**What subtests on the WAIS-III measure Social Cognition?**

**Kimberly A. Barchard, Amy Julia Rusinoski, and Daniel N. Allen**
**University of Nevada, Las Vegas**

**Reference:** Barchard, K. A., Rusinoski, A, & Allen D N. (2008, April). What subtests on the WAIS-III measure Social Cognition? Poster presented at the Western Psychological Association Annual Convention, Irvine, CA.

**Contact Information**: Kimberly A. Barchard, Department of Psychology, University of Nevada, Las Vegas, 4505 S. Maryland Parkway, P.O. Box 455030, Las Vegas, NV, 89154-5030, USA, barchard@unlv.nevada.edu

**Abstract**

Factor analytic studies of the Wechsler Adult Intelligence Scale (WAIS) have provided evidence for a number of distinct cognitive abilities. These include Verbal Comprehension, Perceptual Organization, Working Memory, and Processing Speed. Recent research using confirmatory factor analysis has also identified a Social Cognition factor on the WAIS-R (Wechsler, 1981). The purpose of this study was to extend this research to the 14 subtests on the WAIS-III (Psychological Corporation, 1997). Using the standardization sample, several confirmatory factor analytic models were compared to determine the optimal combination of subtests on the Social Cognition factor. The best fit was obtained by the model where the Social Cognition factor was composed of the Picture Arrangement, Picture Completion, and Object Assembly subtests. These results provide support for the construct validity of a Social Cognition factor. Additional research is necessary to determine its stability across age groups and clinical populations, as well as its sensitivity to various forms of brain dysfunction.

**Introduction**

The Wechsler Adult Intelligence Scale (WAIS) was designed to assess a variety of cognitive abilities and factor analysis often has been used to identify the underlying abilities that are assessed by its various subtests. From very early on factor analyses commonly demonstrated that the WAIS subtests measured the three latent constructs of Verbal Comprehension, Perceptual Organization, and Freedom from Distractibility or alternatively Working Memory (Balinsky, 1941; Cohen, 1952, 1957). While these early results were partially consistent with Wechsler's original conceptualization of intelligence along verbal and performance domains, identification of the memory factor provided clear evidence for a more complex structure of intellectual abilities. The stability of the three-factor solution across various clinical and non-clinical populations and across various age groups (Allen, Seaton, Huegel, Goldstein, Gurklis, & van Kammen, 1998; Beck, Horwitz, Seidenberg, Parker, & Frank, 1985; Bowden, Cook, Bardenhagen, Shores, & Carstairs, 2004; Burton, Ryan, Paolo, & Mittenberg, 1994; Dickinson, Iannone, & Gold, 2002; McGeorge, Crawford, & Kelly, 1996; Plake, Gutkin, Wise, & Kroeten, 1987; Ryan, Paolo, & Brungardt, 1990; Ward, Ryan, & Axelrod, 2000a, 2000b), along with the differential sensitivity of the factors to various forms of brain dysfunction (Goldstein, 1984; Lawson & Inglis, 1983; Matarazzo, 1972; Warrington, James, & Maciejewski, 1986) lead to the interpretation of factor scores in addition to or instead of the Verbal and Performance IQ scores. Thus, factor analysis has been useful not only to evaluate the structure of intellectual abilities assessed by the WAIS, but has also provided valuable information that has assisted in its application and interpretation in various clinical settings and with diverse populations.

For the latest revision of the WAIS, the WAIS-III (Psychological Corporation, 1997), inclusion of a number of new subtests has allowed for the identification of a fourth factor, Processing Speed, in addition to the Verbal Comprehension, Perceptual Organization and Working Memory factors. The four-factor solution was established in the normative sample using confirmatory factor analysis and has since been replicated in other samples (Donders, Tulsky, & Zhu, 2001; Hawkins, 1988; Ryan & Paolo, 2001; Taylor & Heaton, 2001; Ward et al., 2000a). More recently, two confirmatory factor analytic studies of the 11 WAIS-R subtests (Wechsler, 1981), one examining high functioning autism (Goldstein, Allen, Minshew, Williams, Volkmar, Klin, & Schulz, 2006) and the other schizophrenia (Allen, Strauss, Donohue, & van Kammen, 2007), have identified an additional factor that ostensibly measures social cognition. Social cognition is that unique aspect of cognition that is dedicated to the processing of social information and allows for adaptive social interaction (Ostrum, 1984). Support for the distinction between social and nonsocial cognition comes from a number of areas, including studies demonstrating small to moderate correlations among standard neurocognitive and social cognitive measures, as well as the involvement of unique neural substrates in the processing of social and nonsocial information (for a review see Couture, Penn, & Roberts, 2006). This specialized processing of social information is also consistent with the more general view that the development of specialized information processing systems is adaptive, allowing the brain to address specific environmental challenges (Tooby & Cosmides, 2000). Hence, social cognition is itself a multi-factorial construct, with examples of social cognitive abilities including facial affect perception and processing, social perception, and knowledge of social norms.

