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# Wisc-III coding task and coding recall: A New approach for assessing short-term visual memory

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Running Head: Coding Recall

# WISC-III Coding Task and Coding Recall:

# A New Approach for Assessing Short-term Visual Memory

Master's Thesis

Submitted to the Faculty

Of the School Psychology Program

College of Liberal Arts
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By

Deirdre E. Rosenberg

In Partial Fulfillment of the Requirements
for the Degree of Master of Science

Rochester, New York May 10, 1997

Approved: V.K. Costiuliader
(Committee Chair)

Nicholas Romeo
(Committee Member)

Dean: ______________________________

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## Abstract

This study examines an immediate recall technique using the Coding section of the WISC-III as a screening measure of short-term visual memory. Fourth, seventh, and tenth grade students performed the Coding subtest from the WISC-III, the Coding recall technique, and the Abstract Visual Memory (AVM) subtest from the Test of Memory and Learning (TOMAL). A positive correlation of Coding Recall with the AVM subtest was found to be statistically significant for fourth and seventh graders, but not tenth graders. The results suggest that the Coding recall technique may be a useful screening test for evaluating short-term visual memory in children between the ages 9 and 14 years. The results further provide Coding Recall norms for children between the ages 9 and 14 years. Scores that fall below the mean suggest the possibility of memory impairment, and may indicate the need for a comprehensive memory assessment.

# WISC-III Coding Task and Coding Recall:

# A New Approach for Assessing Short-term Visual Memory

Memory is a critical part of all cognitive processes (Matlin, 1994). Complex mental processes require an abundance of functions that tap some aspect of memory—recall of a past experience, encoding a new experience to allow for recall at a later date, sorting out important facts from trivial information, and so forth (Reynolds & Bigler, 1994). Memory is involved whenever we maintain information over time, and information can be maintained for less than a second or as long as a lifetime. During the 1960s, researchers became interested in information-processing approaches to memory. At that time, a number of different models of memory were proposed that outlined separate memory stores for different kinds of memory. These models provided the first systematic account of the structures and processes that form the memory system (Matlin, 1994).

The most familiar model was proposed in 1968 by Richard Atkinson and Richard Shiffrin. The Atkinson-Shiffrin Model proposes that stimuli from the environment first enters our **sensory memory**, a large capacity storage system that records information from each of the senses, and decays rapidly. Next, some of the material from sensory memory passes on to **short-term memory** which contains only the small amount of information that we are actively using. Finally, some of the material passes from short-term memory to **long-term memory** which has a large capacity and contains memories that are decades old as well as memories that arrived only minutes ago.

Years of research on memory has shown that in general, both children and adults have similar kinds of sensory memory, however tests of short-term memory have established that memory span improves as children grow older (Brown, 1975; Dempster, 1981; Dempster, 1985; Engle, Fidler, & Reynolds, 1981; Harris, 1978; Hoving, Spencer, Robb, & Schulte, 1978; Kail & Siegel, 1977; Naus, Ornstein, & Hoving, 1978). These developmental differences are usually found to be larger on tasks that allow or encourage the intentional coding of stimulus information because intentional encoding may maximize the use of organizational strategies that are useful in retrieval (Ackerman, 1985).

Currently several instruments are available that assess visual memory in children and adolescents. Some of the major measures include; the Test of Memory and Learning (TOMAL) (Reynolds & Bigler, 1994), the Benton Revised Visual Retention Test-Fifth Edition (BVRT) (Silvan, 1992), and the "recall" administration of the Bender Visual-Motor Gestalt Test (Bender-Gestalt) (Bender, 1938).

The TOMAL is a comprehensive memory battery standardized for use with ages 5 through 19 years. It is composed of 10 core subtests and 4 supplementary subtests. It is a well-standardized, psychometrically sound instrument for evaluating memory function in both the verbal and nonverbal domains. A skilled examiner can administer the core battery in approximately 45 minutes (Reynolds & Bigler, 1994). The psychometric and administrative properties of the TOMAL are described in the Methods section, below.

