The Relation between Intelligence and Adaptive Behavior: A Meta-Analysis

by

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ABSTRACT

Intelligence tests and adaptive behavior scales measure vital aspects of the multidimensional nature of human functioning. Assessment of each is a required component in the diagnosis or identification of intellectual disability, and both are frequently used conjointly in the assessment and identification of other developmental disabilities. The present study investigated the population correlation between intelligence and adaptive behavior using psychometric meta-analysis. The main analysis included 148 samples with 16,468 participants overall. Following correction for sampling error, measurement error, and range departure, analysis resulted in an estimated population correlation of $\rho = .51$. Moderator analyses indicated that the relation between intelligence and adaptive behavior tended to decrease as IQ increased, was strongest for very young children, and varied by disability type, adaptive measure respondent, and IQ measure used. Additionally, curvilinear regression analysis of adaptive behavior composite scores onto full scale IQ scores from datasets used to report the correlation between the Wechsler Intelligence Scales for Children- Fifth edition and Vineland-II scores in the WISC-V manuals indicated a curvilinear relation—adaptive behavior scores had little relation with IQ scores below 50 (WISC-V scores do not go below 45), from which there was positive relation up until an IQ of approximately 100, at which point and beyond the relation flattened out. Practical implications of varying correlation magnitudes between intelligence and adaptive behavior are discussed (viz., how the size of the correlation affects eligibility rates for intellectual disability).

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CHAPTER I

Introduction

Intelligence tests and adaptive behavior scales measure vital aspects of the multidimensional nature of human functioning. Intelligence tests measure a person's capacity to learn from experience and adapt to the environment (Sternberg, Conway, Ketron, & Bernstein, 1981). Adaptive behavior scales measure the collection of conceptual, social, and practical skills that a person has learned and uses to function independently in daily life (Schalock et al., 2010). Measurement of each is a required component in the assessment and identification of intellectual disability (ID), and both are frequently used together in the assessment and identification of other developmental disabilities such as autism and developmental delay (Harrison, 1987; McGrew, 2015; Schalock & Luckason, 2013).

ID is a special subject in the study of intelligence and adaptive behavior because of the required conjoint use of IQ tests and adaptive behavior scales in the assessment and identification process. It is a condition that has been referred to in texts and writings throughout human history and its hallmarks have nearly always been impairment in intellectual functioning and adaptive behavior (Harris, 2006; Scheerenberger, 1983). In modernity, it is conceptualized as a developmental disability defined and diagnosed/identified using three prongs: (1) significant limitations in intellectual functioning, (2) significant limitations in adaptive behavior, and (3) onset early in development (Kranzler & Floyd, 2013). Major professional, government, and health-related organizations generally agree that significant limitations in intellectual functioning are substantiated by an IQ of approximately two standard deviations below the mean with consideration given to random error via use of confidence intervals. These organizations also require the use of adaptive behavior scales to substantiate significant limitations in adaptive behavior. Criteria varies by entity, but an adaptive behavior composite or domain score that is two or more standard deviations below the mean with consideration given to random error is generally required (Kranzler & Floyd, 2013). Because due consideration must be given to scores from intelligence tests and adaptive behavior scales, it is critical to understand how they are related to each other, and in turn, how that relation affects diagnostic and eligibility decisions.

Responsible and Informed Decision-Making

The assessment and identification of ID or any other disability is no trivial task. It is not like baking a cake, where one opens a book, follows a recipe, and "out comes the certainty of whether or not a diagnosis exists" (Tassé, 2009, p. 122). Meeting, or not meeting, eligibility or diagnostic criteria has the potential of drastically altering an individual's quality of life and access to educational or community resources and supports (Reschly, Myers, & Hartel, 2002). Making an incorrect eligibility or diagnostic decision, therefore, is a circumstance that no responsible and ethical person relishes. In order to prevent and avoid such occurrences, professionals have the responsibility of knowing and, more importantly, of understanding a disability's diagnostic or eligibility criteria. In the case of ID, understanding the relation between intelligence and adaptive behavior is critically important.

Relation between Intelligence and Adaptive Behavior

Intelligence tests and adaptive behavior scales are related in more ways than one. First, each can trace its pedigree back to efforts to improve upon the methods and accuracy of identification and classification of individuals with intellectual disability (Scheerenberger, 1983). Second, research suggests that intelligence tests and adaptive behavior scales, and the constructs that they measure, are moderately correlated, though observed study correlations range from near-zero to nearly one (Harrison, 1987; Keith, Fehrmann, Harrison, & Pottebaum, 1987; McGrew, 2012, Reschly, 2002). Though the first relation lends credence to the second (i.e., two things that were developed to serve a similar purpose should be related), it is this second relation that is of primary interest in this study. Also of interest in this study is the nature of the relation. For example, Harrison (1987) and others (e.g. Vig & Jedrysek, 1995) have suggested that there may be a trend toward higher correlations in studies with more severely impaired samples. This suggests the possibility of a curvilinear relation between IQ and adaptive behavior with stronger correlations at the lower range of intelligence. Others (e.g. McGrew, 2012; Reschly et al., 2002), have suggested that disability type, measures used, age, and adaptive behavior respondent potentially alter the relation IQ and adaptive behavior.

Real World Implications

There are practical reasons for examining the relation between intelligence and adaptive behavior. McGrew (2012), following an examination of the distributional characteristics of 60 correlation values derived from the literature and technical manuals of popular measures, concluded that a reasonable estimate of the typical correlation is approximately a moderate .50. A correlation of .50 means that adaptive behavior and intelligence share approximately 25% common variance, which in practical application suggests that an individual's scores on an IQ test and an adaptive behavior scale will not always be consistent and will frequently diverge. In fact, given a .50 correlation between the two measures and accounting for regression to the mean, a child who receives an IQ score of 70 would be predicted to receive a composite score of 85 on an adaptive behavior scale. One can easily see how this could become problematic if identification or diagnosis is based uncritically on both scores needing to be two standard deviations below the mean.

If the correlation between intelligence and adaptive behavior is zero, which some studies have suggested (see Harrison, 1987), a child with an IQ score of 70 would be predicted to have an adaptive composite score of 100. Probability would dictate that scoring 70 or below on an IQ test is 2.28%, and scoring 70 or below on a scale of adaptive behavior is also 2.28%, but the probability of scoring 70 or below on both measures is only .05%. This probability is problematic when one considers that one estimated, and seemingly conservative, prevalence rate of ID is approximately 1.04% (Maulik, Mascarenhas, Mathers, Dua, & Saxena, 2011).

In a scenario where the relation between intelligence and adaptive behavior is essentially perfect, which some studies have suggested (see Harrison, 1987), then administration of both measures would yield redundant information and is arguably unnecessary. The predicted adaptive composite score for an IQ of 70 would be 70.

Given that correlation values reported in the literature range from nearly zero to nearly one (Harrison, 1987; McGrew, 2012), scenarios similar to those above could be encountered in practice. In fact, discrepant *and* concordant scores on IQ and adaptive measures are frequently observed in research and practice, and both should be expected (McGrew, 2015). These scenarios, therefore, underscore the importance of knowing and understanding the relation between scores on intelligence tests and adaptive behavior scales.

Meta-Analysis

There is no shortage in the literature of studies on the relation between intelligence tests and adaptive behavior scales (Harrison, 1987; McGrew, 2012). In these studies, the relation ranges from near non-existent to near perfect, though most correlations appear to be moderate. To date no attempt has been made to analyze the relation between intelligence and adaptive behavior through meta-analysis. Specifically, psychometric meta-analysis of the intelligence and adaptive behavior relation would be particularly useful because it integrates the findings across studies while correcting for distorting effects caused by study artifacts such as sampling error, measurement error, and other artifacts that may only be producing the illusion of conflicting findings (Schmidt & Hunter, 2014). Through meta-analysis, moderator variables affecting the relation between intelligence and adaptive behavior can also be explored using study characteristics (Schmidt & Hunter, 2014).

Statement of Purpose

The purpose of this study is to investigate the relation between intelligence and adaptive behavior, variables moderating said relation, and the consequences and implications resulting from their relation on diagnosis or identification of intellectual disability and other developmental disorders wherein IQ tests and adaptive behavior scales are utilized. Previous research has examined the relation between intelligence and adaptive behavior; however, the proposed study seeks to update and expand this work by empirically examining this relation through psychometric meta-analysis of extant correlations and examining the effects of potential moderating variables. Further, the nature of the relation will be explored by using existing data-sets to test if the relation between IQ and adaptive behavior is curvilinear.

Research Questions

(1) What is the typical observed correlation between IQ tests and adaptive behavior as reported in extant literature?

(2) What is the typical correlation between IQ and adaptive behavior following statistical correction of study artifacts as reported in extant literature?

(3) What is the effect of moderators on the correlation between IQ and adaptive behavior?

(4) Is the relation between IQ and adaptive behavior curvilinear? Does it vary by IQ level?

Significance of Study

This study contributes valuable information to the field of disability assessment and identification concerning the relation between intelligence and adaptive behavior. A few studies and reviews have explored or reported on this relation; however, the observed correlations vary in magnitude from near-zero to almost one (Harrison, 1987; McGrew, 2015, Reschly, 2002). Additionally, Murray, McKenzie, and Murray (2014) reported that many of these observed correlations between intelligence and adaptive behavior are probably attenuated due to study limitations related to the samples in the studies being selected based on intelligence and adaptive behavior scores. Harrison (1987) described observed correlations between IQ and adaptive behavior in a narrative synthesis of the literature and McGrew (2012) expanded upon her work by augmenting her data set and then describing its distributional characteristics. This study will expand upon the previous research by systematically and empirically examining the relation between IQ and adaptive behavior and variables that moderate this relation through meta-analysis of the extant literature. To my knowledge, this is the first attempt to explore this relationship through meta-analysis, which is needed due to the inadequacy of more traditional narrative procedures to integrate apparently conflicting findings across large numbers of existing studies (Schmidt & Hunter, 2014). Further, existing data-sets will be examined to explore a possible curvilinear relationship between IQ and adaptive behavior. Addressing these gaps in the literature will help guide decisions of practitioners, researchers, and policy makers, especially in regard to the assessment and identification of intellectual disability and other developmental disabilities.

Relevance of the Study to School Psychologists

The assessment and identification of disabilities is a primary responsibility of school psychologists (Watkins, Crosby, & Pearson, 2001). Families and educators rely upon their expertise and input as multidisciplinary teams make educational decisions for students that have far reaching implications. Though specifics vary by state (Kranzler & Floyd, 2013), assessment and identification of intellectual disability requires evaluation of a student's intellectual and adaptive functioning. Also, assessment of intellectual and adaptive functioning is conducted to obtain valuable information during the evaluations of students with other suspected disabilities such as autism or developmental delay. School psychologists are well acquainted with discrepancies being present between scores on IQ tests and adaptive behavior scales that arise during student evaluations. They are also aware that it is not uncommon for these discrepancies to be substantial. A better understanding of the relation between IQ and adaptive behavior will help shed light on these discrepancies and aid school psychologists and multidisciplinary teams as they make better-informed eligibility decisions for students.

CHAPTER II

Review of the Literature

Intelligence tests and adaptive behavior scales are pivotal in the diagnosis and identification of intellectual disability (ID) and other developmental disabilities (Harrison, 1987; McGrew, 2015; Schalock & Luckasson, 2013). Because they are used jointly in the diagnostic and identification process, understanding the relation, or the correlation, between their respective scores and the construct each score represents is critical. Before providing a discussion of how the scores are related, I want to describe the history leading up to the advent of intelligence tests and adaptive behavior scales, a history that is deeply intertwined with the history of the identification and diagnosis of ID.

Characteristics of Intellectual Disability

"ID is a developmental disorder that is characterized by significant limitations in both mental functioning and display of adaptive behavior and that emerges early in development" (Kranzler & Floyd, 2013, p. 182). Over the centuries, many terms have been used to refer to the disability. Some of these terms include idiocy, feeble-mindedness, mental deficiency, mental retardation, mental disability, mental handicap, and mental subnormality (Brown & Radford, 2007; Schalock, Luckasson, Shogren et al., 2007). Even though the terminology has changed over time, US-based definitions used over the last 60 or so years by the American Association on Intellectual and Developmental Disabilities (AAIDD), its progenitors, and the American Psychiatric Association (APA) have remained consistent in that ID is characterized by the following characteristics: (a) significant limitations in intellectual functioning, (b) significant limitations in adaptive behavior, and (c) onset early in development (Kranzler & Floyd, 2013; Schalock & Luckasson, 2013). Special education legislation, such as the Individuals with Disabilities

Education Improvement Act of 2004 (IDEA; Public Law 108-446, 2004), also defines ID in terms of the above noted characteristics.

History of Intellectual Disability

Prior to the advent of formal intelligence tests and adaptive behavior scales in the twentieth century, persons with intellectual disabilities were recognized based on physical abnormalities, behavioral deviance, and inability to function adequately in society (Horn & Fuchs, 1987). Although prioritization of physical abnormality departs from modern definitional characteristics of ID, the consideration of behavioral deviance and inability to function adequately in society without supports are very much in concert with modern conceptualization of intellectual and adaptive limitations inherent in ID. Indeed, limitations in intellectual functioning and in one's ability to adapt to life's daily demands have been defining characteristics of persons with ID throughout history (Borthwick-Duffy, 2007). Despite differences in definition and measurement, the concept of ID—the recognition that a small percentage of the population has intellectual limitations and problems coping with the daily demands of life—is an ancient one (Reschly, Myers, & Hartel, 2002).

Ancient Times through the Eighteenth Century. From ancient times up through the eighteenth century, conceptualization, or lack thereof, of ID differed from society to society. References to persons with ID can be located in religious texts, such as the Bible, Talmud, and Koran (Kanner, 1964). Persons with mild intellectual and adaptive impairment received no special treatment, nor were they identified because they were generally able to adapt to life's daily demands. Those with more significant impairment were recognized and treated in every way imaginable. In some societies they were regarded as innocents or fools, in others, as witches or as being possessed by the devil. Depending on time and place some were cared for, some were neglected, and some were persecuted or even put to death (Doll, 1967; Harris, 2006; Kanner, 1964).

The earliest written reference to ID dates to the Egyptian Papyrus of Thebes in 1552 B.C., which references disabilities of the mind (Harris, 2006). However, the discovery of adult Neanderthal remains at Shanidar produced a specimen exhibiting evidence of both physical and intellectual disability, which places the recorded history of ID at an estimated range of 35,000 to 45,000 years ago in the archeological record. Shanidar I, as the specimen was named, was discovered in Northern Iraq in 1957 by a team of Columbia University researchers led by Ralph Solecki. Through an examination of the remains, it was hypothesized that Shanidar I suffered a crushing blow to his head at a young age resulting in intellectual impairment, partial or complete blindness in his left eye, and extensive damage to the area of the brain controlling the right side of his body, the latter of which resulted in a withered right arm and crippled right leg (Solecki, 1971). Shanidar I's injuries showed extensive healing as he lived to 35 to 45 years of age, old for a Neanderthal. Shanidar I's survival is indicative that he survived with the support and care of his people. Solecki (1971) stated, "The stone heap over his remains, and the mammal food remains show that even in death his person was an object of some esteem if not respect" (p. 196).

The ancient Greeks and Romans believed that children born with ID signified displeasure from the gods (Harris, 2006). Within these societies, adequate adaptive functioning (e.g., responsibility for self-care, work, social engagement, and responding to the needs of others) was indicative of intelligence (Oakland & Harrison, 2011). Though not as common as once believed, infants with severe disabilities were sometimes left out in the elements to die from exposure. Mildly disabled Roman children who were born to wealthy citizens were afforded property rights and guardianships to help them manage their day-to-day affairs, though most were marginalized and excluded from societal involvement (Harris, 2006).

The first classification system of psychological disorders, referred to as *unsoundness of mind,* can be found in *Alcibiades II*, and refers to ID. Typically attributed to Plato or one of his students, the document includes the following passage:

> Those who are affected by it in the highest degree are called mad. Those in whom it is less pronounced are called wrong-headed, crotchety, or—as persons fond of smooth words would say—enthusiastic or excitable. Others are eccentric, others are known as innocents, incapables, dummies…. All these kinds of unsoundness of mind differ from one another as diseases of the body do" (as quoted in Scheerenberger, 1983, p. 13).

Nineteenth Century. In the early nineteenth century advances in medicine, psychiatry, and specialized education resulted in more acute conceptualizations of ID. Phillipe Pinel, known for his humane approach to the custody and care of psychiatric inmates at the Bicêtre Hospital in Paris, used the term *idiot* to describe ID. In 1806, he published a classification system identifying five categories of psychological disorder: (a) melancholia or delirium, (b) mania without delirium, (c) mania with delirium, (d) dementia, or the abolition of the thinking facility, and (e) idiotism, characterized by obliteration of the intellectual faculties and affections (Huertas, 2008). According to Pinel (1806), idiots exhibited "defective perception and recognizance of objects [and] a partial or total abolition of the intellectual and active faculties" (p. 165).

Jean Étienne Dominique Esquirol, a student of Pinel, further divided idiotism into idiot and imbecile while recognizing degrees of variance within each of these categories in his *Mental Maladies: A Treatise on Insanity.* According to Esquirol (1845), idiots lacked intellectual and moral spontaneity and also lacked the potential for their development: "Here, the intellectual and moral faculties are almost null; not that they have been destroyed, but never developed" (p. 455). Imbeciles, on the other hand, were near normal with regard to their intellectual and affective faculties but did not reach their potential with regard to age, educational level, or social relations (Esquirol, 1845; Scheerenberger, 1983). An examination of Esquirol's categories reveals consideration of both intellectual functioning and adaptive behaviors in his classification scheme.

Contemporaries of Pinel and Esquirol also referred to intellectual and adaptive functioning in their classification, descriptions, and work with persons with ID. In 1802 Jean-Marc Itard, for example, described Victor the Wild Boy of Averyon as "destitute of memory or judgment…. He could not open a door, nor get on a chair to obtain the food which was put out of the reach of his hand" (p. 21-22). Samuel Gridley Howe defined three grades of ID in 1848 based on severity of impairment—low grade or idiots, middle grade or fools, and high grade or simpletons. In 1858, he was the first to use the term *adaptability* in reference to adaptive behaviors (Nihira, 1999). In 1837 Édouard Seguin used the term *social competency* to address adaptive behavior (Nihira, 1999); and in 1846 he elaborated upon the classification schemes of Esquirol and Howe, categorizing ID into four levels: (a) idiocy (moderate, severe, and profound impairment), (b) imbecility (mild-to moderate impairment with deficits in social development), (c) backwardness or feeblemindedness, and (d) simpleness or superficial disability with slowing of development (Harris, 2006).

Advent of Intelligence Tests. At the beginning of the twentieth century, tests of intelligence emerged and quickly became the predominant means of identifying and classifying ID. The first textbook on ID was written by Martin Barr in 1904 wherein the term *feeble-mindedness* was used to describe ID (Scheerenberger, 1983). Barr presented a widely used educational classification schema of the feeble-minded, with principal classification based on intellect, with additional consideration given to emotional, social, and educational functioning. In

1905, Alfred Binet and Théodore Simon introduced the first intelligence test (Winzer, 1993). The Binet-Simon scale was developed to define the differences between children of different intellectual capacities and identify children for specialized education in France. At that time, Binet did not view intelligence as a unidimensional entity, but rather as the abilities to judge, comprehend, and reason well (Eysenck, 1994, p. 20).

In 1908, Henry Goddard had the Binet-Simon translated and he introduced it to the United States where it, and its 1910 revision, were used specifically to diagnose ID. Goddard classified people with intellectual impairment into three levels based on severity of impairment: (a) morons, a term coined by Goddard, demonstrated mental development between ages seven and twelve; (b) imbecils demonstrated mental development between ages of two and seven, and (c) idiots demonstrated mental development of two years or less as measured by the Binet-Simon (Winzer, 1993). In 1910, the Committee on Classification of the Feeble-minded of the *American Association for the Study of the Feebleminded* (now AAIDD) based their system of classification of ID on Goddard's three levels, and in 1915 Fred Kuhlmann identified the normal distribution of IQ's, which to this day continues to influence the assessment and identification of individuals with intellectual disability (Harris, 2006; Scheerenberger, 1983).

