	5-15	7-22	4-19
(70-82)	7.7	10.5	14.3	12.2
n=6	(5.6)	(3.9)	(5.5)	(6.0)

* Values are range, mean and (standard deviation)
RMANOVA results for T_1-T_3 : main effect for age group, $p<0.001$; main effect for trial, $p<0.001$; age group x trial interaction, $p=0.053$.
RMANOVA results for T_3-T_4 : main effect for age group, $p<0.001$; main effect for trial, $p<0.001$; age group x trial interaction, $p=0.049$.

For T_1 to T_3, the main effect for age decade was significant ($F=15.12$, d.f.=4,202, $p<0.001$). This indicates that the learning scores progresively decreased with increase in age. The main effect

for trial was significant (Pillai's trace=0.78, F=351.24, d.f.=2,201, p<0.001), indicating that significant learning occurred across trials. The age decade x trial interaction was also significant (Pillai's trace=0.07, F=1.94, d.f.=8,404, p=0.05), indicating that the quantum of learning across trials varied significantly as a function of age decade : it was higher in the forties decade and younger age groups, and lower in the fifties decade and older age groups.

For T_3 to T_4, the main effect for age decade was again significant (F=17.27, d.f.=4,202, p<0.001). This indicates that the T_3 and T_4 scores decreased with increase in age. The main effect for trial was significant (F=70.53, d.f.=1,202, p<0.001), indicating that significant forgetting occurred at T_4. The age decade x trial interaction was significant (F=2.43, d.f.=4,202, p=0.049), indicating that the degree of forgetting increased with increasing age.

DISCUSSION

The objective of this study was to develop and standardize a passage, for the testing of verbal (logical) memory, that was more difficult than the passages in conventional use. The passage addressed in this study was made up of 50 memory units; this contrast with conventional passages, such as the Asha Kumari passage, which are made up of <30 units (Mukundan et al.,1983, 1991). The passage in this study also used more complex words and phrases, more complex syntax, and longer sentences. It was hoped that the passage would provide satisfactory dispersion of learning and recall scores while simultaneously avoiding ceiling and floor effects in middle to upper class populations.

How well were these objectives fulfilled by the passage ? An examination of the data in table 3 showed that the passage was sensitive to differences in performances across decades of life; it is well known that neuropsychological test performances decrease with increasing age (Lezak,1995), and the data in table 3 bear out this observation. From table 2, it is clear that the passage was also sensitive to differences in performances between males and females. Poorer performances in females may be because females in this country are, on average, less well educated than males, and more likely to be employed in non-intellectual pursuits such as housekeeping. Finally, from table 1, it is clear that the passage additionally was sensitive to differences in performance across sites; geographical variations in neuropsychological test performances are also well-known, which is why tests need to be restandardized across countries and cultures (Lezak,1995).

Dispersion in test performance was excellent; for example, T_1 scores ranged fro 11 to 38 in the twenties decade, and from 2 to 31 in the sixties decade, while T_4 scores ranged from 17 to 50 in the twenties decade, and from 13 to 41 in the sixties decade (Table 3). These values show that the test was neither too easy nor too difficult at any decade of life except, possibly in the seventies. Neither ceiling nor floor effects were evident (Table 3). The broad dispersion is an asset because tests with greater dispersion of scores will be able to identify effects (if any) of independent variables with greater sensitivity (Nunnaly,1978).

It is curious that the average GHQ scores of the subjects in this study were high by any definition; on theoretical grounds, these findings suggest that a substantial number of subjects in the sample may have carried a psychiatric diagnosis. Since the vast majority of subjects had high GHQ scores (observe the narrow standard deviations in Table 1), and since it is unlikely that a substantial proportion of a community sample is mentally ill, these findings suggest that the GHQ may not be appropriate for screening Indian populations. Indeed, the previous experience of the senior author of this paper (CA) suggests as much : in an unpublished study conducted on approximately 600 women studying in the graduate courses in an urban college, 17-item GHQ scores exceeded the recommended cut-off level in every case. This poor specificity of the GHQ may also explain why GHQ scores did not

correlate with memory and recall scores in the present study : the GHQ was not a valid measure of the mental status of the subjects in the sample. An additional point to be considered is that every attempt was made to ensure that subjects were relaxed and comfortable before the passage was administered; therefore, even if the GHQ did reflect disturbed functioning during the past week, it would not necessarily represent the subject's frame of mind at the time of testing.

Although data for gender and site were pooled to generate the data for age decade in table 3, it is suggested that the data in table 3 may be used as a reliable guideline for clinical practice. This is because variations across cities and between sexes were very small, amounting to a maximum of one third of one standard deviation for the various learning and delayed recall trials. For more serious purposes, however, it is recommended that independent norms be obtained that are specific to age, sex, education, culture, and other background variables.

This study details an exercise in the development and standardization of a verbal (logical) memory task that is more complex than the tasks conventionally in use in India; consequently, this task is better suited to the assessment of memory functioning in young, well-educated subjects belonging to middle and upper middle socioeconomic strata. This task is also well-suited for research purposes because it shows a high dispersion of scores with neither floor nor ceiling effects in the populations studied.

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CHITTARANJAN ANDRADE, MD, Additional Professor & Head, Department of Psychopharmacology, NIMHANS, Bangalore-560029. ARJUN P. MADHAVAN, MBBS, Intern & M.L. KISHORE, MBBS, Intern, Devaraj Urs Medical College, Kolar - 563101 (e-mail andrade@nimhans.kar.nic.in and andrade@vsnl.com)*

*** Correspondence**