The Benton Visual Retention Test-Fifth Edition (BVRT) is a 10 item test of visual memory, visual perception, and visuoconstructive abilities for use with ages 8 through adult (Silvan, 1992). The examinee studies designs which are presented one by one, and is then asked to reproduce each design from memory as accurately as possible by drawing each one on a sheet of paper (Benton, 1991). A skilled examiner can administer the BVRT in approximately 5 minutes (Benton, 1991). The BVRT has sound psychometric properties for older children and adolescents; however, it has not been fully standardized in the lower age ranges (Reynolds & Bigler, 1994). Interscorer agreement with respect to total scores is very high (Silvan, 1992). Interrater reliability coefficients are routinely above .90 (Silvan, 1992). There is some variability on interrater agreement with respect to the identification of specific types of errors, with the reliability coefficients ranging from .74 to .98 (Silvan, 1992). Validity studies suggest that the BVRT has adequate construct validity (Silvan, 1992). In addition, factor analyses generally support BVRT performance reflecting both a general short-term memory ability and a visuoperceptual analytic ability (Silvan, 1992). The BVRT does however have the confound of requiring the subject to use graphomotor abilities and if there is any disturbance in perceptual-motor functioning, this can affect performance (Reynolds & Bigler, 1994).

The Bender-Gestalt Test is a 9 item test that assesses visual-motor functioning in individuals ages three through adult (Bender, 1938). Administration of the Bender-Gestalt Test consists of presenting nine geometric designs, one by one, to a subject who is asked to copy each of them onto a plain sheet of paper. The subject's responses are then scored according to the development of the concepts of form, shape, and pattern orientation in space (Bender, 1991). The reliability data reported in the Koppitz manual (1975) of the Bender-Gestalt Test for children aged 5-0 through 11-11 is somewhat inconsistent. Nine studies reported data on test-retest reliability with the Bender-Gestalt Test for normal elementary-school children. The test-retest correlations for the Bender-Gestalt Test scores ranged from .50 to .90 (Koppitz, 1975). Salvia and Ysseldyke (1991), and Sattler (1992) suggest that the reliability data is in fact too low for use in making diagnostic decisions. The reported reliabilities do however appear adequate for formulating hypotheses about visual-motor ability. The validity of the Bender-Gestalt Test depends on how the test is used. As a measure of perceptual-motor development in children up to eight years of age, the Bender-Gestalt appears to have acceptable validity (Sattler, 1992). Administration of the standard form of the Bender-Gestalt Test takes approximately 15 to 20 minutes.

The "recall" administration of the Bender-Gestalt Test is a brief screening measure of memory function (Reynolds & Bigler, 1994). The "recall" administration of the Bender-Gestalt Test involves asking the subject to reproduce as many of the designs as possible from memory immediately after the standard administration. Reliability and validity data on the "recall" administration of the Bender-Gestalt Test is not currently available. Finch, Spirito, Garrison, and Marshall (1983) examined the Bender-Gestalt recall scores of child and adolescent psychiatric inpatients and proposed tentative normative data for this population. Imm, Foster, Belter, and Finch (1991) replicated the Finch et al. (1983) study and obtained results consistent with the previous findings. Imm et al. (1991) administered the Bender-Gestalt Test followed by the "recall" administration of the Bender to 270 child and adolescent psychiatric inpatients who were referred for psychological evaluations. They found that as age increased, the number of Bender designs correctly recalled also increased. Based on the results of these two studies, Imm et al. (1991) suggests that the Bender recall technique appears to be a useful measure of short-term visual memory. Like the Benton however, the "recall" administration of the Bender-Gestalt Test has the confound of requiring the subject to use graphomotor abilities, and, if there is any disturbance in perceptual-motor functioning, it is likely that performance will be affected.