In 1916, Lewis Terman introduced the intelligence quotient to the understanding and interpretation of intelligence tests when he published a revision of the Binet-Simon scale, the Stanford-Binet. Terman's classification scheme was structured by applying IQ ranges to Goddard's levels: IQ of 50 to 70, moron; IQ of 20 or 25 to 50, imbecile; IQ of below 20 or 25, idiot (Scheerenberger, 1983). With Terman's classification scheme, IQ quickly came to replace individual clinical evaluation as the principal, if not exclusive, means of diagnosing and classifying individuals with ID.

Advent of Adaptive Behavior Scales. Terman, Kuhlmann, and others cautioned against overreliance on IQ scores in the diagnosis and classification of persons with ID (Scheerenberger, 1983). Terman brought into question the test-retest reliability of intelligence tests. Kuhlmann stressed the importance of considering what is now termed adaptive behavior in addition to intelligence, especially in mildly disabled individuals:

> The dividing line between feeble-mindedness and the normal is more difficult to determine. It is probably not fixed. An individual is normal when he can take care of himself, when he can get sufficient remunerative work to meet his personal needs, and when his intelligence does not rank him below the average of the society in which his parents live. According to this a boy may be feeble-minded in one kind of social environment where he would be normal in another (Kuhlmann, 1911, p. 91-92).

Overreliance on IQ also found opposition in Edgar Doll, who, like Kuhlmann, challenged the lack of consideration for social and environmental influences in the identification of ID. In response, Doll developed the Vineland Social Maturity Scale (VSMS) in 1936, a predecessor to modern adaptive behavior scales (Bruininks, Thurlow, & Gilman, 1987; Tassé et al. 2012). Doll believed that individuals identified with ID should exhibit limitations in social competence (e.g. adaptive behavior) and not only in intellectual functioning. The VSMS measured social competence with items addressing self-help, self-direction, locomotion, communication, and occupation (Doll & Fitch, 1939).

Joint Use of Intelligence Tests and Adaptive Behavior Scales. In the mid-twentieth century, formal assessment of adaptive behavior and intelligence testing became the required norm in the diagnosis and identification of ID due to economic prosperity, parental advocacy, professional enthusiasm, legislation, and socio-political climate (Horn & Fuchs, 1987). The term *adaptive behavior* was included alongside intellectual functioning in the American Association on Mental Deficiency's (AAMD; now AAIDD) 1961 *Classification Manual on Mental Retardation*, and other organizations, such as the American Psychiatric Association, soon followed suit. Concurrently, the establishment of the President's Committee on Mental Retardation, court rulings from *Larry P. v. Riles* in 1972 requiring assessment beyond intelligence testing for educational placement of disabled children, and passage of PL 94-142 mandating educational programming for all children helped solidify the age-old conceptualization that ID is characterized by limitations in intellectual functioning *and* limitations in adaptive behavior as well as the use of *both* intelligence tests and adaptive behavior scales in the assessment and identification of ID (Horn & Fuchs, 1987).

An Intertwined History. The previous discussion of identification and assessment of ID throughout history is not meant to be comprehensive with regard to ID, intelligence, or adaptive behavior. Rather, it is meant to illustrate intertwining of intelligence and adaptive behavior and the assessment and measurement of each throughout history. Intelligence and adaptive behavior have always been viewed as being related. This view is reinforced in a passage by Herbert J. Grossman from *Classification in Mental Retardation* (1973): "Adaptive behavior refers to the quality of everyday performance in coping with environmental demands. The quality of general adaptation is mediated by level of intelligence; thus, the two concepts overlap in meaning." (p. 42).

Intelligence and Adaptive Behavior

Intelligence and adaptive behavior share essential functions in psychology and related fields, especially in the field of ID. First, significant limitations in intellectual functioning and adaptive behavior, along with onset during the developmental period, operationally define the disability. Second, scores on intelligence tests and adaptive behavior scales are used to identify ID. Third, intelligence and adaptive behavior encompass vital aspects of understanding the multidimensional nature of human functioning (see Tassé et al., 2012). What are intelligence and adaptive behavior and how are they measured? Thus far, their intertwined nature has been discussed; however, to better understand them it is necessary to discuss them separately.

Conceptualization and Measurement of Intelligence. Endeavors to understand, quantify, and conceptualize human intelligence is a field of psychological study unto itself. Sternberg, et al. (1981) stated:

> Viewed narrowly, there seem to be almost as many definitions of intelligence as there [are] experts asked to define it. Viewed broadly… two themes seem to run through at least several definitions in the complete set; the capacity to learn from experience and the capacity to adapt to one's environment (p. 196).

While there is no universal consensus with regard to a verbal definition of intelligence, two widely accepted conceptual definitions are presented. In a report published by a task force established by the APA, the following conceptual definition of intelligence was set forth:

> Individuals differ from one another in their ability to understand complex ideas, to adapt effectively to the environment, to learn from experience, to engage in various forms of reasoning, to overcome obstacles by taking thought. Although these individual differences can be substantial, they are never entirely consistent: a given person's intellectual performance will vary on different occasions, in different domains, as judged by different criteria. Concepts of "intelligence" are attempts to clarify and organize this complex set of phenomena (Neisser et al., 1996).

In a collectively signed statement, 52 experts in the field of intelligence research affirmed the following:

> Intelligence is a very general mental capability that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience. It is not merely book learning, a narrow academic skill, or test-taking smarts. Rather, it reflects a broader and deeper capability for comprehending our surroundings—"catching on", "making sense" of things, or "figuring out" what to do. (Gottfredson, 1997, p. 13)

The signatories went on to affirm that intelligence, so defined, can be measured, and that comprehensive tests of intelligence, or IQ tests, measure it well. They also affirmed that IQ tests are among the most accurate of psychological tests, citing their psychometric properties, such as reliability and validity, a statement that is supported in current literature (see Flanagan & Harrison, 2012; Kaufman, 2009; Reynolds, Floyd, & Niileksela, 2013).

In 1904, Charles E. Spearman published a seminal paper reporting the discovery of a factor of general intelligence, derived from his research that demonstrated positive intercorrelations among tests of mental ability. Spearman's (1904) analysis, according to him, demonstrated that "all branches of intellectual activity have in common one fundamental function (or group of functions)" (p. 284), which he later described as general mental energy (Wasserman, 2012). Referred to as Spearman's *g*, psychometric *g*, or the *g* factor, Spearman's factor of general intelligence was derived from shared variance that permeates cognitive tests and has been observed in the analyses of hundreds of data sets (Deary, Penke, & Johnson, 2010).

Early intelligence researchers and test developers generally accepted Spearman's *g*. Despite earlier reservations, in 1909 Binet acknowledged the unitary nature of the mind, affirming that all of its functions are subordinate to one central function (Wasserman, 2012, p. 41). In 1916, Terman wrote:

> The functions called memory, attention, perception, judgment, etc. never operate in isolation. There are no separate and special "faculties" corresponding to such terms, which are merely convenient names for characterizing mental processes of various types. In any test, it is "general ability" which is operative, perhaps now *chiefly* in remembering, at another time *chiefly* in sensory discrimination, again in reasoning, etc. (as quoted in Wasserman, 2012, p. 41; emphasis in original).

In 1939 Wechsler stated that the primary purpose of an intelligence test is to sample enough portions of intelligence to generate a reasonably reliable measure of an individual's global capacity (Wasserman, 2012).

Current psychometric theories of intelligence, and the popular intelligence tests that these theories have facilitated, posit that there is a hierarchal taxonomy of human intelligence, the vertex of which is general intelligence, or *g* (McGrew, 2015). In a survey of 36 experts in the field of intelligence, Reeve and Charles (2008) found consensus that *g* is a "non-trivial determinant (or at least predictor) of important real world outcomes for which there is no substitute, and that tests of *g* are valid" (p. 681). The terms general cognitive ability, general mental ability, general intelligence, and IQ (intelligence quotient) are used interchangeably to describe the functional estimate of *g* provided by tests of intelligence via a global composite score, or IQ (Deary, Penke, & Johnson, 2010; Neisser et al., 1996; Reynolds et al., 2013). Reynolds et al. (2013) found that 82%-83% of IQ variance on three popular individually administered intelligence tests was attributable to *g*. Such research suggests that *g* accounts for a large proportion of individual differences in IQ scores, and additional research suggests that the proportion accounted for is even larger in individuals at the lower end of the IQ range (Reynolds, 2013). Further, IQs or global composites from different intelligence tests have been found to measure the same *g* (Floyd, Reynolds, Farmer, & Kranzler, 2013; Johnson, Bouchard, McGue, & Gottesman, 2004) suggesting that it is generalizable across different intelligence measures.

Conceptualization and Measurement of Adaptive Behavior. Adaptive behavior is defined as the collection of conceptual, social, and practical skills that have been learned and are performed by people in their daily lives (Schalock et al., 2010). In 1959, AAMD (now AAIDD) formally introduced concepts of *maturation*, *learning*, and *social adjustment* into the diagnostic criteria for ID (Heber, 1959). A few years later, these concepts were collapsed into the construct of *adaptive behavior* within the operational definition of ID (Heber, 1961). According to Tassé et al. (2012), Heber's conceptualization and inclusion of adaptive behavior in the definition of ID necessitated the development of scales to measure the construct. At that time, the Vineland Social Maturity Scale (VSMS) was the only available measure and was not, strictly speaking, a measure of adaptive behavior (Tassé et al., 2012). Since then, several measures of adaptive behavior have been developed and used in the assessment, identification, and treatment planning of people with intellectual and other disabilities.

Factor-analytic work on adaptive behavior spanning decades has often yielded a four factor solution: (a) practical skills, (b) conceptual skills, (c) social skills, and (d) motor or physical competence (see Arias, Verdugo, Navas, & Gomez, 2013; Schalock, 1999; Tassé et al., 2012; Thompson, McGrew, & Bruininks, 1999; Widman & McGrew, 1996). Motor or physical competence, which encompasses fine and gross motor development, however, appears to be more developmental in nature, levels off at eight or nine years of age, and may be primarily indicative of physical limitations (Arias et al., 2013; Schalock et al., 2010, Tassé et al., 2012). Discounting motor or physical competence due to its developmental nature, the result is a three-factor solution that is strikingly analogous to Heber's 1959 conceptualization of maturation (practical), learning (conceptual), and socialization (social) concepts (Tassé et al., 2012). Conceptual skills encompass language, reading and writing, money, time, and number concepts. Social skills encompass interpersonal skills, social responsibility, self-esteem, gullibility, naïveté (i.e., wariness), rule following, avoidance of victimization, and social problem solving. Practical skills encompass activities of daily living (personal care), occupational skills, use of money, safety, health care, travel/transportation, schedules/routines, and use of the telephone (Schalock et al., 2010).

Some studies on the factor structure of adaptive behavior have found that a single-factor solution provides the most reasonable fit to the observed data and that adaptive behavior is best understood as a unidimensional construct (Aricak & Oakland, 2003; Harrison & Oakland, 2003; McGrew & Bruininks, 1989; Wei, Oakland, & Algina, 2008). Some of these studies, however, found that the three-factor solution (e.g. conceptual, social, and practical) also provided a close fit (e.g. Harrison & Oakland, 2003).

Current popular adaptive behavior scales yield domain scores that reflect the three- (or four-) factor model, and an overall composite score that reflects the single-factor model.

Adaptive Scores and IQ Scores in Practice

Although specifics and wording vary by entity, there is consensus across major professional, government, and health-related organizations regarding the defining characteristics of ID. Diagnostic and eligibility criteria set forth by the American Association on Intellectual and Developmental Disabilities (Schalock et al., 2010), the American Psychiatric Association (APA, 2013), and the Individuals with Disabilities Education Improvement Act of 2004 (IDEA; Public Law 108-446, 2004) concur that ID is a developmental disorder characterized by significant impairment in both intellectual functioning and adaptive behavior that emerges early in development. The importance of intelligence tests, used to establish intellectual limitations, and adaptive behavior scales, used to establish limitations in adaptive functioning, is, therefore, readily apparent. What follows is a brief overview of guidelines and cutoff scores recommended by the above listed organizations as they pertain to adaptive behavior scales and intelligence tests in the assessment of ID.

American Association on Intellectual and Developmental Disabilities. In 2010, the American Association on Intellectual and Developmental Disabilities (AAIDD) released the 11th edition of the book *ID: Definition, Classification, and Systems of Support* (Schalock et al., 2010), which is arguably the gold standard guiding the assessment and identification of individuals with ID (Kranzler & Floyd, 2013). According to AAIDD, ID originates before age 18 and is characterized by "significant limitations both in intellectual functioning and in adaptive behavior as expressed in conceptual, social, and practical adaptive skills" (p. 1). AAIDD operationalizes intellectual functioning as general mental ability, represented by psychometric *g*, and measured by the global composite/IQ score from psychometrically sound tests of intelligence. AAIDD suggest that a significant limitation in intellectual functioning is evident when an IQ score is approximately 70 or below, with due consideration given to random error via use of confidence intervals. AAIDD recognizes that clinical judgment must be used to determine if the criterion of significant limitations in intellectual functioning is met.

With regard to adaptive behaviors, AAIDD (2010) guidelines explicitly state "significant limitations in adaptive behavior should be established through the use of standardized measures normed with general populations, including persons with disabilities and people without disabilities" (p. 43). When age-based norms are utilized, AAIDD guidelines suggest that significant limitations in adaptive behaviors are evident when 1) an overall score on an adaptive measure representing conceptual, social, and practical domains is at least two standard deviations below the mean, or 2) at least one score representing conceptual, social, or practical domain is at least two standard deviations below the mean. As with intellectual functioning, due consideration must be given to confidence intervals associated with each of these adaptive behavior scores.

American Psychiatric Association. The *Diagnostic and Statistical Manual of Mental Disorders,* Fifth Edition (DSM-5; American Psychiatric Association, 2013) defines ID as "a disorder with onset during the developmental period that includes both intellectual and adaptive functioning deficits in conceptual, social, and practical domains" (p.33). Diagnostic criteria require establishment of intellectual deficits by both clinical assessment and individualized, standardized intelligence testing. According to the DSM-5, intellectual functioning refers to "deficits in general mental abilities such as reasoning, problem solving, planning, abstract thinking, judgment, academic learning and learning from experience" (American Psychiatric association, 2013, p.33). Individuals with deficits in intellectual functioning have IQ scores approximately two standard deviations or more below the population mean, including a margin for measurement error. This margin translates to IQ scores of 70 +/- 5 on tests of intelligence with a mean of 100 and a standard deviation of 15.

According to the DSM-5 (American Psychiatric Association, 2013) deficits in adaptive functioning are assessed using standardized measures and clinical evaluation. No guidelines are given with regard to specific cut-off scores on adaptive behavior scales. Instead, deficits in adaptive functioning are established when "at least one domain of adaptive functioning—conceptual, social, or practical—is sufficiently impaired that ongoing support is needed in order for the person to perform adequately in one or more life settings at school, at work, at home, or in the community" (p. 38). The American Psychological Association Division 33 (Editorial Board, 1996), however, recommends the use of a "comprehensive, individual measure of adaptive behavior" (p. 13) and suggests, "the criterion of significance is a summary index score that is two or more standard deviations below the mean" (p. 13).

Individuals with Disabilities Education Improvement Act. In 2004, the federal definition of *mental retardation* was characterized as "significantly subaverage general intellectual functioning, existing concurrently with deficits in adaptive behavior and manifested during the developmental period, that adversely affects a child's educational performance" (IDEA, 2004). In 2010, the passage of Rosa's Law eliminated the terms *mental retardation* and *mentally retarded* from the federal legal code, replacing them with *intellectual disability*. Although ID is included in federal special education legislation, Kranzler and Floyd (2013) rightly emphasize that each state autonomously labels the condition and determines specific identification eligibility criteria. For example, Bergeron, Floyd, and Shands (2008) gathered 2005-2006 state-level guidelines for identification of *mental retardation* from the Departments of Education from each of the 50 United States and the District of Columbia. At that time 6% of states used the term *intellectual disability*, 14% used *mental disability*, and 53% used *mental retardation*. Other terms used included *cognitive impairment, cognitive disability, cognitive delay,* and *severely limited intellectual capacities*. Approximately one-quarter of states did not provide specific guidelines for the identification of ID beyond citing the federal definitions. More than three-fifths of states used IQ cutoff scores of two standard deviations or more below the population mean, and about 1 in 20 states explicitly required IQ scores to be below two standard deviations. Only about two-fifths of states provided guidance on consideration of measurement error or confidence intervals. Nearly two-thirds of states did not specify whether composite scores reflecting global adaptive functioning or domain level scores reflecting adaptive behaviors be used to establish deficits in adaptive behavior. Of the states that did specify guidance on adaptive functioning scores, two specified use of adaptive behavior composite, 11 specified use of scores for adaptive behavior domains or skill areas, three required both composites and domains or skill areas be used, and two allowed for either composite scores or domain scores to be used. Most states (77%) did not provide specific score criterion to establish deficits in adaptive behavior, 16% required scores of at least two standard deviations below the population mean, and two percent required scores of at least 1.5 standard deviations below the mean. These findings illustrate the importance of being informed about the variability from state to state in special education eligibility criteria for ID.

Summary. As can be seen, there is there is variability across organizations with regard to recommended cutoff scores and acceptable margin of error for diagnostic and eligibility decisions, especially with regard to adaptive behavior scales. Nevertheless, there is general consensus with regard to (a) the definitive characteristics of ID and (b) the importance of using standard scores obtained from both intelligence tests and adaptive behavior scales to inform diagnosis and identification of ID. Further, although there is variability in the definitional guidelines, any use of cut-scores found within definitions results in profound implications stemming from the empirical correlations between IQ and adaptive scales.

Implications of the Relation between Intelligence and Adaptive Behavior

Diagnosis or identification of ID is based on three criteria: significant limitations in intellectual functioning, significant limitations in adaptive functioning as expressed in conceptual, social and/or practical adaptive skills, and onset during the developmental period. Some have suggested that best practice is to define significant limitations in intellectual functioning and adaptive functioning via cutoff scores interpreted in reference to a statistical confidence interval

(Schalock et al., 2010). An IQ score that is approximately two standard deviations or more below the population mean, considering the standard error of measurement for the instrument used, is generally used to establish significant limitations in intellectual functioning. Similarly, a composite score or domain score measuring conceptual, practical, or social skills from a standardized scale of adaptive behavior that is approximately two standard deviations or more below the population mean, considering the standard error of measurement, is generally used to establish significant limitations in adaptive functioning.

Given the prominent status of intelligence tests and adaptive behavior scales in the assessment and identification of ID, and how they are used conjointly, the strength of the correlation between scores from these measures has the potential of drastically affecting diagnostic and eligibility decisions (Reschly et al., 2002). Assuming a moderate correlation between full scale IQ scores and total composite scores on adaptive behavior scales—where the literature suggests most observed correlations tend to cluster (see Harrison, 1987; McGrew, 2015)—one can expect that, using the 68% confidence level, the difference between a full scale IQ score and adaptive behavior composite score may be +/- 15 points in either direction. At the 95% confidence level, the difference may be +/- 30 points in either direction (McGrew, 2015). Again, these score differences assume a moderate correlation between IQ and adaptive behavior; however, correlations observed in studies range from near-zero to almost one. On more highly correlated measures, the expected range of potential score differences would be narrower; whereas on measures with low correlations, the expected range of potential score differences between intelligence tests and adaptive behavior scales would be wider.

The potential diagnostic effect of weakly correlated IQ and adaptive behavior composite scores is illustrated by the following example. As discussed in Reschly et al. (2002), scores from the Wechsler Intelligence Scale for Children-Revised (WISC-R; Wechsler, 1974) and the Adaptive Behavior Inventory for Children (ABIC; Mercer & Lewis, 1978) have very low reported correlations (Kazimour & Reschly, 1981). Studies drew attention to the potential effect of using these two measures jointly to make diagnostic decisions based strictly on cutoff scores. Children with IQ scores of 55 to 70 or 75 almost never had adaptive behavior scores more than one or two standard deviations below the population mean (Heflinger et al., 1987; Reschly, 1981). Considering that approximately 85% of individuals with ID have reported IQ scores within this range (Reschly, 2002), the uninformed use of poorly correlated IQ and adaptive behavior scales in ID diagnosis or identification could devastatingly impact the quality of life, supports, and opportunities of a major proportion of individuals suspected of having ID. In fact, if IQ and adaptive scores are not related in any way, the predicted adaptive behavior score for any individual would be 100, regardless of IQ score, and vice versa. That prediction is simply made from knowing that if IQ scores in no way provide information about adaptive behavior scores, the best prediction of an expected adaptive behavior score would be the mean.

