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INTELLECTUAL IMPAIRMENT FOLLOWING MISSILE WOUNDS TO THE BRAIN: INITIAL ASSESSMENT

by

Lieutenant Colonel R.D. Savage

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Abstract

This paper introduces the major research and clinical neuropsychological practice associated with the assessment of intellectual functioning following missile wounds to the brain. The incidence of such injuries, the major research studies over the past 50 years, some significant types of intellectual impairment and Savage's Cognitive Impairment Model for initial intellectual assessment of such cases are presented.

Military Experience

Military experience offers a distinct opportunity to study the consequences of penetrating missile wounds of the brain on intellectual or cognitive functioning. Such incidents require the clinical psychologist to assess, advise and rehabilitate the individual patient.

Studies of the effects of penetrating missile wounds of the brain in cognition, however, are relatively few. They have occurred during or subsequent to major military conflicts, particularly following World War I and II, the Korean conflict (Luria, 1963; Newcombe, 1969; Russell, 1951; Teuber and Weinstein, 1954; Teuber, 1962) and more recently following Vietnam (Black, 1973a and b, 1976). Some important medico-neurological papers have been published, (Poppelreuter, 1917; Head, 1926; Credner, 1930; Kleist, 1934; Goldstein, 1942; Russell, 1951; Caveness, 1963, 1966, 1976) as well as more specific investigations of intellectual impairment. This paper will concentrate on the latter.

The Oxford Hospital for Head Injuries in England, The German Hirnverletzfenhein Archives and the National Institute of Neurological Diseases and Stroke, Bethesda USA have been the most significant centres for work in this area.

In 1966, at the request of the Surgeon General of the U.S. Navy, a plan was developed to assemble information in a uniform manner during organised military combat in Vietnam. The purpose was to identify cases of head and spinal cord injuries for present and future studies. The Registry represents a series of 2,043 cases who were first seen within six hours of injury and who were observed for seven days in an intensive care environment that permitted an accurate recording of the principal injury characteristics and initial management by dedicated personnel.

All males, the average age was 21.6 years at time of injury. A total of 87% were 17 to 24 years, and 96% were younger than 30 years. From the Army, there were 1,319 cases; Navy, 72; Marine Corps, 486; Air Force, 25; Non-Americans, 57; and 84 of unknown or not recorded sources.

The agent of injury was explosively propelled missiles in 1,806 (88.4%) of the cases: falls, vehicular and blunt traumata accounted for the rest (237 or 11.6%). The head was injured in 1,683* cases (82.4%), the spinal cord in 329 (16.1%), and head and spinal cord in 31 (1.5%). Of the spinal cord injuries, 77 were cervical, 159 thoracic, 91 lumbar, three sacral, and two with location not specified. The right side was involved in 768 cases of head injuries (46.2%), the left side in 735 (44.2%), midline, vertex and basilar in 146 (8.8%), and in 14 (0.8%), there was no localisation recorded. The regional distribution according to initial impact, was facial in 57 (3.4%), frontal in 664 (39.9%), temporal 234 (14.1%), parietal including vertex in 444 (26.7%), occipital in 169 (10.2%), basilar in 38 (2.3%), multiple sites in 43 (2.6%), and unlocalised in 14 (0.8%), (Caveness, 1976).

*Author's Note: Twenty cases appear to have been lost in these breakdowns but the percentages can be generally accepted.

Missile injury to the brain presents a situation markedly different from that of closed head injury. As Russell (1951) and Teuber and Weinstein (1954) have pointed out, penetrating missile wounds of the brain provide a unique opportunity for investigating the effects of focal lesions upon behaviour. The patient population tends to be young and relatively healthy (apart from the brain injury), and the brain lesions found are relatively discrete and self limiting, especially in the absence of significant vascular or infectious complications and cerebral concussion. Such homogeneity of lesion type is not generally found in other brain damaged populations. Variables such as patient age, medical status, nature of neurological involvement and duration of disease present fewer problems in this patient population than in other brain damaged groups.

During and in the years following the First World War, the information gathered from research of this type was of considerable importance to the understanding of cerebral functioning. Poppelreuter (1917) contributed a great deal to the understanding of the visual cortex, and Kleist (1934) used clinical appraisals to comment upon localisation of function. Head (1926) made a detailed study of dysphasia in a group of missile injury subjects, and like Goldstein (1942) commented upon the differences between battlefield injuries and those resulting from tumour or vascular accident.

