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WISCONSIN CARD SORTING TEST

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Introduction

The Wisconsin Card Sorting Test (WCST) is a test of abstract abilities and "shift set" used for both normal and brain-damaged individuals. The test focuses on learning strategies for color, form, and number sorting.

The WCST was developed originally to assess complex cognitive strategies in normals. Unfortunately, numerous versions of the test have been and are currently available, and as a consequence standardization and normative information has been relatively difficult to obtain. Each laboratory or clinic has developed specific administration methods aided with local norms.

According to Heaton (1981), variations have existed according to 1) response cards and deck sizes; 2) order of cards within decks; 3) use of a card-sorting tray; and 4) criteria for shifting sorting strategies, number and order of sorting, categories, and criteria for test completion. In addition, Heaton reports numerous variations for scoring the WCST, including 1) overall measures of success, 2) measures of perseverative tendencies, and 3) measures of nonperseverative sources of error. Individuals responsible for the early WCST versions include E. A. Berg, David A. Grant, Brenda Milner, Ralph Tarter, and Hans Teuber. Of these, Berg (1948) is credited with the first version of the WCST, which she based on Harry Harlow's Wisconsin General Test Apparatus (Harlow, 1959). Harlow used the apparatus to examine learning set problems, as well as reversible shifts in learning strategies. This apparatus has since been adopted to test memory and visual perception abilities in both monkeys and humans.

The current version of the WCST is authored by David A. Grant and Esta A. Berg. The new manual is authored by Robert K. Heaton of the University of Colorado. A standardization sample of 208 inpatients with brain disorders and 150 normal controls were used with the latest version. Approximately half of the brain-damaged group had focal frontal lesions, whereas the other half had nonfrontal lesions. The controls were paid volunteers with no central nervous system dysfunction. The use of specific test protocols with substantial normative information clearly provides the most significant psychometric advancement of the test to date.

No other forms of the tests are currently available from the publisher. However, versions of this test can be relatively easily adapted to sensory-impaired (including hearing-impaired) populations. All that is needed for this test to be adapted for use

with other populations is a translation of verbal instructions. Although cross-cultural norms would assist in the adaptation of the WCST to other cultures, its relative culture-free nature makes such norms useful but not necessary.

The test is comprised of response cards and a scoring and recording form. There are 128 cards divided into two identical decks of 64 cards each. Each card has one to four figures (plus sign, star, circle, or triangle) in one of four colors: red, green, yellow, or blue. On the back of each card is a number that identifies the standard order in which the stimuli should be presented. According to the test manual (p. 19), "no two response cards in succession have the same color, form or number." In addition to the two decks of response cards, four stimulus cards are also provided. A one-page scoring and recording form allows the examiner to record demographic and response data. The response portion is subdivided into seven columns containing space for recording 128 responses. Each item on the response form is labeled C (color), F (form), N (number), and O (other). The materials are housed in a sturdy 8³/₄" x 11¹/₄" cardboard box.

This test is designed to be administered to adults. Furthermore, there is a strong indication that age is related to WCST scores. Strong positive correlations were found by Heaton (1981) between age and total errors, perseverative error, percentage of perseverative errors, and perseverative responses for both normal and brain-damaged subjects. Statistically significant negative correlations were observed between age and categories achieved and percentage of conceptual level responses. Presumably in anticipation of these findings, Grant and Berg (1948) provided simplistic instructions for the administration of the WCST to children. It is important, nevertheless, to note that the mean normative age for normals in the Heaton sample was 35.9 and for brain-damaged individuals 42.1; thus, adequate norms for children are not yet available. The test is designed so that a variety of difficulties are presented to the subject; however, education and full scale IQ are generally negatively correlated with the WCST measures. Therefore, the achievement of basic sorts or categories may be difficult for low-functioning individuals.

Practical Applications/Uses

The WCST is an instrument widely applicable to the study of conceptual ability, or "learning to learn." One would expect the test to be of use in a wide variety of settings, including private practice, mental-health centers, hospitals, and educational settings. Although there are no restrictions to its use, it is probably most applicable to the understanding of cognitive issues in individuals suspected of brain dysfunctions. Numerous mental-health professionals may find the WCST of use, but it has been developed for those with neuropsychological interest, especially those focusing on frontal-lobe dysfunction. The WCST could be used in the diagnosis of dysfunction due to neural complication in general, as well as in following progress in rehabilitation efforts. One application that warrants more attention is the use of the WCST to assess cognitive dysfunction in schizophrenics where it perhaps could be used to provide not only diagnostic data, but prognostic data. Of added interest with this population is the use of the WCST to determine changes of cognitive abilities due to neuroleptic drug treatment. In addition, the use of the WCST with the learning-disabled populations should also be explored

because the specific ability of this test to measure "learning to learn" provides a useful tool for assessing learning disabilities.

According to Heaton (1981), the WCST was developed to assess cognitive abilities in general and abstraction and learning strategies in particular. Six specific variables purport to measure these factors: correct (total number of correct responses), errors (total number of errors), perseverative responses (responses that are perseverative), nonperseverative errors (incorrect responses that are not perseverative), perseverative errors (incorrect responses that are perseverative), and categories (from 0 to 6 categories, two each for color, form, and number).

The test should be administered individually in a quiet room or office. It is not intended for group application or for situations where distractions occur. As indicated earlier, a psychologist, especially a neuropsychologist, is best suited for the administration of the test. However, a well-trained technician could probably suffice, especially in research settings.

Although the WCST can be used easily with a variety of clinical populations, especially those with cognitive deficits, it does require that the patient have adequate vision and upper extremity control. Thus, the test may pose difficulty for the elderly or for those with skeletal, muscular, joint, or connective-tissue disease. Its application to blind populations, at least in the current state, appears impractical.