As part of the same study, Imm et al. (1991) also investigated an immediate recall technique that employed the Coding section of the Wechsler Intelligence Scale for Children-

Revised (WISC-R) as a potential measure of short-term visual memory. Coding Recall was administered to the same 270 child and adolescent psychiatric inpatients. The Coding subtest of the WISC-R is a design copying task that purports to measure psychomotor speed and accuracy, and may also tap attentional skills, short-term memory, cognitive flexibility, and motivation (Wechsler, 1974). In the Imm et al. (1991) study, the Coding B section of the WISC-R was administered, and then the previous answers were covered. The subject was asked to place as many symbols as he/she could remember under the corresponding number. A blank sheet of paper folded in half was placed over the key so that the symbols were covered and only the numbers were visible. The subject was asked to write as many symbols as could be remembered on the blank sheet below the corresponding number in the key. The Coding Recall results were correlated with the results from the same subject's performance on the Bender Recall version of the Bender Visual-Motor Gestalt Test. The Coding Recall technique was found to be positively correlated with Bender Recall, and a statistically significant effect of age for number of coding symbols correctly recalled was indicated. These results suggested that Coding Recall may also be a useful test of short-term visual memory.

The Digit Symbol subtest of the Wechsler Adult Intelligence Scale-Revised as a Neuropsychological Instrument (WAIS-R NI) has been used to measure short-term visual memory impairment (Kaplan, Fein, Morris, & Delis, 1991). Digit Symbol, like Coding, is a design copying task that purports to measure visual-motor speed, efficiency, visual scanning, incidental learning, and the ability to sustain effort. The incidental learning task is identical to Coding Recall in that immediately after completion of the subtest, the subject is asked to fill in all the symbols that he/she can remember that go with the corresponding number. The WAIS-R NI manual reports that normal subjects usually recall at least six (out of nine) of the correct digit-symbol pairs. The manual suggests that mistakes such as confabulations, incorrect pairing, or paucity of symbols recalled, must raise the suspicion of some type of memory impairment which should be followed up with a comprehensive memory assessment.

The present study focused on short-term memory (STM). More specifically, it investigated visual coding in incidental STM by examining current measures of short-term visual memory.

The purpose of the present study was two-fold. The first purpose was to reevaluate the validity of Coding Recall as a measure of short-term visual memory (using the WISC-III) by examining the relationship between Coding Recall and the Abstract Visual Memory subtest of the Test of Memory and Learning (Reynolds and Bigler, 1994). The second purpose was to provide Coding Recall norms based on a large population of typical children.

Based on prior research which investigated the Coding and Digit-Symbol subtests of the Wechsler scales, it was hypothesized that the Coding subtest of the WISC-III can be a useful measure of incidental visual memory when administered along with the Coding recall procedure. That is, a positive correlation between Coding Recall and the Abstract Visual Memory (AVM) subtest of the TOMAL was anticipated.

## Method

### Participants

The present study included 244 fourth, seventh and tenth grade students from a suburban school district in the metropolitan area of a medium-size city (pop. = approx. 750,000) in the Northeast. The school population was homogeneous and consisted of predominantly Caucasian, upper middle class children (85.3% Caucasian, 5.5% African-American, 7.3% Asian, American Indian, Alaskan or Pacific Islander, and 1.9% Hispanic).

Only 5.5% of the youngsters in the suburban district qualified to receive free lunches. According to administrators, nearly all of the children entering the district had previous nursery school experience. Written consent was obtained from the school district prior to collecting the data. Fourth, seventh, and tenth grade students were asked to participate; however, the students were given the option to decline participation or to withdraw at any time during the study. Less than ten students declined to participate in the study. All subjects were assured that their identities would remain anonymous (as no identifying information was collected), and that the results of the experiment or their willingness to participate would in no way affect their grades in school. Subjects included 120 males and 124 females with an age range of 9 to 16 years. Fourth grade students consisted of 45 males and 52 females with an age range of 9 years to 10 years, 11 months. Seventh grade students consisted of 43 males and 45 females with an age range of 12 years to 14 years, 3 months, and tenth grade students consisted of 32 males and 27 females with an age range of 14 years, 7 months to 16 years, 11 months. All students were drawn from the regular education program, although due to the district's practice of including students with disabilities in the regular education classroom, an unknown number of students were receiving special education support services.