A description of the varied and lasting disorders of cognitive functioning attributed to missile injury, considering in particular disorders of language, visual-spatial ability and voluntary movement was presented by Luria (1963). He and his colleagues also looked at the problems of rehabilitation and restoration of function, and stressed the need to define the nature of the defects before proceeding with any retraining of World War II casualties.

In the USA, Teuber and associates conducted a series of experiments on a similar population, considering hemispheric differences and the precise measurement of group differences. Comparisons were made between the dimensions of locus of lesions and the dominant symptoms. Weinstein and Teuber (1957) used a sample of 62 service men who had retained penetrating brain wounds, and 50 controls. Pre-injury scores were available on the Army General Classification Test (AGCT). Appropriately nine years after being injured, the men were retested using the civilian form of the AGCT. The 62 brain injured subjects were subdivided into groups according to location of lesion. Only the left temporal and parieto-temporal groups were significantly inferior to the controls. When dysphasic subjects were excluded from the analysis, the left parieto-temporal groups still differed significantly from the controls. Teuber and Weinstein (1954) using a form-board task demonstrated the effect of right hemisphere wounds on spatial aspects of perception. Negative transfer was found in five of the six subjects with lesions in the right temporal lobe, whereas only three of the 28 subjects with lesions elsewhere showed a lack of spatial transfer. Teuber and Weinstein (1956) found that subjects with missile wounds to the brain were less efficient on a task involving the location of a geometric figure embedded in an abstract visual pattern. Teuber et al (1960) investigated visual field effects in this population and found evidence of incongruence in homonymous field defects and of subtle changes in visual function. Semmes et al (1963) considered and found abnormalities of certain aspects of personal orientation in space following missile injury to the brain.

One of the most extensive and important studies of penetrating missile wounds to the brain was carried out by Newcombe (1969). This study drew subjects from a pool of 1,000 men who had been treated at the Oxford Head Injury Centre. The majority of these men had received missile wounds to the brain during the last years of World War II. Full records of neurological and medical investigations, as well as follow up information, were available. Newcombe (1969) reported the effect of their injuries on cognitive functioning with specific reference to the investigation of hemispheric differences.

The appropriate sample group examined over two years consisted of 93 men with unilateral lesions, 53 left, 40 right and 34 with bilateral lesions. The presence or otherwise of symptoms was assessed during an initial interview prior to testing. Each hemisphere group was subdivided according to locus of lesion. The clinical groups were also matched for age and educational background: the control subjects were selected from among hospital patients and regular servicemen.

Newcombe used a variety of tasks covering a wide range of verbal and spatial abilities, as well as tests of general intelligence. The tasks used were grouped under five headings:

a. tests of intelligence and problem solving (verbal and non-verbal);

b. verbal tests involving the retrieval of familiar or well practised material;

c. verbal tests of immediate registration, of learning and recall;

d. visual pattern identification tasks; and

e. tests of spatial aptitude.

The results indicated evidence of selective cognitive impairment in subjects with unilateral cerebral lesions resulting from missile injury, but showed no indication of generalise intellectual deterioration. Performance on the measure of intelligence and problem solving did not differ from that of the controls. An association between left hemisphere damage and verbal impairment was found. The range of these verbal deficits, residual but consistent, included well practised linguistic skills as well as verbal learning and memory. These were often independent of clinically detectable aphasia. A relationship was found between right hemisphere damage and visual spatial deficits. There was evidence of dissociated deficits with this group in a visual perceptual and maze learning task. The results suggested, however, that, despite selective impairment in language, visual perception and spatial orientation, the general intellectual capacity of the experimental subjects was preserved. Newcombe's specific results can be understood in terms of Savage's Cognitive Impairment Model (SCIM), a general hypothetico-deductive yet practical model for measuring Cognitive Impairment suggested by Savage (1981, 1984), which is detailed in pages 7 to 10.

More recently, Black (1973a and b, 1974a and b) has investigated the effects of missile wounds to the brain in veterans of the Vietnam conflict. These studies have generally looked at the effects of these injuries on performance on standard measures of memory and intelligence. Again hinting at the level-learning distinction of Savage (1973).