The administration of the WCST is composed of two basic steps. First, patients are instructed to take the top card from one of the decks and match it to one of the four stimulus cards placed in front of them. The examiner then responds affirmatively or negatively, depending on whether or not a correct sort is achieved. After the patient completes ten consecutive sorts, the scoring criterion shifts from color to form, then to number. The test terminates when either six complete sets of sorts have been completed or when the 128 cards have been sorted by the patient. Although the test is not timed, the examiner must maintain a steady and moderate sorting procedure. This requires the examiner to score the patient's responses (which requires some practice) simultaneously. In most instances, the test administration should take no more than one hour. Length of administration, of course, depends on the patient's response rate.

The recording of the subject's responses takes practice and requires keen attention. The scoring of the responses can be accomplished more leisurely, but requires a significant understanding of variables scored. If examiners were using the test for the first time, it would be useful for them to refine scoring procedures by scoring approximately ten records that have already been scored. The first few records would then be scored carefully. Once the procedure is understood, scoring should take no more than a few minutes. A well-practiced test administrator can accelerate the scoring process by keeping tally of sorts while coding the subject's individual responses.

WCST scoring is accomplished in several stages. First, the total number of responses and errors are recorded. Next, the perseverative responses and errors are counted. The operational definition of perseverative is "one that would have been correct in the previous stage" (Heaton, 1981, p.22). Two exceptions exist: 1) a correct consecutive response within a sorting category and 2) three unambiguous, incorrect consecutive sorts relative to either a correct or a previously incorrect sort. The final score reflects the total number of sorts completed. Several "experimen-

tal" scores are described by Heaton (1981), including percent of perseverative errors, trials to complete first category, percentage of conceptual level responses, failure to maintain set, and "learning to learn." Of these, the last score may have the greatest application over a wide variety of populations due to assessment of the efficiency of learning strategies. At the current time there are no machine-scoring systems available; therefore, the test must be scored by hand.

Interpretation is largely based on the objective scores of the basic measures outlined earlier. Of these, perseverative scores are most useful when using cutoff scores. Several limitations of interpretation including faking positive and faking negative, are addressed by the manual. Clinical judgment should supplement the objective information, although strict objective interpretation of the WCST using numerical data is possible. As indicated earlier, coding and scoring are by far the most complicated aspects of this test. As with most neuropsychological tests, however, the more training the examiner has, the more sophisticated the interpretation will be. This is especially true when ancillary information (e.g., neurological findings) are to be integrated with test results.

Technical Aspects

According to Heaton (1981), a total of 358 patients were included in the normative studies, with 208 patients having cerebral lesion and 150 being normal controls. The brain-damaged group was divided into two groups: 94 subjects with diffuse damage and 114 with focal lesions. These two groups were further divided into frontal lobe ($N = 43$), nonfrontal lobe ($N = 35$), and frontal and nonfrontal area ($N = 36$). The types of lesion ranged from tumors to infectious diseases (e.g., meningitis). The mean age for all brain-damaged subjects was 42.1 years, and the mean educational level was 12.7. Normal paid volunteers were carefully screened to avoid the inclusion of neurological disorders. These individuals had a mean age of 35.9 years and a mean educational level of 13.9. Participants were administered a variety of psychological tests by trained technicians of the neuropsychology laboratory at the University of Colorado Health Sciences Center. The psychological tests included the Wechsler Adult Intelligence Scale and the Halstead-Reitan Battery.

Means and standard deviations were provided for each demographic and full scale IQ, the Halstead-Reitan Impairment Index, and ten separate WCST variables. These variables included categories achieved, total errors, perseverative errors, percentages of perseverative errors, nonperseverative errors, perseverative responses, trials to first category, percentage of conceptual level responses, "learning to learn," and failures to maintain set. Additionally, mean percent error scores were presented for each category for brain-damaged and normal groups. Finally, correlations were computed between the previously outlined WCST variables, demographic variables, and neuropsychological variables. Age and educational variations were provided according to key WCST measures. Cutoff scores were provided with correct classification in the 70% plus range. False positive and false negative classifications were carefully considered.

No test-retest, alternate form, split-half, or other forms of reliability were presented. Of course, the actual WCST protocol presents split-half and related reliabilities from being computed. Also, practice effects and retest issues were not

presented. However, considering the procedures used by Heaton (1981), content validity appears well established. Criterion-related validity is well established due to rigorous subject selection and comparison to summary neuropsychological measures. Construct validity is addressed in a general fashion by the correlation of the WCST measures to Wechsler and Halstead-Reitan scores. Overall, reliability measures are not presented. Despite the fact that internal consistency may be difficult to assess, comparison over time and a comparable alternate form (beyond short forms of the WCST) may be an area that could be addressed in the future. Of course, Heaton's (1981) standardized version of the WCST will go a long way in allowing these issues to be adequately addressed.

Critique

Although it is important to note that the WCST does not replace the Halstead Category Test, there is strong evidence that the WCST is an excellent addition to any library of tests. As Robinson, Heaton, Lehman, and Stilson (1980, p. 614) state, the WCST is not only a "fairly good screening test for brain damage, it is probably the most efficient test for assessment of perseverative function."

The WCST is an excellent test of abstraction and "learning to learn." Although it has gained popularity in neuropsychological circles, the overall use is still quite restricted. The use of this test in answering cognitive questions and predicting efficacy of rehabilitation programs (especially those requiring retraining of function) is needed. The application of this test to other populations (e.g., schizophrenics) also seems warranted. Finally, the use of the WCST in nonneuropsychological settings, most notably educational environments, appears promising. Although information on reliability is limited, there is strong support for the validity of the WCST. The standardized version of the WCST should go far in popularizing the test in both research and clinical settings.

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