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THE PREDICTIVE VALIDITY OF THE BATTELLE DEVELOPMENTAL
INVENTORY AS A MEASURE OF ADAPTIVE BEHAVIOR: A 2-3
YEAR, LONGITUDINAL COMPARISON WITH THE
SCALES OF INDEPENDENT BEHAVIOR

by

Clarice E. Jentsch

A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

Psychology

Approved:

UTAH STATE UNIVERSITY
Logan, Utah

1994

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ABSTRACT

The Predictive Validity of the Battelle Developmental Inventory as a Measure
of Adaptive Behavior: A 2-3 Year, Longitudinal Comparison with
the Scales of Independent Behavior

by

Clarice E. Jentsch, Master of Science
Utah State University, 1994

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Within the last 5 years, researchers have given increased attention to preschool assessment. One test, the Battelle Developmental Inventory, has become increasingly popular for use with preschool-age children. Despite its frequent use by early intervention programs, few researchers have studied the technical adequacy of the Battelle. The predictive validity of the Battelle was examined, using 154 children with disabilities. Scores on the Battelle for children 3 to 5 years of age were compared with scores on the Scales of Independent Behavior administered to the same children 2 to 3 years later. Moderate to strong relationships were found between the scores. Scores on the Battelle motor domains appeared to correlate the strongest with the Scales of Independent Behavior Total score. In general, the Battelle appeared to be a useful measure for predicting future performance on the Scales of Independent Behavior. (45 pages)

PROBLEM STATEMENT

Within the last 5 years, researchers have given increased attention to preschool assessment. One reason for the interest in preschool assessment is the passage of the Education of the Handicapped Act Amendments of 1986 (P.L. 99-457), which expanded public education to include early intervention programs (McLinden, 1989). With the opportunity for early intervention programs came the need for instruments that could not only identify children with disabilities but also help educators with diagnosis and program planning (Smith, Bauer, & Lyon, 1987).

Many problems with the usefulness and technical adequacy of preschool measures have been noted by researchers. In order to be technically adequate, a measure must be demonstrated to have reliability and validity. It also must have been normed on the population of its intended use. All test construction information should be reported in the test manual so that researchers can judge whether a measure is appropriate for a given study.

Some researchers contend that most preschool instruments (a) do not use multiple sources to collect data, (b) often penalize children with disabilities, and (c) lack instructionally relevant items (Guidubaldi & Perry, 1984). The instructional relevance of items is particularly important for preschool teachers, who use test information to make decisions regarding program planning. Neisworth and Bagnato (1986) contended that "...assessment that fails to provide instructionally relevant information is of little use to preschool teachers and therapists" (p. 180). Finding adequate assessment tools for preschool children with disabilities can be an even

greater challenge (Simeonsson & Bailey, Jr., 1988) because there is such a small population of preschool children with disabilities that it is difficult to find a representative sample for that population. Another problem in assessing child development is that frequently used tests may be valid indicators of the child's ability at the time, but they may lack adequate predictive validity, especially long-term predictive validity (Bayley, 1970 as cited in Anastasi, 1988). The field of early intervention is further plagued with a paucity of technically adequate preschool measures (Mott et al., 1986).

One test, the Battelle Developmental Inventory (BDI; Newborg, Stock, Wnek, Guidubaldi, & Svinicki, 1984), has become increasingly popular for use with preschool-age children. Mott (1987) cited three main reasons for the increased use of the BDI: (a) it can be used with a wide age range (0-8 years), facilitating follow-up assessments; (b) it is multifactored thus covering a variety of behavioral domains; and (c) it contains criterion-referenced items that closely match curricula used in many preschools, thus aiding in making program planning and placement decisions for that population. The BDI is also frequently used to determine the efficacy of early intervention programs (Lawson, Snyder, & Stricklin, 1991).

Neisworth and Bagnato (1986) found the behavioral content of the BDI congruent with the goals and tasks of frequently used infant and preschool curricula. They listed an additional advantage of using the BDI with children who have disabilities: Included in the manual are assessment adaptations for sensorimotor impairments and guidelines for accommodating specific disabilities.

Despite its frequent use by early intervention programs, few researchers have studied the technical adequacy of the BDI. Most research conducted on

its validity has focused on concurrent validity (e.g., Boyd, Welge, Sexton, & Miller, 1989; McLean, McCormick, Bruder, & Burdg, 1987; Mott, 1987; Pezzino, Mott, & Waidler, 1986; Sexton, Thompson, Perez, & Rheams, 1990). One group of researchers examined the predictive validity of the BDI but did not study its long-term predictive validity (e.g., Guidubaldi & Perry, 1984). No studies have been located that have included information on the long-term predictive validity of the BDI. Through this study, the long-term predictive validity of the BDI as a measure of adaptive behavior will be investigated. This study will be accomplished by correlating scores from the BDI and scores from the Scales of Independent Behavior (SIB; Bruininks, Woodcock, Weatherman, & Hill, 1984) obtained from a longitudinal study of young children with disabilities.

REVIEW OF THE LITERATURE

Background information on four concepts is important for understanding this study: preschool development, adaptive behavior, psychometric construct of predictive validity, and the variance issues associated with parent report. Preschool development and adaptive behavior are particularly important because it is within the framework of these structures that the usefulness of the Battelle Developmental Inventory (BDI) can be described. Also included in this review is information on researchers' findings related to the predictive validity of the BDI.

Preschool Development

Assessing preschool children poses some unique problems for psychologists. The characteristics of early childhood development require assessment methods that are developmental in nature. Researchers recommend looking at preschool development from a comprehensive developmental perspective that includes monitoring in several developmental and behavioral domains (Mott, 1987). They also point out that "competencies in play and socialization may be much more relevant and important than the traditional [assessment] preoccupation with cognitive skills" (Bagnato & Neisworth, 1991, p. 4). Focusing on competencies in socialization may be more useful because preschool children often lack the cognitive skills to participate in sophisticated cognitive assessment procedures (Martin, 1986). Also, scores of preschool children's intellectual abilities are not adequately stable over time. Measures given to children

under the age of 18 months have little or no predictive validity, but as the children get older, score validities become more moderate and stable (Anastasi, 1988).