Assessment and identification of ID has life-altering implications for affected individuals. Awareness *and* understanding of the estimated correlations between IQ and adaptive behavior scales and the correlations between the IQ and adaptive measures used in an assessment can easily mean the difference between correct and incorrect identification.

Research on the Correlation between Intelligence and Adaptive Behavior

Because (a) use of intelligence tests and adaptive behavior scales is required in the diagnosis or identification of ID (APA, 2013; Schalock et al., 2010), (b) these measures are serving an ever-increasing informative role in the diagnosis or identification of other disabilities (Harrison, 1987; McGrew, 2015; Schalock & Luckasson, 2013), and (c) the strength of the relation between measures of intelligence and adaptive behavior can drastically affect diagnostic decisions (Reschly et al., 2002), it is imperative to firmly understand the correlation between their respective scores and the correlation between their underlying constructs.

When adaptive behavior became part of AAMD's operational definition of ID (then mental retardation) in 1961, there arose an impetus to develop measures of adaptive behavior, which naturally led to a wave of research in the 1960s, 1970s, and 1980s studying the correlations between scores on intelligence tests and adaptive behavior scales. A narrative review of the research was published by Harrison (1987), which included a table of 42 correlation coefficients between various measures of adaptive behavior and intelligence. Excluding correlations with maladaptive measures, the correlation coefficients between scores from intelligence tests and adaptive behavior scales ranged from .03 to .91 with an approximate mean of .54 and median of .47. Harrison concluded that the majority of observed correlations were in the moderate range. In an attempt to explain the primary reasons for the moderate correlations, Harrison (1987) stated:

> Although intelligence and adaptive behavior scales have many similarities in purposes and uses, several basic differences in the two types of scales warrant this type of investigation. According to Meyers et al. (1979), the measurement of intelligence and adaptive behavior differs in several respects, including the following: (1) intelligence scales emphasize thought process while adaptive behavior scales emphasize everyday behavior, (2) intelligence scales measure maximum performance or potential while adaptive behavior scales measure typical performance, and (3) intelligence scales presume a stability in scores while adaptive behavior scales presume modifiability of performance. (p. 39)

McGrew (2012) recently followed up Harrison's (1987) synthesis informally with an unpublished synthesis of his own. He added several adaptive behavior and IQ correlations to those found in Harrison's for a total of 60 correlations. Among the correlations he included were those reported in the technical manuals of the Vineland Adaptive Behavior Scale, 2nd ed. (Vineland-II; Sparrow, Cicchetti, & Balla, 2005), Adaptive Behavior Assessment System—Second Edition (Harrison & Oakland, 2008), and Scales of Independent Behavior-Revised (Bruininks, Woodcock, Weatherman, & Hill, 1996). He also included latent factor correlations reported in the confirmatory factor analysis models published by Ittenback, Spiegel, McGrew, and Bruininks (1992), Keith, Fehrmann, Harrison, and Pottebaum (1987), and McGrew and Bruininks (1990). The updated synthesis's correlations ranged from .12 to .90, with a mean of .51, a median of .48, and a standard deviation of .20. McGrew (2012) reported that most correlations ranged from .40 to .65 and concluded that adaptive behavior and IQ are separate, yet related constructs.

McGrew (2012) acknowledged several limitations in his synthesis. In addition to not being peer reviewed, he made no attempt to be exhaustive in the correlations he included in his sample. As such, there are many correlations reported in empirical studies and in technical manuals from newer measures that were not included in his or Harrison's (1987) syntheses. McGrew noted that his hope was that his informal synthesis would stimulate further meta-analysis.

Since McGrew's synthesis, the Wechsler Intelligence Scale for Children- Fifth Edition (WISC-V; Wechsler, 2014a) was released. Correlations between the WISC-V and the Vineland-II (Sparrow, Cicchetti, & Balla, 2005), two of the most commonly used measures in the assessment of ID, were reported in the *WISC-V Technical and Interpretive Manual* (Wechsler, 2014b) and the *WISC-V Technical and Interpretive Manual Supplement* (Wechsler, 2014c). In a non-clinical sample of children, the overall correlation between the FSIQ and Adaptive Behavior Composite score was reported as near-zero (.01) (Wechsler, 2014b). In a sample of children with ID-mild or –moderate severity, the overall correlation between the FSIQ and Adaptive Behavior Composite was reported as .26 (Wechsler, 2014c). The low correlations in the ID sample were attributed, in part, to range restrictions. It was not clear why the correlation in the non-clinical sample was near zero.

Further, several studies have been published since Harrison's (1987) review. For example, Platt, Kamphaus, Cole, and Smith (1991) examined the correlation between the interview edition of the Vineland Adaptive Behavior Scales (VABS; Sparrow et al., 1984) and the Stanford-Binet, Fourth Edition (SB4; Thorndike, Hagen, & Sattler, 1986) and WISC-R in a referred sample of children with mild to moderate ID. Moderate correlations (.37–.39) were found between scores on the VABS and the IQ tests. The authors, in their conclusions, indicated that their results supported research asserting that adaptive behavior and intelligence are moderately correlated and represent separate but related constructs.

Vig and Jedrysek (1995) examined the correlation between intelligence and adaptive behavior. They also investigated whether or not differences in patterns of adaptive behavior existed in the sample that could not be explained by intelligence. The sample consisted of pre-school aged children who were diagnosed with developmental disabilities following a comprehensive evaluation that included intelligence tests and adaptive behavior scales. The authors found a strong, positive correlation between adaptive behavior composite scores and IQ scores (.75). Correlation coefficients were stronger, however, for children with more severe disabilities (e.g., autism) than they were for those with milder disabilities or impairments as defined by level of IQ (e.g., mild cognitive deficits, nonspecific developmental delays).

Luthar, Woolston, Sparrow, Zimmerman, and Riddle (1995) examined the risk/protective functions of intelligence, academic achievement, the distinction between internalizing and externalizing symptomatology, and sex for social competence among psychiatrically hospitalized children. Although exploration of the correlation between intelligence and adaptive behavior was not the primary aim of the study, the authors did report correlations found between the VABS and the WISC-R or Kaufman Assessment Battery for Children (K-ABC, Kaufman, A. S., & Kaufman, N. L., 1983). The observed correlation for the overall sample was .37. In a subsample of children with one or more behavior, anxiety, or affective disorder and with no diagnoses of mental retardation, pervasive developmental disorders, tics, or psychoses the observed correlation was .27.

Hayes and Farnhill (2003) examined the correlation between the Kaufman Brief Intelligence Test (KBIT; Kaufman & Kaufman, 1990) and the VABS (self-report) in a forensic sample of adolescents and adults. The correlation between the total scores was strong (.73). When partial correlation coefficients controlling for age were calculated, the results were replicated. Receiver operating characteristics (ROC) curve analyses indicated that cut-off scores of <70 on each instrument successfully predicted a diagnosis of ID on the other instrument, with the K-BIT being a better predictor of performance on the VABS than vice versa, which the authors hypothesized was due to greater variations in adaptive behavior skills. The authors concluded that assessment of IQ and adaptive behavior provides a wide view of an individual's functioning, with each test contributing important information to the diagnosis of ID.

Last, de Bildt, Kraijer, Sytema, and Minderaa (2005) studied the psychometric properties of the VABS in a sample of children and adolescents with ID, and also in severe/profound, moderate, and mild subgroups. The authors concluded that the reliability and the construct validity of the VABS scores were excellent in all groups, and that the scale primarily measures one dimension—adaptive functioning, although the distinction of three domains was also recognized. Observed correlations between the VABS and multiple IQ tests were .65 for the severe/profound ID subgroup, .18 for the moderate ID subgroup, and .36 for the mild ID subgroup.

As these study summaries illustrate, even a cursory review of the extant literature and technical manuals beyond the Harrison (1987) and McGrew (2012) reviews demonstrates that there is extreme variation in the correlations between IQ and adaptive behavior measures—from near-zero to .75 at the very least. The sample sizes, sample characteristics, and measurement instruments in those studies also varied substantially. Therefore, it is important to identify variables that may have altered those reported correlations across the studies, and then to systematically study how they may have altered those correlations.

Variables Affecting Observed Relation of Intelligence and Adaptive Behavior

Sampling error, measurement unreliability, range variation, and (likely) moderating variables affect the observed correlations between intelligence and adaptive behavior in the extant research. This study seeks to address each of these.

Sampling Error. Outcomes of psychological research are subject to sampling error. Although large random samples yield parameter estimates that approximate actual population values, small samples are "randomly unrepresentative of the populations from which they are drawn" (Schmidt & Hunter, 2014, p. 12). Sampling error, especially in small samples, can result in estimated parameters that vary drastically from study to study. Because of sampling error, the validity of any study on the relation between IQ and adaptive behavior varies randomly from the true correlation value (Schmidt & Hunter, 2014).

Measurement Error. All psychological measures, IQ tests and adaptive behavior scales not excepted, have imperfect reliability and are thus subject to measurement error. Measurement error results in effect size estimates (i.e. correlation coefficients between scores on measures of IQ and adaptive behavior scales) that are attenuated (Borenstein, Hedges, Higgins, & Rothstein, 2009). Ceteris paribus, studies that use latent variables for intelligence and adaptive behavior therefore may report stronger correlations than those that use observed IQ scores and adaptive behavior scale scores.

Range Variation. In research on the relations between IQ and adaptive behavior, samples are often selected in ways that do not contain the full range of variation on either the IQ measure or on the adaptive behavior scale. Due to this restriction of range, the effect size estimates (i.e. correlation coefficients) are often attenuated (Borenstein et al., 2009). Some form of range restriction affects nearly all samples in the reviewed literature. One example is simultaneous selection on intellectual ability and adaptive functioning (Murray et al., 2014). Samples including only subjects previously identified with ID may result in attenuated correlations relative to samples that include some subjects with low IQ but no ID diagnosis. Being identified with an ID requires the presence of significant limitations in both intellectual and adaptive functioning, which imposes simultaneous selection criteria present in many IQ and adaptive behavior correlation studies with subjects previously identified with ID using both these measures, which in turn may attenuate reported correlations. For example, Murray et al. (2014) suggest that the relatively low correlations of .18 and .36 between IQ and adaptive behavior reported by de Bildt et al., (2005) for subjects with mild or moderate ID respectively may be attributable to attenuation caused by range restriction due to simultaneous selection.

Studies with homogenous samples lacking variability ought to result in lower correlations than studies with subjects with a wider distribution of scores on both adaptive behavior scales and intelligence tests (Reschly et al., 2002). Nevertheless, observing the correlations between IQ and adaptive behavior scores, this pattern does not always hold. Indeed, high correlations have been observed in more severely impaired samples (e.g., Vig & Jedrysek, 1995). Interestingly, the high correlations are likely attenuated due to restriction of range. Such data suggests a possible curvilinear association between IQ and adaptive behavior with an especially strong correlation at the lower IQ range.

Possible Moderators. Researchers and authors of studies examining the correlations between scores from intelligence tests and adaptive behavior scales have commented on potential moderating influences that have led to the wide range of correlations reported in the literature.

Harrison (1987) reported that correlations varied widely according to the type of adaptive behavior scale, intelligence scale, and sample used. She found it difficult to describe any major trends across the correlations in her synthesis except possibly a slight trend toward higher correlations between intelligence and adaptive behavior for more severely disabled samples, although even then several exceptions were observed.

Reschly et al. (2002) reported that the relation between IQ and adaptive behavior appears to vary significantly by age and levels of intellectual disability, and suggested that the relation is strongest in the severe and moderate ranges and weakest in the mild range. The authors also suggested that the relation between IQ and adaptive behavior is subject to several other moderating factors. Informed by general observations made by Meyers et al. (1979) and by data published in test manuals in the 1980s and 1990s, Reschly et al. reported that scale content, measurement of competences versus perceptions, sample variance (e.g., range variation), problems with measures' floors and ceilings, and level of ID may moderate the correlation of scores from adaptive behavior scales and intelligence tests.

McGrew (2012) reported that a reasonable estimate of the typical adaptive behavior/IQ correlation is approximately .50, with most observed correlations ranging from approximately .40 to .65. He acknowledged, however, that he made no attempt to determine if there are moderator effects in the relation between IQ and adaptive behavior. He listed potential moderators that should be investigated in future research including adaptive behavior measure used, IQ measure used, variability in the sample's level of functioning, manifest/measured versus latent variable correlation (i.e., related to measurement error), and level of ability.

Disability Type. There is evidence that the relation between IQ and adaptive behavior varies based on disability type. For example, Carpentieri and Morgan (1996) examined the relation between adaptive functioning on the VABS and intellectual functioning on the SB4 in a sample of children with autism and ID and a sample of children without autism of comparable age and IQ. Even though the groups did not differ on the SB4 composite score, the autism group's composite score on the VABS was substantially lower than was the ID group's. Differences were attributed to the much lower scores of the autism group in the Socialization and Communication domains on the VABS. The observed correlation was .57 for the total sample, .77 for the autism subsample, and .29 for the ID group. The authors concluded that intellectual impairment in autism is reflected in greater impairment in adaptive behaviors than in ID without autism.

Scales Utilized. In a review of several studies, Reschly (1982) concluded that the scales used in a study have major influence on the correlation between IQ test scores and adaptive behavior scores. For example, correlations between the Adaptive Behavior Inventory for Children (ABIC: Mercer & Lewis, 1978) and the Wechsler Intelligence Scale for Children-Revised (WISC-

R, Wechsler, 1974) ranged from near-zero to .3, with a median of about .15 (Kazimour & Reschly, 1980; Mercer, 1979); whereas the Children's Adaptive Behavior Scale (CABS, Richmond & Kicklighter, 1980) was moderately correlated with the WISC-R, with values ranging from .4 to about .5 (Kicklighter, Baily, and Richmond, 1980). Reschly (1982) surmised that the differences between the correlations could be explained, at least partially, because the CABS contains more content addressing cognitive and communication-based skills than the ABIC. DiSibio (1993) reported that adaptive behavior scales emphasizing underlying cognitive or school-related functions, which are high in communication or language-based items, tend to correlate higher with IQ tests that focus on out-of-school adaptive skills.

Adaptive Behavior Respondent. Most adaptive behavior scales rely upon information provided by third-party informants, such as parents, teachers, or caregivers. As such, variability in the relation between IQ and adaptive behavior as reported in the literature could vary dependent upon who is providing the information used to obtain adaptive behavior scores for an individual. Harrison (1989) reported that scores on adaptive behavior scales obtained through direct observation or through teacher interview tend to correlate more highly with IQ than ratings obtained via parent interviews.

Floor and Ceiling Effects. Intelligence tests and adaptive behavior scales often have ceiling and floor problems "at the extremes of ability or near the bottom and top ages covered by the instrument" (Reschly, 2002, p. 220). Intelligence tests often have floor problems because items do not go low enough to effectively discriminate the performance of very low functioning individuals. Adaptive measures often have ceiling problems because items do not go high enough to discriminate between average or near average functioning individuals. Murray et al. (2014) reported that it is reasonable to expect correlations to be lower in higher functioning samples because subjects are expected to score at ceilings on adaptive behavior scales, which are generally based on a concept of minimum criteria for independent living. Therefore, in their view the test ceilings are more important for correlations than the test floors.

Level of ID. The correlation between intelligence tests and adaptive behavior scales appears to be moderated by level of ID. The literature suggests that correlations between intelligence tests and adaptive behavior scales are higher for individuals that function well below average on both intelligence tests and adaptive behavior scales (Harrison, 1987; McGrew, 2012, Reschly et al., 2002). Meyers et al. (1979) and Grossman (1983) even went so far as to conclude that little difference exists between the constructs of intelligence and adaptive functioning for individuals with severe ID. According to Reschly et al. (2002), the relation is less clear with individuals in the moderate to mild levels of ID, but appears to be slightly higher than for individuals without ID. Murray et al. (2014) cited correlations of .07 to .36 between the VABS and K-ABC from samples of children from the measures' standardization population and compared them to correlations of .31 and .54 between the VABS and WAIS or WAIS-R in a sample of adults with ID. The latter, more impaired sample, yielded higher correlations between IQ and adaptive behavior. Such correlations may suggest a curvilinear relation between IQ and adaptive behavior where the relation decreases as a function of IQ level.

Summary. Intelligence tests and adaptive behavior scales are both used to facilitate the diagnosis and identification of ID and are also frequently used in the diagnosis and identification of other developmental disabilities (Harrison, 1987; McGrew, 2015; Schalock & Luckasson, 2013). Diagnosis and identification of ID and other developmental disabilities is not limited scores from IQ tests and adaptive behavior scales; however, they are pivotal, and the strength of their correlation can drastically affect diagnostic and eligibility decisions (Reschly et al., 2002).

Previous studies have suggested that the population correlation between IQ and adaptive behavior is likely moderate, though reported correlations range from near zero to near one (Harrison, 1987; McGrew, 2012). Reported correlation coefficients, however, are affected by sampling error, measurement error, range variation, and likely by moderating factors including disability type, scales utilized, adaptive behavior respondent, floor and ceiling effects, and level of ID. Through meta-analysis corrections can be made for sampling error, measurement error, and range variation; and moderator analyses can be conducted to determine if the relation between IQ and adaptive behavior differs across populations. This information will increase awareness and understanding of the relation between IQ and adaptive behavior and will help guide decisions of practitioners, researchers, and policy makers.

CHAPTER III

METHOD

Meta-Analysis

Identifying Studies for Analysis. Retrieval of studies for the meta-analysis initially involved searching for articles, dissertations, and theses in PsycINFO and ERIC using the terms *IQ, intelligence, cognitive functioning,* or *intellectual functioning* with *adaptive behavior* or *adaptive functioning,* and *relationship, relation, correlation or association*. These parameters resulted in 1,486 results from PsychINFO and 268 results from ERIC. The literature search covered all articles published before February 2017. Exclusion of obviously ineligible articles and dissertations following abstract review resulted in 164 independent studies (many with multiple correlations) for possible inclusion in the meta-analysis. Attempts were also made to include each of the correlations reported in Harrison (1987) and McGrew (2012). Many of these correlations were from unpublished sources, such as symposiums or papers presented at conferences. Original authors were contacted; however, none responded to requests. A number of studies reported correlations between IQ and domain scores on adaptive behavior scales. Authors of these studies were contacted to request correlation values between IQ and adaptive behavior composite scores. Only one author responded with the pertinent data. Correlations between IQ and adaptive functioning reported in technical manuals of popular and psychometrically sound intelligence tests and adaptive behavior scales were also included when a copy of the manual could be located. The search for technical manuals included contacting three university psychological clinics, one medical center psychological clinic, a school district, and two prominent researchers in the field of adaptive behavior.

Inclusion Criteria for Study Eligibility. Specific selection criteria were used to determine a study's eligibility for inclusion in the final sample in order to control for extraneous variables and to ensure validity. I carefully read the abstract for each study as a first step to determine eligibility. In the event that inclusion criteria were not clearly met after reading the abstract, the full study was read. The following criteria were applied to determine the eligibility of each study, including validity studies reported in technical manuals, for inclusion in the meta-analysis of IQ and adaptive behavior correlations:

1. Studies must be in English.
2. Studies must include reported sample size.
3. Studies must include at least one IQ and adaptive behavior measure.
4. Studies must report precise correlations between the global composites from the IQ and adaptive behavior measures or report sufficient information to convert other reported effect sizes to *r*. (Studies were excluded if correlations were not reported at all, were reported as a range without a precise breakdown, or when correlations between measures were based on scores such as mental age or other scores confounded by subjects' age or other variables).
5. To avoid duplication, data were not included when they were reported in another work included in the analysis.

Application of the exclusion criteria resulted in retention of 87 studies, 14 dissertations and theses, and nine technical manuals for coding.