Black (1973a) tested 50 subjects with penetrating missile wounds, and a matched sample of 50 subjects with closed head injury on the Wechsler

Adult Intelligence Scale (WAIS), Wechsler Memory Scale (WMS), and the Shipley-Hartford Scale. The results indicated that the degree of impairment as measured by these tests was significantly greater for the group with closed head injury. The results further indicated that brain-damage resulting in the localised lesions secondary to penetrating missile wounds do not necessarily lead to significant general intellectual level or the general memory impairment measured by these tests. Black (1973a), however, points out that his chosen measures may be inadequate to measure the neuropsychological effects of brain damage that is neither diffuse, nor of long duration.

Black (1973b) used the Wechsler Scale and a paired associate learning task with a group of young adult subjects with unilateral brain damage following a penetrating missile wound. The subjects were divided into left hemisphere damaged group and a right hemisphere damaged group. Subjects were matched for age, IQ, education and time since injury and size and location of lesion. A control group was also used. The results indicated that left hemisphere subjects had a mean performance significantly lower than that of the normal controls on the WMS and on both measures of paired associate learning. In contrast to this, the performance of the right hemisphere lesioned subjects did not differ significantly from that of the controls. In comparison of the two brain damaged groups, mean WMS scores and different paired associate learning performance was significantly lower in the left hemisphere damaged group. Black (1973b) points out this discrepancy in memory and new learning for the right and left hemisphere lesioned subjects is consistent with the results reported by Newcombe (1969).

Differential performance on the WAIS verbal and performance subtests by subjects with unilateral brain lesions (36 right hemisphere and 50 left hemisphere) has been reported by Parsons et al (1969). These were compared to 50 normal controls, and tested using the WAIS, WMS, and Shipley-Hartford Scale of Abstract Ability. As a group, the subjects with penetrating missile wounds showed no significant impairment of general intellectual ability, or verbal, visual-perceptual, attention, memory or abstract performance. There was a tendency for the right hemisphere lesioned subjects to perform less well in non-verbal measures than verbal measures, while the left hemisphere lesioned subjects showed the reverse pattern. The results also showed that right hemisphere lesioned subjects performed better in relation to left lesioned subjects on verbal measures but relatively less well on non-verbal measures. This difference did not, however, reach significance. Individual subjects within each sample did show both general and specific cognitive impairment. The incidence of these deficits tended to be higher in the left hemisphere lesioned subjects when compared to the right hemisphere lesioned subjects, and higher in posterior lesion subjects when compared to frontal lesion subjects. Deficits in abstracting ability tended to be most frequent while visual perceptual and verbal comprehension deficits were less frequent. These results were consistent with the earlier findings of Weinstein and Teuber (1957), Teuber (1962) and Newcombe (1969). They suggest only a small number of patients who sustain penetrating missile wounds to the brain show significant signs of cerebral impairment. However, the choice of general memory and somewhat aged impairment indices make this work less important than it seems. Memory should be broken down into verbal and performance, short term and long term, etc.

Black (1976) continued his investigation of subjects with penetrating missile wounds to the brain, by looking specifically at the question of differential impairment of cognitive functions in subjects with frontal lobe lesions. The study also considered the question of impairment in relation to laterality of the frontal lesions.

The results indicated no significant general cognitive impairment in subjects with unilateral frontal lobe lesions. Greater cognitive impairment was found in subjects with posterior lesions when compared with matched frontal lobe lesioned subjects. Patients with frontal lobe lesions showed normal performance levels on a variety of verbal and non-verbal intelligence memory and conceptual tests. The most frequently occurring problems in the patient samples were in sustaining attention and in conceptualisation. Individual and mean performance were also found to be generally consistent with estimated premorbid function based on educational background. In general, it was found that specific cognitive deficits were infrequent in subjects with frontal lobe lesions due to penetrating missile wounds, and no significant differential impairment of cognitive performance was associated with the hemisphere lateralisation of frontal lesions. It was also noted that no significant differential impairment of verbal and non-verbal performance was associated with side of the frontal lesion. These results are in agreement with those reported by Newcombe (1969) and Teuber (1962) which also reflect this relative lack of significant impairment with frontal lesions.

