Updated Guidance on the use of the Symbol Digit Modalities Test (SDMT)

The SDMT, although in wide use, is a very old and weakly standardised test (in adults) and there are concerns about the use and interpretation of this test. The test manual does not offer the normative information (e.g. standardised scores) now expected for assessment tests. In November 2015 the SpLD Test Evaluation Committee (STEC) conducted a review of the test with a view to providing updated guidance to assessors on the strengths and limitations of the use of the test in the diagnostic assessment of adults with specific learning difficulties such as dyslexia and dyspraxia.

Test	**SYMBOL DIGIT MODALITIES TEST (SDMT)**
Author	Aaron Smith
Publisher Date published	Western Psychological Services First published **1973**
What it tests	The test is described in the manual as a measure for **screening cerebral dysfunction** in children and adults. It is designed to tap into the ways in which both the left and right hemispheres of the brain **integrate** the interpretation of visual-spatial, spatial-constructional and nonverbal reasoning functions with language processing i.e. processing of meaningful verbal symbols, including numbers. The SDMT is often thought of and described as a test of visual-spatial processing and/or of 'information processing'. In fact, the author claims that the hemispheric *integration* of visual **and** verbal processing abilities is tapped in this test. Substitution tests such as the SDMT and the similar WAIS IV UK Coding test are widely used by assessors in many clinical settings but one of the key problems in interpreting the results of these tests is in determining exactly which, or which combination, of many possible factors (attention, reaction time, motor execution, incidental learning, visual-spatial memory, working memory, visual acuity, oral fluency and executive functioning), could have contributed to scores obtained. **There is little agreement or clarity as to what this test or similar substitution tests such as the (closed) WAIS IV UK Coding test actually measure[1].** The SDMT can be administered orally and/or in written form. The SDMT requires the examinee to substitute a number, either orally or in writing, for randomised presentations of geometric figures. The written test can be used alone but where an examinee obtains a score of 1.5 SD below the mean or lower on the written test, it is recommended that the oral test be administered for comparative purposes. The SDMT manual has been reprinted many times (now in its 13th edition). P.3 of the latest manual describes an error in the 7th, 8th and 9th printings which altered the administration instructions for when the oral version of the SDMT is given as a retest shortly after the written version of the test. In the earlier instruction, the examinee began with the first practice item, thus including the

[1] Coding on the WAIS IV UK is described as a core Processing Speed subtest. Using a key, the examinee copies symbols that are paired with numbers within a specified time limit. In addition to processing speed, the manual reports that the subtest measures short-term visual memory, learning ability, psychomotor speed, visual perception, visual-motor coordination, visual scanning ability, cognitive flexibility, attention, concentration and motivation. It may also involve visual sequential processing and fluid intelligence.'

	10 practice items in the oral retest. In the later printings, the instruction was then changed to say that the examinee should begin with the first item following the 10 practice items, thus eliminating these first practice items from the oral retest. The manual now advises following the **original** standardisation procedure for the oral sub-test (i.e. beginning with the first practice item, thus including the 10 practice items in the administration) although it recognises that the consequences of having a pool of 120 versus 110 items in the oral retest may lead to questions about the reliability and validity of scoring cutoff values, e.g. at what point a score obtained becomes a 'below average' score. In referencing this test, assessors are advised to cite 1973 as the original date of publication but should also include which re-printing of the test was used. The manual suggests that comparisons between performance on the written and oral forms of the test can indicate possible areas of deficit or dysfunction such as manual motor skill or writing difficulties, speech disturbances, visual acuity, dyslexia, and/or other learning difficulties. However, **it does not elaborate upon *how* to interpret test results to indicate these possible and variable areas of deficit and to distinguish them from the many other possible forms of 'cerebral dysfunction' which, it is claimed, the test can assist in identifying or confirming.**
Age range	Children 8-17, Adults 18-78
Cost	The test is available from a variety of test distributors in the UK, including Ann Arbor, Hogrefe and Dyslexia Action. Cheapest prices available at time of review: £89.00 for full test kit. £43.00 for a pack of 25 test forms.
Standardisation	No date for the full standardisation is given in the manual although the test was first published in 1973. At a rough estimate therefore, the standardisation data is approximately **40+ years old**. There are many subsequent reported studies of the re-standardisation or use of the SDMT on clinical and 'normal' populations, including a huge re-standardisation study (Kiely, Butterworth, Watson, Wooden, 2014) of 14.456 Australians, but the updated norms from these studies are not available to UK assessors and have not been incorporated into published revisions of the test manual. There was **no SpLD specific sub-group** in the original standardisation sample. In adults, the norms for adults are based on apparent 'samples of convenience' i.e. are not randomised**.** Adult sampling consisted of volunteers although the final samples obtained were then stratified by age and two education levels. While reasonably sound reliability studies were conducted in the original standardisation, validity studies are substantially weaker, especially in regard to **content validity, i.e. how well the test measures all facets of the skills it purports to test.** This is because the **multiple skills** involved in successful completion of this test are not differentiated, examined or investigated in detail in the standardisation of the test. The issue is not really addressed in the manual apart from reporting one small study of patients with right or left hemispheric brain damage. In this study, there were no significant differences in the scores of patients with either left or right brain hemispheric damage, (lending support to the hypothesis that the test taps bilateral processing) although the mean scores for these groups were markedly subnormal.