Coding of Study Variables. The purpose of the present meta-analysis was (1) to calculate the magnitude of the correlation between IQ and adaptive behavior, and (2) to identify important variables moderating the correlation. Descriptive characteristics, potential moderators suggested in extant empirical and narrative studies reflecting sample and measurement characteristics, and effect sizes in the form of Pearson product moment correlations were coded. To ensure clear, concise, and valid coding of variables, a coding guide including an entry for all coded variables was prepared and regularly consulted (see Appendix B). To help ensure accuracy of coding, the first 20 studies were also coded by a master's level psychologist trained by the author in the coding procedures. Given the straightforward, objective nature of the coded variables, interrater agreement was high. Two disagreements were resolved through discussion. The remaining studies were coded by the author, who consulted with the master's level psychologist and dissertation advisor whenever a coding question arose.

Study Characteristics. For descriptive purposes, study identifiers were coded including (a) author, (b) year of publication, (c) source (i.e., test technical manual, journal article, unpublished dissertation or thesis), and (d) the national origin of each study.

Sample Characteristics. Coded sample characteristics included (a) mean age of participants, (b) disability type, (c) level of IQ, (d) sample description, (e) number of participants, (f) racial composition of sample, and (g) range variation (restriction or extension; calculated from mean sample IQ standard deviation and population IQ standard deviation).

Measurement Characteristics. Coded measurement characteristics included (a) IQ measure(s) used, (b) adaptive measure(s) used, (c) adaptive behavior informant, (d) whether or not the measures used in the study have been deemed psychometrically sound and researcher endorsed for the purpose of disability identification or diagnosis, (e) internal consistency reliability coefficient for the IQ measure(s) used, and (f) internal consistency reliability coefficient for the adaptive behavior measure(s) used.

Effect Size. All effect sizes except one were retrieved in the form of Pearson product moment correlations. In that study, a reported *t*-value reflecting the statistical significance of the correlation was converted to a Pearson product moment correlation. Following methodology proposed by Schmidt and Hunter (2014), correlations were not transformed into Fisher's *z* scores for the meta-analysis because this transformation produces an upward bias in the estimation of mean correlations. This upward bias caused by the transformation is usually greater than a negligible downward bias that occurs when using untransformed correlations (Field, 2001; Schmidt & Hunter, 2014).

For the initial database, each reported Pearson product moment correlation between IQ and adaptive behavior was recorded. When total and subgroup correlations were reported, the total sample correlation was preferred for the initial meta-analysis, though subgroups were used in moderator analyses where appropriate (resulting in different *k* values, i.e., the number of correlation coefficients used in a given analysis). When studies reported multiple non-independent correlations, composite correlation values were calculated using the method reported in Schmidt and Hunter (2014) in order to preserve the assumption of independence. When studies reported multiple independent correlation coefficients (e.g., comparison subgroups), the independence assumption was not violated and the correlation coefficient for each sample was included.

Coding of Moderator Variables. Several study, sample, and measure characteristics were subsequently categorically coded for moderator analysis including IQ level, participant age, disability type, adaptive measure respondent, year published, IQ measure used, adaptive behavior measure used, overall measure quality, and sample racial composition. As expected, a specific datum was not always reported in all studies; however, in some cases there was sufficient information provided to allow for subgroup coding for moderator analyses. For example, if mean sample IQ was not reported, but sample IQ range was reported, then subgroup assignment was made using this information. It must be noted that the independence assumption was conscientiously violated for a small number of subgroup correlation coefficients included in some moderator analyses. For example, if the adaptive behavior of participants was rated by both a parent and teacher, a composite correlation was calculated and included in the main analysis; however, the correlations resulting from each adaptive behavior respondent were coded separately for moderator analysis. According to Schmidt and Hunter (2014), there is evidence that such violations of the assumption of independence have little or no effect in realistic data conditions.

IQ Level. Based on reported sample mean IQ or other information permitting subgroup assignment (such as IQ range or descriptive level), studies were assigned to one of the following moderator subgroups: IQ 39 and Below, IQ 40-49, IQ 50-59, IQ 60-69, IQ 70-79, IQ 80-89, IQ 90-99, IQ 100-109, or IQ 110 and Above.

Participant Age. Based on reported sample mean age, samples were assigned to one of the following moderator subgroups: early childhood (zero to four), childhood (five to 12), adolescence (13 to 18), and adulthood (19 and older).

Disability Type. Samples were assigned to one of the following moderator subgroups based on disability type: intellectual disability, autism, sensory disabilities (deaf-blindness, deafness, hearing impairment, visual impairment), developmental delay, learning disability, unspecified disability, non-disabled, and mixed. Admittedly, a degree of post-hoc categorization was required due to limited samples representing various disabilities, though effort to align studies to categorization of disabilities outlined in IDEA (2004) was made. The unspecified disability and mixed subgroups were excluded from the moderator analyses, as were subgroups consisting of fewer than five samples.

Adaptive Measure Respondent. Samples were assigned to one of the following moderator subgroups based on adaptive measure respondent: parent/caregiver, teacher, self-report, and direct measure.

Year Published. Samples from studies published prior to Harrison's (1987) narrative review, which suggested that the majority of correlations between IQ and adaptive behavior are moderate, were assigned to one subgroup, studies published after (1988 to present) were assigned to another.

Racial Composition. Following an approach similar to Voyer and Voyer (2014), who followed a coding scheme proposed by Goldberg, Prause, Lucas-Thompson, and Himsel (2008), samples were assigned to one of the following moderator subgroups based on studies' sample racial composition: ≥75% White, ≥75% Black, ≥75% Hispanic, racially diverse, and non-U.S. sample. The Hispanic subgroup was excluded from this moderator analysis due to limited samples (k = 2).

IQ Measure. Samples were assigned to one of the following moderator subgroups based on IQ measure used: Stanford-Binet (any edition, full battery), Wechsler (any edition, full battery), Bayley (any edition), Leiter (any edition), and abbreviated/short IQ forms. Studies using unspecified IQ measures and measures that were used in fewer than five studies were excluded from this analysis.

Adaptive Behavior Measure. Samples were assigned to one of the following moderator subgroups based on the adaptive behavior measure used: VSMS, Vineland/Vineland-II (any edition), SIB/SIB-R (any edition), ABS (any edition), ABIC, ABAS (any edition), and abbreviated/short adaptive behavior forms. Studies using unspecified adaptive behavior scales and measures that were used in fewer than five studies were excluded from this analysis.

Overall Measure Quality. McGrew (2015) reported that the Cognitive Assessment System (CAS; Naglieri & Das, 1997), Differential Ability Scales—Second Edition (DAS-II; Elliott, 2007), Kaufman Assessment Battery for Children—Second Edition (KABC-II; Kaufman & Kaufman, 2004), Stanford Intelligence Scales—Fifth Edition (SB5; Roid, 2003), Wechsler Adult Intelligence Scale—Fourth Edition (WAIS-IV; Wechsler, 2008), Wechsler Intelligence Scale for Children—Fourth Edition (WISC-IV; Wechsler, 2004), and Woodcock-Johnson Battery—Third Edition and Normative Update (WJIII/NU; Woodcock, McGrew, Schrank, & Mather, 2007) are comprehensive, nationally normed, individually administered IQ tests possessing satisfactory characteristics for use in the diagnosis or identification of ID. Tassé et al. (2012) identified the Adaptive Behavior Scale—School, Second Edition (ABS-S:2; Lambert, Nihira, & Leland, 1993), Adaptive Behavior Assessment System—Second Edition (ABAS-II; Harrison & Oakland, 2003), Scales of Independent Behavior--Revised (SIB-R; Bruininks, Woodcock, Weatherman, & Hill, 1996), and Vineland Adaptive Behavior Scales—Second Edition (Vineland-II; Sparrow, Cicchetti, & Balla, 2005) as comprehensive individualized, standardized, and psychometrically sound adaptive behavior scales developed specifically to aid in the diagnosis or identification of ID. Samples utilizing both an IQ and adaptive behavior measure from these lists (or their direct predecessors or revisions) were assigned to one moderator subgroup. The remaining studies were assigned to another subgroup.

Meta-Analytic Procedures.

Correction for Measurement Error and Range Variation. Due to measurement error and range departure, observed correlations between IQ and adaptive behavior are likely attenuated (e.g., Murray et al., 2014). Information to correct for these artifacts at the individual study level were not available for many of the included studies. As such, correction for measurement error and range variation were accomplished by use of a distribution of artifact values compiled across the studies. In order to correct for measurement error, internal consistency reliability coefficients for the IQ and adaptive behavior measures were recorded. In order to correct for range variation, observed sample IQ standard deviations and population IQ standard deviations were recorded. For many studies, reliability information for the IQ and adaptive behavior measures was drawn from sources not included in the meta-analysis. For example, reliability information on IQ tests and adaptive behavior scales was often obtained from test manuals or validity studies of the measure of interest. For studies that utilized multiple measures, the mean reliability of the measures of interest used was recorded. For studies that did not specify which IQ or adaptive behavior measures were used, the data were reported as missing. Artifact correction took place using the interactive procedure (so called because it takes into account the slight interaction between measurement error and range variation effects) wherein the variances due to between-study differences in criterion reliability, test reliability, and range variation are calculated simultaneously as opposed to sequentially. (Schmidt & Hunter, 2014). Due to the complexity of the calculations required for the interactive procedure of artifact correction, they were completed via computer software (Schmidt & Le, 2014).

Main Meta-Analysis. Using Software for the Hunter-Schmidt Meta-Analysis Methods (Schmidt & Le, 2014) and following procedures set forth by Schmidt and Hunter (2014), meta-analysis of the included studies took place in three stages. First, the studies were used to compile information on four distributions: (1) the distribution of the studies' observed correlations and their sample sizes, (2) distribution of the reliabilities of IQ, (3) distribution of the reliabilities of adaptive behavior, and (4) the distribution of range departure. Second, the distribution of observed correlations was corrected for sampling error. Schmidt and Hunter (2014) refer to this step as a bare-bones meta-analysis because the resulting estimate of the average correlation and its variance are corrected for sampling error only. Third, the distribution corrected for sampling error was then corrected for measurement error and range variation, thus providing an estimate of the population correlation between intelligence and adaptive behavior and its variance.

Moderator Analyses. Based on the recommendations of Schmidt & Hunter (2014, p. 64), the remaining heterogeneity in the population correlation ρ was examined to determine the presence of moderators based on the "75% rule," which states that if 75% or more of the variance of the observed correlations is attributable to the corrected artifacts, it can then be assumed that the remaining variance is also due to artifacts, albeit those for which no correction was made. If the variance of the observed correlations was lower than 75% following artifact correction, it is assumed that moderator variables may contribute to the total amount of variance and a search for potential moderators via subgroup analysis is necessary.

As recommended by Schmidt & Hunter (2014), 95% confidence intervals (95%-CIs) were used to test for the statistical significance of the difference of ρ between different moderator subgroups. Non-overlapping confidence intervals and distinct mean differences are good indicators of moderating effects.

Availability Bias. A frequent criticism of meta-analysis is that available studies are typically a biased sample of existing studies. It is often suspected that unpublished study findings are not statistically significant and have smaller effect sizes than published study findings (see Bakker, van Kiik, & Wicherts, 2012). As a result, it is contended that effect size estimates from meta-analysis will be biased upward (Schmidt & Hunter, 2014). Given that the correlations present in my study were likely to range from near-zero to near-one (e.g., Harrison, 1987) and given that many of the reported correlations in my study were likely to be provided simply as descriptive statistics without concern for statistical significance or size in studies primarily interested in other research queries, availability bias was not suspected as an issue. Even so, availability bias was assessed via subgroup analysis between published and unpublished studies included in the main meta-analysis. A significantly larger corrected mean correlation for published correlations would suggest availability bias (Schmidt & Hunter, 2014). For additional analysis of availability bias, the statistical package MAVIS (Hamilton, Aydin & Mizumoto, 2016) was used to generate a funnel plot of Fisher's z transformed correlation coefficients included in the main analysis. Using this graphic method of detecting availability bias, introduced by Light and Pillemer (1984), correlations included in the study were evaluated to determine whether they were distributed symmetrically about their mean. Overrepresentation of correlations above the mean correlation suggests availability bias based on the argument that correlations below the mean are missing from the literature due to insignificance.

Testing for Curvilinearity

Data-Sets. Raw data-sets containing age standardized FSIQ scores and Vineland-II ABC composite scores used to report the correlations found in the *WISC-V Technical and Interpretive Manual* (Wechsler, 2014b) and *WISC-V Technical and Interpretive Manual Supplement* (Wechsler, 2014c) were requested and obtained from the WISC-V publisher, Pearson. The data included a clinical sample of individuals with ID (n = 80) and a non-clinical sample (n = 59).

Regression Analysis. Using SPSS (version 23, IBM Corp., 2013), IQ was regressed on adaptive behavior and then IQ^2 and IQ^3 were introduced to examine if there are curvilinear effects in the relation between IQ and adaptive behavior. In essence, a test of whether IQ interacts with itself in its effects on adaptive behavior took place (see Keith, 2006). IQ was centered and then squared and cubed. Centered IQ, centered IQ^2, and centered IQ^3 were then used in the regression.

A statistically significant increase in the variance explained by the regression following the introduction of IQ^2 and IQ^3 indicated a statistically significant curve in the regression line. The curved regression line was then graphically explored using linear, quadratic, cubic, and LOESS fit lines in SPSS's scatterplot command.

Summary

An extensive search for studies, technical manuals, and other research reporting correlations between IQ and adaptive behavior was conducted. Correlation values, study characteristics, and measurement characteristics were coded for studies that met pre-determined eligibility criteria. Following methods outlined in Schmidt and Hunter (2014), bare-bones meta-analysis and meta-analysis correcting for measurement error and range departure were conducted to calculate the typical observed correlation between IQ tests and adaptive behavior scales and the estimated population correlation between IQ and adaptive behavior. Following the meta-analysis, moderator analysis was conducted to test for moderator variables via subgrouping of reported correlations using methods provided by Schmidt and Hunter (2014). The meta-analysis was completed using Software for the Hunter-Schmidt Meta-Analysis Methods (Schmidt & Le, 2014).

Additionally, data-sets used to calculate correlations reported in the WISC-V manuals (Wechsler, 2014b; Wechsler 2014c) were requested and obtained from the publisher. Regression analysis was conducted to examine if there are curvilinear effects in the relation between IQ and adaptive behavior using SPSS (version 23, IBM Corp., 2013).

CHAPTER IV

Results

Meta-Analysis Descriptives

There were 111 primary test manuals, dissertations, theses, and studies published between 1937 and 2017 included in the final data set for meta-analysis, which provided $k = 148$ independent samples. The overall sample size was $N = 16{,}468$, with individual study sample sizes ranging from 13 to 1,089. Average sample participant age was provided for 113 samples and was 11.83 ($SD = 7.9$). Participants had a primary disability of ID in 34.5% of studies, no disability in 22.3% of studies, and autism in 13.5% of studies. Participant primary disability reported in the remaining studies were hearing and/or visual impairment (3.4%), various developmental disabilities (5.4%), learning disabilities (2.7%), emotional and behavioral disorders (2.7%), unspecified disabilities (11.5%), and mixed samples of participants with and without disabilities (4.1%). Racial/ethnic sample composition information was provided for 65 U.S. based samples. Twenty-two of these samples consisted of primarily White participants, 11 samples consisted of primarily Black participants, two samples consisted of primarily Hispanic participants, and 30 samples were racially diverse. Samples included in the meta-analysis were from nine countries: Australia ($k = 3$), Canada ($k = 6$), Israel ($k = 1$), Netherlands ($k = 3$), Portugal ($k = 2$), Sweden ($k = 3$), Taiwan ($k = 1$), the United Kingdom ($k = 3$), and the United States ($k = 126$).

Estimated Population Correlation from Bare-Bones Meta-Analysis

The first research question of this study sought to estimate the typical observed correlation between IQ tests and adaptive behavior as reported in the extant literature. The mean observed correlation (*r*) between IQ and adaptive behavior, corrected for sampling error only and referred to as bare-bones meta-analysis by Schmidt and Hunter (2014), was .46 (see Table 4-1).

Estimated Population Correlation following Correction of Study Artifacts

The second research question of this study sought to estimate the typical correlation between IQ and adaptive behavior following correction of study artifacts. Following correction for sampling error, measurement error and range departure, the estimated mean population correlation (ρ) between IQ and adaptive behavior was .51 (95%-CIs for correlation coefficients are given in Table 4-1). Because the variance reduction following correction of study artifacts was less than 75%, generalization of this correlation would be an oversimplification because of the likely presence of moderators (see results in Table 4-1).

Moderator Analyses

The third research question sought to determine the presence and effect of moderators on the correlation between IQ and adaptive behavior. According to Schmidt and Hunter (2014), if 75% or more of the variance in observed correlations is attributable to corrected artifacts, then it can be assumed that the remaining variance is due to uncorrected artifacts. When the 75% rule is met, moderator analysis is unnecessary and the estimated population correlation following correction of study artifacts can be generalized. For this meta-analysis, the percent of variance in observed correlations attributable to sampling error, measurement error, and range departure was 45%, which indicates that a moderate amount of variance across the studies included in the analysis was due to corrected artifacts. However, since less than 75% of the variance was attributable to corrected artifacts, which indicates the presence of moderators, generalization of the population correlation cannot be made. Moderator analysis was conducted via subgrouping of coefficients included in the main meta-analysis. Results can be seen in Table 4-1.

Table 4-1

Meta-analytic results and moderator analyses

			Bare bones meta-analysis (corrected only for sampling error)			Meta-analysis with artifact correction					
	k[a]	*N*[b]	Mean *r*	VAR_r	SD_r	ρ	σ^2_ρ	σ_ρ	95%-CI LB[c]	95%-CI UB[d]	Variance reduction (%)[e]
Main meta-analysis	148	16,468	.46	0.04	0.20	.51	0.03	0.17	.47	.55	45.0
Moderator: Adaptive behavior measure[f]	142	14,839	.45	0.04	0.20	.50	0.03	0.17	.46	.53	42.6
VSMS	18	1,592	.65	0.02	0.14	.71	0.01	0.07	.63	.79	79.4
VABS/Vineland-II	75	8,411	.47	0.02	0.15	.51	0.01	0.09	.47	.55	72.1
SIB/SIB-R	8	597	.45	0.01	0.09	.49	0.00	0.00	.40	.59	100.0
ABS	6	651	.69	0.02	0.13	.75	0.00	0.04	.63	.87	91.3
ABIC	12	1,786	.23	0.05	0.23	.25	0.06	0.24	.10	.40	19.1
ABAS	15	1,039	.36	0.03	0.19	.39	0.03	0.17	.27	.51	47.2
Short form/screener	8	763	.33	0.03	0.18	.36	0.03	0.16	.20	.51	43.1
Moderator: Adaptive behavior respondent[f]	152	16,692	.44	0.04	0.19	.49	0.03	0.17	.46	.53	44.8
Parent/caregiver	121	13,612	.45	0.04	0.20	.49	0.03	0.18	.45	.54	41.3
Teacher	20	1,434	.38	0.00	0.06	.42	0.00	0.00	.36	.48	100.0
Self-report	6	616	.40	0.05	0.23	.44	0.05	0.21	.23	.66	32.4
Direct assessment	5	1,030	.54	0.01	0.10	.60	0.00	0.00	.49	.71	100.0
Moderator: Disability type[f]	112	13,699	.47	0.04	0.20	.53	0.03	0.18	.48	.57	40.8
Intellectual disability	51	5,890	.52	0.03	0.17	.59	0.02	0.13	.53	.65	57.2
Autism	20	2,516	.48	0.02	0.15	.54	0.01	0.11	.45	.62	64.9
Developmental delay	8	817	.71	0.00	0.01	.79	0.00	0.00	.75	.83	100.0
No disability	33	4,476	.34	0.04	0.20	.39	0.04	0.19	.31	.47	32.9
Moderator: IQ level[f]	142	15,591	.45	0.04	0.19	.50	0.03	0.17	.47	.54	45.7
IQ 39 and below	14	1,864	.49	0.03	0.16	.54	0.01	0.11	.44	.64	65.1
IQ 40-49	16	1,174	.68	0.04	0.21	.75	0.03	0.17	.63	.86	42.9
IQ 50-59	18	1,889	.55	0.02	0.12	.61	0.00	0.00	.54	.68	100.0
IQ 60-69	10	1,556	.46	0.01	0.10	.51	0.00	0.00	.44	.60	100.0
IQ 70-79	14	1,073	.42	0.05	0.21	.47	0.04	0.20	.33	.61	40.1
IQ 80-89	21	2,422	.51	0.02	0.13	.56	0.00	0.03	.49	.63	96.8
IQ 90-99	17	1,559	.41	0.04	0.19	.45	0.03	0.17	.34	.56	46.3
IQ 100-109	24	3,586	.32	0.04	0.20	.35	0.04	0.19	.26	.45	32.2
IQ 110-above	8	468	.37	0.00	0.06	.41	0.00	0.00	.31	.51	100.0
Moderator: IQ measure[f]	106	8,818	.44	0.05	0.23	.50	0.05	0.22	.44	.55	33.2
Stanford-Binet	23	1,975	.58	0.03	0.17	.65	0.02	0.13	.56	.74	58.0
Wechsler	55	4,395	.34	0.05	0.22	.38	0.05	0.22	.31	.46	31.9
Bayley	10	1,021	.66	0.01	0.10	.74	0.00	0.00	.66	.82	100.0
Leiter	7	309	.51	0.01	0.12	.57	0.00	0.00	.44	.71	100.0
Abbreviated/short form	11	1,118	.36	0.04	0.19	.41	0.03	0.18	.27	.55	40.3
Moderator: Measure quality[f]	148	16,468	.46	0.04	0.20	.51	0.03	0.17	.47	.55	45.0
Yes	56	5,098	.43	0.02	0.15	.48	0.01	0.11	.43	.53	67.0
No	92	11,370	.47	0.04	0.21	.53	0.03	0.19	.47	.58	39.4
Moderator: Race[f]	85	8,679	.42	0.05	0.22	.46	0.04	0.20	.41	.51	36.4
White	22	1,768	.39	0.04	0.21	.42	0.04	0.20	.31	.53	38.5
Black	11	588	.39	0.03	0.17	.42	0.02	0.14	.29	.55	61.4
Diverse	30	3,819	.40	0.07	0.26	.44	0.06	0.25	.33	.54	25.1
Non-U.S. sample	22	2,504	.49	0.02	0.14	.53	0.01	0.08	.45	.60	77.9
Moderator: Year Published[f]	148	16,468	.46	0.04	0.20	.51	0.03	0.17	.47	.55	45.0
Before 1988	58	8,209	.46	0.04	0.21	.51	0.03	0.18	.45	.57	39.4
1988 to present	90	8,259	.46	0.03	0.19	.51	0.02	0.15	.47	.56	51.3

