

## REVIEW

# The clock-drawing test

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## Introduction

The clock-drawing test is used for screening for cognitive impairment and dementia and as a measure of spatial dysfunction and neglect. It was originally used to assess visuo-constructive abilities but we know that abnormal clock drawing occurs in other cognitive impairments. Doing the test requires verbal understanding, memory and spatially coded knowledge in addition to constructive skills [1]. Education, age and mood can influence the test results, with subjects of low education, advanced age and depression performing more poorly [2–4].

## Different ways of performing the clock-drawing test

Clock drawing can be performed in different ways and the scoring also varies. The subject is presented with a white paper with the instructions to draw a clock. There is no time limit. In the free-drawn method, the subject is asked to draw a clock from memory. In the pre-drawn method, the subject is presented with a circular contour and is expected to draw in the numbers on the clock face. Sometimes the subject is asked to draw the hands at a fixed time, often 10 past 11, but in many cases the hands are excluded. In still another method the subject is asked only to set the hands at a fixed time on a pre-drawn clock, complete with contour and numbers (Table 1).

Clock drawing using the free-drawn method with the subject drawing the hands at a fixed time is part of the Short Test of Mental Status [5]. In the clock test [6], clock drawing is combined with clock setting and clock reading. This combined test requires little extra time or effort to administer and is more sensitive and specific than clock drawing alone in differentiating normal elderly people from those with Alzheimer's disease, using the American Psychiatric Association Diagnostic and Statistical Manual of the Mental Disorders, 3rd edition, revised [7] and NINCDS-ADRDA criteria [8].

The scoring varies greatly from a simple nominal scale (right/wrong) to detailed 22- and 31-point scoring (Table 1 [4–6, 9–19]).

The various ways of presenting the test and the different principles involved in scoring make comparisons difficult, although some scoring systems are highly intercorrelated [2, 3, 14]. For a quick screening of cognitive status, the method of Watson *et al.* [17] can be recommended, not because it is much better than the others in terms of sensitivity and specificity, but because of its simplicity. The subject is instructed to draw numbers within a pre-drawn circle 10 cm in diameter to make that circle look like the face of a clock. After completion, the clock face is divided into quadrants by drawing one line through the centre of the circle and the number 12 and a second line perpendicular to the first line. The number of digits in each quadrant is counted. If a digit falls on the reference line, it is included in the quadrant that is clockwise to the line. The placing of any three digits in a quadrant is considered to be correct. An error score of one is assigned for each of the first three quadrants containing any erroneous number of digits and an error score of four is assigned for the fourth quadrant if it contains an erroneous number of digits. Thus a maximum error score of seven can be obtained. The normal range for the score is 0–3. A score of 4 or greater in this scoring system has a sensitivity of 87%, a specificity of 82% and a  $\kappa$  value of 0.70 for identifying dementia (according to the NINCDS-ADRDA criteria [8] for probable dementia [17]).

## Dementia

Visuo-spatial deficits are a common and early sign of dementia, and the clock-drawing test has been suggested as a valuable tool for screening [3]. Clock drawing (with a score range of 1–5) is strongly correlated [9] with the Mini Mental State Examination (MMSE) [20] in patients with various cognitive dysfunctions. In elderly medical and surgical patients,