	It is possible to view 'processing' as the integration of multiple cognitive skills which, by definition, are not amenable to differentiation or elucidation. Inaccurate or slower processing can be viewed as a comparative weakness in this integrative process. However, it is also possible that poor performance on either the written or oral version of the SDMT could be the result of a single area of weakness, e.g. in working memory, in motor coordination or in oral fluency. Other cognitive skills may be 'integrating' normally. Moreover, it is unlikely that performance on substitution tests taps cognitive processes alone: personality may also play a role. For example, an anxious person may check and recheck a response before moving on to the next item, slowing performance. **Criterion validity,** i.e. how far scores obtained by someone on the SDMT will predict performance in real-life situations or distinguish individuals with different clinical attributes, is also weakly addressed in the original standardisation with regards to specific learning difficulties. The manual reports **no studies at all** of the use of the SDMT in identifying children or adults with dyslexia or dyspraxia although it claims, (p.11) that 'Studies provide evidence of the utility of the SDMT in the identification of children and adults with various types of brain dysfunctions and **with learning and language problems.**' The WAIS IV UK manual, not open to specialist assessors, reports strong test re-test reliability measures for the Coding sub-test, a similar test to the SDMT. Unfortunately, in the manual, there is no comparative validity correlational study of the WAIS IV UK Coding sub-test and the SDMT, which could help establish confidence in the original standardisation of the SDMT. However, the manual does report a comparison of performance on the WAIS IV UK Coding subtest for individuals diagnosed with a **reading disorder** and a matched control group. In this study, differences in performance are statistically significant, as they are with a similar study comparing individuals with a **mathematics disorder** with a matched control group and with those with **ADHD/ADHD** and a matched control group. In a study by Morgan (1992), not reported in the manual (see references below), 45 persons aged 19–74 yrs referred for neuropsychological evaluation were administered both the Symbol Digit Modalities Test (SDMT) and the Digit Symbol (DS) subtest of the Wechsler Adult Intelligence Scale (WAIS). SDMT and DS scores correlated very highly (r=.91). Relative to the tests' normative populations, however, the SDMT yielded scores for individuals that were the equivalent of 4–5 WAIS age-scaled points lower than obtained DS age-scaled scores. Results indicate that SDMT and DS scores cannot be presumed to be directly interchangeable in clinical use. These studies suggest that substitution tests ***are*** sensitive to the underlying cognitive difficulties associated with specific learning difficulties. However, they do not necessarily assist in pinpointing the precise underlying cognitive processes which might be associated with specific learning difficulties. Small but significant differences in design between the tests (for the SDMT, the examinee writes the number, whereas for the Coding/DS test, the examinee writes the symbol- possibly a less automatic and more onerous task) can affect typical performance.

