DEMENTIA: THE ESTIMATION OF PREMORBID INTELLIGENCE LEVELS USING THE NEW ADULT READING TEST

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Introduction

In an earlier paper (Nelson and McKenna, 1975) it was established that word-reading ability and general intelligence level were significantly correlated in a group of normal adults. Using the Schonell Graded Word Reading Test (Form A) to assess reading ability and the Full Scale IQ of the Wechsler Adult Intelligence Scale (WAIS) to assess general intelligence level a regression equation was extracted so that a prediction of Full Scale IQ could be made from the number of words correctly read on the Schonell. This equation was: Predicted F.S. IQ $= 44.1 + 0.71 \times$ Schonell Score, and the standard error of prediction was 8.6 IQ points.

This study also established that word-reading ability was relatively well preserved in a group of dementing patients. Previous indices of intellectual deterioration — e.g. the Hunt-Minnesota (Hunt, 1943) and the Shipley-Hartford (Shipley, 1940) tests — have been based extensively on the use of vocabulary-type items as "hold" tests, whilst Kendrick (1964) has noted that amongst elderly organic patients the synonym section of the Mill Hill Vocabulary Scale (Raven, 1958) provides a higher estimate of premorbid verbal ability than does the WAIS Verbal Scale IQ which includes subtests generally accepted to be sensitive to the effects of deteriorating processes. In the Nelson and McKenna (1975) study it was reported that word reading ability had been less affected by the dementing processes than had the vocabulary subtest of the WAIS, and on the grounds that the mean reading scores for the dementing and control subjects were almost identical it was argued that word-reading ability may be retained virtually intact until the degree of dementia becomes quite severe. These results implied that word-reading ability could provide a useful indicator of the premorbid level of intellectual functioning of the demented patient.

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One of the most obvious limitations to the use of the Schonell GWRT as a means of estimating levels of intelligence was that it could not differentiate between the higher levels of intelligence because its ceiling level of 100 words correct was equivalent to a Full Scale IQ of only 115. Since the Schonell GWRT was constructed to measure reading attainments in children from the most elementary levels, the easier words on this test are much too simple to provide any discrimination between literate adults and there are not enough difficult words at the upper end of the test to provide adequate discrimination between adults with high levels of literacy skills. For this reason it was considered desirable to follow up this original study by devising a new graded word-reading test with words of more appropriate difficulty levels for an adult population.

The usefulness of a word-reading test in the estimation of the premorbid intelligence level of a dementing patient relies upon that test providing a measure of previous familiarity with words rather than a measure of current cognitive ability to analyse a complex visual stimulus and from this to synthesize the correct oral response. Despite the complexity of the English orthographical system the majority of words do follow common rules of grapheme/phoneme representation and pronounciation, and application of these rules will enable the literate adult to read aloud these words correctly even though he may be quite unfamiliar with them and quite unaware of their meanings. In contrast to these "regular" words, some words exist in the English language which are written in such atypical ways that application of the common rules of phonetic interpretation would result in incorrect reading aloud. For example the correct rendering of "naive" could not be reached without knowledge of the word, as intelligent guesswork alone would produce "nave". Each "irregular" word can only be read correctly if the subject knows of the word and recognises its written form. Whereas the reading of a "regular" word may depend as much on the subject's current ability to intelligently apply the common rules as it does on previous familiarity with the word, the reading of an "irregular" word maximizes the importance of the "previous familiarity" factor. For this reason a list of "irregular" words should be a more sensitive indicator of the premorbid intellectual status of a dementing patient than the words of the Schonell list, many of which are of the "regular" type. With these points in mind Nelson devised and constructed the New Adult Reading Test (NART), which is given in Appendix 1.

Standardization of the New Adult Reading Test

Full details of the standardization of the NART are given in the test manual (Nelson, 1977), but the information and results which are pertinent to the present study will be briefly restated.

The NART was standardized on an unselected series of 120 patients, all of whom were inpatients at the National Hospital with extra-cerebral disorders. As these subjects also constituted the control group for the present study details of their results are available from Table I: the tests included the Schonell Graded Word Reading Test (GWRT) and the Wechsler Adult Intelligence Scale (WAIS) in addition to the NART.