(continued on next page)

Table 4-1 *(continued)*

			Bare bones meta-analysis (corrected only for sampling error)			Meta-analysis with artifact correction					
	k[a]	N[b]	Mean r	VAR$_r$	SD_r	ρ	σ^2_ρ	σ_ρ	95%-CI LB[c]	95%-CI UB[d]	Variance reduction (%)[e]
Moderator: Participant Age[f]	148	16,468	.46	0.04	0.20	.51	0.03	0.17	.47	.55	45.0
Early childhood	16	1,548	.63	0.01	0.11	.70	0.00	0.00	.63	.77	100.0
Childhood	90	9,812	.39	0.03	0.18	.44	0.02	0.16	.39	.48	47.6
Adolescence	14	1,151	.58	0.03	0.19	.64	0.02	0.14	.53	.76	54.3
Adult	28	3,957	.53	0.03	0.18	.58	0.02	0.14	.50	.66	52.2

Note. [a] Number of correlation coefficients used in analysis.
[b] Total *N*.
[c] Lower bound of 95% confidence interval (CI).
[d] Upper bound of 95% confidence interval (CI).
[e] Percent variance in observed correlations attributable to corrected artifacts (sampling error, measurement error, range departure).
[f] The number of coefficients with sufficient information for moderator analysis varied; therefore, results from the full group from each of the moderator analyses are reported in addition to results for each subgroup within the moderator analyses.

IQ Level. Analysis of IQ level resulted in a partially moderating effect. Estimated population correlations between IQ and adaptive behavior generally decreased as IQ increased, though IQ 39 and below (ρ = .54; .44 ≤ ρ ≤ .64), IQ 80-89 (ρ = .56; .49 ≤ ρ ≤ .63), and IQ 110 and above (ρ = .41; .31 ≤ ρ ≤ .51) did not strictly follow this trend. IQ 40-49 yielded the highest population correlation (ρ = .75; .63 ≤ ρ ≤ .86), followed by IQ 50-59 (ρ = .61; .54 ≤ ρ ≤ .68), IQ 60-69 (ρ =.51; .44 ≤ ρ ≤.60), IQ 70-79 (ρ =.47; .33 ≤ ρ ≤ .61), IQ 90-99 (ρ =.45;.34 ≤ ρ ≤ .56), and IQ 100-109 (ρ =.35; .26 ≤ ρ ≤ .45). The 95%-CI for the IQ 39 and below subgroup overlapped with the confidence intervals of all subgroups. The 95%-CI for IQ 40-49 only overlapped with those of IQ 39 and below, IQ 50-59, and IQ 80-89. The 95%-CI for IQ 100-110 showed no overlap with those of IQ 40-49, IQ 50-59, and IQ 80-89. Confidence intervals for each of the other subgroups demonstrated overlap with those of all but one or two of subgroups.

Variance reduction following correction for measurement error and range departure was 100% for IQ 50-59, IQ 60-69, and IQ 110 and above, and 96.8% for IQ 80-89, which suggests that these artifacts were entirely responsible for the heterogeneity of the correlation coefficients included in each of these subgroups, and a variance reduction of 65.1% suggests that a substantial degree of heterogeneity in the IQ 80-89 coefficients was attributable to corrected artifacts. For the IQ 39 and below, IQ 90-99, IQ 40-49, IQ 70-79, and IQ 100-109, variance reduction ranged from 46.4% to 32.2%, suggesting that corrected artifacts were responsible for a moderate degree of the heterogeneity of study coefficients included in each subgroup, but that there is still variation within subgroups that was not accounted for.

Participant Age. The Early Childhood subgroup resulted in the highest population correlation (ρ = .70), followed by the Adolescence (ρ = .64) and Adult (ρ = .58) subgroups. The lowest population correlation was found for the Childhood (ρ = .44). A partially moderating effect was found. The Adolescence subgroup's confidence interval (.53 $\leq \rho \leq$ .76) overlapped significantly with the Early Childhood (.63 $\leq \rho \leq$ .77) and Adult (.50 $\leq \rho \leq$ .66) subgroup confidence intervals, and there was a small overlap in the Early Childhood and Adult confidence intervals. No overlap was observed between the Childhood subgroup's confidence interval (.39 $\leq \rho \leq$ .48) and the confidence intervals of all other subgroups in this analysis; its correlation was substantially lower. Variance reduction following correction of study artifacts was 100.0% for the Early Childhood subgroup, and ranged from 49.6% to 57.9% for the Childhood, Adolescence, and Adult subgroups.

Disability Type. Moderator analysis conducted on subgroups defined by disability type resulted in a partially moderating effect. The Developmental Delay subgroup resulted in the highest population correlation (ρ = .79), followed by ID (ρ = .59), Autism (ρ =.54), and the Non-Disabled subgroup (ρ = .39). The 95%-CI for the Developmental Delay subgroup (.75 $\leq \rho \leq$ .83) did not overlap with that of the ID (.53 $\leq \rho \leq$ .65), Autism (.45 $\leq \rho \leq$ .62), and Non-Disabled (.31 $\leq \rho \leq$ .47) subgroups, suggesting the correlation was significantly higher for that group than the others. The ID and Autism confidence intervals overlapped substantially, the ID and the Non-Disabled confidence intervals did not overlap, and there was a very small overlap between the Autism and Non-Disabled confidence intervals. Reduction of variance resulting from artifact correction was 100.0% for the Developmental Delay subgroup, 64.9%for the Autism subgroup, 57.2% for the ID subgroup, and 32.9% for the Non-Disabled subgroup.

Adaptive Measure Respondent. Analysis of subgroups based on adaptive measure respondent yielded a partially moderating effect. Direct assessment measures of adaptive behavior resulted in a population correlation of .60, parent or primary caregiver reports resulted in a population correlation of .49, teacher reports resulted in a population correlation of .42, and the population correlation of Self-report measures of adaptive behavior was .40. The 95%-CI for correlations of self-reported measures of adaptive behavior was very wide ($.23 \leq \rho \leq .66$), wholly encompassing the 95%-CIs of parent/primary care-giver reports ($.45 \leq \rho \leq .54$) and teacher reports ($.36 \leq \rho \leq .48$), and significantly overlapping with direct assessment measures of adaptive behavior ($.49 \leq \rho \leq .71$). There was some overlap of confidence intervals between all adaptive behavior respondent subgroups except for the Teacher subgroup and the Direct Assessment subgroup. The reduction in variance following correction of study artifacts was 100.0% for the Teacher and Direct Assessment subgroups, 43.4% for the Parent/Caregiver subgroup, and 33.8% for the Self-report subgroup.

Year Published. Moderator analysis of studies published before and after 1988 yielded no effect. The population correlation ρ of both subgroups was .51 with very similar confidence intervals (Before 1988: $45 \leq \rho \leq .57$; After 1988: $.47 \leq \rho \leq .56$). Variance reduction resulting from artifact correction was 39.4% for pre-1988 sources and 51.3% for sources dated 1988 and later.

Racial Composition. No moderating effect was found among racial composition subgroups. The Non-U.S. sample subgroup yielded the highest population correlation (ρ = .53), followed by the Diverse subgroup (ρ = .44), and the Black and White subgroups (for both, ρ = .42). The confidence intervals for all subgroups overlapped significantly (Non-U.S.: .45 ≤ ρ ≤ .60; Diverse: .33 ≤ ρ ≤ .54; Black: .29 ≤ ρ ≤ .55; White: .31 ≤ ρ ≤ .53). The variance reduction resulting from artifact correction was 77.9% for the Non-U.S. subgroup, 61.4% for the Black subgroup, 38.5% for the White subgroup, and 25.1% for the Diverse subgroup.

IQ Measure. Analysis of subgroups defined by IQ measure used yielded a partially moderating effect. The Bayley subgroup yielded the highest population correlation (ρ = .74), followed by the Stanford-Binet (ρ = .65), Leiter (ρ = .57), Abbreviated/Short Form (ρ = .41), and Wechsler subgroup (ρ = .38). Confidence intervals for the Stanford-Binet (.56 ≤ ρ ≤ .74), Bayley (.66 ≤ ρ ≤ .82), and Leiter (.44 ≤ ρ ≤ .71) overlapped. Confidence intervals of the Leiter, Abbreviated/Short Form, and Wechsler (.31 ≤ ρ ≤ .46) subgroups overlapped. There was no overlapping of confidence intervals of the Wechsler subgroup and the Stanford-Binet or Bayley subgroups. The correlation between the Wechsler tests and adaptive behavior measures were significantly lower than those between the Stanford-Binet and the Bayley and adaptive behavior measures. Variance reduction following artifact correction of studies was 100.0% for the Bayley and Leiter subgroups, 58.0% for the Stanford-Binet subgroup, 40.3% for the Abbreviated/Short Form subgroup, and 31.9% for the Wechsler subgroup.

Adaptive Behavior Measure. Analysis of subgroups defined by adaptive behavior measure used yielded a partially moderating effect. The ABS subgroup yielded the highest population correlation (ρ = .75), followed by the VSMS (ρ = .71), Vineland/Vineland-II (ρ = .51), SIB/SIB-R (ρ = .49), ABAS (ρ = .39), Short Form/Screener (ρ = .36), and ABIC (ρ = .25).

Confidence intervals of the VSMS ($.63 \le \rho \le .79$) and ABS ($.63 \le \rho \le .87$) subgroups overlapped only with each other. Confidence intervals of the Vineland ($.47 \le \rho \le .55$), SIB ($.40 \le \rho \le .59$), ABAS ($.27 \le \rho \le .51$), and Short Form/Screener ($.20 \le \rho \le .51$) subgroups overlapped significantly. The ABIC confidence interval ($.10 \le \rho \le .40$) overlapped significantly with the ABAS and Short Form/Screener subgroups, and overlapped very little with the confidence interval of the SIB subgroup. Statistically insignificant differences in correlations were found between IQ and the VABS/Vineland-II measures, SIB/SIB-R measures, ABAS measures, and screener measures of adaptive behavior, though confidence intervals for the ABAS and screener measures were much wider. Correction of study artifacts resulted in a 100.0% reduction in variance for ABS subgroup, 91.3% for the ABS subgroup, 79.4% for the VSMS subgroup, and 72.1% Vineland subgroup. Variance reduction resulting from artifact correction was 47.2% for the ABAS subgroup, 43.1% for the Short Form/Screener subgroup, and 19.1% for the ABIC subgroup.

Measure Quality. No moderating effect was found between subgroups defined by measure quality. Studies conducted with both IQ and adaptive behavior measures recently deemed psychometrically sound and endorsed by experts for disabilities identification yielded a population correlation ρ of .48 ($.43 \le \rho \le .53$); whereas studies conducted with one or both measures not meeting these criteria yielded a population correlation ρ of .53 ($.47 \le \rho \le .58$).

Availability Bias

Subgroup analysis of published/test manual correlation coefficients versus unpublished correlation coefficients included in the main meta-analysis yielded corrected mean correlations with significantly overlapping confidence intervals (published: $\rho = .51$, 95%-CI $.47 \le \rho \le .55$; unpublished: $\rho = .46$, 95%-CI $.36 \le \rho \le .55$), thus providing evidence against availability bias.

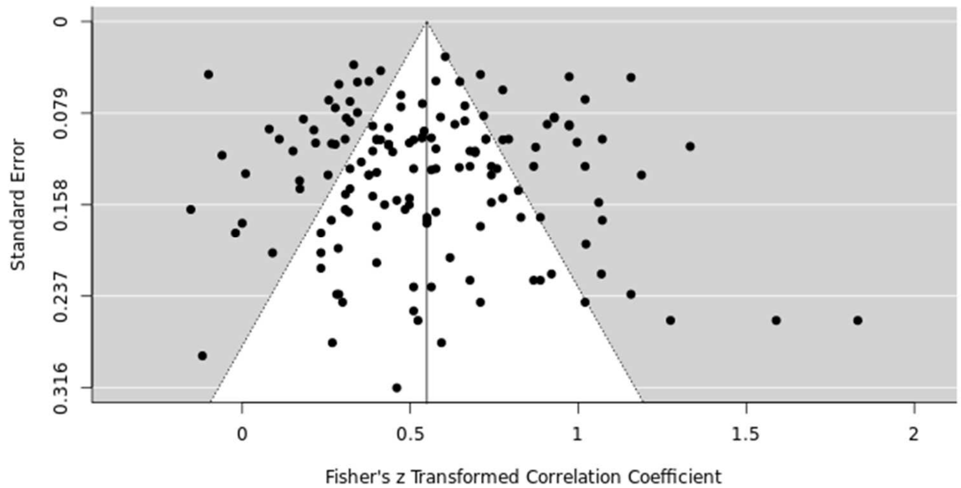

Fig. 4-1. Funnel-plot of Fisher's *z* transformed correlation coefficients included in the main meta-analysis. Dotted lines represent the 95%-standard error of the mean correlation. Dots represent correlations included in the analysis.

A funnel plot of Fisher's z transformed correlation coefficients included in the main meta-analysis is shown in Fig. 4-1. Visual analysis suggests that correlation coefficients are distributed symmetrically around the mean, and availability bias is not suspected because there is not an overrepresentation of correlations above the mean correlation. Further, a regression test for funnel plot asymmetry using a mixed-effects meta-regression model with standard error as the predictor yielded the following results: $z = .93$, $p = .35$. Resulting values where $p > .05$ suggest that there is no availability bias (Hamilton, Aydin & Mizumoto, 2016).

Regression Analysis

The fourth research question of this study sought to determine if there is a curvilinear relation between IQ and adaptive behavior by conducting curvilinear regression on combined raw data-sets containing FSIQ scores and Vineland-II ABC age-standardized composite scores used to report the correlations found in the *WISC-V Technical and Interpretive Manual* (Wechsler, 2014b) and *WISC-V Technical and Interpretive Manual Supplement* (Wechsler, 2014c). The resulting

Table 4-2
Regression Analysis Summary

	b	SE_b	R^2	F for Change in R^2
Model 1				
Constant	85.87	1.25		
Centered FSIQ	.58	.05	.46	116.29***
Model 2				
Constant	88.62	1.67		
Centered FSIQ	.64	.06		
Centered FSIQ^2	-.01	.002	.48	5.95*
Model 3				
Constant	86.91	1.75		
Centered FSIQ	.81	.09		
Centered FSIQ^2	.0004	.003		
Centered FSIQ^3	-0.0002	.00007	.51	7.47**

*$p < .05$. **$p < .01$. ***$p < .001$.

dataset that combined the clinical and non-clinical samples into a single dataset included $n = 139$ WISC-V FSIQ and Vineland-II ABC scores.

As shown in Table 4-2, a statistically significant curvilinear relation was observed between the WISC-V and Vineland-II ABC scores. The amount of variance accounted for when ABC scores were regressed on FSIQ was statistically significant ($R^2 = .46$; $F[1, 137] = 116.29$, $p < .001$). The addition of the FSIQ^2 term to the regression resulted in a statistically significant increase in the variance explained by the regression ($\Delta R^2 = .023$, $F[1, 136] = 5.949$, $p < .05$). The addition of the FSIQ^3 term to the regression also resulted in a statistically significant increase in the variance explained by the regression ($\Delta R^2 = .027$, $F = [1, 135]$ 7.467, $p < .01$), and yielded the best fit line. Scatterplots containing linear, quadratic, cubic, and LOESS fit lines are shown in Fig. 4-2 for graphical exploration. For the quadratic model, there appears to be a positive correlation between WISC-V IQ and Vineland-II ABC scores that gradually decreases as IQ increases. In the cubic model, WISC-V FSIQ scores appear to have little correlation with Vineland-II ABC scores until

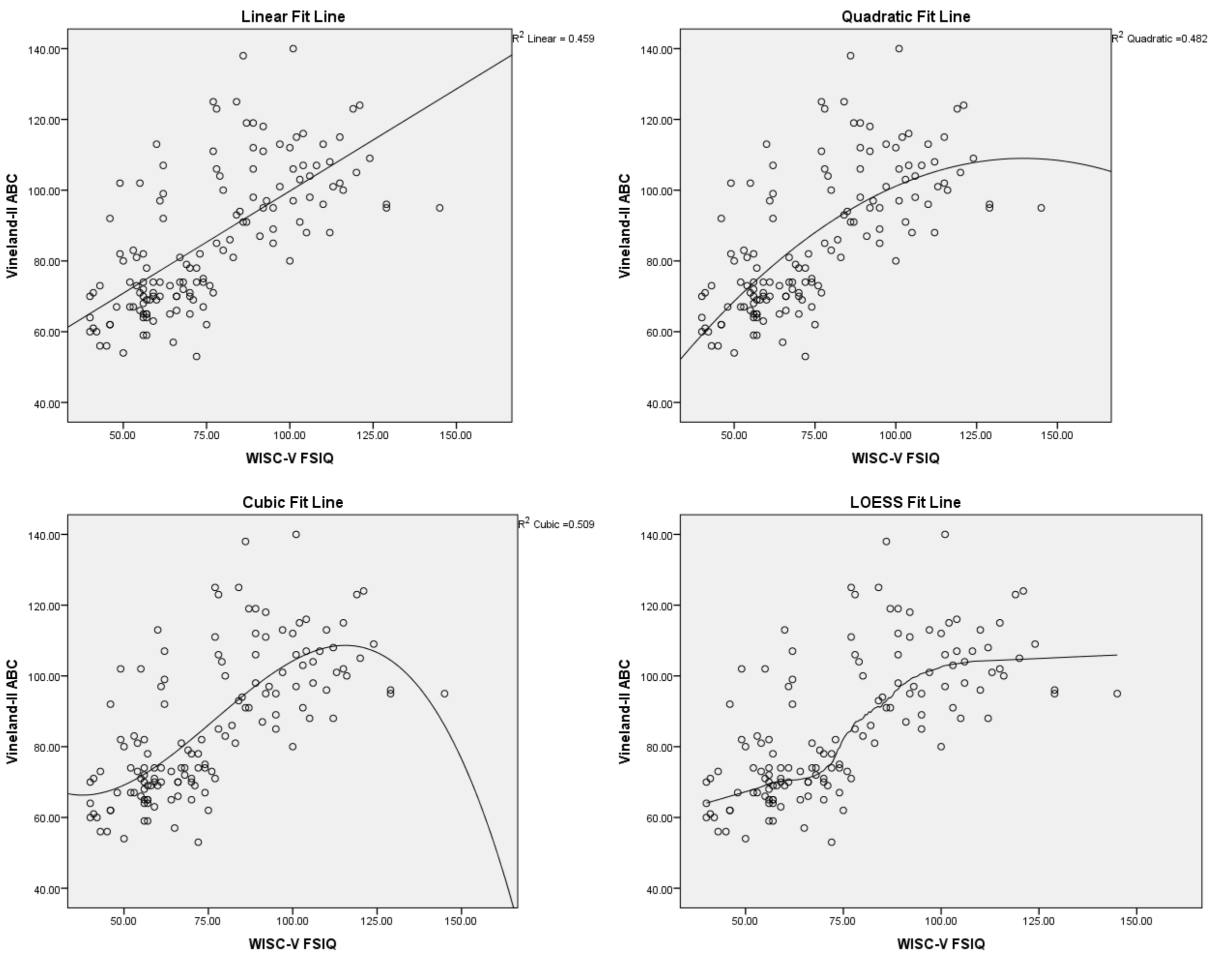

Fig. 4-2. Scatterplots containing linear, quadratic, cubic, and LOESS fit lines for the regression of vineland-II ABC scores on WISC-V FSIQ scores.