Another problem with preschool assessment is linked to the developmental nature of preschool children. Although development occurs at observable increments, the appropriate behaviors exhibited at each age vary with each child. Although a child may exhibit deficits in one area, he or she may actually be developmentally advanced in other areas. The developmental qualities of behavior in preschool children necessitate the need for measures that assess varied behavioral domains.

Anastasi (1988) has suggested that measurement predictions might be improved if tests were based on developmental levels of children. She used the term "developmental transformations" to describe age-linked behaviors that are indicative of intellectual competence (p. 344). Studying developmental levels might aid researchers by helping to stabilize preschool assessment. As children get older, "individual differences widen, become increasingly more stable across age, and yield higher correlations with both genetic and environmental factors" (Anastasi, 1988, p. 343). Developmental levels or milestones are behaviors that are likely to occur by a certain age. Information on normal preschool development is included in this review because it is only within the construct of normal development that it is possible to understand or identify deviance or delay. Also, preschool development is linked to adaptive behavior. Adaptive behavior for an adult may be comprised of holding a job and responding to social rules in varied settings, whereas adaptive behavior for children encompasses skills such as

walking, talking, and basic self-care (Horn & Fuchs, 1987), which are all components of normal preschool development.

One of the primary behaviors assessed in preschool development is motor development. Motor development is especially important because "specific motor abilities are necessary for locomotion, communication, learning, and extensive interactions with the environment, all of which help to drive developmental processes" (Crnic & Harris, 1990, p. 16). Major milestones in preschool motor development include grasping, walking, jumping, and running. Fine motor skill development becomes of major importance after infancy because of its relationship to language development.

Language development follows a similarly established pattern. Development begins with prespeech and moves through gestural communication to expressive language. Language is critical to development because it greatly influences other abilities, especially cognition (Crnic & Harris, 1990). Language also is particularly important because many tests of cognitive skills depend on the child's ability to verbally respond. Cognitive development occurs through maturational stages that are linked to language development. It also involves certain degrees of attentional capabilities, which are particularly important for accurate testing of preschool children.

Along with motor, language, and cognitive development, social and emotional development have been shown to occur in incremental steps. Infants show some emotional responses as important adaptive components and then move to secondary emotions, such as pride, shame and guilt, by the middle of the second year of life. Likewise, social development occurs, beginning with attachments to people and moving to social referencing (Crnic & Harris, 1990).

Preschool development relies on a set of interrelated and yet separate skills. Even though the distinct developmental stages for various behaviors can be identified, it is difficult to pinpoint an exact age at which each behavior should occur. Also, it is possible for children to display some behaviors (e.g., talking) only in certain settings (e.g., home). Researchers must strive to use measures that assess various behavioral domains across a variety of settings (Neisworth & Bagnato, 1986). The valid identification of children at risk for delays helps improve the effectiveness of early intervention programs. By linking scores on assessments to normal characteristics of development, it is possible to identify children who might benefit from remedial training or intervention.

Adaptive Behavior

Adaptive behavior was originally labeled social competence by Edgar Doll (1953), a pioneer in the assessment of mental retardation. Current definitions of adaptive behavior vary (Kamphaus, 1987; McGrew, Bruininks, & Thurlow, 1992). Some models of adaptive behavior include social skills and adaptive behavior as subordinate constructs to the higher construct of social competence (Gresham & Elliott, 1987). Most researchers agree that adaptive behavior includes those skills necessary to function as independently as possible in the community. As Cohen (1988) has stated, it involves the "fit between individual performance and societal expectation" in relation to diverse cultural norms (p. 38-39).

The most influential definition of adaptive behavior to date comes from the American Association on Mental Retardation (AAMR). According to the AAMR, adaptive behavior is the "...effectiveness or degree with which

the individual meets the standards of personal independence and social responsibility..." (Grossman, 1983, p. 1). Situational specificity and performance rather than achievement also are important components of adaptive behavior (Bruininks, Thurlow, & Gilman, 1987). Consistent with Grossman's (1983) definition, Cicchetti and Sparrow (1990) stated that there are four main elements in the definition of adaptive behavior: Adaptive behavior is "(a) age-related (becoming increasingly more complex as one grows older); (b) defined by societal standards (or expectations); (c) measured in terms of typical behavior, not ability; and (d) modifiable" (p. 174). Societal expectations are key because a person's behavior may be adaptive only in certain settings (Horn & Fuchs, 1987).

The American Association on Mental Retardation (AAMR) published a new definition of mental retardation in 1992 based on concerns regarding past reliance on IQ-derived scores for diagnosis. The new definition allows clinicians to focus on how individuals function within their environments and facilitates the identification of needed supports (AAMR, 1992). The following is the AAMR definition of mental retardation:

Mental retardation refers to substantial limitations in present functioning. It is characterized by significantly subaverage intellectual functioning, existing concurrently with related limitations in two or more of the following applicable adaptive skill areas: communication, self-care, home living, social skills, community use, self-direction, health and safety, functional academics, leisure, and work. Mental retardation manifests before age 18. (p. 1)

Adaptive skill areas replaced the general construct of adaptive behavior in the AAMR definition of mental retardation. By identifying low functioning within specific skill areas, the new diagnosis facilitates identification of skills to target for remediation. It also helps identify skill areas that are strengths

within a person, allowing educators to maximize a person's level of independence within the community.

Adaptive behavior is a critical construct because deficiencies in adaptive behavior limit a person's ability to function independently. Bruininks et al. (1987) indicated that interpersonal and social skill deficiencies are the main reasons persons with mental retardation do not obtain employment or remain in job settings. Early identification improves the chances that children who might not receive any formal adaptive behavior training until they attend school get the training they need to be successful in the regular classroom. Successful intervention and training in adaptive behavior may reduce the need for student placement in isolated or self-contained programs (Reschly, 1990).