All subjects fell in the 20-70 years age range. Age did not correlate significantly with numbers of errors on the NART (Pearson's $r = 0.14$) so it was concluded that age does not have a significant effect on reading ability in this age group. This finding is consistent with that obtained in the earlier study (Nelson and McKenna, 1975) using the Schonell GWRT.

Details of each subject's occupational and educational histories were recorded and on the basis of this information he was given a social class rating according to the HMSO Censuses classification system. But in none of the social classes was the mean predicted IQ (based on reading ability) significantly different from the mean obtained IQ, so it was concluded that social class per se does not have a significant independent effect on word-reading ability.

The following regression equations were obtained from the data:

(R1): Predicted Verbal IQ $= 129 - 0.92 \times$ Errors on NART (with a S.E. est. $= 7.6$)

(R2): Predicted Performance IQ $= 124 - 0.65 \times$ Errors on NART (with a S.E. est. $= 9.4$)

(R3) Predicted Full Scale IQ $= 128 - 0.83 \times$ Errors on NART (with a S.E. est. $= 7.6$)

(R4): Predicted Full Scale IQ $= 117 - 0.97 \times$ Errors on GWRT (with a S.E. est. $= 7.9$)

(R5): Predicted Full Scale IQ $= 124 - 0.50 \times$ Errors on NART + GWRT (with a S.E. est. $= 7.2$)

Materials and Methods

Subjects

The experimental group. The experimental group was composed of a series of 40 patients from the National Hospital, Queen Square, whose EMI Scan records showed evidence of bilateral cortical atrophy. The presence of atrophy does not necessarily guarantee a generalised intellectual deterioration (indeed in at least two patients there was no evidence at all of any intellectual loss) but as a group one would expect a set of patients with cortical atrophy to include a majority with intellectual deterioration.

The experimental subjects were not selected on the grounds of the presence

of intellectual deterioration, in case the available methods of deciding whether or not a patient was demented from his results on cognitive tests involved some considerations which would inadvertently bias the results of the investigations. In particular, since vocabulary and reading error score had been found to be highly correlated in the control subject (Pearson's $r = -0.77$), the use of patterns of WAIS subtest scores involving the interpretation of a relatively high Vocabulary subtest score as an indicator of dementia might tend to bias the results in the predicted direction.

The control group. The control group was composed of the 120 subjects used in the NART standardization study. These subjects were an unselected series of inpatients from the National Hospital who had extracerebral disorders.

Tests and Procedure

Assessment of verbal, performance and full scale IQs were obtained for each subject by pro-rating from the Arithmetic, Similarities, Digit Span, Vocabulary, Picture Completion, Block Design and Picture Arrangement subtests of the WAIS.

The Schonell GWRT was administered in the standard way, and each word was scored according to a correct/incorrect dichotomy. The total number of errors made was recorded for each subject. The NART was administered according to the instructions set out in the Test Manual. This is similar to the procedure followed for the Schonell GWRT except that the reading of words is paced by requiring the subject to pause between words until the examiner calls "next." The total number of errors made was recorded for each subject. The total number of errors made on both these reading tests was also recorded for each subject.

In addition to the total number of errors recorded on the NART each error word made was scored (1) according to whether or not the attempt was a possible phonetic interpretation of the written word, and (2) according to whether or not the attempt was a substitution of a real word. It was hypothesized that dementing subjects might be more likely than the controls to misread words because they failed to take account of all the stimulus elements of the words, thereby producing phonetically impossible renderings of the graphemes as written, whereas the control subjects would be relatively more likely to misread words because they failed to recognise the appropriate phonetic rendering for those particular sets of graphemes, thereby producing "possible" though incorrect interpretation. On the basis of this hypothesis it was predicted that the dementing subjects would tend to produce more "impossible" errors than the controls. On the grounds that the dementing subjects might pay less attention to the constraints of the written graphemes it was also predicted that they would tend to produce more errors of "real word" substitution than the controls.

To contrast with the "irregular" words of the NART a set of 20 long but "regular" words was also given to each subject; 10 of these were common words and 10 were very rare words that few subjects recognised (See Appendix II). It was hypothesized that in contrast to the reading of the NART words the reading of these latter words would maximize the importance of current ability to analyse and synthesize the elements of the written word according to the common rules of pronunciation, and minimize the importance of the previous familiarity factor. On the basis of this hypothesis it was predicted that the dementing patients would have more difficulty in reading these "regular" words than the control subjects. (N.B. As these lists were constructed after data collection had begun,

the analysis of these results is based on 114 of the control subjects and 34 of the cortical atrophy patients.)