IQ reaches approximately 50, from which there appears to be a positive correlation that flattens at an IQ of approximately 100.

Summary

Following the Schmidt and Hunter (2014) methods of meta-analysis, the mean observed correlation (r) between IQ and adaptive behavior, corrected for sampling error, was .46. Following correction for measurement and range departure, the estimated mean population correlation (ρ) between IQ and adaptive behavior was .51. Due to substantial residual variance suggesting that these correlations are not generalizable, moderator analyses were performed. Partially moderating effects were found for IQ level, participant age, disability type, adaptive measure respondent, IQ measure used, and adaptive behavior measure used. No effect was found for year published, racial composition, and overall measure quality. Analysis of availability bias through subgroup analysis of published and unpublished correlation coefficients and funnel plot analysis provided evidence against availability bias.

Regression analysis of Vineland-II ABC scores onto WISC-V FSIQ scores after introducing the terms IQ^2 and IQ^3 into the regression yielded statistically significant results, indicating a curvilinear relationship between the WISC-V FSIQ and Vineland-II ABC scores. For the cubic model, there appeared to be little correlation between IQ and adaptive behavior until approximately an IQ of 50, and then a positive correlation that flattens out at an IQ of approximately 100.

CHAPTER V

Discussion

The primary purpose of this study was to investigate the relation between IQ and adaptive behavior via meta-analysis, adding to the previous narrative and descriptive reviews currently available in the literature. The Schmidt and Hunter (2014) methods of meta-analysis were employed because they allow for a bare-bones analysis (correction of sampling error only, which is comparable to other methods of meta-analysis), as well as analysis correcting for statistical artifacts present in studies beyond sampling error, such as sample size, measurement reliability, and range departure. Examination of a predetermined set of potential moderators on the IQ and adaptive behavior correlation was also conducted to try to clarify why there has been such substantial variation in reported correlations across studies (e.g., Harrison, 1987). In this section, the results of the main meta-analysis, moderator analyses, and curvilinear regression will be discussed in the context of extant research. This section is organized by research questions and is followed by study limitations, contributions, and future research directions.

Research Question 1: Estimated Population Correlation from Bare-Bones Analysis

The first research question sought to determine the typical observed correlation between IQ tests and adaptive behavior measures as reported in the extant literature. This is the first study to use meta-analysis methods to examine the relation between IQ and adaptive behavior. Harrison (1987) provided a narrative synthesis of the research, which included 40+ correlations ranging from .03 to .91. She concluded the majority of observed correlations were in the moderate range. McGrew (2012) conducted an ad hoc update of Harrison's synthesis, and provided descriptive statistics of 60 correlations, ranging from .12 to .90, with a mean of .51 and a median of .48. McGrew concluded that his finding was consistent with Harrison's conclusion of a moderate correlation. In the present study, analysis of $k = 148$ correlation coefficients, ranging from -.15 to .95 and corrected for sampling error, resulted in a sample size weighted mean observed correlation (r) of .46; a result that reinforces the conclusions of Harrison and McGrew. Even so, Murray et al. (2014) reported that many correlations reported in the literature are most likely attenuated due to study limitations such as measurement error and range departure, suggesting that the sample size weighted mean observed correlation ($r = .46$) may well be smaller than the true correlation between intelligence and adaptive behavior.

Research Question 2: Estimated Mean True Score Correlation following Correction of Study Artifacts

The second research question sought to determine the correlation between IQ and adaptive behavior following correction of study artifacts. Herein lies the central finding of the present study. The meta-analysis for the full sample resulted in an estimated mean true score correlation (ρ) of .51 between IQ and adaptive behavior. Because the 95%-CI ($.47 \leq \rho \leq .55$) does not include zero, it can be considered statistically significant. The increase of .05 from the sample size weighted mean observed correlation is not particularly large; but it is also not trivial.

This result addresses the concern brought forth by Murray et al. (2014) that observed correlations between intelligence and adaptive behavior may be attenuated, and corresponds directly with McGrew's 2012 assertion that a reasonable estimate of the correlation between IQ and adaptive behavior is approximately .50. It also reinforces conclusions made by Harrison (1987), Keith et al. (1987), and Reschly et al. (2002) that intelligence and adaptive behavior are separate, moderately related constructs. The correlation of .51 between intelligence and adaptive behavior means that IQ accounts for approximately 28% of the variance in adaptive behavior. To put this correlation in context, Roth et al. (2015) reported that intelligence is considered to be the strongest predictor of scholastic achievement and found an estimated mean true correlation of .54 between intelligence and school grades using similar meta-analysis methods to those used in the present study. The present study's estimated mean true score correlation (ρ) of .51 clearly demonstrates the significant influence of intelligence on adaptive behavior. Even so, generalization of this finding would be an oversimplification of the relation due to substantial residual variance left unaccounted following artifact correction. Therefore, discussion of the results of the moderator analyses is warranted as the magnitude of the correlation varies dependent upon the subgroup analyzed.

Research Question 3: Moderator Effects

The third research question addressed in this study resulted in an exploration of the effect of moderators on the correlation between IQ and adaptive behavior. Examination of the effects of IQ level, participant age, disability type, adaptive measure respondent, year published, racial composition, IQ measure, adaptive behavior measure, and overall measure quality took place via subgroup analyses following the Schmidt and Hunter (2014) methods of meta-analysis.

IQ level. With regard to the moderator analysis of IQ level, Harrison (1987) suggested that the IQ/adaptive behavior relation may be stronger for individuals that function well below average on both intelligence tests and adaptive behavior scales; however, she noted that there were several exceptions among samples in her synthesis of the research. The present study also contained exceptions to this observation when examining sample estimates across and within *individual* studies. Results from the present moderator analyses lend quantitative reinforcement to Harrison's qualitative observation: There is a trend for the correlation between IQ and adaptive behavior to increase as IQ decreases.

Reschly et al. (2002) surmised that the IQ/adaptive behavior relation was not as clear for individuals in the moderate to mild levels of ID, but suggested that correlations seemed to be slightly higher in these samples than for typically developing individuals. Again, the results from the present analyses quantitatively support this qualitative observation. The three smallest correlations were found for the subgroups with a mean IQ of 90 or above. The IQ/adaptive behavior population correlation of subgroups with mean IQ scores in the ID range (two or more standard deviations below the mean) were higher than subgroups with mean IQ scores above the ID range, and even though overlap in 95%-CIs were present across neighboring subgroups, population correlations tended to decrease as IQ increased. A notable exception to the overall trend was the subgroup containing samples with a mean IQ of 39 and below. Even though it was expected to have the highest correlation if the correlation was strictly a function of IQ, this subgroup's population correlation (ρ = .54) was lower than all subgroup population correlations in the ID range except IQ 60-69 (ρ = .51). This may be due to floor effects inherent in many IQ measures, which decrease in sensitivity as IQ decreases (Whitaker & Gordon, 2012), or because many popular IQ measures do not even have scores that go below 45. It may also simply be related to the categorization of what is essentially a continuous IQ variable. Regardless, the important finding with this moderator is that in general, the correlation between IQ and adaptive behavior is likely to be stronger in the lower IQ groups (i.e., below the 25th percentile). It is these groups for which the correlations may be of greatest importance from a practical point of view. Further, it supports assertions of others who have contended that that IQ and adaptive behavior are not as differentiated at lower IQ levels (Meyers et al. 1979; Grossman 1983).

Participant age. Reschly et al. (2002) suggested that the relation between IQ and adaptive behavior appeared to vary significantly by age; however, no trend or tendency by age was reported.

In the present analyses, a partially moderating effect for age was observed. This effect, however, was not linear. The population correlation between IQ and adaptive behavior was strongest for children under 5 (ρ = .70), followed by adolescents from age 13 to 18 (ρ = .64), and adults over 18 (ρ = .58); the correlation was lowest, and significantly so, for children between ages five and 12 (ρ = .44). It is possible that the higher correlations observed in the Adolescent and Adult subgroups, as compared to the Childhood subgroup correlation, are confounded by IQ. The mean IQs of the Adolescent and Adult subgroups were 74 and 52, respectively; whereas the mean IQ of the Childhood subgroup was 81. The mean IQ of the Early Childhood subgroup (80), however, is comparable to that of the Childhood subgroup, and the absence of overlap in the 95%-CIs between the correlations in these two subgroups suggests a clear age effect. Vig and Sanders (2007) hypothesized that cognitive demands are stronger for young children whose adaptive skills are just emerging (particularly those with disabilities) when compared to older individuals who have been exposed to practice and training. This would result in a stronger correlation between IQ and adaptive behavior. (Incidentally, a similar hypothesis could be made about those who have IQ deficits relative to peers, and may also explain the stronger IQ and adaptive behavior correlation in lower IQ groups). Results of the present analyses lend empirical support to this hypothesis. In the future, it would prove interesting to examine the effects of age on IQ/adaptive correlations between age ranges that are more finely defined (e.g., separating infancy from early childhood).

Disability type. The moderator analyses concerning disability type yielded a partial moderating effect. The 95%-CI of the No Disability subgroup shared no overlap with those of the ID and Developmental Delay subgroups, indicating a clear moderator effect, and negligible overlap with that of Autism subgroup, which makes cautious interpretation of a meaningful difference between these moderator groups feasible. The lower correlation observed in the No

Disability subgroup is likely due to higher mean IQs reported in the samples in this group, demonstrating the likely confound of IQ level in these analyses as the correlation between IQ and adaptive behavior also decreased as IQ increased. Specifically, the mean IQ for the No Disability subgroup was 103; whereas the ID and Developmental Delay subgroups consisted exclusively of samples with a mean IQ of 70 or below and the average mean IQ for the Autism subgroup was approximately one standard deviation lower than that of the No Disability group.

Another interesting finding that emerged was that the correlation (ρ = .79) of the Developmental Delay subgroup was significantly higher than those of any other subgroup, indicating a clear moderating effect. Of note, sample and study characteristics associated with the correlations included in the Developmental Delay subgroup were much more homogenous than the other subgroups. All samples but one consisted of participants with a mean age of five or younger, all but one utilized an edition of the Bayley Scales of Infant Development as the measure of intelligence, and all reported mean intelligence scores that were well below a standard score of 70. The high correlation for the Developmental Delay subgroup runs counter to the assertion of Reschly et al. (2002) who stated that studies with homogenous samples lacking variability ought to result in lower correlations. Nevertheless, as reported above, lower IQ and a chronological age of five or below were both shown to yield higher IQ/adaptive behavior correlations in the previous analyses. Taken together, this finding in particular lends more weight to the hypothesis set forth by Vig and Sanders (2007), which suggested stronger correlations between IQ and adaptive behavior would be expected from children that are younger *and* have intellectual impairment. Future research examining the interaction or confounding effects of IQ level, age, and even measure used on IQ/adaptive behavior correlations are warranted.

No moderator effect was found between the Autism and ID subgroups in the present study as correlations for the two groups, and their confidence intervals, were comparable. Both disabilities are characterized by deficits in adaptive behavior, and Fombonne (2003) reported that between 50-70% of individuals with autism also have ID, so similar correlations may be reasonably expected. Some studies (e.g., Carpentieri & Morgan, 1996; Schatz & Hamdan-Allen, 1995), however, have reported lower correlations between IQ and certain adaptive behavior domains for people with autism *and* ID compared to people with ID but not autism. Findings in the present study suggest that when the samples are not "matched" on IQ level, the correlation between IQ and adaptive behavior for people with autism is *similar* in size to the correlation between IQ and adaptive behavior for those with ID. Only 15% of the samples with autism had reported mean IQs in the ID range, so differences between ID and autism matched for IQ were left largely unexplored. It may be that some of the differences found in matched groups are due to sampling error, or there may indeed be a true difference when matched. Findings from the current study, however, indicate a moderate relation between adaptive behavior and IQ in those with autism in general. This correlation is not unexpected. Howlin, Goode, Hutton, and Rutter (2004) reported that individuals with autism with an IQ of at least 70 have significantly better outcomes with regard to independence than those with lower IQs.

Adaptive behavior respondent. Harrison (1989) reported that scores on adaptive behavior scores obtained through teacher interview and direct observation tend to correlate more highly with IQ than ratings obtained through parent interview. She hypothesized that a potential explanation is that teachers often have to estimate responses to items on adaptive measures and do so based on their knowledge of a child's cognitive functioning and school achievement—that is, teachers rate children on what they believe the child can do rather than on what they do. On the one hand, her conclusions about a higher ID/adaptive behavior correlation for teacher ratings were not supported by the moderator analyses in this study. There was not a significant difference found between IQ/adaptive correlations from the teacher ($\rho = .42$) and parent/primary caregiver ($\rho = .49$) subgroups. If anything, the relatively small overlap in confidence intervals could cautiously be interpreted to mean that the IQ/adaptive behavior correlation is lower for teacher responses than for parent/caregiver responses. On the other hand, Harrison's (1989) conclusions about a higher correlation for direct assessment measures compared to parent responses were supported—a clear effect was found for the higher correlation ($\rho = .60$) of direct adaptive behavior assessment measures. Meyers et al. (1979) reported that IQ tests measure maximum performance; whereas adaptive behavior scales measure typical performance. One possible reason for the higher IQ/adaptive behavior correlation for direct assessment measures may be due to testing procedures that are more similar to IQ testing. Setting up for children to engage in adaptive behaviors may place a greater emphasis on maximum performance rather than typical performance.

The adaptive behavior/IQ correlation was .44 for self-report respondents. The 95%-CI was very wide, and reported sample correlations ranged from 0.0 to .73. Tassé et al. (2012) urged that results on self-report measures should not be used as a basis for a diagnosis of ID because there may be a tendency for individuals to overestimate their adaptive skills in order to appear more capable than they may actually be. All but one sample from the Self-report subgroup were recruited from incarcerated populations, rendering generalization of the present result questionable. It is possible that in the case of some incarcerated individuals, there might even be a tendency to underreport adaptive skills, such as in circumstances where execution is a possible sentence. In *Atkins v. Virginia* (2002), the Supreme Court ruled against the death penalty for convicted murderers with ID. Further, assessment of adaptive behavior has been found to be difficult in prison settings in general because validity of self-reported adaptive behavior is questionable and because, often, no third party informants know the individual well enough to provide accurate responses (Boccaccini et al., 2016).

Year published. In 1904, Spearman reported the discovery of a factor of general intelligence, *g*, and research has demonstrated that IQ tests measure the same *g* (Floyd et al., 2013, Johnson et al., 2004). Conceptualizations of adaptive behavior have formally included notions of practical, conceptual, and social skills since as early as the mid-20th century (e.g., Heber, 1959). Harrison (1987), however, was the first to conduct a large scale review of the relation between IQ and adaptive behavior, indicating a moderate correlation between the two. Has the correlation between IQ and adaptive behavior changed since her review in 1987? Perhaps due to refination of adaptive behavior as a construct and improvements In IQ measurement there has been some change. Here, however, it was shown that the IQ/adaptive population correlations before Harrison's study and those since are the same. The population correlation of both subgroups was $\rho = .51$, which is the same as the estimated mean true score correlation from the main meta-analysis, lending support to the notion that the correlation between intelligence and adaptive behavior has remained stable over time once corrections for study artifacts are made..

Racial composition. The moderator analysis concerning racial composition yielded no moderating effect. No significant difference was found in the IQ/adaptive behavior population correlation between the diverse, White, Black, and non-U.S. subgroups. This finding suggests that race does not significantly alter the correlation between IQ and adaptive behavior. Comparable findings have been found with relations between IQ and achievement (Weiss & Prifitera, 1995). The prediction of adaptive behavior from IQ scores is not different for Black students and White students. Nevertheless, only the racial composition of the individuals being rated was considered in this study. Future research should also consider the racial composition of the raters as a possible moderator.

IQ measure. The type of IQ measure used was a partial moderator. Population correlations for families of intelligence measures with adequate representation in the main sample (i.e., $k \geq 5$) was highest for the Bayley Scales of Infant Development ($\rho = .74$), followed by the Stanford-Binet scales ($\rho = .65$), Leiter scales ($\rho = .57$), various short form scales ($\rho = .41$), and the Wechsler scales ($\rho = .38$). The finding of most interest in in this subgroup analysis was the absence of overlap in the 95%-CIs for the Wechsler batteries ($.31 \leq \rho \leq .46$) and Stanford-Binet batteries ($.56 \leq \rho \leq .74$), which are the only measures included in the present analysis that have been identified to possess satisfactory characteristics for use in the diagnosis or identification of ID (McGrew, 2015). Because no overlap in 95%-CIs was observed between these two families of measures, a clear moderating effect can be assumed. Results of the present analysis indicate that the population correlation of Wechsler scales ($\rho = .38$) is significantly lower than the population correlation of Stanford-Binet scales ($\rho = .65$), supporting postulations of Reschly (1982), Harrison (1987), Reschly et al. (2002), and McGrew (2012), who identified measure used as a possible variable affecting the relation between IQ and adaptive behavior.

Floyd, Clark, & Shadish (2008) reported that correlations between popular intelligence tests typically range from the .60s to .80s and measure about 40% to 60% common abilities, and that approximately 25% of individuals will have score differences of more than 10 points higher or lower between two IQ tests. McGrew (2015) reported that even IQ scores from the same family (e.g. WAIS-III/WAIS-IV compared to WAIS/WAIS-R) are not 100% comparable since subtests and abilities measures have changed across editions. In the present analyses, IQs from same families were grouped together. This also occurred frequently at the individual study level, especially for studies utilizing Wechsler IQs, which are published separately for different age groups (e.g., WPPSI, WISC, and WAIS). Grouping of IQs within families aside, it is noteworthy that the mean IQ for studies utilizing some version of the Stanford-Binet was approximately 62; whereas the mean IQ for studies utilizing a full Wechsler scale was approximately 82. This twenty point difference may partially explain the higher Stanford-Binet IQ/AB correlation, which tend to be stronger at lower IQ levels. Further research examining the impact of specific IQ measures on IQ/adaptive behavior correlations are needed. Ideally, in such research age and disability level would also be controlled for when making the comparisons.