Table 1. Ways of performing the clock-drawing test and scoring systems

Scoring Maximum .....	Normal limits .....	Circle		Time shown	Patient population	Reference
		Pre-drawn	Circle			
10	≥6	No		Yes	Alzheimer's, controls	Sunderland <i>et al.</i> , 1989
20	≥19	No		Yes	Alzheimer's, controls	Mendez <i>et al.</i> , 1992
4	≥3	Yes		No	Stroke	Ishai <i>et al.</i> , 1993
7	≤3	Yes		No	Geriatric outpatients + others	Watson <i>et al.</i> , 1993
6	6	No		Yes	Alzheimer's	Shua-Haim <i>et al.</i> , 1996
5	≤1	Yes		Yes	Demented, depressed, controls	Shulman <i>et al.</i> , 1986 <sup>a</sup>
10	≥7	Yes		No	Alzheimer's, controls	Wolf-Klein <i>et al.</i> , 1989
Nominal scale; normal-impaired		Yes		No	Stroke	Friedman, 1991
22	22	No		No	Alzheimer's	Förstl <i>et al.</i> , 1993
31	≥3	Yes		Yes	Alzheimer's, controls	Tuokko <i>et al.</i> , 1992
4	≥3	Yes		No	Acute somatic patients	Death <i>et al.</i> , 1993
10	≤7	Yes		Yes	Somatic and demented patients	Manos and Wu, 1994
Nominal scale; normal-impaired		No		No	Stroke, diffuse cerebral damage	Halligan <i>et al.</i> , 1989;
2	2	No		Yes	Alzheimer's, controls	Schenkenberg <i>et al.</i> , 1980 Kokmen <i>et al.</i> , 1991

<sup>a</sup>Shulman also has a modified scoring system where a score >2 is abnormal

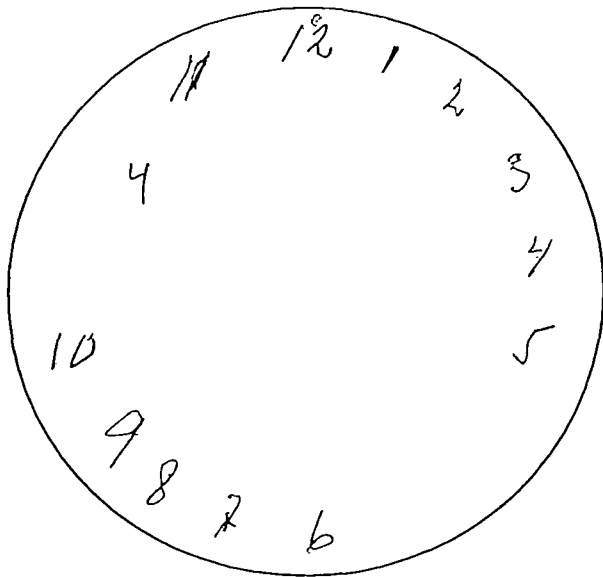


Figure 1. A clock-drawing test with a pre-drawn circle 10 cm in diameter performed by a 76-year-old woman with Alzheimer's disease. Her Mini Mental State Examination score was 17, she belonged to Katz index grade E [33] and was classified as severity class 3 (needs direction to function but can respond appropriately to instruction) on the Berger scale [34]. She had seven error scores according to the method of Watson *et al.* [17].

clock drawing (score range 1–4) also correlates significantly with the MMSE [11]. Clock drawing (score range 1–31) could correctly classify 86% of patients with Alzheimer's disease and 92% of elderly controls [6] in an outpatient clinic. In both outpatients and hospitalized patients with and without dementia, the test (score range 1–10) could correctly classify 77% of patients with Alzheimer's disease, 89% of patients with multi-infarct and mixed dementias and 78% of normal elderly people [4]. There have been fewer clock-drawing studies in patients with vascular dementia than in patients with Alzheimer's disease [4, 12]. Patients with vascular dementia, diagnosed by the Hachinski ischaemic scale [21], the Dementia Rating Scale [22] and the MMSE, made more errors in spacing, while patients with Alzheimer's disease showed a wider variety of errors (score range 1–10) [12]. In cases of very mild Alzheimer's disease, the clock-drawing test (score range 1–10) can be normal [23]. The sensitivity of the test thus may vary according to the level of cognitive impairment [23].