Interestingly, while Wechsler himself was critical of the concept of social cognition, or what was then referred to as social intelligence, he notes that because the items on the Picture Arrangement subtest nearly always involved "some human or practical situation…[it]…more nearly corresponds to what other writers have referred to as 'social intelligence' " (Wechsler, 1958, p. 75). Much earlier, Thorndike (1920) had suggested three types of intelligence including mechanical, abstract, and social, with the latter type allowing one to understand, interact with, and manage others (Thorndike, 1920; Thorndike & Stein, 1937). His suggestion of a social intelligence thus gained some popularity, and more recently has received increasing interest as reflected through studies of emotional intelligence (e.g., Amelang & Steinmayr, 2006; Barchard, 2003; Barchard & Hakstian, 2004; Lee, Wong, & Day, 2000; Salovey & Mayer, 1990) and social cognition (Green, Olivier, Crawley, Penn, & Silverstein, 2005; Ostrum, 1984). Despite these early indications by Wechsler and others regarding the social cognitive aspects of subtests such as Picture Arrangement and Comprehension (Rapaport, Gill, & Schafer., 1968; Schafer, 1948; Wechsler, 1958), and the extensive factor analytic work with the Wechsler scales, confirmatory factor analysis has only recently been applied to investigate the possibility of a WAIS factor that might assess social cognition, although some studies have examined associations between individual WAIS subtest scores and some aspects social functioning and personality (Campbell & McCord, 1996; Lipsitz Dworkin, & Erlenmeyer-Kimling, 1993; Shean, Murphy, & Meyer, 2005).

Two recent studies that have directly evaluated the possibility of a social cognition factor in individuals with autism or schizophrenia (Allen et al., 2007; Goldstein et al., 2006). The impetus for hypothesizing a social cognition factor in autism and schizophrenia was based on the observation that deficits in social interaction are core features of both disorders. For children and adults with high-functioning autism, confirmatory factor analysis of the 11 traditional subtests from the WAIS-R supported a four-factor model of neurocognitive abilities consisting of Verbal Comprehension, Perceptual Organization, Working Memory, and Social Cognition (SC) factors (Goldstein et al., 2006). Consistent with these findings, Allen et al. (2007) also demonstrated the presence of this SC factor on the WAIS-R in males with schizophrenia. This factor structure differed from those previously reported for schizophrenia (Allen et al., 1998; Dickinson et al., 2002) by identifying an SC factor, which was loaded on by the Picture Arrangement and Picture Completion subtests. In both of these studies, the SC factor also emerged when the 11 WAIS-R subtests were examined in selected age groups from the WAIS-R or WAIS-III standardization sample. Thus, while direct comparisons between the factor structures identified for autism and schizophrenia were not accomplished in these studies, their results provide support for a factor structure that is similar across groups in two respects. First, a model incorporating an SC factor composed of Picture Arrangement and Picture Completion provided the best fit of the data in both clinical samples and normals. Second, the WAIS-R subtest loadings on the various factors were also consistent across studies and groups. These results provide more general support for an SC factor that is not specific to a particular population or clinical group and apparently reflects the social and contextual properties of the subtest that composes it.

The current investigation extends findings beyond the 11 traditional subtests of the WAIS-R by using confirmatory factor analysis of the complete set of 14 subtests to test competing hypotheses regarding the factor structure of the WAIS-III. Various models were examined and compared, to determine which combination of subtests on the social cognition factor creates the best fit. Based upon previous research, we hypothesized that the model incorporating an SC factor composed of the Picture Arrangement and Picture Completion subtests would be the best of the competing models. Given its wide use and excellent psychometric properties, further investigation of the WAIS-III factor structure may provide a clearer understanding of the cognitive constructs that it measures and thereby assist with its application in clinical settings.

## Method

### *Participants*

The correlation matrix for the entire standardization sample of 2450 individuals reported in the WAIS-III WMS-III Technical Manual was used (Psychological Corporation, 1997, Table 14.12, p. 98). The technical manual indicates the standardization sample was selected to represent the US population in terms of geographic region, race/ethnicity, sex, and education. It includes individuals aged 16-89 distributed across 13 age groups. Two hundred individuals are included in each of the 11 age groups from ages 16-79, with the 80-84 year old group containing 150 individuals, and the 85-89 year old group consisting of 100 individuals. Geographic regions included south, west, northeast and north central. Categories for race/ethnicity included White, African American, Hispanic and Other. Equal numbers of males and females were included in the 8 age groups from 16-64 years old. For the remaining five age-groups, the numbers of males and females were determined to represent the general population. Years of education was divided into five levels that included 8 or fewer years, 9-11 years, 12 years, 13-15 years, and 16 or more years. It should be noted that the Letter-Number Sequencing subtest was administered to only 1250 individuals in the standardization sample (Wechsler, 1997) rather than the total 2450, so correlations reported in the Technical Manual are based on this reduced number of individuals.

### *Models Tested*

To determine the optimal composition of the Social Cognition factor, we compared four different models. These models each had five factors and are shown in Table 1. To explain these five factor models, we will first discuss one-, two-, three-, and four-factor models that have been examined in the literature.

The one- and two-factor models are historical models related to early conceptualizations of intelligence. In the one-factor model (M1), all subtests load on a single factor. This model was used to evaluate the hypothesis that intelligence involves a single latent trait or “g” (Spearman, 1904). The two-factor model (M2) divides subtests into Verbal and Performance factors. M2 is consistent with Wechsler’s early conceptualization of IQ along verbal and performance dimensions (Wechsler, 1958), and has been suggested as the most parsimonious of the various models (Leckliter, Matarazzo, & Silverstein, 1986).