Advantages of the SDMT:	1. It is a relatively inexpensive test which is quick to administer. It is open to specialist assessors. 2. There is no similar test open to specialist assessors. 3. Observation of performance on the written or oral tests combined with a very low score could lend weight to **evidence elsewhere in an assessment** of difficulties in fine motor skill and/or a wide range of other cognitive impairments. Assessors are advised to investigate possible patterns of weaknesses **across a range of tests**.
Disadvantages of the SDMT:	1. Low scores could be the result of impairment in a **number of domains** such as attention, concentration, reaction time, motor execution, incidental learning, visual-spatial memory, visual scanning ability, working memory, visual acuity, oral fluency and executive functioning. Performance in combinations of some of these domains may be regarded by some as aspects of intelligence. However, it is very difficult or impossible to interpret the results of this test to suggest which or which combinations of the specific impairments listed above may be influencing weak scores. Assessors should therefore exercise caution in describing and reporting the results of this test. While it is understandably easier, when describing this test, to conflate these differing cognitive processes into a general term such as 'information processing' or 'processing speed' it is also possible that impaired performance on this test might be entirely attributable to just one factor, e.g. motor execution skill. For example, it is noted in the manual that **left-handers** may obtain lower scores on the written test but this is not accounted for in the norming of the test, i.e. there are no separate norms for left-handers. It would therefore be erroneous to assert, on the basis of weak performance on this test alone, that the examinee is likely to experience impairment in **all** aspects of 'information processing.' 2. There appears to be no research evidence which can tell us anything about how the performance of a non-SpLD sample of adults on the SDMT compares to a SpLD sample. 3. A study of 14,456 Australians given the SDMT found that **age, gender, and education** were all significantly associated with SDMT performance, as was **poor health**, and **cultural background**. (Kiely, Butterworth, Watson, Wooden, 2014). This supports a conclusion that **the original SDMT was inadequately standardised**, since, in adults in the original standardisation, only age and two broad levels of education were significantly associated with performance. Assessors may be wrongly attributing poor performance on the SDMT to a range of cognitive/motor factors when they might be equally well explained by factors not properly assessed in the original standardisation such as gender, poor health and cultural background.

	4. **No standardised scores are given in the manual.** Circulating amongst assessors is a '**conversion table'** to standardised scores[2]. STEC is concerned about the basis on which the apparent extrapolation of standardised scores was made. For example, the manual (p.6) states that a written score of 37 or below would be 1.5SD below the mean for a 40 year old with a college education. However the circulating conversion table gives a written score of 42 as 1.5SD below the mean for a 40 year old with a college education. STEC recommends reporting scores as presented in the manual, i.e. as distances, in standard deviations, from the mean, for the relevant age group / level of education or as standardised score range equivalents. For example, a raw score falling between -1.0SD and -1.5 SD below the mean could be reported as a standardised score of 85-78.
Summary	There is a limit to the useful diagnostic information this test can give. Very low scores are obviously of concern but what exactly they indicate is problematic. Interpretation of test results should therefore be treated with great caution. ***Observation of performance*** on the written test could give some useful information about motor skill difficulties if an examinee is clearly struggling to write numbers clearly and quickly in the boxes provided. A very high number of errors on the written or oral test, particularly in recognising symbol reversals, would also be worth reporting since errors ***might*** indicate underlying difficulties in scanning, visual perception, working memory etc. **However, because of the difficulties in test validity noted above, this test should never be used as a single diagnostic criterion for identifying a SpLD in adults. Performance on this test should be interpreted with extreme caution and should always be interpreted in conjunction with patterns of strength and weakness across a range of other tests.**

References:

Kiely, Butterworth, Watson, Wooden, (2014) **The Symbol Digit Modalities Test: Normative Data from a Large Nationally Representative Sample of Australians**. Arch Clin Neuropsychol (2014) 29 (8): 767-775 first published online October 28, 2014

Morgan (1992) **Digit Symbol and Symbol Digit Modalities Tests: Are They Directly Interchangeable?** Neuropsychology (Impact Factor: 3.27). 09/1992; 6(4):327-330.

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[2] This table originated from Dyslexia Action but was apparently withdrawn several years ago. It should no longer be used.