More recent work by Black (1975) and Black (1980) has considered Minnesota Multiphasic Personality Inventory (MMPI) performance, and WAIS Verbal Performance discrepancies in relation to lateralisation, respectively in patients with penetrating missile wounds to the brain. Black and Strub (1976) investigated constructional apraxia in this patient population.

Summary

The results of the studies reviewed here are remarkably consistent both with patients with recently sustained penetrating missile wounds (Black, 1973a and b, 1974a and b), and in those tested after a period of approximately 25 years (Newcombe, 1969). The studies generally show no indication of generalised intellectual level impairment deterioration in these patients as a whole, but there is evidence of selective impairment when locus of lesion is taken into account.

Those with posterior lesions tended to show greater cognitive impairment when compared to subjects with frontal lesions (Black, 1976).

As Newcombe (1969) pointed out, a strong association existed between left hemisphere damage and verbal impairment - which included well practised linguistic skills - as well as learning and memory. Right hemisphere damage seemed to be associated with visual-spatial deficits (Newcombe, 1969; Teuber and Weinstein, 1956). These results add further support to the distinction made in the SCIM (Savage, 1984) between level and learning by indicating the need to consider more than just current intellectual level performance when looking at cognitive impairment. The distinction made between Verbal and Performance modes is also supported by these results. More work on Verbal and Performance Learning abilities is needed.

Types Of Intellectual Impairment

There are basically three approaches to the measurement of Intellectual Impairment:

a. Normative Investigation - in the here and now;

b. Longitudinal Monitoring; and

c. Retrospective Estimation.

There are, however, several types of impairment related to the nature or structure of intellectual functioning.

Normative impairment relates to one's age or group position on standardised measures, usually recorded and assessed in terms of deviation IQ, Z score, percentile points, raw scores, standard errors of measurement, standard deviation and variance distributions or sets of criteria. Its type or form, accuracy, reliability and validity, however, depend on the definition of the appropriate intellectual process measures: Spearman's g or one of Guilford's 120 factors, speed of reaction or memory span, auditory, visual or motor responses.

Longitudinal monitoring is essential and should be done with all identified "clinical cases" or in occupational monitoring. There are, however, complex problems in defining statistically and clinically significant changes in scores. Readers are referred to an excellent introduction to these problems and their solutions in Nunnally (1977) and Meehl (1954). Reasonable, satisfactory techniques for profile analysis and comparison are available. "Clinical Intuition" and "personal magic" alone are not justified.

Retrospective estimation of intellectual impairment is a very different and very difficult task which has exercised the minds of many investigators of cognitive impairment since the beginnings of this century. Some significant developments have emerged. Early attempts to measure the clinically crucial "impairment" seen in many psychiatric and neurological patients are probably well known to you. The main formal measures were:

a. Babcock and Levy (1941);

b. Shipley-Hartford Test of Deterioration (Shipley, 1940); and

c. Hunt-Minnesota Test of Deterioration (Hunt, 1943).

The logic behind these measures of deterioration gives some indication of the way in which psychologists have tried to measure deterioration. In the Babcock-Levy, Shipley-Hartford and Hunt-Minnesota tests, there are two basic assumptions:

a. that vocabulary tests in normal people have a high correlation with other tests of general intelligence, and

b. that the test yielding the smallest mean difference between normal and psychotic or brain damaged groups is a vocabulary test.

It was concluded, therefore, that the present level of vocabulary of the psychotic or organically disordered is a good measure of his or her present intelligence. The discrepancy between the present IQ and the vocabulary score provides an indirect measure of deterioration. These methods, though having an element of truth in them, turned out to be less than satisfactory (Eysenck, 1960; Savage, 1984; Yates, 1954).

The fourth method of estimating intellectual impairment retrospectively is represented by the Deterioration Index (DI) and Deterioration Quotient (DQ) of the Wechsler Bellevue and later WAIS Intelligence Scales. Here the Deterioration Index was based on the assumption that certain sub-tests "hold up" and others "decline" with age. The approach assumes, in addition, that the deterioration produced by psychosis or brain damage can be identified with normal deterioration with age, except in respect of speed of onset. Several reviewers have been very critical of these assumptions and measures (Payne, 1960, 1971; Yates 1954) but the Newcastle work on cognitive impairment with the aged has cast some new light on their role (Savage, 1981; Savage et al, 1973, Savage and Adams, 1979).