Despite their increased complexity, three-factor models of the WAIS have generally gained acceptance over the less complex two-factor models. The three factors are Verbal Comprehension, Perceptual Organization, and Working Memory. In all three-factor models, the Working Memory factor borrows subtests from the Verbal factor (Arithmetic, Digit Span, Letter-Number Sequencing) and the Performance factor (Digit Symbol-Coding, Symbol Search). However, three-factor models vary in terms of Digit Symbol-Coding. In some studies, Digit Symbol-Coding loads on the Perceptual Organization factor, in some studies it loads on the Working Memory factor, and in some studies it loads on both (compare Allen et al., 1998, Burton et al., 1994, and Ward et al., 2000a). In Table 1, we specified that Digit Symbol-Coding loads on the Working Memory factor. Previous research has shown that this three-factor model fits the WAIS-R and WAIS-III data better than the one- and two-factor models (Leckliter et al., 1986; Psychological Corporation, 1997). It should also be noted that the three-factor model described here differs from the one reported for the standardization sample (Psychological Corporation, 1997), in that the Arithmetic subtest was specified to load on the Working Memory factor in this study rather than the Verbal Comprehension factor (Leckliter et al., 1986). However, Arithmetic has been consistently placed on the Working Memory factor in factor analytic studies of the Wechsler scales, probably because it requires the maintenance and manipulation of numerical information in the short-term memory store.

As previously mentioned, with the development of the WAIS-III, a four-factor model has gained acceptance. This model retains the Verbal Comprehension, Perceptual Organization and Working Memory factors, but separates out the Digit Symbol-Coding and Symbol Search subtests from the Working Memory factor to form a Processing Speed factor. In the WAIS-III WMS-III Technical Manual

(Psychological Corporation, 1997) the model that provided the best fit for the standardization sample apparently allowed the residual errors for Digit Span and Letter Number Sequencing to correlate (see Ward et al., 2000a), but had the four factors described here.

Finally, a number of five-factor models have been investigated, which retained the Verbal Comprehension, Perceptual Organization, Working Memory, and Processing Speed factors from the four-factor model, but also included a Social Cognition factor. The purpose of this current study was to compare the five-factor Social Cognition models to each other, to determine the optimal composition of this factor.

For each of these Social Cognition models, various combinations of subtests that contained social content were specified to load on an SC factor. Selection of subtest combinations for the SC factors in this current study was guided primarily by prior investigations (Allen et al., 2007; Goldstein et al., 2006), but also by long-held clinical interpretations of subtest content (Rapaport et al., 1968; Schaefer, 1948). In the first of the five-factor social cognition models, the SC factor consisted of the Picture Arrangement and Comprehension subtests (M5:PA,C). These two subtests have been traditionally viewed as requiring the greatest amount of social reasoning abilities (Rapaport et al., 1968; Schaefer, 1948). In the second five-factor social cognition model, Picture Arrangement and Picture Completion comprised the SC factor (M5:PA,PC). This composition of the SC factor has demonstrated the best fit in studies using the 11 traditional subtests included in the WAIS-R (Allen et al., 2007; Goldstein et al., 2006). Two additional five-factor models were tested that incorporated Object Assembly into the SC factor, because the Object Assembly subtest contains social content (e.g., human figure, face). In the third five-factor social cognition model, the SC factor consisted of Picture Arrangement and Object Assembly (M5:PA,OA), and in the fourth five-factor model, the SC factor consisted of the Picture Arrangement, Picture Completion, and Object Assembly subtests (M5:PA,PC,OA). Each of these models attempts to separate subtests with social content (Picture Completion, Picture Arrangement, and in some cases Object Assembly) from those with neutral content (Block Design and Matrix Reasoning).

### *Statistical Analyses*

All models were tested with confirmatory factor analysis using LISREL 8 (Jöreskog & Sörbom, 1993). To determine which model best fit the standardization sample data, four goodness-of-fit statistics were examined: the maximum-likelihood chi-square test, the Comparative Fit Index (CFI), the Root Mean Square Error of Approximation (RMSEA), and the Akaike Information Criterion (AIC). Rationale for the selection of these indices are provided in detail elsewhere (Byrne, 2006; Kline, 2005). Briefly, these four statistics capture different aspects of model fit. The maximum-likelihood chi-square test indicates how well the hypothesized statistical model fits the actual data set. A significant chi-square test is one indication that the sample data did not come from a population in which the proposed model is valid. However, because the chi-square test is sensitive to sample size, it often rejects models that fit the data quite well (Bentler & Bonnett, 1980). Nevertheless, it is reported here because it is the basis for most other fit statistics. The Comparative Fit Index (CFI; Bentler, 1990) is an incremental fit index that compares the relative fit of the hypothesized model and the baseline independence model. It ranges from 0 to 1, with higher values indicating better fit. CFI values greater than .95 indicate good fit (Hu & Bentler, 1999). The Root Mean Square Error of Approximation (RMSEA; Steiger & Lind, 1980) indicates how well the hypothesized model fits the population covariance matrix. Because it takes into account model complexity, it is classified as a parsimony index. It ranges from 0 to 1, with smaller values indicating better fit. Good fit is indicated by values of .05 or less, with values between .06 and .08 indicating adequate fit (Jöreskog & Sörbom, 1993). Finally, the Akaike Information Criterion (AIC; Akaike, 1987) is a predictive fit index that estimates how well the model would fit in a hypothetical replication sample. The AIC takes into account degrees of freedom, and thus is influenced by model parsimony. Lower values indicate better predicted fit. Kline recommends using the AIC to compare non-nested models, and thus we used the AIC to determine which of the SC models provided the best fit. Because AIC is not scaled between 0 and 1, interpretation of AIC is entirely comparative: when comparing two non-nested models, the one with the smaller AIC provides better fit.

