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Colour association and "colour amnesia" in aphasia

NILS R VARNEY

From the Psychology Service, VA Medical Center and Division of Behavioral Neurology, Benton Laboratory of Neuropsychology, University of Iowa College of Medicine, Iowa City, Iowa, USA

SUMMARY "Colour association" performance of 50 aphasic patients was investigated by means of a test in which they identified the characteristic colours of objects shown in line drawings. All aphasics with defects in colour association were impaired in reading comprehension. However, some (33%) retained normal aural comprehension. Approximately half the aphasics with receptive language impairment performed normally in colour association. The findings suggest that "colour amnesia" may be the result of a specific cognitive disturbance which is also responsible for a subtype of aphasic alexia.

The term colour association refers to those non-verbal performances in which patients must identify the characteristic colour of familiar objects.[1] Lewandowsky[2] was the first to develop a task of this type, and he emphasised the fact that many patients who were impaired in colour association retained normal colour vision and colour perception. Based on these observations, he suggested that impaired colour association reflected a cognitive disturbance in which there was a "splitting" between image for colour and image for form. That is, the patients appeared to have "forgotten" how objects should be coloured. For this reason, the term "colour amnesia" is sometimes used in reference to defects in colour association.

The first systematic studies of colour association were initiated by De Renzi and his co-workers[3-5] nearly 60 years after the initial observations of Lewandowsky. Among patients with unilateral cerebral lesions, defects in colour association were found primarily among Wernicke and global aphasics. A few right brain damaged patients were also impaired in colour association, but these patients typically showed defects in colour perception, and thus did not represent true cases of colour amnesia. It was concluded that colour amnesia was the result of cognitive disturbances which did not specifically affect colour memory or colour imagery. It was also suggested that impaired colour association might be the result of a "general disturbance in conceptualisation" whose relationship to the receptive aphasic syndromes had yet to be established.

The primary objective of the present study was to investigate the nature of the relationship between colour association and reading comprehension. This topic was suggested, in large part, by findings from studies on pantomime recognition. Like impaired colour association, impaired pantomime recognition is found primarily in association with aphasia.[6 7] While virtually all aphasics with defects in pantomime recognition are also impaired in reading comprehension, their performances in aural comprehension, naming, repetition, and non-verbal reasoning were highly variable and at least sometimes normal.[8-10] Similar findings with regard to colour association would suggest that colour amnesia is the result of relatively specific cognitive disturbances which also affect reading comprehension, but have no direct relevance to severity of aphasia or impairment in conceptual thinking. Two earlier case reports[11 12] of non-aphasic alexics with colour amnesia suggested that this result might be obtained.

Subjects and methods

Two groups of subjects, aphasic and control, were selected from patient populations at the VA Medical Center and University Hospitals in Iowa City, Iowa and from the Rockford Memorial Hospital in Rockford, Illinois. Inclusion in either group was restricted to patients between 30 and 70 years of age who had at least an 8th grade education, who had no history of mental subnormality or psychiatric illness, and who performed normally on the 1976 version of the *Ishihara Test for Color-Blindness*.[13]

Address for reprint requests: Dr Nils R Varney, Psychology Service (116B), VA Medical Center, Iowa City, IA 52240, USA.

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The aphasic group consisted of 50 right handed patients for whom neurological evaluation and neuroradiographic testing indicated cerebral lesions confined to the left hemisphere. All had demonstrated impairments in naming, writing, and/or language comprehension in formal neuropsychological evaluation. Thirty-seven had vascular lesions, 12 had neoplastic lesions, and one had a penetrating missile wound.

The control group consisted of 100 hospital inpatients from non-neurological wards who had been hospitalised for at least one week (that is, they had been about as seriously ill as the aphasics). This group was used to standardise the colour-object matching test described below.

Tests

Colour-object matching This 24 item test required patients to identify the characteristic colour of objects shown in line drawings by pointing to that object's colour from among four one-by-two inch colour patches. All of the stimulus drawings were objects with an intrinsic colour, and error foils were selected from among colours of completely different hue from the correct choice. For example, when the stimulus was a banana, the correct choice was yellow, and the error foils were red, blue, and brown.

The test proved relatively easy for controls, 37 of whom obtained errorless scores of 24 correct. Another 53 controls scored between 23 and 20 correct, with six obtaining a score of 20. Performances below 20 correct (that is, the 4th centile) were classified as defective.