A Level Deterioration Quotient (LDQ), was proposed by Savage for use with a short form of the WAIS and the assessment of Learning Ability was suggested in a Cognitive Impairment Model (SCIM) (Savage, 1978, 1981, 1984).

Most of the retrospective estimation methods in the Neuropsychological Test Batteries of Halstead, Reitan and Luria and their successors or derivatives are based on these assumptions. (Halstead, 1947; Kolb and Wishaw, 1985; Lezak, 1976; Luria, 1980; Reitan and Davison, 1974; Pendleton Jones and Butters, 1983).

Savage's Cognitive Impairment Model

An Initial Psychological Assessment Model for Missile Wounds to the Brain is suggested for Military Psychologists. SCIM in its most recent form (Savage, 1984) - by presenting a theoretical and practical framework to work within - could be very useful in this type of clinical practice and in any research investigation. It offers a model that allows for easier comparison of studies and could lead to a more appropriate standardisation of the procedure used. Each cognitive process investigated should have a level and learning measure. (See Figure 1).

The latest theoretical position presented here derives from the author's investigations and the reinterpretation of the empirical and theoretical positions referred to in Savage (1984). It now suggests a two dimensional Cognitive Impairment Model. This cognitive model (SCIM) includes:

a. Factors - Level and Learning; and

b. Processes - general, intelligence, memory, information processing in any of the Modalities - Verbal, Performance, Visual, Auditory and Kinesthetic (See Figure 1 on Page 9).

Furthermore, SCIM defines cognitive functioning and impairment in standard normative and ipsofactive terms. Methods of measuring these are presented in Table 1. The processes may well be hierarchical from 'g' to the Standardised Reaction Time (SRT).

Intellectual Level

Intellectual Level can be measured by a short form of the Wechsler Adult Intelligence Scale - Revised (WAIS-R). From this Full Scale IQ (FSIQ), Verbal IQ (VIQ) and Performance IQ (PIQ) can be assessed (Table 1).

Table 1

Savage's Cognitive Impairment Model
Measurement Techniques - Individual

INTELLECTUAL LEVELS

WAIS or WAIS-R Short Form (Wechsler, 1958; Savage et al, 1973; Savage, 1984)

General Level

FSIQ

$$3\ (VOC + C) + 5\ \frac{(BD + OA)}{2}$$

Verbal Level (V)
Vocabulary (VOC)
Comprehension (C)

$$VIQ = 3\ (VOC+C)$$

Performance Level (P)
Block Design (BD)
Object Assembly (OA)

$$PIQ = 5\ \frac{(BD + OA)}{2}$$

Normative Statements

LEVEL IMPAIRMENT

Level Deterioration Quotient (LDQ)

$$LDQ = 100\ \frac{(VOC - BD)}{VOC}\ \%$$

VIQ-PIQ Abnormality of Difference

LEARNING ABILITY

Verbal Learning (VL)

Modified Word Learning Test (MWLT)
(Walton and Black, 1957;
Savage et al, 1973)

Performance Learning (PL)

Block Design Learning Test (BDLT)
(Savage et al, 1973)

Normative Statements
VL/PL Discrepancy

Figure 1

Savage's Cognitive Impairment Model:
Factors/Processes

		PROCESS INTELLIGENCE	
FACTOR I Level	Verbal Intelligence Level	Level Impairment Level Deterioration Quotient V/P Discrepancy	Performance Intelligence Level
FACTOR II Learning	Verbal Intelligence Learning	Learning Impairment VL/PL Discrepancy	Performance Intelligence Learning

		PROCESS INFORMATION PROCESSING	
FACTOR I Level	Verbal Information Process Level	Level Impairment V/P Discrepancy	Performance Information Process Level
FACTOR II Learning	Verbal Information Process Learning	Learning Impairment VL/PL Discrepancy	Performance Information Process Learning

The Britton/Savage short form of the WAIS consists of vocabulary (VOC), and comprehension (C), verbal subtests and the block design (BD) and object assembly (OA) subtests of the performance scale published by Wechsler. It gives VIQ and PIQ as well as FSIQ representing the general, verbal and performance intelligence level measures by prorating and using the normal Wechsler manual procedures. A similar short form of Wechsler Intelligence Scale for Children - Revised (WISC-R), and Wechsler Preschool and Primary Scale of Intelligence (WPPSI), and the Bayley Scales can be used with children or severely handicapped Adults (Savage, 1981; Wechsler, 1949, 1963).