Assessment of adaptive behavior has become increasingly important as normalization rather than institutionalization has become a goal for people with mental retardation. It also has been influenced by the demand for greater integration of regular and special education students in public schools. Adaptive behavior assessment has two primary purposes: classification and program planning. Classification is especially important when determining eligibility for specialized services. To classify someone as mildly mentally retarded, the person must exhibit concurrent deficits in intellectual functioning and adaptive behavior (Harrison, 1987; Harrison, 1990; Middleton, Keene, & Brown, 1990). No longer is low intellectual functioning the only criterion for classification of mental retardation (Horn & Fuchs, 1987). Also important are deficits in specific adaptive skill domains (AAMR, 1992).

After classification is completed, information derived from adaptive behavior assessment is useful for program planning. Teachers can use scores on individual domains to target behaviors and plan interventions for students. The accuracy with which classification and program planning can be made is dependent on the technical adequacy of the instrument. Educational decisions must be based on tests that reliably measure what they were designed to measure.

Predictive Validity

Psychometrically sound tests are essential for valid identification of individuals who might benefit from training in adaptive behavior. Measures must be both valid and reliable to be technically adequate. Reliability refers to the consistency of scores across time or under different conditions. Adequate reliability of a measure does not guarantee that it is also valid because data may be reliably administered and scored and may repeatedly yield the same scores but may not measure what the authors purport the data to measure. Accurate conclusions from test information cannot be made unless measures are both reliable and valid (Lawson et al., 1991).

A valid test is a test that measures what it is designed to measure. This simplistic definition can be misleading because there are many forms of validity, and some tests are valid only for specified uses. Predictive validity, which is one form of criterion-related validity, measures the "degree to which the predictions made by a test are confirmed by the later behavior of the subjects" (Borg & Gall, 1989, p. 252). It measures the likelihood that given behaviors will occur in the future.

Predictive validity differs from another form of criterion-related validity called concurrent validity. Concurrent validity is determined by comparing children's scores on a measure to scores on some criterion made at the same time, whereas a time lapse in assessment occurs with predictive validity. Using preschool measures with valid predictive features helps improve the chances that children who are at risk of developmental delays are identified for inclusion in early intervention programs. Users should evaluate a measure's predictive validity based on the intended use and the importance of the decision to be made in order to determine if a chosen instrument is appropriate (Bracken, 1987).

Sources of Variance

The data collection technique used to gather information about individuals can affect the validity of the test results. Behavior ratings are often used to make judgments about a person's social or adaptive functioning level as a matter of convenience. One advantage of using checklists that asks questions about a person's behavior in different settings is that checklists can be completed fairly quickly. Using direct observation in naturalistic settings is often time-consuming, thus limiting its practical use. Behavioral ratings can be accomplished in a short period by many different individuals, thus providing a plethora of information about a person in a relatively short time period. Another advantage to using checklists is that scores can be more easily standardized so that comparison of findings across individuals and studies is facilitated.

The disadvantage to using checklists is that reports can be biased--that is, a person might make a guess as to the functioning level of an individual

but that guess is not made from systematic data collection techniques. Rather, the observation is made from "cumulative, uncontrolled observations of daily life" (Anastasi, 1988, p. 645). In order to improve the accuracy of the report, several considerations should be made. First, the person making the rating should have had contact with the person in the relevant setting. For example, if a teacher does not know how well a person dresses him- or herself because the teacher does not aid in this kind of caregiving, the rating should be made by another person.

Second, the halo effect also is a problem. The halo effect occurs when one characteristic about a person affects the way he or she is viewed in other arenas. For example, a student may justly receive A's in math. Unknowingly, the teacher may let the A grade affect the grade the student receives in spelling. The math grade tends to influence the subjective judgment of the teacher in other areas. Likewise, the halo effect can occur in the negative direction. For example, a parent or teacher so frustrated with a particular student might tend to let an unfavorable trait influence ratings. To minimize the halo effect, researchers tie the behavioral ratings to concrete behaviors rather than subjective descriptors, and they use carefully formulated behavioral anchors (Anastasi, 1988).

Third, there also is a tendency to avoid judging people and placing them at the extremes. Two types of errors are derived from this: the error of central tendency and the leniency error. The error of central tendency reflects the tendency for people to rate individuals in the middle of the scale and avoid the extreme positions both positive and negative. The leniency error reflects the reluctance for people to rate people on the negative or unfavorable end of the scale. One way to combat the tendency for people to

avoid judging others is to train raters on techniques used in observation of behavior and to train them about rating scale formats (Anastasi, 1988).

Previous Research on the BDI

Little research has been conducted on the predictive validity of the BDI. Guidubaldi and Perry (1984) studied the concurrent and predictive validity of the BDI on 124 kindergarten children, using cognitive, personal-social, perceptual-motor, communication, adaptive behavior, and academic measures. They found the BDI to be a favorable predictor of first-grade achievement in reading and math. Correlations between the BDI scales and first grade Wide Range Achievement test scores ranged from .30 to .62.

Other researchers have examined the concurrent but not the predictive validity of the BDI. Mott (1987) looked at the concurrent validity of the BDI for children with speech and language disorders. She found that the BDI was useful for assessing children with speech and language disorders between the ages of 3 and 5 years and that the BDI measured skills comparable to other instruments designed to assess language. One advantage of the BDI, according to Mott, was that scores on different domains allowed for the comparison of language to other behavioral dimensions.

Bailey, Jr., Vandiviere, Dellinger, and Munn (1987) studied the BDI's usefulness for assessing preschool children with disabilities. They found preschool teachers thought the BDI was much less useful with the severely disabled population than with the mild population, with the most frequent complaint being the adaptations did not address unique disabilities. Teachers also reported that only about two-thirds of the items on the BDI were instructionally relevant.

Merrell and Mauk (1993) studied the BDI as a measure of social-behavioral development. The BDI was administered to subjects and then, after 2 to 3-year intervals, the subjects were rated by their parents on the Social Skills Rating System (SSRS; Gresham & Elliott, 1990). Merrell and Mauk found very weak to moderate relationships between the BDI and the SSRS. The sample from Merrell and Mauk's study participated in the same research study from which subjects were drawn for this study.