Instrumentation

Three instruments were administered in the following order: Coding B of the Wechsler Intelligence Scale for Children - Third Edition (WISC-III), Coding Recall, and the Abstract Visual Memory subtest of the Test of Memory and Learning (TOMAL). The WISC-III was published in 1991 and is the latest version of the Wechsler scales for children ages 6 through 16 years (Wechsler, 1991). It consists of 13 subtests divided into two scales—a Verbal Scale and a Performance Scale. The Verbal Scale is an overall measure of auditoryvocal intelligence and the Performance Scale is an overall measure of nonverbal thinking and visual-motor coordination (Kaufman, 1994). The subtests of each scale yield scale-specific IQs (i.e., Verbal IQ and Performance IQ), and together yield a Full Scale IQ. The Verbal subtests use language-based items, whereas the Performance subtests use visual-motor items that are less dependent on language (Braden, 1995). The WISC-III subtests can be further divided into four factors which are: Verbal Comprehension (VO), Perceptual Organization (PO), Freedom from Distractibility (FD) and Processing Speed (PS). The Coding subtest is included in both the Performance IQ and the PS factor. The PS factor is a measure of response speed. Tasks included in the PS factor require speed of thinking and motor speed in solving an assortment of nonverbal problems (Kaufman, 1994).

The WISC-III has outstanding psychometric properties. The internal consistency and stability coefficients for the three scales range from .89 to .97. Subtest reliabilities are lower than those for the three scales. The mean subtest internal consistency reliabilities range from a low of .69 to a high of .87. Across all ages, the average internal consistency and test-retest reliability coefficients for the Coding subtest are .79 and .77 respectively (Sattler, 1992). The validity of the WISC-III is well established. Validity studies suggest that the WISC-III has adequate concurrent, criterion, and construct validity (Braden, 1995). In addition, factor analyses generally support the four-factor "Index" model of the WISC-III (Braden, 1995).

The Coding subtest of the WISC-III purports to measure a child's ability to learn an unfamiliar task. The subtest involves speed and accuracy of visual-motor coordination, attentional skills, visual scanning and tracking, short-term memory (paired-associate learning of an unfamiliar code), cognitive flexibility, handwriting speed, speed of mental operation (psychomotor speed), visual acuity, and motivation (Sattler, 1992). Coding B may also involve a verbal-encoding process if verbal descriptions are attached to the meaningless symbols (Sattler, 1992). The Coding subtest is a poor measure of overall intelligence "*g*"(20 percent of variance is attributed to g), whereas it contributes substantially to the Processing Speed factor (74 percent of variance is attributed to g) (Sattler, 1992). The Coding subtest has a high correlation with the Symbol Search subtest, and a low correlation with the three scale scores (VIQ, PIQ, FSIQ) (Wechsler, 1991).

Coding Recall is a brief memory screening test that was created for the purpose of this study. Its reliability and validity have not yet been established. After the Coding B section of the WISC-III was administered, subjects were asked to turn the page to the next task which was Coding Recall. The Coding Recall task was created by using a copy of the Coding answer key minus the symbols so only the numbers were visible. The subjects were instructed to draw as many symbols as they could remember under the corresponding number in the key.

The TOMAL was published in 1994. It is a comprehensive, well-standardized battery of tests used for evaluating memory function for ages 5 through 19 years. It is composed of verbal and nonverbal subtests which yield a Verbal Memory Index and a Nonverbal Memory Index. A combination of the scores forms the Composite Memory Scale (Reynolds & Bigler, 1994). The TOMAL is a psychometrically sound instrument. The internal consistency and stability coefficients for the composite indexes are routinely above .90. Subtest reliabilities are lower than those for the composites. The average subtest internal consistency reliabilities range from a low of .74 to a high of .98. The average test-retest reliability coefficients range from a low of .71 to a high of .91. Across all ages, the average internal consistency reliability coefficients for the Abstract Visual Memory (AVM) subtest range from a low of .85 to a high of .95, and the average test- retest reliability coefficient for the AVM subtest is .71 (Reynolds

& Bigler, 1994). Although validation is an ongoing process, several validity studies suggest that the TOMAL has adequate concurrent, criterion, and construct validity (Reynolds & Bigler, 1994).