Colour-blindness The Ishihara test was administered to control subjects in the standard manner, which requires an oral number reading response. Aphasic patients were permitted to trace the numerals in the test plates with a brush or their index finger (for those with graphomotor apraxia). In accord with interpretive criteria contained in the test manual, scores of less than 17 correct for the first 21 items were classified as being impaired in colour vision. By this criterion, 15 potential control and seven aphasic subjects (all male) were excluded from the study. It may be noted that the rate of impaired performance among the 57 original aphasic subjects (12%) was rather high, but not substantially different from the failure rate among the 115 original control subjects (14%).

Reading comprehension This 18 item subtest from the Multilingual Aphasia Examination[14] required patients to point to drawings of objects whose names were shown in 5/8 inch bold type. Four choices were available on each test trial. Based on previously established norms, scores of 15 and below were classified as defective.

Aural comprehension This 21 item test from the Multilingual Aphasia Examination was similar in format to the reading comprehension test, requiring patients to point to drawings of objects named by the examiner from among four response alternatives. Based on previously established norms, scores of 16 and below were classified as defective.

Block design This subtest from the Wechsler Adult Intelligence Scale[16] was included as a measure of nonverbal problem solving ability. The test was administered and scored in accordance with procedures set in the WAIS manual.

Results

The colour-object matching performances of aphasics were quite variable, ranging from errorless performances of 24 correct to a grossly defective score of 10 correct. Fifteen aphasics (30%) obtained defective colour-object matching scores of 19 correct and below. Aphasic performances in reading comprehension and aural comprehension were also highly variable, with 28 (56%) failing reading comprehension and 22 (44%) failing aural comprehension.

Contingencies of intact and defective performance are shown in table 1. As can be seen, all of the aphasics who failed colour-object matching were also impaired in reading comprehension, and all of the aphasics with intact reading comprehension performed normally in colour-object matching. By contrast, there were five aphasics with intact aural comprehension who were impaired in colour-object matching. Thus, while all aphasics with impaired colour-object matching were impaired in reading comprehension, some retained normal aural comprehension.

It should also be noted that about half the aphasics who failed either the reading comprehension or aural comprehension tests performed normally in colour-object matching. Included here were aphasics with two of the worst five reading comprehension scores and two of the worst four aural comprehension scores. In other words, it was possible to be severely impaired in oral and/or written language comprehension while retaining normal colour-object matching.

To investigate further the relationships of colour-object matching with reading comprehension and aural comprehension, individual raw scores on each of these tests were converted to standard scores which reflected the number of standard deviations the individual raw score was above or below the

Table 1 *Contingencies of intact and defective test performance*

Colour object matching	*Reading comprehension*		*Aural comprehension*	
	int	*def*	*int*	*def*
int (n = 35)	22	13	23	12
def (n = 15)	0	15	5	10

int = intact test performance; above 5th centile.
def = defective test performance; below 5th centile.

criterion for defective performance. By this method, it was possible to express individual scores on the three tests on comparable scales which indicated severity of impairment. With a standard score of zero reflecting performance at the 5th percentile, standard scores in colour-object matching ranged from +0·8 SD to −2·2 SD, those in reading comprehension ranged from +0·4 SD to −2·5 SD, and those in aural comprehension ranged from +0·8 SD to −2·3 SD.

For each of the 50 aphasic subjects, standard score performance in colour-object matching was compared with that in reading comprehension and aural comprehension, and the result expressed as a difference score. The distributions of the obtained difference scores are shown in table 2. In accord with the results of the contingency analysis, these data indicate that some aphasics performed significantly worse in reading comprehension than colour-object matching, but no aphasic performed more than 0·6 SD poorer in colour-object matching than reading comprehension. By contrast, colour-object matching's relationship with aural comprehension was bidirectionally variable; some aphasics being significantly poorer in aural comprehension than colour-object matching, some being poorer in colour-object matching than aural comprehension.

Aphasics with defective colour-object matching showed wide variability in WAIS Block Design performance, with age corrected scale scores ranging from zero to 15 (that is, total impairment to the 95th percentile). Five of these aphasics obtained average or better performances (that is, scale scores of at least 10), which included one aphasic whose colour-object matching performance was ranked 49th in the aphasic sample of 50 patients. Block Design performances were similarly variable among the aphasics who performed normally in colour-object matching.

SUPPLEMENTARY OBSERVATIONS

(1) Among the 15 aphasics with defective colour-object matching, 10 were non-fluent, four were fluent, and one could not be classified confidently with regard to fluency. Among the 13 alexic aphasics who performed normally in colour-object matching, eight were non-fluent, three were fluent, and two were unclassifiable. Thus, both groups of alexic aphasics included fluent and non-fluent aphasics in roughly equal proportion.