Two forms of intellectual level impairment appeared to represent deterioration or abnormality in level of intellectual functioning (LDQ), and V/P discrepancy. The LDQ, calculated 100 (VOC - BD)/VOC %, was found to be significantly related to Wechsler's DQ from the full WAIS (Wechsler, 1958) and identified as a sound measure of intellectual level impairment in several clinical conditions (Savage, 1978, 1981; Savage, et al, 1973). The V/P discrepancy used as an index of intellectual impairment by investigators such as Wechsler (1958) and Matarazzo (1972) becomes very useful if carefully interpreted in relation to age (Savage, 1978, 1981; Savage, et al, 1973). Very careful clinical interpretation is also necessary to identify the nature of the V/P discrepancy.

Intellectual Learning

The cognitive model proposed stresses the importance of both verbal and performance learning as vital aspects of intellectual functioning (Figure 1, Table 1). Verbal learning can be measured by the Modified Word Learning Test (MWLT) originally published by Walton and Black (1957), standardised for the aged by Bolton, Savage, and Roth (1967) and used with children by Savage (1965). The WAIS-R, WISC and WPPSI Vocabulary Scales can be used as well as the original Stanford Binet and WAIS Vocabulary Scales.

A measure of performance learning was developed by Savage et al (1973) and has been used with children, adults and the aged (English, et al, 1978; Savage and Adams, 1979; Savage et al, 1973).

After attempts to modify large numbers of measures for this purpose, it was found that the block design subtest of the WAIS, WISC and the WPPSI could be given as a performance learning measure. The Block Design Learning Test (BDLT), like the MWLT, makes allowances for the intellectual level of the individual in determining the difficulty of the learning task. From these two measures, learning impairment can be estimated with reference to the norms and the VL/PL Discrepancy scores.

The detailed series of multivariate analyses on which these orthogonal "Level" and "Learning" factors were identified are published in Savage et al (1973) and Savage (1978, 1984).

More recently, Savage (1982a and b, 1986a and b) has produced a series of Verbal and Performance Intelligence, Learning, Memory and Information Processing Tasks for individual and group administration. They are designated Alphabet Code Learning Tasks 5, 10, 15, 20: Shape Code Learning Tasks 5, 10, 15, 20: Alphabet Information Processing Tasks 5, 10, 15, 20 and Shape Information Processing Tasks 5, 10, 15, 20. These measures are consistent with the cognitive theory developments summarised in Baddeley (1976, 1982), Hunt (1980), Sternberg (1981) and SCIM. Verbal and Performance Learning, Short and Long Term Memory, Phonemic and spatial information processing can be assessed in terms of cognitive impairment in the verbal performance and other modalities.

Other intellectual process deficits which are hypothesised and which might need to be assessed are aphasia, language functioning, amnesia, specific memory losses, and psychomotor functioning. All work in this area should be performed on a "Hypotheses Testing" basis. Specific measures are recommended where the hypotheses to be tested are appropriate. For example, when a low verbal IQ and poor learning ability are diagnosed, one might test out a series of hypotheses on verbal short term and long term memory. Kimura's measure of short term verbal memory and Baddeley's measures of semantic memory may be administered. If PIQ is normal, but Performance Learning Ability impaired, measures of short and long term spatial and motor skills memory by Posner and Mitchell (1967) or Sternberg (1975) should be applied. In each case, level and learning aspects of the intellectual process should be measured.

References

Babcock, H., & Levy, L. (1941). Manual of directions for the revised examination for the measurement of efficiency of mental functioning. Chicago: Stoelting.

Baddeley, A.D. (1976). The psychology of memory (Harper International ed.). London: Harper & Row.

Baddeley, A.D. (1982). Implications of neuropsychological evidence for theories of normal memory. Phil. Trans. R. Soc. Lond., B298, 59-72.

Black, F.W. (1973a). Cognitive and memory performance in subjects with brain damage secondary to penetrating missile wounds and closed head injury. Journal of Clinical Psychology. 29, 4, 441-442.

Black, F.W. (1973b). Memory and paired associate learning of patients with unilateral brain lesions. Psychological Reports. 33, 919-922.