PURPOSE AND OBJECTIVES

The purpose of the study was to examine the long-term predictive validity of the Battelle Developmental Inventory (BDI) as a measure of adaptive behavior development. This purpose was achieved by obtaining correlations of BDI scores and scores from the Scales of Independent Behavior (SIB) at 2- to 3-year intervals, using longitudinal data from a large group of young children with disabilities.

Specifically, the study was designed to answer the following four primary research questions:

1. What is the relationship between scores on the BDI and scores on the SIB gathered 2 to 3 years later?
2. Does the magnitude of the relationship between these two measures indicate that the BDI is useful for predicting adaptive behavior development at a later point in time?
3. Does the BDI have differential predictive validity as an adaptive behavior measure for subjects younger than 3 years old versus subjects 3 years and older?
4. Can BDI and SIB scores predict gender of study subjects with a high degree of accuracy?

METHOD

Subjects

The target population for this study included 154 children. Subjects were from an array of socioeconomic backgrounds and included 61% ($n=94$) boys and 39% ($n=60$) girls. Subjects were part of a larger national longitudinal research project designed to study the effects of early intervention on children with disabilities (for a complete report of this project see White, 1991). The subjects for this project had a variety of disabilities. The most frequent diagnoses were developmentally delayed ($n=42$, 26%), cognitively impaired ($n=33$, 21%), Downs Syndrome ($n=19$, 12%), and language impaired ($n=16$, 10%). Other disabilities included motor impaired, cerebral palsy, multihandicapped, and "other." Subjects were from various research sites throughout the U.S. Approximately 85% of the population was Caucasian and 15% were from minority groups. African-American subjects (about 5%) comprised the largest non-Caucasian group.

Procedure

Social-behavioral data consisted of subject's scores on the Battelle Developmental Inventory (BDI; Newborg et al., 1984) and the Scales of Independent Behavior (SIB; Bruininks et al., 1984). The subjects' BDI scores were obtained at their entry into the longitudinal study through parent interviews, direct observation, and standardized testing. The subjects were preschool age at the time the BDI was administered, ranging from 2 to 5 years

old. The subjects' SIB scores were obtained 2 to 3 years after the BDI score was obtained through a standardized assessment interview with parents of the subjects. When the SIB scores were obtained, the subjects ranged in age from 5 to 8 years old.

Instruments

Battelle Development Inventory

The Battelle Development Inventory (BDI) is an early childhood assessment battery, which is individually administered to children birth to 8 years old. Nationally normed, the BDI is used for the identification of developmental strengths and weaknesses of handicapped and nonhandicapped children; it also is used for screening of those children at risk for developmental delays.

The subjects' scores are yielded through parent interviews by trained examiners, direct observation, and standardized testing. The battery yields 30 subdomains across 5 domains, which include Personal-Social, Adaptive, Motor, Communication, and Cognitive. The BDI's 341 items have been grouped into 30 subdomains designed to measure specific skill areas such as adult interaction, eating, fine motor, and memory. An outline of the items, domains, and recording responses of the BDI is included in Figure 1.

Items are scored on a 3-point scale with 0 equal to rarely or never, 1 equal to sometimes (50%), and 2 equal to typical (90%). Scores are derived through a combination of methods: a structured format, interviews with parents or other primary caregivers, and observation.

BDI Total Items	Domains (5)	Subdomains (30)	Recording Responses
341 total items	Personal-Social, Adaptive, Motor, Communication, and Cognitive	(e.g., adult interaction, eating, fine motor, memory, etc.)	2 = typical (90% of the time) 1 = sometimes (50% of the time) 0 = rarely or never

Figure 1. An outline of the items, domains and recording responses of the BDI.

BDI normative data were collected using 800 children, across four geographic regions (24 states). Approximately 75% of the subjects were from urban settings, and 25% were from rural settings. Subjects included 49% males and 51% females. Subject ethnicity was 84% white and 16% minority, which included mainly African-American and Hispanic individuals.

Reliability data for the BDI are adequate to good. Test-retest reliability, collected during a 4-week time span, reportedly ranges from .76 to .99 on the subdomains; most coefficients are above .85. Interrater reliability ranges from .70 to 1.0 on the subdomains, with most above .80. Interrater reliability ranges from .70 to 1.0 on the subdomains, with most above .80. No information on internal consistency is reported in the test manual.

The authors stated that content validity of the BDI was ensured by lengthy test development, which included item review by content experts. Construct validity data were reported based on intercorrelations between domain scores, subdomain scores and the total score. The resulting correlations were approximately .80 and above.

For concurrent validity, the authors reported correlations between the BDI and the Vineland Social Maturity Scale (Doll, 1965), the Developmental Activities Screening Inventory (DASI, Dubose & Langley, 1977), Stanford-Binet Intelligence Scale (Terman & Merrill, 1960), the Wechsler Intelligence Scales for Children-Revised (WISC-R; Wechsler, 1974), and the Picture Vocabulary Test-Revised (PPVT-R; Dunn & Dunn, 1981). Coefficients reported in the manual between the BDI subdomain scores and the tests listed above are as follows:

1. Vineland--coefficients range from .79 to .94.
2. DASI -- coefficients range from .78 to .92.
3. Stanford-Binet -- coefficients range from .41 to .61.
4. WISC-R Full Scale IQ -- coefficients range from .42 to .79.
5. PPVT-R -- coefficients range from .36 to .83.

In sum, the BDI appears to have adequate psychometric properties for use with young children. However, little research has been conducted to extend the validation performed by its authors.

Scales of Independent Behavior

The Scales of Independent Behavior (SIB; Bruininks et al., 1984) are used to assess behaviors that are required for individuals to function independently at home and in community settings. Designed for use from infants to adults, the SIB consists of three components: the Broad Independence Scale, the Early Development Scale, and the Short Form Scale. The Broad Independence Scale measures two main areas, Problem Behavior and Adaptive Behavior, and is administered individually. Figure 2 illustrates the areas and domains on the Broad Independence Scale.