## Results

We tested four models that included a Social Cognition factor. All of these models fit the data relatively well. See Table 2. Of these four models, the model with Picture Arrangement, Picture Completion, and Object Assembly on the Social Cognition factor had the best overall fit (see Figure 1). The chi-square and AIC values were smaller for this model than for the other SC models tested.

As a new factor on the WAIS-III, it was vitally important for the subtests composing the SC factor to demonstrate strong loadings. In this case, the Picture Completion, Picture Arrangement, and Object Assembly loadings of .69 or above on the SC factor indicate that they are strong measures of this factor. In addition, the SC factor has strong correlations with the Working Memory, Perceptual Organization, Processing Speed, and Verbal Comprehension factors, as would be expected.

## Discussion

The primary purpose of this study was to determine the optimal composition of a Social Cognition factor for the 14 WAIS-III subtests. The model where the SC factor was composed of Picture Arrangement, Picture Completion, and Object Assembly provided the best statistical fit to the standardization sample.

This study is unique in two ways. The present study was the first to examine the fit of structural models that included a Social Cognition factor, while also including Verbal Comprehension, Perceptual Organization, Working Memory, and Processing Speed factors. This study was also the first to compare these Social Cognition models, to determine which has the optimal fit.

It is somewhat surprising that it is only recently that factor analysis has been applied in an attempt to identify an SC factor. The Verbal Comprehension, Perceptual Organization, and Working Memory factor solution was identified very early on by Balinsky (1941), Cohen (1952, 1957) and others. Because exploratory factor analysis requires at least three indicators to properly identify each factor, these early analyses did not allow the identification of an SC factor. With a few notable exceptions (e.g., Burton, Ryan, Axelrod, Schellenberger, 2002; Ward et al., 2000b), the tendency has been for most studies of the WAIS-R to replicate and generalize the three-factor solution to various clinical populations and across various age groups. A similar approach has been taken for the WAIS-III, with most studies investigating a four-factor model composed of Verbal Comprehension, Perceptual Organization, Working Memory and Processing Speed, which was the optimal model originally reported for the standardization sample (Psychological Corporation, 1997). Consequently, until now the possibility and optimal configuration of an SC factor has received relatively little attention in factor analyses of the Wechsler scales and thus, the present study is the first to compare different configurations of an SC factor in the WAIS-III standardization sample.

The identification of the optimal configuration of the SC factor is a crucial first step in the validation process. Examinations of its criterion-related validity with clinical populations are necessary to demonstrate its practical and clinical value. Some preliminary evidence of this type has been found using the 11-subtest WAIS-R. In a study of adults with schizophrenia, Allen et al. (2007) found that factor scores from an SC factor exhibited small but significant correlations with some symptom dimensions, as well as an index of social functioning. In addition, the SC factor score was differentially sensitive to neurocognitive deficit, in that relative decreases in the score were apparent in comparison to the Verbal Comprehension and Perceptual Organization factors, with a comparable level of impairment to the Working Memory factor. Additional studies are needed with other clinical populations and with the 14-subtest WAIS-III to support the conceptual and practical value of the SC factor, and to examine whether the Picture Arrangement, Picture Completion, and Object Assembly combination has the optimal validity.

The issue remains as to whether the Picture Arrangement-Picture Completion-Object Assembly factor should be interpreted as measuring Social Cognition, or if it might more appropriately reflect another ability such as Perceptual Processing as suggested by Ward et al. (2000b) for the Picture Arrangement-Picture Completion factor identified in their analysis of the WAIS-R. The underling construct loaded on by Picture Arrangement and Picture Completion was clarified in the current study by comparing competing models that separated the nonverbal subtests with social content (Picture Arrangement, Picture Completion, and Object Assembly) from those without social content (Block Design and Matrix Reasoning). Such a distinction could not be made on the WAIS-R, because Block Design was the only WAIS-R subtest that was totally devoid of social content. For the WAIS-III, however, the addition of Matrix Reasoning allowed for the specification of a nonverbal, nonsocial factor that was measured by more than one subtest. When this nonverbal nonsocial factor was specified and all 14 of the WAIS-III subtests were included, the combination of the Picture Arrangement, Picture Completion and Object Assembly subtests into the SC factor provided the best overall fit of the data. And, while all five of these subtests require some perceptual processing ability, a clear demarcation can be drawn between those requiring analysis of nonsocial information (Block Design and Matrix Reasoning) and those requiring analysis of real-world objects, people, or situations. The distinction between processing of these two different types of information (social vs. nonsocial) is consistent with the view of the brain as an array of computational machines that are specialized to solve specific real-world adaptive computational problems, such as is required for facial affect recognition (Tooby & Cosmides, 2000). Based on these considerations, evidence supports the SC factor as a unique measure of social cognition, rather than simply a measure of perceptual processing ability.