For each subject WAIS verbal, performance and full scale IQs were predicted from his results on the Schonell GWRT and the NART, using the regression equations R1 - R5. In order to allow for the ceiling and basal effects on predictions, for each regression equations all obtained IQs which fell above the maximum possible predictable IQ were reduced to this level whilst all obtained IQs which fell below the minimum possible predictable IQ were increased to this level. Having made this adjustment the difference between predicted and obtained IQs for each regression equation was calculated to give a Predicted-Obtained IQ Discrepancy Score.

Results

Means and standard deviations of age and test results are given in Table I, toghether with the results of t-tests for group differences. The following points emerge.

The patients with cortical atrophy were significantly older than the control patients and they obtained significantly poorer scores on all the WAIS IQ measures. In view of the pathologies represented in each of the patient groups both the greater age and the poorer cognitive abilities of the atrophy group were expected.

The means and standard deviations of the NART error scores were very similar for the cortical atrophy and control groups. Although the difference between the two groups in their error scores on the Schonell GWRT did not reach even the 10% significance level, the s.d.s. on this test were relatively large compared with the means, and the trend of the results would be consistent with the hypothesis that some aspect of reading ability as measured by this test may have been impaired in the atrophy group. The atrophy group made significantly more errors than the control group in the reading of the long "regular" words, confirming the prediction made for this test.

The predictions made concerning possible group differences in the quality of reading errors in the NART were supported by the results, though the actual numbers of errors which were phonetically "impossible" interpretations of the written word and the number of errors which were real word substitutions were few for both groups. In both cases the difference between the two subject groups was in the direction predicted but whereas the larger proportion of "impossible" errors made by the atrophy group just reached the five percent significance level on a one-tailed test the increased proportion of "real-word" errors made by atrophy group did not reach the normally accepted levels for significance.

The group means and SDs of the Predicted-Obtained IQ Discrepancy

TABLE I

Details of Age and Test Results of Control Subjects (N = 120) and Subjects with Cortical Atrophy (N = 40)

		Control group	Atrophy group	t test	Sig. level
Age	Mean	48.0	58.0	2.98	$p < 0.01$
	S.D.	12.0	12.0		
Verbal IQ	Mean	108.5	94.8	3.00	$p < 0.01$
	S.D.	12.0	14.4		
Performance IQ	Mean	109.1	88.3	5.92	$p < 0.001$
	S.D.	11.5	18.4		
Full scale IQ	Mean	109.2	91.6	5.39	$p < 0.001$
	S.D.	11.3	15.9		
Schonell errors (Max = 100)	Mean	7.7	11.3	1.58	n.s.
	S.D.	8.3	10.4		
NART errors (Max = 50)	Mean	22.4	23.9	0.57	n.s.
	S.D.	10.1	11.2		
Schonell + NART errors (Max = 150)	Mean	30.0	35.2	1.11	n.s.
	S.D.	17.3	21.0		
NART - Percentage of "impossible" errors	Mean	11.8	18.4	1.71	$p < 0.05$ (1-tailed)
	S.D.	15.2	15.6		
NART - Percentage of "real word" errors	Mean	9.4	12.4	1.46	n.s.
	S.D.	7.7	9.0		
Total errors in "regular" words (Max = 20)	Mean	1.98	4.56	5.43	$p < 0.001$
	S.D.	2.04	3.67		
Errors in 10 common "regular" words	Mean	0.09	0.82	3.63	$p < 0.001$
	S.D.	0.40	1.40		
Errors in 10 rare "regular" words	Mean	1.89	3.74	4.69	$p < 0.001$
	S.D.	1.85	2.50		

Scores for each regression equation are given in Table II, together with the results of t-tests for group differences. The results clearly show that relative to the control group the obtained IQs of the patients with cortical atrophy are consistently poorer than the IQs which would be predicted on the basis of their current reading abilities.