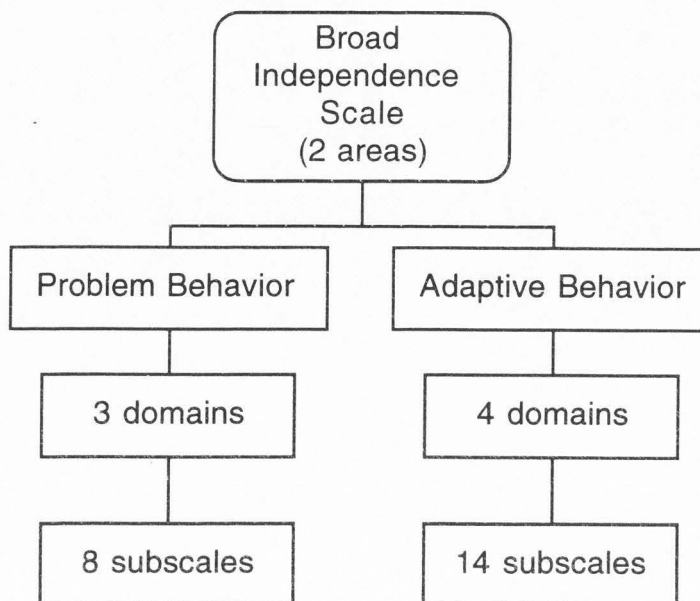


Figure 2. The domains on the SIB Broad Independence Scale.

The Adaptive Behavior area is comprised of four main clusters of behaviors called domains. The four domains are as follows: Motor Skills, Social Interaction and Communication Skills, Personal Living Skills, and Community Living Skills. The four domains are comprised of 14 subscales that consist of 226 items. The Problem Behavior area consists of three domains as follows: Internalized Maladaptive Behavior, Asocial Maladaptive Behavior, and Externalized Maladaptive Behavior. The Problem Behavior domains are further broken down into eight subscales. Figure 3 illustrates the four domains that comprise the Adaptive Behavior Area.

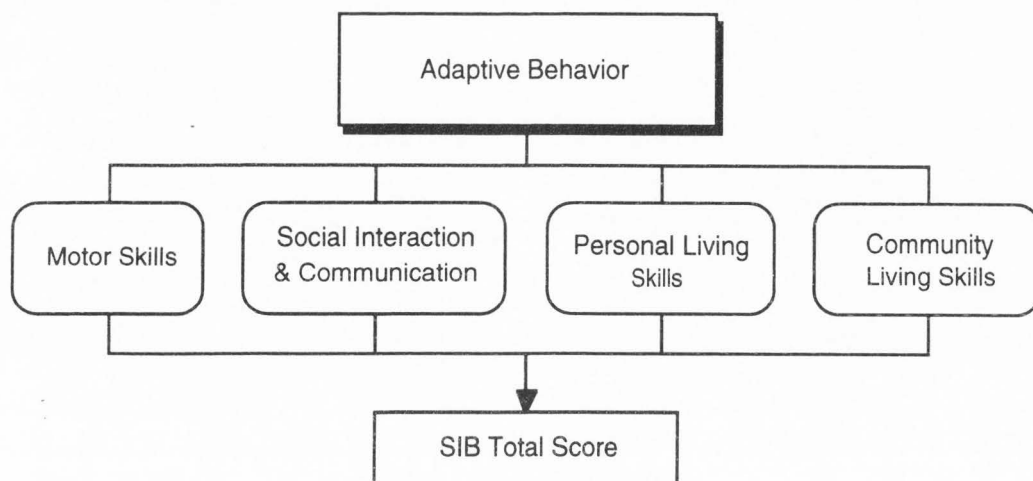


Figure 3. An illustration of the four domains that comprise the Adaptive Behavior Area.

SIB items, which are written in precise behavioral statements, are scored differently for the two subdomains. Adaptive Behavior items are scored using a 4-point Likert-type scale with 0 equal to never or rarely, even if asked and 3 equal to does very well, always or almost always without being asked. Problem Behavior items are scored on a 5-point Likert-type scale for frequency and severity.

The SIB was standardized on 1,700 subjects, the same subjects used for the standardization of the Woodcock-Johnson Psycho-Educational Battery (Woodcock & Johnson, 1977). The sample population used to collect normative data ranged from infants to 40 years and was demographically distributed.

Reliability data for the SIB generally are good. Test-retest reliability was reported in the manual to be in the .80s and .90s, and a few coefficients were reported in the .70 range. Split-half reliability was reported to average in the .90 range, although split-half reliability for some populations (i.e., adolescents and preschoolers) was low.

Validity data reported in the manual indicate that the SIB have good content validity. To illustrate construct validity, the authors made the assumption that scores would systematically improve with the age of various subjects tested. They reported scores from various populations to illustrate the construct validity of the SIB. For criterion-related validity, the authors compared scores on the Broad Independence Scale of the SIB to subjects' scores on the AAMD Adaptive Behavior Scale (School Edition). Coefficients ranged from .45 to .91 for the various domains.

RESULTS

Scores on the BDI obtained upon entry into the longitudinal project and scores on the SIB obtained 2 to 3 years later were analyzed by computing Pearson product-moment correlations. The relationships between scores on the two instruments were examined in five stages. First, correlations were computed for all subjects ($N=154$). Second, the shared variance between the BDI domain and subdomain scores and the SIB total score was calculated. Third, the relationship between scores on the two instruments was calculated for subjects younger than three years old ($n=56$). Fourth, correlations were computed for subjects 3 years and older ($n=98$). And fifth, a discriminant function analysis was conducted to determine if scores could accurately classify the subjects based on the grouping variable of gender.

All Subjects

Correlations between BDI and SIB scores are presented in Table 1. These correlations ranged from weak to moderately strong. Most coefficients were significant at the $p < .001$ level, although a few coefficients were significant at the $p < .01$ level. The lowest coefficient was between scores on the Personal-Social domain of the BDI and the Motor Skills domain of the SIB (.24). The next lowest correlation (.28) was between scores on the Personal-Social domain of the BDI and the Personal Living Skills domain of the SIB. The highest correlation (.69) was between the Motor (total) domain of the BDI and the Personal Living Skills domain as well as the total score on the SIB. More than half of the coefficients were .5 or above, and about 23%

were .6 and above. Only 13% (5 out of 40) were below .40. Correlations between the BDI total score and the SIB scores were consistent, ranging from .53 to .58.