Finally, the question remains as to what aspects of social cognition the SC factor actually measures. The Picture Arrangement, Picture Completion, and Object Assembly subtests require the perception and analysis of simple drawings depicting various social situations, people, and objects, with identification of specific details crucial to successful performance. Additionally, the social content of Picture Arrangement and some items from the Picture Completion and Object Assembly subtests further require social knowledge. Given these considerations, it appears that the areas of social cognition assessed by this factor would be social perception and social knowledge. In a recent review, Green et al. (2005) noted that these two areas closely interface, because knowledge of social situations is necessary for interpreting social cues.

It is important to reiterate that as a measure of social perception and knowledge, the SC factor measures only some aspects of social cognition, which is itself a multifactorial construct. Its multifactorial nature was apparent from early attempts to measure social intelligence with tests such as the George Washington Social Intelligence Test, which included subtests such as Judgment in Social Situations, Recognition of the Mental State of the Speaker, Observation of Human Behaviors, and Identification of Emotional Expressions, among others (as reviewed in Thorndike & Stein, 1937). Since then, it has been recognized that impairment may occur in one or more of these component processes, with relative sparing in other areas. As a result, it is possible that individuals who exhibit adequate performance on the SC factor may experience significant deficits in psychosocial function and visa versa. It appears that Wechsler's skepticism regarding the validity of a social intelligence construct as measured by the Picture Arrangement subtest was at least to some extent influenced by his observation that "Alas, both delinquents and psychopaths often do very well on this test" (Wechsler, 1958, p. 75). Although accurate, this conclusion does not allow for the complexity of Social Cognition or the possibility of differential impairment across its various component processes. This multidimensionality may result in a failure to observe anticipated associations among test performance and social functioning.

As in prior studies, a Social Cognition factor including the Comprehension subtest provided poor fit to the data (Allen et al., 2007; Goldstein et al., 2006). It may be that substantial method variance (visual vs. verbal) precluded its loading on the same factor as Picture Arrangement. However, it may also be that it did not load on the SC factor because many of the Comprehension subtest items measure practical knowledge rather than social knowledge. Cutting and Murphy (1990) demonstrated the distinction between these two types of knowledge in patients with schizophrenia who exhibited more impairment on social knowledge questions (e.g., "What do you think would be the most sensible thing to say if you came across two strangers having a fight in the street?" [p. 357]) than on practical knowledge questions (e.g., "Why is it unsafe to drink tap water in some countries?" [p. 358]). The Comprehension subtest is a measure of practical knowledge, whereas the Picture Arrangement subtest relies more heavily on social knowledge. This dissociation between social knowledge and practical knowledge may account for the poor fit indices of models including the Picture Arrangement and Comprehension subtests on the same factor, again reflecting the multifactorial nature of social cognition.

Future research could pursue a number of directions. Given differences between the performance of males and females on the WAIS and other tests of intellectual abilities (Camarata, & Woodcock, 2006; van der Sluis, Posthuma, Dolan, de Geus, Colom, & Boomsma, 2006), as well as the variability in its factor structure across various clinical populations and age groups, further confirmatory factor analyses are warranted across these diverse groups. As the aim of the current study was not to investigate variability in factor structure associated with such variables as age, sex, and ethnicity, the solution presented here reflect both individual differences as well as group differences, and the latter deserves further investigation. Additionally, the clinical significance of this factor requires further investigation to determine the specific aspects of social functioning that are predicted by this factor. Such studies are needed to bear out the usefulness and validity of the optimal SC factor identified here.

**References**


Akaike, H. (1987). Factor analysis and AIC. *Psychometrika, 52*, 317-332.

Allen, D. N., Seaton, B. E., Huegel, S. G., Goldstein, G., Gurklis, Jr J. A., & van Kammen, D. P. (1998). Confirmatory factor analysis of the WAIS-R in patients with schizophrenia. *Schizophrenia Research, 34,* 87-94.

Allen, D. N., Strauss, G. P., Donohue, B., & van Kammen, D. P. (2007). Factor analytic support for Social Cognition as a separable cognitive domain in schizophrenia. *Schizophrenia Research, 93,* 325-333.

Amelang, M., & Steinmayr, R. (2006). Is there a validity increment for tests of emotional intelligence in explaining the variance of performance criteria? *Intelligence, 34*, 459–468

Balinsky, B. (1941). An analysis of the mental factors of various age groups from nine to sixty. *Genetic Psychology Monographs, 23*, 191-234.

Barchard, K. A. (2003). Does emotional intelligence assist in the prediction of academic success? *Educational and Psychological Measurement, 63*, 840–858.

Barchard, K. A. & Hakstian, A. R. (2004). The nature and measurement of emotional intelligence abilities: Basic dimensions and their relationships with other cognitive-ability and personality variables. *Educational and Psychological Measurement, 64*, 437-462.

Beck, N. C., Horwitz, E., Seidenberg, M., Parker, J., Frank, R. (1985). WAIS-R factor structure in psychiatric and general medical patients. *Journal of Consulting and Clinical Psychology, 53*, 402-405.

Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychological Bulletin, 107*, 238-246.

Bentler, P. M., & Bonnett, D. G. (1980). Significance tests and the goodness of fit in analysis of covariance structures. *Psychological Bulletin, 88,* 588-606.

Bowden, S. C., Cook, M. J., Bardenhagen, F. J., Shores, E. A., Carstairs, J. R., (2004). Measurement invariance of core cognitive abilities in heterogeneous neurological and community samples. *Intelligence, 32*, 363-389.

Burton, D. B., Ryan, J. J., Axelrod, B. N., Schellenberger, T. (2002). A confirmatory factor analysis of the WAIS-III in a clinical sample with crossvalidation in the standardization sample. *Archives of Clinical Neuropsychology, 17*, 371-387.

Burton, D. B., Ryan, J. J., Paolo, A. M., & Mittenberg, W. (1994). Structural equation analysis of the Wechsler Adult Intelligence Scale-Revised in a normal elderly sample. *Psychological Assessment, 6,* 380-385.

Byrne, B. M. (2006). *Structural equation modeling with EQS: Basic concepts, applications, and programming (2nd ed.).* Mahwah, NJ: Lawrence Erlbaum.

Campbell, J. M., & McCord, D. M. (1996). The WAIS-R Comprehension and Picture Arrangement subtests as measures of social intelligence: Testing traditional interpretations. *Journal of Psychoeducational Assessment, 14*, 240-249.

Camarata, S., & Woodcock, R. (2006). Sex differences in processing speed: Developmental effects in males and females. *Intelligence, 34*, 231–252.

Cohen, J. (1952). Factors underlying the Wechsler-Bellevue performance of three neuropsychiatric groups. *Journal of Abnormal and Social Psychology, 47*, 359-365.

Cohen, J. (1957). The factorial structure of the WAIS between early adulthood and old-age. *Journal of Consulting Psychology, 21*, 283-290.

Couture, S. M., Penn, D. L., & Roberts, D. L. (2006). The functional significance of social cognition in schizophrenia: A review. *Schizophrenia Bulletin, 32, S1*, 44-63.

Cutting, J., & Murphy, D. (1990). Impaired ability of schizophrenics, relative to manics or depressives, to appreciate social knowledge about their culture. *British Journal of Psychiatry, 157*, 355-358.

Dickinson, D., Iannone, V. N., & Gold, J. M. (2002). Factor structure of the Wechsler Intelligence Scale III in schizophrenia. *Assessment, 9*, 171-180.

Donders, J., Tulsky, D. S., & Zhu, J. (2001). Criterion validity of the new WAIS-III subtest scores after traumatic brain injury. *Journal of the International Neuropsychological Society, 7*, 892-898.

Goldstein, G. (1984). Comprehensive neuropsychological assessment batteries. In G. Goldstein and M. Hersen (Eds.), *Handbook of Psychological Assessment* (pp. 282-310). New York: Pergamon Press.

Goldstein, G., Allen, D. N., Minshew, N. J., Williams, D., Volkmar, F., Klin, A., & Schulz, R. (2006, June). *Confirmatory factor analysis of the Wechsler scales in high functioning autism.* Presentation at the International Meeting for Autism Research, Montreal, Canada.

Green, M. F., Olivier, B., Crawley, J. N., Penn, D. L., Silverstein, S. (2005). Social Cognition in Schizophrenia: Recommendations from the Measurement and Treatment Research to Improve Cognition in Schizophrenia New Approaches Conference. *Schizophrenia Bulletin, 31*, 882-887.

Hawkins, K. A. (1988). Indicators of brain dysfunction derived from graphic representations of the WAIS-III/WMS-III technical manual samples: A preliminary approach to clinical utility. *The Clinical Neuropsychologist, 12*, 535-551.

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*, 1-55.

Jöreskog, K. G., & Sörbom, D. (1993). *LISREL 8 user's reference guide*. Chicago: Scientific Software International.

Kline, R.B. (2005). *Principles and practice of structural equation modeling* (2nd ed.). New York: Guilford.

Lawson, J. S., & Inglis, J. (1983). A Laterality Index of cognitive impairment after hemispheric damage: A measure derived from a principal-components analysis of the Wechsler Adult Intelligence Scale. *Journal of Consulting and Clinical Psychology, 51*, 832-840.

Leckliter, I. N., Matarazzo, J. D., & Silverstein, A. B. (1986). A literature review of factor analytic studies of the WAIS-R. *Journal of Clinical Psychology, 42*, 332-342.

Lee, J. E., Wong, C. M. T., & Day, J. D. (2000). Social and academic intelligences: A multi-trait multimethod study of their crystallized and fluid characteristics. *Personality & Individual Differences*, *29, 539*-553.

Lipsitz, J. D., Dworkin, R. H., & Erlenmeyer-Kimling, L. (1993). Wechsler Comprehension and Picture Arrangement Subtests and Social Adjustment. *Psychological Assessment, 5*, 430-437.

Matarazzo, J. D. (1972). Factorial structure of the W-B I and WAIS. In J. D. Matarazzo, *Wechsler's measurement and appraisal of adult intelligence* (5th ed.). New York: Oxford University Press.