TABLE II

Predicted-Obtained IQ Discrepancy Scores

		Controls	Atrophies	t test	Sig. level
1. Using NART: to predict verbal IQ	Mean	0.29	10.90	7.4	$p < 0.001$
	S.D.	7.08	9.84		
2. Using NART: to predict performance IQ	Mean	0.47	11.20	6.9	$p < 0.001$
	S.D.	8.36	8.92		
3. Using NART: to predict full scale IQ	Mean	0.42	12.15	8.0	$p < 0.001$
	S.D.	7.35	9.70		
4. Using Schonell: to predict full scale IQ	Mean	2.00	14.42	8.4	$p < 0.001$
	S.D.	5.97	12.6		
5. Using NART + Schonell: to predict full scale IQ	Mean	0.63	14.55	8.5	$p < 0.001$
	S.D.	6.62	13.97		

Discussion

Although the group of patients with cortical atrophy was older than the group of control patients this is not considered to be a relevant factor in the discussion of other results obtained since it was established in the NART standardization study that age does not have a significant effect on word reading ability in the 20-70 year age range, and WAIS IQ measures are age corrected.

In view of the nature of cortical atrophy, intellectual deterioration is a very common feature of the disorder. Both the overall lower IQs and the larger Verbal/Performance IQ discrepancies found in the group of cortical atrophy patients supported the assumption that this group would incorporate a group of dementing patients.

The results of the present study have confirmed those of the preliminary study by Nelson and McKenna (1975) in demonstrating that word-reading ability is a relatively very well maintained cognitive skill in patients suffering from cortical atrophy, and thereby have supported their conclusion that current word-reading ability can serve as a most useful indicator of the premorbid intelligence levels of dementing patients. The most obvious advantage of the NART over the Schonell GWRT for this purpose lies in its higher ceiling level, enabling IQs to be predicted in the bright normal and superior range.

The trend in the Schonell GWRT results suggested that some mild

degree of impairment in the reading of these words may have been present in some of the patients with cortical atrophy. In contrast the close similarity between the two groups in the NART error-scores implied that reading ability as measured by this test is more resistant to the effects of dementing processes than that measured by the Schonell GWRT: indeed, these results suggest that any deleterious effects on the NART scores are negligible. The fact that the mean predicted Full Scale IQ of the atrophy group was higher using the NART than the Schonell is also consistent with the conclusion that IQs predicted from the NART approximate more closely to premorbid IQ levels (Nelson and McKenna, 1975).

Although the atrophy group made significantly more errors than the control group in reading the long "regular" word list this impairment was certainly not apparent in all the patients with cortical atrophy and the size of the overall effects was not large. For these reasons this particular reading test of long "regular" words cannot be used as a reliable indicator of the presence or absence of dementia in every individual patient. Nevertheless, if a patient has a particular difficulty with this type of word which is not associated with a specific dysphasia then this may be taken as supplementary evidence for a diagnosis of dementia, particularly if his overall score on the NART is good. Similarly, although as a group the patients with cortical atrophy also produced more 'impossible' interpretations of the NART words than the control group, the size of this effect was so small and the overall adverse effects on the NART error scores apparently so negligible that no reliable significance can be attached to the occurrence of this type of error in the individual patient as far as the detection of generalised dementia is concerned. (N.B. this type of error may have extremely important implications concerning the presence of a dyslexia and/or dyspasia, and so should not be disregarded in this context).

In adult subjects two ways of reading have been identified, in the first the word's meaning is elicited directly by the written stimulus (the direct or graphemic-semantic route) whilst in the second a transitional stage is involved in which the written stimulus is translated into its phonological equivalent (the graphemic-phonemic route). The existence and independence of these two routes has been supported by studies of patients with acquired dyslexia (Marshall and Newcombe, 1973; Shallice and Warrington, 1975) and normal adult subjects (e.g. Meyer, Schvaneveldt and Ruddy, 1974). By their very nature the NART words are unsuitable for reading via the graphemic-phonemic route whereas the long regular words, especially the list of 'rare' unfamiliar words, maximize the importance of this route. Therefore the present results of the patients with cortical atrophy imply that the direct graphemic-semantic route of reading is very well maintained despite a dementing condition whereas the graphemic-phonemic route may show impairment. The small but increased tendency amongst

the patients with cortical atrophy to produce more phonetically impossible renderings of the NART words suggests that some impairment of the graphemic-phonemic route may stem from inaccurate phonological conversions, but this factor alone did not appear to play a major role in the poorer reading of the long regular words. The trend amongst the patients with cortical atrophy to produce more errors of real word substitution than the controls suggests a tendency to guess on the basis of only some of the phonemic elements because accurate processing of the full word via the graphemic-phonemic route has become difficult. It is suggested that this difficulty is one aspect of a more generalized impairment in the ongoing intellectual ability to accurately process complex stimuli.