Correlations between the BDI domain scores and the SIB total score ranged from .35 to .69. For the SIB total score, the lowest coefficient (.35) was

Table 1

Correlations Between Domain Scores on the BDI and the SIB for All

Subjects (N = 154)

Battelle Developmental Inventory	Scales of Independent Behavior				SIB total score
	Motor skills	Social interaction & communication	Personal living skills	Community living skills	
Personal social	.24*	.42	.28	.39	.35
Adaptive behavior	.55	.57	.60	.57	.63
Motor total	.68	.54	.69	.55	.69
• Gross motor	.64	.44	.64	.45	.61
• Fine motor	.60	.57	.62	.60	.67
Communication total	.34	.54	.43	.52	.50
• Receptive communication	.28	.45	.34	.42	.41
• Expressive communication	.26*	.48	.32	.46	.41
Cognitive	.35	.53	.41	.46	.48
BDI total score	.48	.55	.53	.53	.58

*These correlations are significant at $p < .01$; all others are significant at $p < .001$.

between the SIB total score and the BDI Personal-Social domain. The highest coefficients were between the SIB total score and the following BDI domain scores: the BDI total (.58), the Adaptive Behavior Domain (.63), the Motor total (.69), the Gross Motor subdomain (.61), and the Fine Motor subdomain (.67). Scores on the BDI Motor domain and motor subdomains appeared to correlate the highest between scores on all the SIB domains and the SIB total score.

Shared Variance

The next analysis was conducted to determine the amount of shared variance between BDI domain scores and the SIB total score by calculating the Coefficient of Determination, which is obtained by squaring the correlation coefficients. For example, if the correlation between the total scores of the two measures was .50, the coefficient of determination (r^2) would be .25, indicating that the measures share 25% of their variance.

Results from this analysis are included in Table 2. The r^2 values ranged from .13 to .48. The two domains with the highest degree of shared variance with the SIB total were the Motor domain (.48) and the Gross Motor subdomain (.45). The lowest degree of shared variance (.13) was obtained between the BDI Personal-Social domain and the SIB total.

Coefficients for Two Age Groups

Subjects Younger than 3 Years Old

The next phase in the analysis was conducted to examine the relationship of scores for subjects who were younger than 3 years old at the time the SIB was administered. The purpose of this analysis was to identify any differences between correlations for different-age subjects. Coefficients for scores on both instruments of subjects younger than 3 years old are included

Table 2

Shared Variance Between BDI Domain Scores and the SIB Total Score: R^2 Values Reported in Descending Order

BDI domains	SIB total
Motor total	.48
• Gross motor	.37
• Fine motor	.45
Adaptive behavior	.39
BDI total score	.34
Communication total	.25
• Receptive communication	.17
• Expressive communication	.17
Cognitive	.23
Personal social	.13

in Table 3. Most correlations were significant at the $p < .001$ level; five of the coefficients were significant at the $p < .01$ level. Coefficients were weak to moderately strong, ranging from .36 to .70. Overall, the SIB domain score that correlated the highest with the BDI scores, including the BDI total score, was

Table 3

Correlations Between Domain Scores on the BDI and the SIB for Subjects Less Than 3 Years of Age (n=56)

Battelle Developmental Inventory	Scales of Independent Behavior				
	Motor skills	Social interaction & communication	Personal living skills	Community living skills	SIB total score
Personal social	.36*	.54	.46	.41*	.46
Adaptive behavior	.49	.63	.59	.55	.58
Motor total	.59	.43	.58	.57	.62
• Gross motor	.53	.43	.51	.46	.54
• Fine motor	.61	.62	.63	.63	.65
Communication total	.44	.66	.56	.58	.59
• Receptive communication	.42*	.62	.57	.57	.56
• Expressive communication	.36*	.57	.41*	.47	.49
Cognitive	.51	.70	.61	.60	.61
BDI total score	.55	.68	.64	.61	.65

*These correlations are significant at $p < .01$; all others are significant at $p < .001$.

the Social Skills and Communication Skills domain with coefficients ranging from .43 (BDI Motor Total and Gross Motor domain) to .70 (BDI Cognitive domain). The SIB domain score that correlated the lowest with the BDI scores was the Motor Skills domain score with coefficients ranging from .36 to .61.

For BDI domains, the BDI total and the Fine Motor subdomain appeared to have the strongest correlations with the SIB domains with all correlations at .60 and above. The lowest coefficient (.36) was found between the Personal Social domain on the BDI and the Motor Skills domain on the SIB. The same coefficient value (.36) was obtained between the BDI Expressive Communication subdomain and the SIB Motor Skills domain.

Subjects 3 Years and Older

The next phase in the analysis was conducted to examine the relationship of scores for subjects who were older than 3 years of age at the time the SIB was administered. Coefficients for scores on both instruments of subjects older than 3 years of age are included in Table 4. Most of the coefficients were significant at the $p < .001$ level and were weak to moderately strong, ranging from .33 to .77. Coefficients between the Receptive Communication subdomain and the SIB domains were low, ranging from .25 to .45. In contrast, coefficients for the BDI Receptive Communications Subdomain and SIB domains for subjects less than 3 years of age ranged from .56 to .62.

For older subjects, coefficients between the BDI Cognitive domain and SIB domain scores also were low, ranging from .26 to .43. In contrast, coefficients for the BDI Cognitive domain and SIB domains for subjects less than 3 years of age ranged from .60 to .70.

The BDI Adaptive Behavior domain appeared to correlate the highest with the SIB domains. Coefficients between the BDI Adaptive Behavior and the SIB domains ranged from .64 to .77. The correlation between the BDI Adaptive Behavior domain and the SIB total was .76. In contrast, the coefficient between the BDI Adaptive Behavior domain and the SIB total for subjects less than 3 years of age was .58.