McGeorge, P., Crawford, J. R., Kelly, S. W. (1996). The relationship between WAIS--R abilities and speed of processing in a word identification task. *Intelligence, 23,* 175-190.

Ostrum, T.M., 1984. The sovereignty of social cognition, in: Wyer, R.S., Skrull, T.K. (Eds.), Handbook of Social Cognition, vol. 1. Laurence Erlbaum, Hillsdale, NJ, pp. 1-37.

Plake, B. S., Gutkin, T. B., Wise, S. L., & Kroeten, R. (1987). Confirmatory factor analysis of the WAIS-R: Competition of models. *Journal of Psychoeducational Assessment, 3,* 267-272.

Psychological Corporation (1997). *WAIS-III WMS-III Technical Manual*. San Antonio, TX: Psychological Corporation.

Rapaport, D., Gill, M. M., & Schafer, R. (1968). *Diagnostic Psychological Testing* (rev. ed.). New York: International Universities Press.

Ryan, J. J., & Paolo, A. M. (2001). Exploratory factor analysis of the WAIS-III in a mixed patient sample. *Archives of Clinical Neuropsychology*, *16*, 151-156.

Ryan, J. J., Paolo, A. M., & Brungardt, T. M. (1990). Factor analysis of the Wechsler Adult Intelligence Scale-Revised for persons 75 years and older. *Professional Psychology: Research and Practice, 21,* 177-181.

Salovey, P., & Mayer, J. D. (1990). Emotional Intelligence. *Imagination, Cognition and Personality, 9*, 185–211.

Schafer, R. (1948). *The Clinical Application of Psychological Tests*. New York: International Universities Press.

Shean, G., Murphy, A., & Meyer, J. (2005). Social cognition and symptom dimensions. *Journal of Nervous and Mental Disease, 193*, 751-755.

Spearman, C. (1904). "General Intelligence" objectively determined and measured. *American Journal of Psychology, 15*, 201-293.

Steiger, J. H. & Lind, J. C. (1980, May). *Statistically based tests for the number of common factors.* Paper presented at the meeting of the Psychometric Society, Iowa City, IA.

Taylor, M. J., & Heaton, R. K. (2001). Sensitivity and specificity of the WAIS III/WMS III demographically corrected factor scores in neuropsychological assessment. *Journal of the International Neuropsychological Society, 7*, 867-874.

Thorndike, E. L. (1920). Intelligence and its uses. *Harper's Magazine, 140*, 227-235.

Thorndike, R. L., & Stein, S. (1937). An evaluation of the attempts to measure social intelligence. *Psychological Bulletin, 34*, 275-285.

Tooby, J., & Cosmides, L. (2000). Toward mapping the evolved functional organization of mind and brain. In M. S. Gazzaniga (Ed.), *The New Cognitive Neurosciences* (pp. 1167-1178). MIT Press: Cambridge, MA.

van der Sluis, S., Posthuma, D., Dolan, C. V., de Geus, E. J. A., Colom, R., & Boomsma, D. I. (2006). Sex differences on the Dutch WAIS-III. *Intelligence, 34,* 273-289.

Ward, L. C., Ryan, J. J., & Axelrod, B. N. (2000a). Confirmatory factor analyses of the WAIS-III standardization data. *Psychological Assessment*, *12*, 341-345.

Ward, L. C., Ryan, J. J., & Axelrod, B. N. (2000b). Observations on the factor structure of the WAIS-R. *Assessment*, *7*, 79-86.

Warrington, E. K., James, M., & Maciejewski, C. (1986). The WAIS as a lateralizing and localizing diagnostic instrument: A study of 656 patients with unilateral cerebral lesions. *Neuropsychologia*, *24*, 223-239.

Wechsler, D. (1958). *The Measurement and Appraisal of Adult Intelligence* (4th ed.). The Williams & Wilkins Company: Baltimore MD.

Wechsler, D. (1981). *Manual for the Wechsler Adult Intelligence Scale-Revised*. Psychological Corporation, New York.

Wechsler, D. (1997). *WAIS-III Administration and Scoring Manual*. San Antonio, TX. Psychological Corporation.

Table 1

*Historical Models and Models with a Social Cognition Factor.*

| WAIS-III Subtest | Historical Models | | | | Models with Social Cognition Factor | | | |
|---|---|---|---|---|---|---|---|---|
| | M1 | M2 | M3 | M4-PS | M5: PA,C | M5: PA,PC | M5: PA,OA | M5: PA,PC,OA |
| Vocabulary | g | V | VC | VC | VC | VC | VC | VC |
| Information | g | V | VC | VC | VC | VC | VC | VC |
| Similarities | g | V | VC | VC | VC | VC | VC | VC |
| Comprehension | g | V | VC | VC | SC | VC | VC | VC |
| Arithmetic | g | V | WM | WM | WM | WM | WM | WM |
| Digit Span | g | V | WM | WM | WM | WM | WM | WM |
| Letter-Number Sequencing | g | V | WM | WM | WM | WM | WM | WM |
| Digit Symbol-Coding | g | P | WM | PS | PS | PS | PS | PS |
| Symbol Search | g | P | WM | PS | PS | PS | PS | PS |
| Matrix Reasoning | g | P | PO | PO | PO | PO | PO | PO |
| Block Design | g | P | PO | PO | PO | PO | PO | PO |
| Picture Arrangement | g | P | PO | PO | SC | SC | SC | SC |
| Picture Completion | g | P | PO | PO | PO | SC | PO | SC |
| Object Assembly | g | P | PO | PO | PO | PO | SC | SC |

*Note*. g=general intelligence. V=Verbal Ability. P=Performance Ability. VC=Verbal Comprehension. PO=Perceptual Organization. WM=Working Memory. PS=Processing Speed. SC=Social Cognition.