In a study of poorly educated people, Ainslie and Murden [2] found that the value of the test as a single screening instrument for dementia was questionable. In that study three different scoring systems were used—those of Shulman *et al.* [9] (score range 1–5), Sunderland *et al.* [13] (score range 1–10) and Wolf-Klein

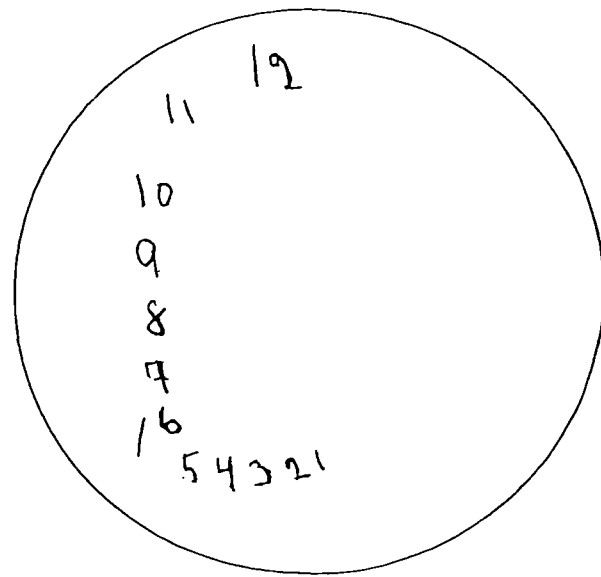


Figure 2. A clock-drawing test with a pre-drawn circle 10 cm in diameter performed by a 79-year-old woman with vascular dementia. Her Mini Mental State Examination score was 19, she belonged to Katz index grade C [33] and was classified as severity class 4 (needs assistance to function and cannot respond to direction alone) on the Berger scale [34] and did not show any clinical signs of neglect. She had seven error scores according to the method of Watson *et al.* [17].

*et al.* [12] (score range 1–10). The scoring method of Wolf-Klein *et al.* was least affected by education and maximized specificity but it had a low sensitivity. On the other hand, Ferrucci *et al.* [24] found the clock-drawing test (score range 1–10) to be a sensitive and specific tool for the detection of patients with mild cognitive impairment as diagnosed with the MMSE and the Dementia Rating Scale [22].

The test (score range 1–5) can be used during follow-up as a sensitive measure of deterioration of dementia [25], diagnosed using the MMSE and the Short Mental Status Questionnaire [26]. Examples of the test are shown in Figures 1 and 2.

## Neglect

Constructional apraxia may occur with lesions in either the left or right parietal lobe, although it is more frequent after right parietal damage [14]. It can also be observed early in the course of Alzheimer's disease [14]. The clock-drawing test correlates strongly with tests of constructional apraxia and to a global deterioration scale [10].

The clock-drawing test is a part of a visual neglect battery of six pencil and pen tests from the Behavioural Inattention Test [27]. Many authors [19, 28–32] have

used other tests beside clock drawing to diagnose neglect as there is no accepted standard for the measurement of neglect [28].

Clock drawing has been used as a diagnostic measure of unilateral spatial neglect, with neglect patients omitting numbers halfwise, with or without transposition of the numbers from the neglect side to the other, or demonstrating inattention to parts of the spatial layout of numbers [15, 16]. A problem with using the test as a diagnostic measure is that visuo-constructive dysfunction and other signs of cognitive dysfunction may interfere, and that patients with demonstrated neglect may show no impairment or only slight impairment in clock drawing. In one study of stroke patients with left-sided neglect (as judged from results of the line cancellation test, the line bisection test and the copying of a daisy), clock drawing did not correlate significantly with the other tests [15]. In another study, only one-quarter of patients with stroke and with impaired clock drawing demonstrated neglect of one side of the clock [16]. It has therefore been recommended that the test not be used as a measure of visuo-spatial neglect [15]. Verbal intelligence may compensate for left unilateral spatial neglect, thereby resulting in a false negative outcome [15].

Clock drawing might be a valuable test in focal brain damage with the characteristic deficits associated with a particular lesion location, but this requires confirmation [1].