Table 4

Correlations Between Domain Scores on the BDI and the SIB for Subjects 3 Years or Older (n=98)

Battelle Developmental Inventory	Scales of Independent Behavior				SIB total score
	Motor skills	Social interaction & communication	Personal living skills	Community living skills	
Personal social	.26**	.50	.34	.44	.40
Adaptive behavior	.69	.68	.77	.64	.76
Motor total	.75	.53	.77	.54	.74
• Gross motor	.75	.43	.74	.46	.69
• Fine motor	.65	.61	.71	.62	.74
Communication total	.34	.56	.46	.52	.51
• Receptive communication	.25**	.45	.34	.38	.39
• Expressive communication	.24**	.50	.36	.49	.41
Cognitive	.26*	.43	.33	.39	.40
BDI total score	.49	.57	.58	.53	.60

**These correlations are not statistically significant.

*These correlations are significant at $p < .01$.

All others are significant at $p < .001$.

The BDI Motor Domain and the Gross and Fine Motor subdomains also appeared to strongly correlate with SIB domains. Both the Motor Total and the Fine Motor Domain appeared to have slightly stronger correlations with SIB domain scores than did the Gross Motor Domain.

Discriminant Analysis

The last phase of analysis, a discriminant function analysis, was conducted to determine if scores on the SIB and the BDI could be used to classify subjects based on gender. The combined subscale scores of the BDI and SIB were utilized as classification variables, while gender was used as a predictor or grouping variable. The results from the discriminant analysis were not significant: $F(11) = .92, p < .33$, indicating that the BDI and SIB scores could not be used to classify or predict the gender of subjects with a high degree of accuracy. Overall, only about 61% of the "grouped" cases were classified correctly, a figure only slightly higher than chance prediction.

DISCUSSION

All Subjects

Overall, the BDI appears to be a good predictor for future performance on the SIB. The shared variance (r^2) between the SIB total score and the BDI total was .34, indicating that the measures share 34% of their variance. This relationship is a moderate one indicating that the BDI is a moderate predictor of future performance on the SIB.

The highest correlation (.69) was between the Motor (total) domain of the BDI and the Personal Living Skills domain as well as the total score on the SIB. An interpretation of this result indicates that motor skills correlate highly with behaviors associated with personal living as well as with overall adaptive behavior. The relationship between motor skills and personal living skills makes logical sense as motor skills might be seen as a requisite skill to perform many self-care behaviors independently (e.g., the ability to button a shirt, brush one's teeth, etc.). Interestingly, the BDI motor domain correlated higher with SIB scores than the BDI Adaptive Behavior domain. Although the correlation between the BDI Adaptive Behavior domain and the SIB total is only slightly less than with the Motor domain, it is interesting to note that the construct of Adaptive Behavior did not correlate as highly as Motor with the SIB, which is an adaptive behavior measure. One explanation might be that the construct of adaptive behavior on the SIB and the BDI might be somewhat different as the BDI is designed to assess more

overall developmental issues and the SIB more specifically adaptive behavior.

The lowest coefficient was between scores on the Personal-Social domain of the BDI and the Motor Skills domain of the SIB (.24). In some ways, the low coefficient between the Motor score on the SIB and the Personal-Social domain on the BDI lends credibility to these two domains measuring different behavioral constructs, providing some evidence of divergent construct validity. However, the Personal-Social domain coefficients were the lowest across all the SIB domains and the SIB total (.35). It appears that the BDI Personal-Social domain is the least useful in predicting future performance on the SIB.

The Communication Total of the SIB correlated the highest with the Social Interaction and Communication domain on the SIB (.54). It also correlated similarly with the Community Living Skills on the SIB (.52). It appears that the construct of communication is reflected both in social interaction and the ability to function in the community greater than with motor skills and personal living skills.

The BDI Cognitive domain correlated the highest with the Social Interaction and Communication domain on the SIB (.53). The relationship can be explained in terms of the need to be able to communicate in order to illustrate to care-givers or observers one's needs. It is difficult to assess the cognitive capabilities of a child who cannot communicate verbally.

Coefficients for Two Age Groups

Subjects Younger than 3 Years Old

The relationship between scores for subjects who were younger than 3 years old at the time the BDI was administered was also examined. The purpose of this analysis was to identify if there would be a difference between correlations for different-age subjects. Coefficients were higher than expected for this analysis. It was hypothesized, based on the unstable nature of early childhood intelligence and the wide range of abilities accepted in the realm of normal development, that coefficients for the younger children would be much lower than scores for the older children. Children who were younger than 3 at the time the BDI was administered would have been only 5 to 6 at the time the SIB was administered, the age at which individual intelligence and development begins to stabilize and intelligence tests become more reliable estimates of children's abilities.

When all subjects were included in the analysis, the coefficient between the Social Skills and Communication Skills domain on the SIB and the Cognitive domain on the BDI was .53, but with only the younger-age subjects the coefficient was .70. All scores for the BDI Cognitive domain as correlated with SIB domains were greater with the younger children. Interpretation of the results indicates that the Cognitive domain is a strong predictor of future performance on the SIB. This is a useful finding for preschool programs who screen children for special education services. It shows that the BDI can help determine which children might be at later risk

for requiring adaptive behavior assessment in order to qualify under the classification of mental retardation.

Again, the BDI Motor Total was a strong predictor of future performance on the SIB. This relationship emphasizes the importance of motor skills in the evaluation of children's developmental level. Even the BDI total score correlated modestly with the SIB total score (.65). The BDI appears to be a strong predictor of future performance on the SIB for children under the age of 3.

The SIB domain score that correlated the highest with the BDI scores, including the BDI total score, was the Social Skills and Communication Skills domain with coefficients ranging from .43 (BDI Motor Total and Gross Motor domain) to .70 (BDI Cognitive domain). It appears that the BDI total score is especially useful for predicting future performance on the Social Skills and Communication Skills domain of the SIB. This could reflect that the BDI might measure social skills and communication to a greater extent than other behaviors for young children. The SIB domain score that correlated the lowest with the BDI scores was the Motor Skills domain score with coefficients ranging from .36 to .61. The low correlation between the SIB Motor total and all other BDI scores is consistent with the coefficients calculated for the entire sample.