The Abstract Visual Memory subtest of the TOMAL is a nonverbal visual-spatial memory task that assesses immediate recall for meaningless figures. This subtest allows for assessment of a child's ability to process and retain obtuse geometric patterns as they increase in complexity. This task taps visual processing, attention to detail, and the ability to match a retained abstract figure with its counterpart in an array of similar figures (Reynolds & Bigler, 1994).

Procedure

Subjects were tested in groups in their classrooms by the principle investigator. The data were collected for the fourth and seventh grade students in the Spring of 1996, and for the tenth grade students in the Fall of 1996. The tasks were prepared as a booklet. All subjects completed the Coding B subtest of the WISC-III, Coding Recall, and the Abstract Visual Memory subtest of the TOMAL. Subjects were asked to indicate, by writing on their booklet, if they had ever done any of the tasks before. Two hundred sixty three subjects were tested, however subjects were eliminated if (a) they indicated prior familiarity with any of the tasks ($n$ = 8), (b) they continued to work on Coding B beyond the 2 minute time-limit ($n$ = 4), or (c) there was evidence of drawing the TOMAL designs on their answer sheet during administration of the Abstract Visual Memory subtest ($n$ = 7). On the first page, subjects provided demographic information. The three tasks were on separate pages. Task 1 was Coding B from the WISC-III presented in group format[1]. An overhead transparency of the task was projected onto a screen and shown to the subjects during the instructions. The instructions were read verbatim from the WISC-III manual (Wechsler, 1991). They read:

> Look at these divided boxes. You see, each box has a number in the top part and a special mark in the bottom part. Each number has its own mark.[2] Now look down here where the boxes have numbers in the top parts but are empty in the bottom parts. You are to put in the empty squares the marks that should go there, like this. Here is a two. The two has this mark, so I put it in this square like this. (*Draw in the symbol.*) Here is a one. The one has this mark, so I put it in this square. (*Draw in the symbol.*) This is the number four. The four has this mark, so I put it in this square. (*Draw in the symbol.*) Now you fill in the rest of these boxes up to this heavy line. (*Point to the heavy line.*) (*Walk around room and observe children filling in the boxes and give praise for correct responses and corrective feedback for incorrect responses. When the children successfully complete the Sample items and understand the task, say*): When I tell you to start, you do the rest of them. Begin here (*point to first test item*) and fill in as many squares as you can, one after the other, without skipping any. Keep going until I tell you to stop. Work as quickly as you can without making mistakes. When you finish this line, go on to this one (*point to the first item in the second row*). Go ahead (p. 72).

After 2 minutes the subjects were asked to put down their pencils and turn to the next page in the booklet (a blank colored opaque sheet). When all colored sheets were visible, subjects were immediately asked to turn to the next page (page 4) and complete Task 2--Coding Recall. This was done by using the Coding answer key minus the symbols so that only the numbers were visible. The subjects were instructed to draw as many symbols as could be remembered under the corresponding number in the key. Subjects were given credit only for correct associations; therefore scores for Coding Recall ranged from 0 to 9. After 1 minute, the subjects were asked to turn to the last page of the booklet.

Task 3 was the Abstract Visual Memory subtest of the TOMAL[3]. Subjects were provided with an answer sheet divided into 2 columns numbered 1 through 40, with the numbers 1 through 5 in each row. Items were presented in group format on an overhead projector. Item 1 was used as a Sample or Teaching item to ensure that all subjects understood the task. Subjects were shown the stimulus symbol while the investigator said, "See this." After 5 seconds the investigator removed that transparency and replaced it with the response choices transparency and said, "Find it here." The investigator also announced which item number everyone should be working on after each transparency was shown. Subjects were instructed to circle the number (1-5) on their answer sheet corresponding to their choice.