## Conclusions

The clock-drawing test is a good screening test for dementia and cognitive dysfunction with the possible exception of cases of very early Alzheimer's disease. The test has a high correlation with the MMSE and other tests of cognitive dysfunction. Its value in diagnosing unilateral neglect and focal brain damage requires further study. It is easy to administer, is not threatening to the patient and takes very little time. It is easy to document graphically in clinical records and it can be used to document deterioration over time in dementia patients. Normal clock-drawing ability reasonably excludes cognitive impairment.

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## Key points

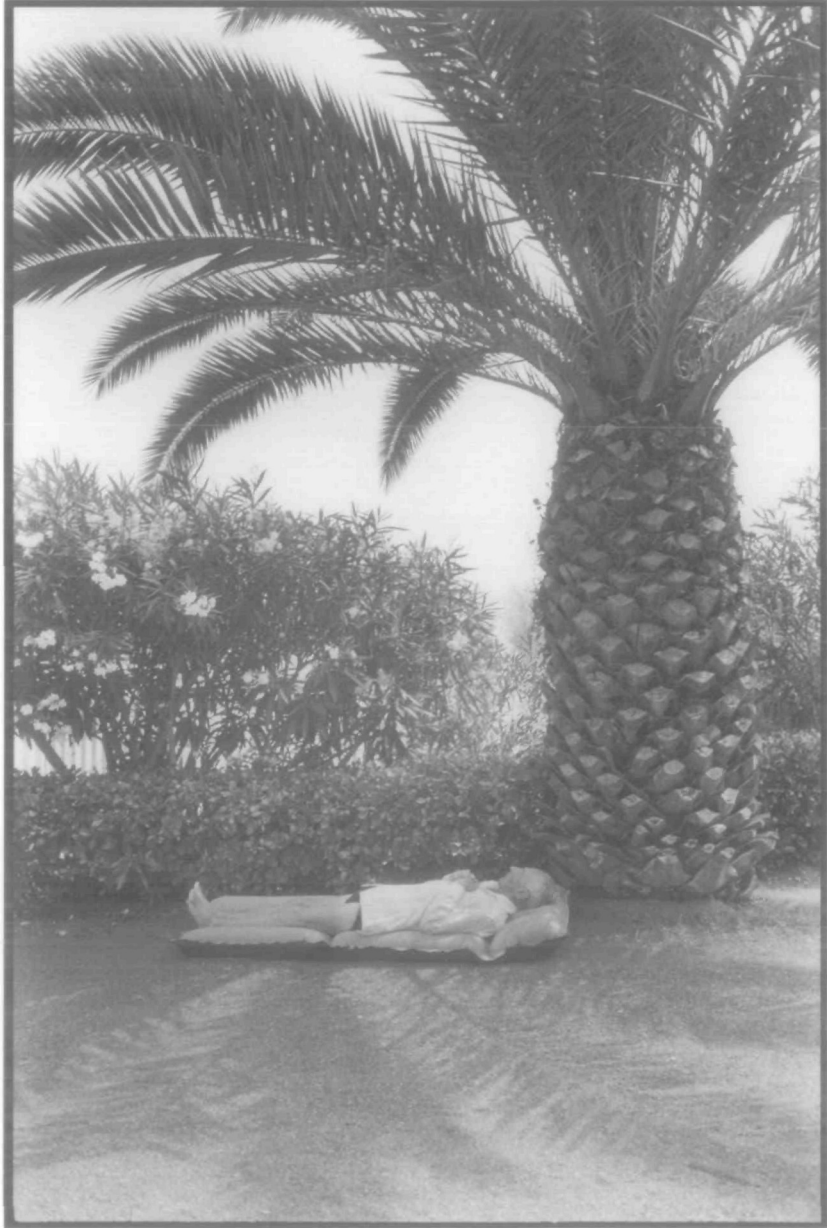
- The clock-drawing test is a good screening test for dementia and cognitive dysfunction: normal clock-drawing ability reasonably excludes cognitive impairment.
  - It is easy to administer, is not threatening to the patient, takes very little time, is easy to document graphically in clinical records and can be used to document deterioration over time.
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