Black, F.W. (1974a). Cognitive effects of unilateral brain lesions secondary to penetrating missile wounds. Perceptual and Motor Skills. 38, 387-391.

Black, F.W. (1974b). The cognitive sequelae of penetrating missile wounds of the brain. Military Medicine. 139, 10, 815-817.

Black, F.W. (1975). Unilateral brain lesions and MMPI performance: A preliminary study. Perceptual and Motor Skills. 40, 87-93.

Black, F.W. (1980). WAIS verbal-performance discrepancies as predictors of lateralisation in patients with discrete brain lesions. Perceptual and Motor Skills. 51, 213-214.

Black. F.W. (1976). Cognitive deficits in patients with unilateral war-related frontal lobe lesions. Journal of Clinical Psychology. 32, 2, 366-372.

Black, F.W. & Strub, R.L. (1976). Constructional apraxia in patients with discrete missile wounds of the brain. CORTEX. 12, 3, 212-220.

Bolton, N.L., Savage, R.D., & Roth, M. (1967). The modified word learning test and aged psychiatric patient. British Journal of Psychiatry. 113, 1139-1140.

Caveness, W.F. (1963). Onset and cessation of fits following cranocerebral trauma. Journal of Neurosurgery. 20, 570-583.

Caveness, W.F. (1966). Post-traumatic sequelae. In W.F. Caveness and A.E. Walker (Eds.), Head Injury. (pp. 202-219). Philadelphia: J.B. Lippincott.

Caveness, W.F. (1976). Sequelae of cranial injury in the Armed Forces. In P. Vinken and G.W. Bruyn (Eds.), Handbook of Clinical Neurology. 24, 2, 455-476.

Credner, L. (1930). Klinische und soziale Auswirkungen Von Hirnschadigungen. Z. ges. Neurol. Psychiat. 126, 721-757.

English, A., Savage, R.D., Britton, P.G., Ward, M., & Kerr, D. (1978). Intellectual impairment in chronic renal failure. British Medical Journal. I. 888-890.

Eysenck, H.J. (Ed.) (1960). Handbook of abnormal psychology. London: Pitmans Medical Publications.

Goldstein, K. (1942). After-effects of brain injuries in war. London: Heinemann.

Halstead, W.C. (1947). Brain and intelligence: A quantitative study of the frontal lobes. Chicago: University of Chicago Press.

Head, H. (1926). Aphasia and kindred disorders of speech. Cambridge: Cambridge University Press.

Hunt, H.F. (1943). A practical clinical test for organic brain damage. Journal of Applied Psychology. 27, 375-386.

Hunt, E. (1980). Intelligence as an information processing concept. British Journal of Psychology. 71, 449-474.

Kleist, K. (1934). Gehim-Pathologie Bornehmlich auf Grund der Kriegserfahrungen. Leipzig: Barth.

Kolb, B., & Wishaw, I.Q. (1985). Fundamentals of human neuropsychology. (2nd Ed.). New York: Freeman & Co.

Lezak, M.D. (1976). Neuropsychological assessment. Oxford: Oxford University Press.

Luria, A.R. (1963). Restoration of function after brain injury. Oxford: Pergamon Press.

Luria, A.R. (1980). Higher cortical functions in man (2nd Ed.). New York: Basic Books.

Matarazzo, J.D. (1972). Wechsler's measurement and appraisal of adult intelligence (5th Ed.). Baltimore: Williams & Wilkins.

Meehl, P.E. (1954). Clinical vs statistical prediction: A theoretical analysis and a review of the evidence. Minneapolis: Minnesota University Press.

Newcombe, F. (1969). Missile wounds of the brain: A study of psychological deficits. London: Oxford University Press.

Nunnally, J.C. (1977). Psychometric Theory. New York: McGraw Hill.

Parsons, O., Vega, A., & Burn, J. (1969). Different psychological effects of lateralised brain damage. Journal of Consulting and Clinical Psychology. 33, 551-557.

Payne, R.W. (1960). Cognitive abnormalities. In H.J. Eysenck (Ed.) Handbook of abnormal psychology (Ch. 6). London: Pitmans Medical Publications.

Payne, R.W. (1971). Cognitive abnormalities. In H.J. Eysenck (Ed.) Handbook of abnormal psychology (2nd Ed.) (Ch. 14). London: Pitmans Medical Publications.