All Coding B and Abstract Visual Memory data were scored using the objective scoring manuals provided by the WISC-III and the TOMAL. Coding Recall was scored using a scoring template created for purposes of the current study.

## Results

The Coding recall technique for the overall population correlated positively with the Abstract Visual Memory (AVM) subtest of the TOMAL ($r = .21$, $p = .001$, $n = 244$). Significant positive correlations were found between the Coding recall technique and the AVM subtest for the fourth and seventh grade populations ($r = .34$, $p = .001$, $n = 97$) and ($r = .27$, $p = .01$, $n = 88$) respectively, but not for the tenth grade population ($r = .11$, $p = .39$, $n = 59$).

# Discussion

The main finding of this study revealed a positive correlation between the Coding recall task and the Abstract Visual Memory (AVM) subtest of the TOMAL. Although the correlation for the overall population of students was found to be significant, it was not as strong as anticipated. It remains equivocal as to what this means.

Moderate positive correlations were found for the fourth and seventh grade students, suggesting that the Coding recall technique may be a useful screening measure of short-term visual memory in children up to age 14 years. These results must however be viewed with caution because of the large sample size used for statistical analyses. Although the positive correlations between the Coding recall technique and the AVM subtest of the TOMAL were found to be statistically significant, the power of the study was extremely high which can result in smaller correlations being significant.

The Coding Recall data from the current study support the norms reported for the Digit Symbol subtest of the WAIS-R NI. Kaplan, et al. (1991) reported that normal subjects usually recall at least six (out of nine) of the correct digit-symbol pairs. They suggested that lower scores must raise the suspicion of some type of memory impairment. The data obtained from the current study suggest that most children between the age of 9 and 14 can be expected to accurately recall at least 6 Coding symbols (see Table 1).

## Limitations and Future Directions

Current discussion is based on the data from only one school district with a relatively homogeneous upper middle class population of students. In addition, it should be noted that the Coding and AVM subtests were presented in group format. In that both of these tasks were standardized on individual administration, it is unknown how much the group administration may have affected individual performance results.

Future research might further investigate the validity of the Coding recall technique by individually administering Coding, Coding Recall, and the AVM subtest during a standard psychoeducational evaluation. With the additional information provided from a standardized intelligence measure, the Coding Recall results can be covaried with IQ, and the effect of intelligence on Coding Recall performance can be analyzed. In addition, the study will ideally include students from more than one school district to help insure a more heterogeneous population.

In summary, this study suggests that the Coding recall technique may be a useful screening measure for evaluating short-term visual memory in children between ages 9 and 14. Used in combination with the Coding subtest, these two tasks provide a means of evaluating the need for further investigation into the memory functioning of individual children. The Coding recall technique can be quickly and easily administered during the standard administration of the WISC-III. It is important to keep in mind that the Coding recall technique is not intended for use as a diagnostic measure.

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Table 1

Mean number of Symbols Recalled Correctly for Coding Recall

| Data for Coding Recall by grade/age | | | | |
|---|---|---|---|---|
| **Grade** | **Age Range** | **n** | **M** | **SD** |
| 4 | 9 years, 0 months to 10 years, 11 months | 97 | 7.2 | 1.9 |
| 7 | 12 years, 0 months to 14 years, 3 months | 88 | 6.5 | 2.2 |
| 10 | 14 years, 7 months to 16 years, 11 months | 59 | 6.5 | 2.3 |
| Total | | 244 | | |

Author Note

Deirdre E. Rosenberg, Department of Psychology, Rochester Institute of Technology, 18 Lomb Memorial Drive, Rochester, NY 14623.

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Footnotes

[1] Permission to reproduce the Coding subtest for the purposes of this thesis was granted from *The Psychological Corporation*, publisher of the WISC-III.

[2] The code, or answer key, referred to above appeared at the top of each student's page. The students did not have to look up at the overhead to copy the code.

[3] Permission to reproduce the Abstract Visual Memory subtest for the purposes of this thesis was granted from *Pro-Ed*, the publisher of the TOMAL.