Subjects 3 Years and Older

The next phase in the analysis was to examine the relationship of scores for subjects who were older than 3 years of age at the time the SIB was administered. For older children, coefficients were more scattered, ranging from weak to strong, than they were for the younger children. The BDI

Adaptive Behavior domain appeared to correlate the highest with the SIB domains. Coefficients between the BDI Adaptive Behavior and the SIB domains ranged from .64 to .77. The correlation between the BDI Adaptive Behavior domain and the SIB total was .76. In contrast, the coefficient for the BDI Adaptive Behavior domain and SIB total for subjects less than 3 years of age was .58. One explanation for the difference between the coefficients is that adaptive behavior for older children as measured by the BDI more closely reflects the construct of adaptive behavior as measured by the SIB. For younger children, it appears that motor skills is a stronger predictor of future performance on the SIB. Another explanation is that true adaptive behavior begins to emerge more readily at older ages and that younger children's developmental levels are more closely monitored by the Cognitive domain on the BDI.

The BDI Motor domain and the Gross and Fine Motor subdomains also appeared to correlate strongly with SIB domains. Both the Motor Total and the Fine Motor domain appeared to have slightly stronger correlations with SIB domain scores than did the Gross Motor domain. The strong correlation with SIB scores and the Motor Total on the BDI was a consistent finding throughout the analysis.

For older subjects, coefficients between the Receptive Communication subdomain and the SIB domains were lower, ranging from .25 to .45. In contrast, coefficients for the BDI Receptive Communications Subdomain and SIB domains for subjects less than 3 years of age ranged from .56 to .62. The difference might be explained in relation to the types of communication that a parent engages in with a young child as opposed to an older child. Younger children are more likely to experience orienting responses to receptive

communication (e.g., "hello" and the child looks). An older child is more likely to be given commands or orders from the parent (e.g., put your toys away). If the older child does not follow through on the command, the parent might construe this lack of follow through to mean that the child does not understand. The relationship also might be the result of poor understanding in communication. The child may very well have difficulty understanding demands or strings of commands, which might reflect attentional difficulties as well as other problems.

For older subjects, coefficients between the BDI Cognitive domain and SIB domain scores also were low, ranging from .26 to .43. In contrast, coefficients for the BDI Cognitive domain and SIB domains for subjects less than 3 years of age ranged from .60 to .70. One explanation for the difference in coefficients between the two age groups might be that intervention greatly affected the children's cognitive abilities for the older subjects. Given the unstable nature of intelligence below school age, intervention might have improved the cognitive abilities of the children who participated in this study. These children had originally been identified as having a developmental disability and many of them came from low SES families. The intervention for the older children may have provided a differentially positive effect on the older children. Another explanation is that the older children were more likely involved in a public school system. The educational and social benefits of being in public school all or part of the day may have had a greater impact than early intervention alone.

Comparison with Other Research

No study was located that specifically examined the predictive validity of the BDI as compared to the SIB. Several studies were located that compared the BDI to other measures with concurrent or criterion-related validity (not predictive validity) as the focus (e.g., McLean et al., 1987; Sexton, McLean, Boyd, Thompson, & McCormick, 1988).

One study was located that specifically included information on the predictive validity of the BDI. Merrell and Mauk (1993) examined the relationship between the BDI and the Social Skills Rating System on the same sample population that was used for the current study. They found weak to modest relationships, providing limited support for the BDI as a predictive measure for social-behavioral development. The current study results are stronger than those found by Merrell and Mauk. The current study results ranged from weak to strong with most coefficients in the moderate to moderately strong range. The difference between the two studies' results can be explained in terms of the types of relationships examined. It appears the BDI is more reflective of future, global adaptive behavior performance than specific social skill performance.

Practical Implications of the Study

Even though the study is limited in scope, the results provide some means for generating practical information related to use of the BDI. First, the BDI appears to be a generally good instrument for predicting future performance on the SIB. This is useful information for planning appropriate interventions for children with disabilities. Because children must have both

intellectual and adaptive behavior deficits in order to qualify for the classification of mental retardation, the BDI can be used to help screen for individual qualification in developmental preschools. Second, it appears that motor skills might be strong predictors of future functioning in the area of adaptive behavior particularly for younger children. The third implication is that the BDI may closely resemble the SIB, which is frequently used to make classification decisions related to special education services. This can provide much needed historical information related to particular students. For example, BDI scores can be used to help judge whether a student has had strengths or weaknesses in particular domains since early childhood. If scores are dramatically different and injury is suspected, this can provide useful information for the clinician. The fourth implication is that the BDI is a useful instrument for early childhood assessment, an area which has too few valid assessment tools (Mott et al., 1986).

Study Limitations

The current study has several limitations that may hinder the generalizability of the results. First, this study does not represent the BDI's overall predictive validity. It only represents a possible relationship between the BDI and the SIB. This study would need to be replicated by other researchers in order to draw more global conclusions in relation to the sample population from the data presented. Second, the entire sample used in this study was comprised of children of varying disabilities. It is unclear how this may have affected the results obtained on the measures and how it impacted the statistical analysis. This study would need to be replicated with

a group of subjects that represented a more normal distribution in order for the results to be generalized to sample populations without disabilities.

Implications for Future Research

The study's findings have several implications for future research. First, it would be useful to determine the relationship between the cognitive domain on the BDI and intelligence tests administered several years later. The possibility of gaining a fairly stable measure of intelligence for young children could have profound implications for the types of interventions used in developmental preschools. Second, because little research was found to validate the validity of the BDI in general, and more specifically the predictive validity of the BDI, it is apparent that more research needs to be done in this area. The BDI is frequently used to identify children who are developmentally delayed. With little research to support its technical adequacy, only limited justification can be given for its use. Furthermore, additional research should be conducted to validate existing measures like the BDI in relation to frequently used measures like the SIB in order to advance the field of early childhood assessment.

Summary

In summary, the BDI appears to be a useful measure for predicting future performance on the SIB. Coefficients ranged from weak to strong, with most in the moderate to moderately strong range. Specifically, the Motor total on the BDI is the best overall predictor of future performance on the SIB. The Adaptive Behavior and BDI total scores also are useful. For younger

children, the Cognitive domain appears to predict future performance the best, and for older children the Adaptive Behavior domain appears to predict future performance.

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