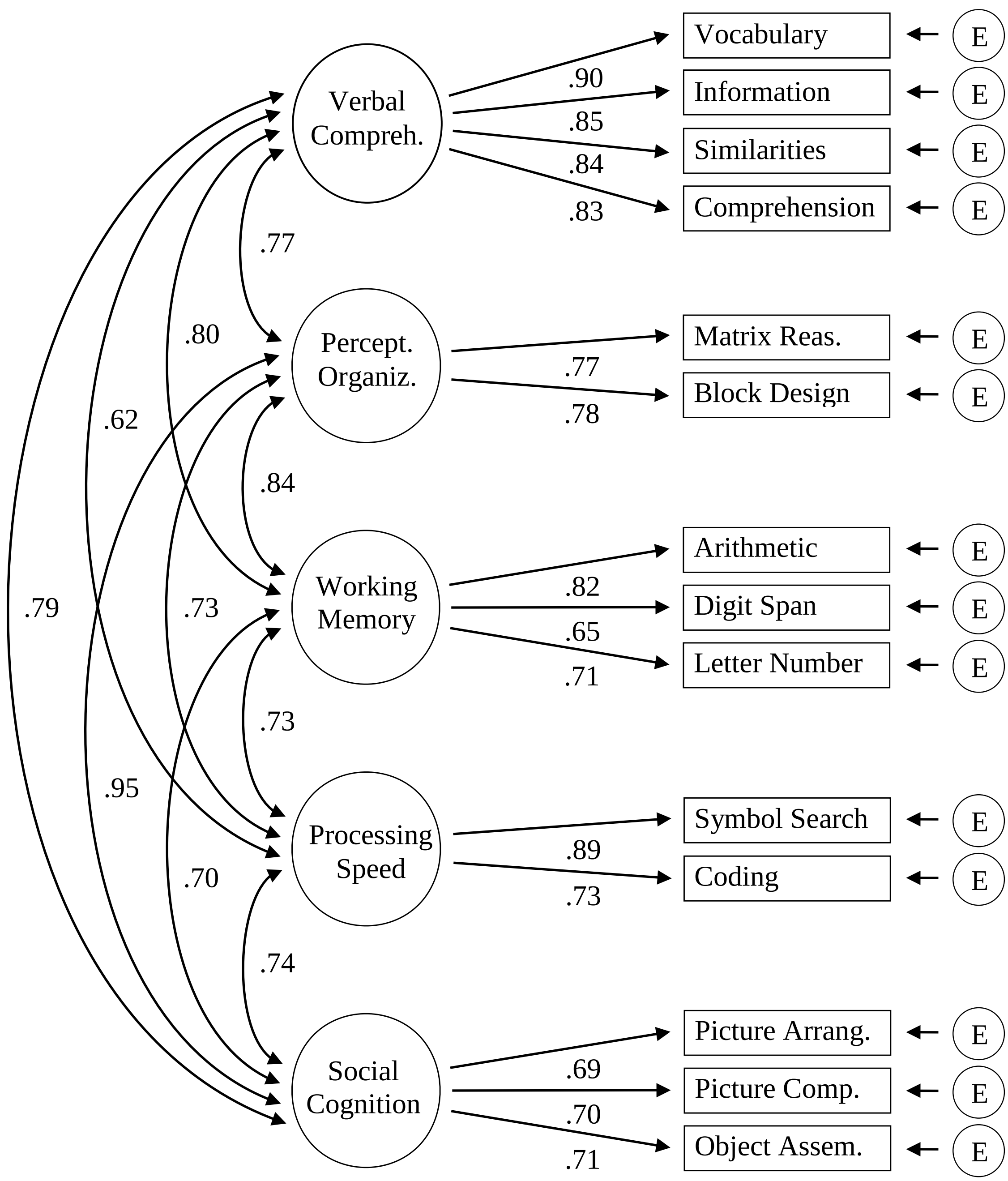
Table 2

*Goodness of Fit Indices for all models and subtest combinations for the WAIS-III standardization sample.*

| Model | Fit Indices | | | | |
|---|---|---|---|---|---|
| | $\chi^2$ | *df* | CFI | RMSEA | AIC |
| M5:PA,C | 912.87 | 67 | .96 | .07 | 988.87 |
| M5:PA,PC | 756.70 | 67 | .97 | .06 | 832.70 |
| M5:PA,OA | 742.23 | 67 | .97 | .06 | 818.23 |
| M5:PA,PC,OA | 702.60 | 67 | .97 | .06 | 778.60 |

*Note.* Chi-square for independence model = 20438.27; df = 91; n = 2450.

*Figure 1*. Model M5:PA,PC,OA. Best fitting model for 14 subtests.




*Note*. RMSEA = .06. CFI = .97.