Pendleton Jones, B., & Butters, N. (1983). Neuropsychological assessment. In Herson, Kazdin & Belak (Eds.) The clinical psychology handbook. Oxford: Pergamon Press.

Poppelreuter, W. (1917). Sie psychischen Schadigungen dusch Kipfsschuss in Kriege 1914-1916: die Stoningen der niederen und usheren Sehleistungen durch Verletzungen des Okzipitalhisis. Leipzig: Voss.

Posner, M.I., & Mitchell, R. (1967). Chronometric analysis of classification. Psychological Review. 74, 392-409.

Reitan, R.M., & Davison, L.A. (Eds.) (1974). Clinical neuropsychology: current status and applications. New York: Wiley.

Russell, W. (1951). Disability caused by brain wounds. Journal of Neurology, Neurosurgery and Psychiatry. 14, 35-39.

Savage, R.D. (1973). Old Age. In Eysenck, H.J. (Ed.) Handbook of abnormal psychology (Rev. Ed.). London: Pitmans Medical Publications.

Savage, R.D., Britton, P.G., Bolton, N., & Hall, E.H. (1973). Intellectual functioning in the aged. London: Methuen.

Savage, R.D. (1978). Intellectual impairment in the elderly. In L. Evans (Ed.) Geigy psychiatric symposium on psychogeriatrics (pp. 31-35). Brisbane: University of Queensland Press.

Savage, R.D., & Adams, M. (1979). Cognitive functioning and neurological deficit. Australian Psychologist. 14(1), 59-75.

Savage, R.D. (1981). Intellect, personality and adjustment in the aged. In R. Lynn (Ed.) Dimensions of personality. Oxford: Pergamon Press.

Savage, R.D. (1982a). Alphabet code learning tasks. Perth: Murdoch University.

Savage, R.D. (1982b). Shape code learning tasks. Perth: Murdoch University.

Savage, R.D. (1984). Cognitive theory, cognitive impairment and clinical practice. Australian Psychologist. 19, 2, 163-177.

Savage, R.D. (1986a). Alphabet information processing task. Perth: Murdoch University.

Savage, R.D. (1986b). Shape information processing tasks. Perth: Murdoch University.

Semmes, J., Weinstein, S., Ghent, L., & Teuber, H.L. (1963). Correlates of impaired orientation in personal and extrapersonal space. Brain. 86, 747-772.

Shipley, W.C. (1940). A self administering scale for measuring intellectual impairment and deterioration. Journal of Psychology. 9, 371-377.

Sternberg, R.J. (1975). Memory scanning: New Findings and Current Controversies. Quarterly Journal of Experimental Psychology. 27, 1-32.

Sternberg, R.J. (1981). Testing and cognitive psychology. American Psychologist. 36(10) (Special Issue), 1181-1189.

Teuber, H.L. (1962). Effects of brain wounds implicating right or left hemisphere in man. In V.B. Mountcastle (Ed.) Interhemisphere relations and cerebral dominance (pp. 131-157). Baltimore: The John Hopkins Press.

Teuber, H.L., Battersby, W.S., & Bender, M.B. (1960). Visual field defects after penetrating missile wounds of the brain. Cambridge Mass.: Harvard University Press,

Teuber, H.L., & Weinstein, S. (1954). Performance on a formboard-task after penetrating brain injury. Journal of Psychology. 38, 161-175.

Teuber, H.L., & Weinstein, S. (1956). Ability to discover hidden figures after cerebral lesions. Archives of Neurology and Psychiatry. 76, 369-379.

Walton, D., & Black, D.A. (1957). The validity of a psychological test of brain damage. British Journal of Medical Psychology. 30, 270-279.

Wechsler, D. (1949). Wechsler intelligence scale for children. New York: Psychological Corp.

Wechsler, D. (1958). The measurement and appraisal of adult intelligence (4th ed.). Baltimore: Williams & Wilkins.

Wechsler, D. (1963). The wechsler preschool and primary school scale of intelligence. New York: Psychological Corp.

Weinstein, S., & Teuber, H.L. (1957). Effects of penetrating brain injury intelligence test scores. Science. 125, 1036-1037.

Yates, A.J. (1954). Validity of some psychological tests of brain damage. Psychological Bulletin. 51, 359-379.