The Test Manual containing full details of the NART and its standardization is available form the senior author. Also included in this Test Manual are detailed abnormality tables for the Predicted-Obtained IQ Discrepancy Scores for use in the clinical assessment of the individual patient.

Summary

The NART is a new word-reading test which was specifically designed for use with adults: the 50 words were selected in order to assess familiarity with words rather than the ability to phonetically decode unfamiliar words, i.e. for each word intelligent guesswork alone would not result in a correct response. The results from a group of patients with cortical atrophy and a control group demonstrated the superiority of the NART over the best previously available word list (the Schonell GWRT) in enabling higher and more accurate levels of intelligence to be predicted. The evidence implied that the reading of the NART words was not significantly affected by the dementing processes in the patients with cortical atrophy, and therefore that the NART reading score can provide an accurate estimate of premorbid intelligence levels in these patients.

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APPENDIX I

The New Adult Reading Test

ACHE	SIMILE
DEBT	RAREFY
PSALM	CELLIST
DEPOT	ZEALOT
CHORD	ABSTEMIOUS

BOUQUET	GOUGE
DENY	PLACEBO
CAPON	FACADE
HEIR	AVER
AISLE	LEVIATHAN
SUBTLE	AEON
NAUSEA	DETENTE
EQUIVOCAL	GAUCHE
NAIVE	DRACHM
THYME	IDYLL
COURTEOUS	BEATIFY
GAOLED	BANAL
PROCREATE	SIDEREAL
QUADRUPED	PUERPERAL
CATACOMB	TOPIARY
SUPERFLUOUS	DEMESNE
RADIX	CAMPANILE
ASSIGNATE	LABILE
GIST	SYNCOPE
HIATUS	PRELATE

APPENDIX II

The Long Regular Word List

ADVENTUROUSLY	CHITTERLING
INDIVIDUAL	HERPETOLOGY
UNINTERESTED	FLEERINGLY
EXPERIMENTER	HUCKABACK
APPREHENSIVE	INTERTERGAL
INDISCOVERABLE	TIPULARIAN
MANUFACTURED	GRESSORIAL
ORGANISATIONS	PEGMATITIC
PARTICULARLY	HECTOGRAPHIC
MASTERPIECE	SHIBBOLETH

References

H. M. S. O. Office of Population Censuses and Surveys, *Clasification of occupation 1970.*

Hunt, H. F. (1943) *A practical clinical test for organic brain damage*, "J. Appl. Psychol.," *27*, 375-386.

Kendrick, D. C. (1964) *Assessment of premorbid intelligence of elderly patients with diffuse brain pathology*, "Psychol. Reps.," *15*, 188.

Marshall, J. C., and Newcombe, F. (1973) *Patterns of paralexia: A psycholinguistic approach*, "J. Psycholing. Res.," *2*, 175-199.

Meyer, D. E., Schvaneveldt, R. W, and Ruddy, M. G. (1974) *Functions of the graphemic and phonemic codes in visual word recognition*, "Mem. and Cog.," *2*, 309-323.

Nelson, H. E., and McKenna, P. (1975) *The use of current reading ability in the assessment of dementia*, "Br. J. Soc. Clin. Psychol.," *14*, 259-267.

— (1977) *The Adult Reading Test: Test Manual* (obtainable from the author).

Raven, J. G. (1958) *Mill Hill Vocabulary Scales* (2nd ed.), Lewis, London.

Shallice, T., and Warrington, E. K. (1975) *Word recognition in a phonemic dyslexic patient*, "Quart. J. Exp. Psychol.," *27*, 187-199.

Shipley, W. C. (1940) *A self administering scale for measuring intellectual impairment and deterioration*, "J. Psychol.," *9*, 371-377.

Schonell, F. J. (1942) *Backwardness in the Basic Subjects*, Oliver and Boyd, Edinburgh.

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