Adaptive behavior measure. IQ and adaptive behavior population correlations were also partially moderated by the type of adaptive measure used. Population correlations for adaptive behavior scale families with adequate representation in the main sample (i.e., $k \geq 5$) was highest for the ABS (ρ = .75), followed by the VSMS (ρ = .71), VABS/Vineland-II (ρ = .51), SIB/SIB-R (ρ = .49), ABAS (ρ = .36), various screeners (ρ = .33), and the ABIC (ρ = .23). IQ/adaptive behavior correlations were moderate to strong for the VSMS and ABS, two measures that are no longer in use, and the 95%-CIs for these two measures did not overlap with any those of any of the other subgroups. The IQ/adaptive behavior correlation for the ABIC was weak to moderate, with a very wide 95%-CI that overlapped negligibly with that of the SIB/SIB-R subgroup and substantially with the ABAS subgroup; however, this measure is also no longer in use. Comparable moderate IQ/adaptive behavior population correlations were found for the VABS/Vineland-II (ρ = .51) and SIB/SIB-R (ρ = .49) subgroups, and a weaker, yet still moderate, correlation was found for the ABAS (ρ = .39) and screener (ρ = .36) subgroups; there was substantial overlap in the 95%-CIs for each of these subgroups. The important finding of this analysis concerns the comparability of the VABS/Vineland-II, SIB/SIB-R, and ABAS subgroups. Tassé et al. (2012) identified the

ABAS-II, Vineland-II, and SIB-R (along with the ABS-S:2, which was not represented in the analyses) as possessing satisfactory characteristics for use in the diagnosis or identification of ID. This said, the adaptive behavior measures endorsed for disability identification that are currently in use correlated similarly with IQ.

Measure quality. The moderator analysis concerning overall measure quality yielded no significant effect. The population correlation (ρ = .43) of studies utilizing IQ measures *and* adaptive behavior measures possessing satisfactory characteristics for use in the diagnosis or identification of ID (see McGrew, 2015; Tassé et al., 2012) did not differ from the population of correlation of studies where one or both measures were not researcher endorsed (ρ = .53), as indicated by significantly overlapping 95%-CIs. In retrospect, the meaningfulness of this analysis is suspect. Several studies employed one endorsed measure, but not both. Other studies reported correlations based on multiple (sometimes) unspecified measures wherein the measure quality status at the level of individual participants likely varied. Simply put, this analysis has produced results that likely are not of much utility.

Research Question 4: Curvilinear Relation of IQ and Adaptive Behavior

The fourth research question of this study sought to determine if there is a curvilinear relation between IQ and adaptive behavior. This question was previously addressed in the IQ level moderator analyses; however, regression analysis of Vineland-II ABC and WISC-V FSIQ scores used in validity studies found in the WISC-V manuals (Wechsler, 2014b; 2014c) and provided by Pearson, the test publisher, lends further support to the assertion that the relation between IQ and adaptive behavior depends on level of IQ. Introduction of IQ^2 and IQ^3 to the regression of adaptive behavior on IQ resulted in a statistically significant increase in the variance explained, indicating a statistically significant curve in the regression line. In the cubic model, WISC-V FSIQ scores appeared to have little correlation with Vineland-II ABC scores until IQ approached 50, from which there appeared to be a steady positive correlation that flattened at an IQ of approximately 100. The clinical group was oversampled in this study, which may have influenced the findings, although it is typical that this group is under-sampled, so there was a wider range of cases than are often reported. Regardless, analysis the WISC-V validity study data supports the conclusion that the relation between IQ and adaptive behavior is curvilinear.

Limitations

There are several limitations associated with this study that limit the generalization of the findings. Many of the limitations are associated with the use of subgroup analysis for the identification of moderators. These limitations include categorization of continuous moderators, interaction and confounding effects of correlated moderator variables, and inadequate representation of moderator variables due to an insufficient number of studies.

Subgroup analysis requires categorization of continuous variables, thus resulting in a loss of information (Schmidt & Hunter, 2014). In the present analysis, IQ level, Participant age, and Year published were continuous variables that were categorized for subgroup analysis. It may be that the effect of these variables on IQ/adaptive correlations would be better modeled with these as continuous variables. Although not reported, the relation between IQ and adaptive behavior was explored in an unweighted sample with a scatterplot of the correlations and a continuous IQ variable. The trend in that analysis was somewhat consistent with the subgroup analysis in that correlations generally decreased as IQ increased.

Another limitation of subgroup analysis deals with intercorrelation of moderator variables. Results of moderator analysis via subgrouping can be deceptive when moderators are correlated, and are thus subject to confounding and interaction effects (Schmidt & Hunter, 2014). Such effects can result in spurious differences for one potential moderator that are, in reality, produced by actual differences in another. A possible example from the present study was the significantly lower population correlation of the Childhood subgroup of the participant age moderator analysis as compared to the Early Childhood, Adolescent, and Adult subgroups. As previously discussed, the lower mean population correlation of the Childhood subgroup might be attributable, at least in part, to the subgroup's higher mean IQ. Obviously correlated moderator variables included in the study were IQ level and Disability type, so recognizing the relation between the two is important. There is likely some level of correlation between most moderator variables included in the study that resulted in some degree of interaction or confounding effects, some of which would be more obfuscated than others. For example, one might not immediately think IQ measure and Participant age to be correlated; however, most of the samples in the Early Childhood subgroup were administered the Bayley Scales of Infant Development as a measure of intelligence, a scale only administered to young children. The same can be said of Disability type and IQ measure—most samples in the Developmental delay subgroup were administered the Bayley Scales of Infant Development.

Another difficulty of conducting moderator analyses in meta-analysis is that there are often too few studies for adequate representation (Schmidt & Hunter 2014). Many subgroups were excluded from the present analyses for this reason, and many subgroups included in the analysis were substantially smaller than their counterparts. For moderator subgroups where the number of studies was small, the conclusions can only be tentative (Schmidt & Hunter, 2014). More complete and accurate moderator analyses will be able to be performed as more studies accumulate over time. But the findings in this study are only generalizable to the groups, measurement instruments, etc. that were adequately represented in the sample.

There are other methods of moderator analysis beyond subgroup analysis, such as meta-regression, that are able to control (at least in theory) for potential correlations among moderator variables, and thus avoid some of the limitations discussed above. For example, meta regression is able to better deal with continuous moderators. However, these methods are not without their own limitations. Perhaps if they were used in this study, slightly different conclusions may have been drawn about moderators. Even so, for the present study, methods advocated by Schmidt and Hunter (2014) were followed, and only a few moderators were continuous (though many were likely correlated).

Although this study represents the most extensive empirically rigorous examination of the relation between IQ and adaptive behavior to date, the correlations included in the meta-analysis are not exhaustive. Test manuals known to contain reported correlations, such as the ABAS-II, were unavailable at the time of the analysis despite efforts to obtain them. Also, many of the correlations reported in Harrison's (1987) review were unavailable, even though efforts were taken to obtain the pertinent data from Harrison and original authors. This was not surprising, given that the study is 30 years old and many of the included correlations are much older than that. The majority that were not obtained came from unpublished sources, such as papers presented at conferences. Additionally, studies included in the meta-analysis were limited by the terms and databases used in the initial search. Correlations from several studies in the present analysis came from studies with research queries ultimately uninterested, or only marginally interested, in the IQ/adaptive behavior relation. This suggests that there are many more studies in the literature that may have met inclusion criteria that simply did not turn up given the search terms and databases used.

Research Contributions and Future Research Directions

There is no shortage in the literature and other sources, including test manuals and dissertations, that report on the relation between IQ and adaptive behavior; however, the observed correlations vary in magnitude from near-zero to almost one. Harrison (1987) conducted a narrative synthesis of studies reporting on the relation, and estimated that the population correlation is likely moderate. She also commented that the correlation appears to be stronger in more severely disabled samples, but was not sure. McGrew (2012) augmented Harrison's data-set and conducted an informal analysis including a total of 60 correlations, describing the distributional characteristics observed in the literature regarding the relation. He concluded that a reasonable estimate of the correlation is approximately .50, but made no attempt to explore factors potentially influencing the strength of the relation. Murray et al. (2014) reported that many of the correlations reported in the literature are probably attenuated due to study limitations and various sources of error. This study contributes valuable information to the field of disability assessment and identification concerning the relation between intelligence and adaptive behavior and is the first to employ meta-analysis procedures and techniques to the exploration of this relation and its moderating variables; it is the first to empirically integrate findings across large numbers of existing studies (k = 148 for the main meta-analysis) while correcting for distorting effects caused by sampling error, measurement error, and range departure. Results from the present study corroborate the conclusions of Harrison (1987) and McGrew (2012) that the IQ/adaptive behavior relation is moderate, indicating distinct yet related constructs. The results showed indeed that the correlation is likely to be stronger at lower IQ levels—a trend that spans the entire ID range, not just the severe range. The estimated true mean population is .51, and study artifacts such as sampling error, measurement error, and range departure resulted in somewhat attenuated findings in individual studies (a difference of about .05 between observed and estimated true correlations overall). Thus, the assertions of Murray et al. (2014) were likely correct to some extent. With this information, researchers should be careful about generalizing findings from single samples from single studies. As demonstrated in the present study, correlations can and do vary greatly in magnitude between individual studies.

Further, moderator effects were identified and explored. The correlation between IQ and adaptive behavior is likely to be stronger in those with lower IQs and in very young children (especially those with disabilities), but weaker in typically developing individuals. The IQ/adaptive behavior correlation is likely to be comparable when parents/caregivers and teachers act as adaptive behavior respondents, but stronger when adaptive behavior is directly assessed. Results indicate that the IQ/adaptive behavior correlation has remained stable over time, and that race of an individual being evaluated does not significantly alter the correlation between IQ and adaptive behavior. The IQ/adaptive behavior correlation can differ depending on which IQ test is used—the correlation for Stanford-Binet scales is significantly higher than that of Wechsler scales. IQ/adaptive behavior correlations are comparable when adaptive behavior measures from the Vineland, SIB, and ABAS families of measures are used. These findings can help guide decisions of practitioners, researchers, and policy makers, especially in regard to the assessment and identification of intellectual disability and other developmental disabilities.

The accuracy of meta-analysis and especially moderator analyses can only improve with the addition of further studies into the sample pool; as such, there are numerous areas for potential future research. Studies specifically exploring the impact of potential moderators is needed as evidenced by the exclusion of several subgroups in this study’s moderator analyses due to insufficient representation in the literature. For example, in the present study, Wechsler and Stanford-Binet scales were collapsed into families of measures for analysis, and other IQ tests possessing satisfactory characteristics for use in disability diagnosis lacked sufficient representation for inclusion in the moderator analyses at all. Adaptive behavior measure subgroups were also collapsed and excluded. Future studies examining the relation between intelligence and adaptive behavior that employ specific psychometrically sound and researcher endorsed measures would yield important information further detailing the impact of measure used on said relation.

Studies comparing and contrasting the relation's magnitude among varied and distinct disabilities would also add to the robustness of future meta-analytic studies with regard to the impact of disability type on the relation. In the present study, several disability subgroups were excluded from moderator analyses due to insufficient representation, and disabilities were examined with rather wide strokes. For example, no attempt was made (nor was there sufficient information) to differentiate between the numerous etiologies resulting in ID.

This study examined moderator effects via study subgrouping. Other methods, such as met-regression, multilevel meta-analysis, hierarchical linear modeling, and mixed effects meta-analysis, are not without their own limitations; however, they have the advantage of being better able to deal with continuous moderators and control for any potential correlations among moderator variables (Schmidt & Hunter, 2014). Continuation of the present study (and future studies augmented with additional correlation values) may yield interesting outcomes as presumed correlation among moderators and categorization of continuous variables were observed in this study. Study of the impact of IQ level and age on the IQ/adaptive behavior relation as continuous variables, as well as controlling for potential correlations between moderators such as IQ level and disability type is needed.

Future research studies should also explore the relation between intelligence and adaptive behavior domains. The present study focused exclusively on the relation between intelligence and global adaptive functioning. With regard to the diagnosis or identification of ID, AAIDD, the APA, and the education departments of several states indicate that deficits in adaptive functioning can be established using either composite *or* domain level adaptive behavior scores (APA, 2013; Schalock et al., 2010; Bergeron et al., 2008). Meta-analysis of correlations between IQ and the practical, conceptual, and social skills domains of adaptive behavior would serve to shed further light on the IQ/adaptive behavior relation and inform practice, research, and policy.

Practical Implications

Assessment of intelligence and adaptive behavior are a vital component in the diagnosis or identification of developmental disabilities such as ID, autism, and developmental delay, and are a required component for diagnosis or identification of ID (Harrison, 1987; McGrew, 2015; Schalock & Luckason, 2013). Defined using three prongs, ID is characterized by (1) significant limitations in intellectual functioning, (2) significant limitations in adaptive behavior, and (3) onset early in development (Kranzler & Floyd, 2013). Professional, government, educational, and health-related organizations generally agree that significant limitations in intellectual functioning are substantiated by an IQ of approximately two standard deviations below the mean with consideration given to random error using of confidence intervals. The criteria for establishing deficits in adaptive behavior varies by organization; however, an adaptive behavior composite score or domain score that is two or more standard deviations below the mean, with consideration given to random error is generally required (Kranzler & Floyd, 2013).

The present study found the estimated true population mean correlation to be .51, meaning that adaptive behavior and intelligence share 26% common variance. In practical terms, this magnitude of relation suggests that an individual's IQ score and adaptive behavior composite score will not always be commensurate and will frequently diverge, and not by a trivial amount. Using the formula $\hat{Y} = \bar{Y} + \rho\,(X - \bar{X})$, where $\hat{Y}$ is the predicted adaptive behavior composite score, $\bar{Y}$ is the mean adaptive behavior score in the population, ρ is the correlation between adaptive behavior and intelligence, X is the observed IQ score for an individual, and $\bar{X}$ is the mean IQ score, and accounting for regression to the mean, the predicted adaptive behavior composite score corresponding to an IQ score of 70, given a correlation of .51, would be 85 —a score that is a full standard deviation above an adaptive behavior composite score of 70, the cut score recommended by *some* entities to meet ID eligibility requirements. With a correlation of .51, and accounting for regression to the mean, an IQ score of 41 would be needed in order to have a predicted adaptive behavior composite score of 70. Considering that approximately 85% of individuals with ID have reported IQ scores between 55 and 70±5 (Heflinger et al., 1987; Reschly, 1981), the eligibility implications, especially for those with less severe intellectual impairment, are alarming. In fact, derived from calculations by Lohman and Korb (2006), only 17% of individuals obtaining an IQ score of 70 or below would be expected to also obtain an adaptive behavior composite score of 70 or below when the correlation between the two is .50.

Taking into consideration the effect of moderators on the relation between intelligence and adaptive behavior, predicted score differences would be expected vary from the example given above, which used the estimated true population mean score found in the study. For higher correlations, expected score differences would be narrower; whereas for lower correlations, the expected differences would be greater. For example, based on IQ/adaptive behavior correlations from the subgroup analysis of IQ measure used, score differences between Stanford-Binet IQ scores and adaptive behavior composite scores ($\rho = .65$) would be expected to be lower than score differences between Wechsler IQ scores and adaptive behavior composite scores ($\rho = .38$).

The magnitude of the correlation between intelligence and adaptive behavior and the use

Table 5-1
Hypothetical Prevalence Rates of ID per 100 Population, Using Various Score Criteria and Estimates of the Population Correlation between IQ and Adaptive Behavior

Correlation (ρ)	Criteria	
	IQ -2 *SD and* Adaptive Behavior -2 *SD*	IQ -2 *SD and* Adaptive Behavior -1.5 *SD*
.35	0.245	0.544
.40	0.292	0.628
.45	0.345	0.720
.50	0.405	0.820
.55	0.473	0.930
.60	0.550	1.050
.65	0.637	1.181
.70	0.736	1.324
.75	0.850	1.481
.80	0.983	1.651

of IQ and adaptive behavior composite cut scores to determine eligibility (and thus identify or diagnose ID) has a drastic impact on estimates of the prevalence of ID. Table 5-1 presents the bivariate normal distribution estimates at various correlation magnitudes of the proportion of ID cases when IQ and adaptive behavior scores are both two standard deviations from the mean or more, and when IQ is two standard deviations from the mean or more and adaptive behavior is 1.5 standard deviations from the mean or more. Table 5-2 provides an estimate of the prevalence of ID in the United States based on an assumed population of 325,000,000. These tables were prepared with the aid of data provided by the National Bureau of Standards (1959), and were modeled after the method and calculations used by Silverstein (1973). Maulik et al. (2011) estimated that the prevalence rate of ID is approximately 1.04%. Using the estimates from Table 5-1, a similar prevalence rate (1.05%) would be expected if deficits in intellectual functioning were established by an IQ score two or more standard deviations below the mean, deficits in adaptive behavior were established by an adaptive behavior composite score 1.5 *SD* below the mean, and the IQ/adaptive behavior correlation was .60. This is but one combination of correlation and

Table 5-2
Hypothetical Prevalence of ID in the United States, Using Various Score Criteria and Estimates of the Population Correlation between IQ and Adaptive Behavior

Correlation (ρ)	Criteria	
	IQ -2 *SD* and Adaptive Behavior -2 *SD*	IQ -2 *SD* and Adaptive Behavior -1.5 *SD*
.35	796,250	1,768,000
.40	949,000	2,041,000
.45	1,121,250	2,340,000
.50	1,316,250	2,665,000
.55	1,537,250	3,022,500
.60	1,787,500	3,412,500
.65	2,070,250	3,838,250
.70	2,392,000	4,303,000
.75	2,762,500	4,813,250
.80	3,194,750	5,365,750

Note. Data are based on a population of 325,000,000.

eligibility criteria that could be used to obtain an estimated prevalence rate approximating 1.04%; however, it is especially pertinent given that the estimated ρ for the ID subgroup in the Disability type moderator analyses in this study was .59 (which is very close to .60). Using this example, the reported prevalence rate and statistically estimated prevalence rate of ID would be comparable when eligibility criteria for establishing deficits in intellectual ability is established by an IQ of 70 or below and deficits in adaptive behavior are established by an adaptive behavior composite score of 78 or below. Continuation of this example would place the estimated prevalence of individuals with ID in the United States at approximately 3.4 million (see Table 5-2), nearly twice the population that would be estimated when eligibility criteria are two standard deviations or more on both IQ and adaptive behavior measures. The impact stemming from the difference in these two sets of criteria is that approximately 1.7 million individuals either would or would not be found eligible for services and supports that could drastically affect their quality of life.

Conclusion

The purpose of this study was to investigate the relation between IQ and adaptive behavior and variables moderating the relation using psychometric meta-analysis. The findings contributed in several ways to the current literature with regard to IQ and adaptive behavior. First, the estimated true mean population correlation between intelligence and adaptive behavior following correction for sampling error, measurement error, and range departure is moderate, indicating that intelligence and adaptive behavior are distinct, yet related, constructs. Second, IQ level has a moderating effect on the relation between IQ and adaptive behavior. The correlation is likely to be stronger at lower IQ levels, and weaker as IQ increases. Third, while not linear, age has an effect on the IQ/adaptive behavior relation. The population correlation is highest for very young children, and lowest for children between the ages of five and 12. Fourth, the magnitude of IQ/adaptive behavior correlations varies by disability type. The correlation is weakest for those without disability, and strongest for very young children with developmental delays. IQ/adaptive behavior correlations for those with ID are comparable to those with autism when not matched on IQ level. Fifth, the IQ/adaptive correlation when parents/caregivers serve as adaptive behavior respondents is comparable to when teachers act as respondents, but direct assessment of adaptive behavior results in a stronger correlation. Sixth, an individual's race does not significantly alter the correlation between IQ and adaptive behavior, but future research should evaluate the influence of race of the rater on adaptive behavior ratings. Seventh, the correlation between IQ and adaptive behavior varies depending on IQ measure used—the population correlation when Stanford-Binet scales are employed is significantly higher than when Wechsler scales are employed. And eighth, the correlation between IQ and adaptive behavior is not significantly different between adaptive behavior composite scores obtained from the Vineland, SIB, and ABAS families of adaptive behavior measures, which are among those that have been deemed appropriate for disability identification. Limitations of this study notwithstanding, it is the first to employ meta-analysis procedures and techniques to examine the correlation between intelligence and adaptive behavior and how moderators alter this relation. The results of this study provide information that can help guide practitioners, researchers, and policy makers with regard to the diagnosis or identification of intellectual and developmental disabilities.

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References marked with an asterisk are included in the meta-analysis.