(2) Most of the aphasics who were impaired in colour-object matching appeared to be aware when making errors or indicated by various ways that they were guessing (for example, they said, "I don't know", shrugged, or grimaced).

(3) It was possible to question seven of the aphasics who failed the colour-object matching test about their performance. (The remaining eight were too severely aphasic to understand or respond to the questions reliably.) None reported being aware of their deficit prior to testing, and none admitted to being aware of any peculiarities in their perception of colour in familiar objects (for example, food, skin tone, trees, personal effects).

Table 2 *Distribution of difference scores*

	RC	*AC*
COM superior by more than 2 SD	4	1
COM superior by 1 to 2 SD	6	8
Difference less than 1 SD	40	36
COM inferior by 1 to 2 SD	0	4
COM inferior by more than 2 SD	0	1

COM = colour-object matching.
RC = reading comprehension.
AC = aural comprehension.

Discussion

The results of the study are clear in indicating a close relationship between impaired colour association performance and impaired reading comprehension. All of the aphasics who failed our test of colour association were also impaired in reading comprehension at the single word level, and reading comprehension was always at least as severely impaired as colour association. It would appear, therefore, that the cognitive disturbances responsible for impaired colour association also prevent normal reading comprehension.

Although all of the aphasics with impaired colour association were also alexic, nearly half of the reading impaired aphasics involved in the study performed normally in colour association. Even among those with very severe alexia, colour association performance was sometimes intact. Thus, it must also be concluded that the determinants of impaired colour association are responsible for some, but not all aphasic reading defects. Put in another way, it could be said that "colour amnesia" is symptomatic of a distinct subtype of aphasic alexia.

For descriptive purposes, it can be said that the relationship between colour association and reading comprehension is unilaterally dependent. That is, reading comprehension was at least as impaired as colour association, but colour association was not always as impaired as reading comprehension. By contrast, the relationship between colour association and aural comprehension can be described as being non-dependent. In this instance, aural comprehension varied from being significantly better to being significantly poorer than colour association, and some aphasics for whom colour association was severely impaired performed at normal or nearly normal levels in aural comprehension.

Comparison of the present findings with those reported by De Renzi[4] and Basso[5] is difficult because of differences in testing procedure and statistical analysis. For example, the colour association test used by De Renzi and Basso required patients to identify the characteristic colours of objects from a 30 rather than four choice array, and many of the colour choices available in their test were closely similar in hue (for example, six blues, five reds). These studies reported that impaired performance in colour association was observed primarily among Wernicke and global aphasics, groups in which reading comprehension is likely to be impaired. It was also reported that a significant proportion of Wernicke and global aphasics performed normally in colour association. Thus, to the limited extent the results can be compared, they would appear to be similar.

At the same time, however, the results do not support Dr Renzi's[4] conclusion that impaired colour association reflects a "general disorder in conceptualisation". Some of the aphasics who failed the colour association test demonstrated intact aural comprehension, and others performed at average or better levels of a visually mediated test of non-verbal problem solving. It would appear, therefore, that defective colour association is the result of a relatively specific visual information processing disorder. However, this does not also mean that impaired colour association is an independent symptom with relevance only for colour cognition. For this view to have been supported, it would have been necessary to find aphasics with defective colour association and intact reading comprehension.

Colour association is not the only non-verbal performance for which the left hemisphere appears to be dominant. Defects in pantomime recognition and sound recognition are also found primarily in association with aphasia.[6 7 16] In addition, aphasics with defective pantomime recognition are typically impaired in reading comprehension,[8-10] and aphasics with defective sound recognition are typically impaired in aural comprehension.[17] At the same time, some aphasics with significant impairment in language comprehension perform normally in pantomime recognition and/or sound recognition. Thus, the findings from these areas are similar to those on colour association, and they also suggest that some aphasic language comprehension defects involve cognitive disturbances which can affect related areas of non-verbal performance.

It should be mentioned that "colour amnesia" is, in some respects, a rather artifactual deficit, being apparent only when specific tests are performed. Very few individuals are required to *remember* the characteristic colours of objects. These objects appear naturally in their intrinsic colours. In addition, the "amnesia" of such patients is not total. As has been reported elsewhere,[5 12] "colour amnestic" patients are typically able to identify incorrectly coloured line drawings, including those they have themselves miscoloured. By contrast, the "amnesia" for faces in prosopagnosia is usually complete and immediately apparent to affected patients. Thus, there is little reason to suppose that colour memory of the type affected in "colour amnesia" is a primary ability mediated in neural structures specifically evolved for that purpose.

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