Appendix A. Overview of the characteristics of samples included in the main meta-analysis

Author (year)	Study Source	n^a	r^b	r_{xx}^c	r_{yy}^d	u_x^e	Age	Disability Type	IQ Measure	IQ	Adaptive Measure	Adaptive Respondent
Adams (1973)	Journal	100	.79	n.a.	0.86	1.41	7.84	Intellectual Disability	Unspecified	46.60	VSMS	Parent/Caregiver
Angkustsiri et al. (2012)	Journal	78	-.06	0.97	0.94	0.86	10.60	Chromosome 22q1 1.2 deletion syndrome	WISC-IV	76.40	BASC-2 ASC	Parent
Angkustsiri et al. (2012)	Journal	36	.50	0.97	0.94	0.87	10.80	Typically Developing	WISC-IV	108.80	BASC-2 ASC	Parent
Angkustsiri et al. (2012)	Journal	33	-.02	0.97	0.96	0.79	10.90	Chromosome 22q1 1.2 Deletion Syndrome	WISC-IV	76.20	ABAS-II	Parent
Atkinson, Bevc, Dickens, & Blackwell (1992)	Journal	24	.73[e]	0.88	0.94	0.94	6.80	Developmental Delay	Multiple	50.57	VABS	Parent
August, MacDonald, Ralmuto, & Scare (1996)	Journal	213	.31	0.94	0.96	0.83	9.50[g]	Behavior Disorder/Typically Developing	K-BIT	106.91	BASC-TRS ASC	Teacher
Bayley (2006)	Manual	60	.36	0.91	0.96	0.90	1.50[g]	n.a.	Bayley-III	101.50	ABAS-II	Parent/Caregiver
Boccaccini, Kan, Rufino, Noland, Young-Lundquist, & Canales (2016)	Journal	56	.17[f]	0.95	0.31	0.76	30.25	n.a.	WASI	96.14	ABAS-II	Multiple
Brawn & Porter (2014)	Journal	28	.23	0.96	0.95	1.06	18.33	William's Syndrome	WJIII Cog	61.68	Vineland-II	Parent/Caregiver
Brown, Bundy, & Gore (2010)	Journal	25	.23	0.95	0.98	n.a.	13.40	Autism	Multiple	95.90	SIB-R	Parent
Carpentieri & Morgan (1996)	Journal	20	.77	0.97	0.94	0.87	8.73	Autism	SB4	48.70	VABS	Parent
Carpentieri & Morgan (1996)	Journal	20	.29	0.97	0.94	0.60	9.09	Intellectual Disability	SB4	49.45	VABS	Parent
Chang, Yen, & Yang (2013)	Journal	94	.46[f]	n.a.	0.71	1.13	10.40	Autism (High Functioning)	WISC-IV Chinese	84.80	ABAS-II	Multiple
Childs (1982)	Journal	50	.68	n.a.	0.97	n.a.	6.92	Intellectual Disability	Unspecified	53.63[g]	ABIC	Parent
Christian & Malone (1973)	Journal	129	.75	0.94	0.90	0.73	14.00	Intellectual Disability	Multiple	50.00	ABS	n.a.
Dacey, Nelson, & Stoeckel (1999)	Journal	40	.52	0.97	0.94	0.60	20.80	Intellectual Disability	SB4	43.60	VABS	Caregiver
de Bildt, Kraijer, Sytema, & Minderaa (2005)	Journal	99	.65	0.93	0.94	n.a.	10.95	Intellectual Disability	Multiple	21.25[g]	VABS	Parent
de Bildt, Kraijer, Sytema, & Minderaa (2005)	Journal	144	.18	0.93	0.94	n.a.	11.54	Intellectual Disability	Multiple	45.00[g]	VABS	Parent
de Bildt, Kraijer, Sytema, & Minderaa (2005)	Journal	378	.36	0.93	0.94	n.a.	11.33	Intellectual Disability	Multiple	62.25[g]	VABS	Parent
di Sibio (1993)	Journal	51	.31	0.96	0.98	1.00	5.92	n.a.	WPPSI-R	106.00	VABS	Teacher
Doll & McKay (1937)	Journal	38	.50	n.a.	0.86	0.56	12.57	Intellectual Disability	SB1	61.00	VSMS	Parent
Doll & McKay (1937)	Journal	38	.68	n.a.	0.86	0.69	12.17	Intellectual Disability	SB1	68.00	VSMS	Parent
Doll (1953)	Manual	431	.82	0.92	0.86	0.99	25.38	Intellectual Disability	SB1	47.70	VSMS	Parent/Caregiver
Dykens & Cohen (1996)	Journal	104	.49	0.94	0.94	n.a.	22.92	Intellectual Disability	K-BIT	53.63[g]	VABS-Screener	Parent

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Appendix 1. *(continued)*

Author (year)	Study Source	n^{a}	r^{b}	r_{xx}^{c}	r_{yy}^{d}	u_{x}^{e}	Age	Disability Type	IQ Measure	IQ	Adaptive Measure	Adaptive Respondent
Dykens et al. (1996)	Journal	38	.71	0.90	0.94	1.03	16.67	Fragile-X Syndrome	SB3	40.00	VABS	Parent
Dykens et al. (1996)	Journal	37	.79	0.97	0.94	0.86	9.65	Fragile-X Syndrome	SB4	47.00	VABS	Parent
Ekström, Hakenäs-plate, Tulinius, & Wentz (2009)	Journal	19	.47	0.96	0.94	0.93	10.58	Congenital Myotonic Dystrophy Type 1, severe	WISC-III, WAIS-III	40.30	VABS	Parent/Caregiver
Ekström, Hakenäs-plate, Tulinius, & Wentz (2009)	Journal	18	.95	0.96	0.94	1.19	11.92	Congenital Myotonic Dystrophy Type 1, mild	WISC-III, WAIS-III	47.90	VABS	Parent/Caregiver
Ekström, Hakenäs-plate, Tulinius, & Wentz (2009)	Journal	18	.92	0.96	0.94	0.97	13.67	Myotonic Dystrophy Type 1, Childhood Onset	WISC-III, WAIS-III	50.40	VABS	Parent/Caregiver
Erickson, Johnson, & Campbell (1970)	Journal	30	.77[f]	0.99	0.86	1.29	2.72	Developmental Delay	Multiple	48.20	VSMS	Parent
Freeman, Ritvo, Yokota, Childs, & Pollard (1988)	Journal	27	.55	0.96	0.94	1.72	10.20	Autism	WISC-R	84.78	VABS	Parent/Caregiver
Fromme (1974)	Journal	41	.45	0.94	0.86	1.19	4.17	Speech Impaired	WISC	87.70	VSMS	Parent/Caregiver
Fromme (1974)	Journal	67	.63	0.92	0.86	1.24	4.17	Speech Impaired	SB2	84.40	VSMS	Parent/Caregiver
Gath & Gumley (1984)	Journal	22	.47	n.a.	0.90	n.a.	8.50[g]	Down's Syndrome	Unspecified	48.00	ABS-SE	Parent/Caregiver
Goldstein, Smith, Waldrep, & Inderbitzen (1987)	Journal	66	.57[f]	0.88	0.92	1.46	12.17	n.a.	Bayley	101.86	Multiple	Parent/Caregiver
Halpern, Raffeld, Irvin, & Link (1975)	Journal	374	.57	0.93	0.94	0.53	12.50[g]	Intellectual Disability	Multiple	68.00	Social and Prevocational Information Battery	Direct Assessment
Halpern, Raffeld, Irvin, & Link (1975)	Journal	382	.52	0.93	0.93	0.67	16.00[g]	Intellectual Disability	Multiple	67.00	Social and Prevocational Information Battery	Direct Assessment
Hanzel (2003)	Dissertation	16	.53[f]	0.82	0.96	1.22	11.25	Autism (High Functioning)	Multiple	87.35	Multiple	Parent
Hanzel (2003)	Dissertation	15	-.12[f]	0.74	0.96	0.98	10.67	Typically Developing	Multiple	108.73	Multiple	Parent
Harrison & Oakland (2015)	Manual	24	.79[f]	0.96	0.71	0.70	10.70	Intellectual Disability	RIAS	50.90	ABAS-3	Multiple
Harrison (1981)	Journal	65	.47	0.93	0.97	1.38	6.50[g]	n.a.	McCarthy Scales	90.60	ABIC	Parent
Hayes & Farnill (2005)	Journal	150	.73	0.94	0.94	1.27	25.00	n.a.	K-BIT	78.20	VABS	Self-Report
Hayes (2005)	Journal	202	.49	0.94	0.94	1.30	26.20	n.a.	K-BIT	73.10	VABS	Self-Report
Hill, Gray, Kamps, & Varela (2015)	Journal	220	.25	0.95	0.96	1.18	8.25	Autism	Multiple	84.20	ABAS-II	Parent/Caregiver
Huberty (1986)	Journal	83	.37	0.96	0.90	0.73	12.75	Suspected Learning/Behavior Problems	WISC-R	72.50	ABS-SE	Teacher
Hull & Thompson (1980)	Journal	369	.33	n.a.	n.a.	n.a.	36.00[g]	Intellectual Disability	Unspecified	37.44	Adaptive Functioning Index	Caregiver

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Appendix 1. *(continued)*

Author (year)	Study Source	n^a	r^b	r_{xx}[c]	r_{yy}[d]	u_x[e]	Age	Disability Type	IQ Measure	IQ	Adaptive Measure	Adaptive Respondent
Hurst (1962)	Journal	91	.41	0.92	0.86	0.90	5.99	Typically Developing	SB2	118.90	VSMS	Parent
Hurst (1962)	Journal	64	.51	0.92	0.86	1.18	4.79	Behavior Disorder	SB2	121.40	VSMS	Parent
Hurst (1962)	Journal	100	.62	0.92	0.86	0.78	12.26	Intellectual Disability	SB1	50.30	VSMS	Parent
Ittenbach, Spiegel, McGrew, & Bruininks (1992)	Journal	183	.27	1.00	1.00	n.a.	5.79	n.a.	Modified KABC	n.a.	VABS	Parent
Janniro, Sapp, & Kohler (1994)	Journal	18	.86[f]	0.96	0.21	0.60	14.00	Intellectual Disability	WISC-R	45.06	Multiple	Multiple
Johnson, Cook, & Kullman (1982)	Journal	67	.70	0.88	0.94	1.94	1.55	Developmental Delay	Bayley	49.00	VABS	Parent/Caregiver
Kadell (1960)	Dissertation	100	.62	0.92	0.86	0.81	11.50[g]	Intellectual Disability	SB2	50.00	VSMS	Parent/Caregiver
Kalis (2009)	Dissertation	36	.00	0.98	0.99	0.28	25.20	Learning Disability	WAIS-III	78.50	ABAS-II	Self-Report
Kanne et al. (2011)	Journal	1089	.54	0.94	0.95	1.57	9.20	Autism	Multiple	88.40	Vineland-II	Parent
Kazimour & Reschly (1981)	Journal	482	-.10	0.96	0.97	n.a.	8.50	n.a.	WISC-R	100.00[g]	ABIC	Parent/Caregiver
Keith, Fehrmann, Harrison, & Pottebaum (1987)	Journal	556	.39	1.00	1.00	n.a.	8.50	n.a.	K-ABC	100.00[g]	VABS	Parent/Caregiver
Keller (1988)	Journal	154	.62[f]	0.96	0.64	n.a.	7.00	n.a.	WISC-R	100.00[g]	Multiple	Multiple
Kenworthy, Case, Harms, Martin, & Wallace (2010)	Journal	29	.28	0.96	0.96	0.74	15.99	Typically Developing	WAIS-III, WISC-III, WISC-IV	112.83	ABAS-II	Parent
Kenworthy, Case, Harms, Martin, & Wallace (2010)	Journal	40	.31	0.96	0.96	1.08	15.30	Autism (High Functioning)	WAIS-III, WISC-III, WISC-IV	111.75	ABAS-II	Parent
Kicklighter & Bailey (1980)	Journal	60	.36	0.96	0.91	n.a.	9.40	Intellectual Disability	WISC-R	53.63[g]	CABS	Direct Assessment
Kicklighter & Bailey (1980)	Journal	60	.25	0.96	0.91	n.a.	9.34	Slow Learner	WISC-R	77.50[g]	CABS	Direct Assessment
Kullgren, Morris, Bachanas, & Jones (2004)	Journal	67	.59	0.94	0.94	1.00	6.69	HIV	Multiple	84.31	VABS	Parent/Caregiver
Kuriakose (2012)	Dissertation	23	.59[f]	0.96	0.95	1.40	11.20	Autism	Multiple	84.20	Vineland-II	Parent
Kushalnagar et al. (2007)	Journal	46	.65	n.a.	0.94	1.27	3.24	Hearing Impaired	Multiple	94.34	VABS	Parent/Caregiver
Leiser (2010)	Dissertation	65	.31	n.a.	0.95	n.a.	4.02	Various Medical Conditions	Multiple	n.a.	Vineland-II	Parent/Caregiver
Lopata et al. (2012)	Journal	41	-.15	0.95	0.96	0.86	9.28	Autism (High Functioning)	WISC-IV Short-Form	104.36	ABAS-II	Parent
Louttit & Watson (1941)	Journal	62	.38	0.92	0.86	n.a.	6.50[g]	Typically Developing	SB2	100.00[g]	VSMS	Parent/Caregiver
Low (2007)	Dissertation	16	.26	0.97	0.98	1.20	10.63	Autism (High Functioning)	WISC-IV	89.37	SIB-R	Parent
Luthar, Woolston, Sparrow, Zimmerman, & Riddle (2005)	Journal	126	.37	0.95	0.94	1.11	10.79	Psychiatric Disturbance	Multiple	95.54	VABS	Caregiver
Malone & Christian (1975)	Journal	126	.75	0.94	0.90	0.68	13.90	Intellectual Disability	Multiple	49.42	ABS	Caregiver

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Appendix 1. *(continued)*

Author (year)	Study Source	*n*[a]	*r*[b]	r_{xx}[c]	r_{yy}[d]	u_x[e]	Age	Disability Type	IQ Measure	IQ	Adaptive Measure	Adaptive Respondent
Maxton (1997)	Dissertation	100	.66	0.88	0.94	1.41	1.66	Developmental Delay	Bayley-II	75.54	VABS	Parent/Caregiver
Maxton (1997)	Dissertation	102	.51	0.88	0.94	0.80	1.92	Typically Developing	Bayley-II	103.00	VABS	Parent/Caregiver
McCrowell (2004)	Dissertation	94	.22[f]	0.94	0.57	0.53	8.83	Intellectual Disability	WISC-III	62.12	VABS	Parent/Caregiver, Teacher
McDonald et al. (2015)	Journal	71	.34	0.95	0.95	0.89	9.00	Autism (High Functioning)	WISC-IV Short-Form	103.70	Vineland-II	Parent
McDonald et al. (2017)	Journal	119	.08	0.95	0.94	0.96	8.70	Autism (High Functioning)	WISC-IV Short-Form	103.27	BASC-2 ASC	Parent/Caregiver
McGrew & Bruininks (1990)	Journal	100	.38	1.00	1.00	n.a.	5.24	n.a.	WJ	100.00[g]	SIB	Parent/Caregiver
McGrew & Bruininks (1990)	Journal	130	.56	1.00	1.00	n.a.	10.60	n.a.	WJ	100.00[g]	SIB	Parent/Caregiver
McGrew & Bruininks (1990)	Journal	192	.58	1.00	1.00	n.a.	27.45	n.a.	WJ	100.00[g]	SIB	Parent/Caregiver
Montague (1981)	Dissertation	150	.53	0.96	0.97	0.89	8.70	Suspected Disability	WISC-R	66.70	ABIC	Parent/Caregiver
Montfort (2015)	Dissertation	41	.30	0.93	0.95	1.12	9.20	Autism (High Functioning)	KBIT-2	93.95	Vineland-II	Parent
Mouga, Almeida, Café, Duque, & Oliveira (2015)	Journal	115	.49	0.94	0.94	1.35	12.50	Autism	WISC-III Portuguese	80.30	VABS	Parent/Caregiver
Mouga, Almeida, Café, Duque, & Oliveira (2015)	Journal	102	.49	0.94	0.94	1.18	12.00	Intellectual Disability/Learning Disability	WISC-III Portuguese	75.20	VABS	Parent/Caregiver
Murray, McKenzie, & Murray (2014)	Journal	88	.70	1.00	1.00	n.a.	11.41	Intellectual Disability	WISC-IV	37.44[g]	ABAS-II	Parent/Caregiver
Oakland (1980)	Journal	136	.31	0.96	0.97	1.00	10.00[g]	n.a.	WISC-R	106.00	ABIC	Parent/Caregiver
Oakland (1980)	Journal	117	.21	0.96	0.97	0.87	10.00[g]	n.a.	WISC-R	93.00	ABIC	Parent/Caregiver
Oakland (1980)	Journal	92	.27	0.96	0.97	0.93	10.00[g]	n.a.	WISC-R	95.00	ABIC	Parent/Caregiver
Oakland (1980)	Journal	343	.28	0.96	0.97	1.00	10.50	n.a.	WISC-R	98.00	ABIC	Parent
Odishaw (2007)	Dissertation	37	.26[f]	0.78	0.15	0.71	12.05	Fetal Alcohol Syndrome	Multiple	83.68	ABAS-II	Multiple
Paskiewicz (2009)	Dissertation	22	.51	0.96	0.95	0.97	7.95	Autism	Multiple	70.61	Multiple	Teacher
Paskiewicz (2009)	Dissertation	33	.23	0.96	0.95	0.64	10.39	Intellectual Disability	Multiple	51.94	Multiple	Teacher
Paskiewicz (2009)	Dissertation	21	.28	0.96	0.95	0.54	8.71	Learning Disability	Multiple	76.76	Multiple	Teacher
Patterson (1943)	Journal	91	.41	0.92	0.86	0.90	5.00[g]	n.a.	SB2	118.90	VSMS	Parent
Patterson (1943)	Journal	35	.38	n.a.	0.86	1.01	5.00[g]	n.a.	Merril-Palmer	116.47	VSMS	Parent
Patterson (1943)	Journal	35	.61	n.a.	0.86	1.06	5.00[g]	n.a.	Gesell	114.47	VSMS	Parent
Perry, Flanagan, Geir, & Freeman	Journal	290	.65	n.a.	0.94	1.45	4.30	Autism	Unspecified	50.20	VABS	Parent/Caregiver
Platt, Kamphaus, Cole, & Smith (1991)	Journal	99	.39	0.97	0.98	0.54	12.00[g]	Intellectual Disability	SB4	59.00	VABS	Teacher
Platt, Kamphaus, Cole, & Smith (1991)	Journal	47	.37	0.96	0.98	0.60	12.00[g]	Intellectual Disability	WISC-R	58.50	VABS	Teacher
Platt, Kamphaus, Cole, & Smith (1991)	Journal	26	.38	0.96	0.98	0.66	12.00[g]	Intellectual Disability	WISC-R	61.50	VABS	Teacher

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Appendix 1. *(continued)*

Author (year)	Study Source	*n*[a]	*r*[b]	r_{xx}[c]	r_{yy}[d]	u_x[e]	Age	Disability Type	IQ Measure	IQ	Adaptive Measure	Adaptive Respondent
Popoff-Walker (1983)	Journal	60	.83	n.a.	0.97	1.62	8.90	Typically Developing/Intellectual Disability	Multiple	83.97	ABIC	Parent/Caregiver
Raggio & Massingale (1993)	Journal	44	.79[f]	0.88	0.56	1.35	1.00	Developmental Delay	Bayley	42.50	Multiple	Parent/Caregiver
Raggio, Massingale, & Bass (1994)	Journal	44	.63	0.88	0.94	n.a.	1.00	Developmental Delay	Bayley	n.a.	VABS	Parent/Caregiver
Rankhorn (1996)	Dissertation	82	.42	0.95	0.98	n.a.	9.42	Learning Disability	WISC-R, WISC-III	n.a.	VABS	Teacher
Reesman et al. (2009)	Journal	13	.43	0.96	0.98	0.69	10.50	Sturge-Weber Syndrome	Multiple	82.20	SIB-R	Parent
Reynolds (1981)	Journal	481	.61	n.a.	0.95	1.14	35.22	Intellectual Disability	Unspecified	53.15	Personal Competency Scale	Caregiver
Reynolds (1981)	Journal	67	.77	n.a.	0.90	n.a.	40.25	Intellectual Disability	Unspecified	37.44[g]	ABS	Caregiver
Rihtman et al. (2010)	Journal	60	.63	0.97	0.94	n.a.	9.25	Down's Syndrome	SB4	n.a.	VABS	Parent
Roszkowski & Bean (1980)	Journal	224	.77	n.a.	0.90	1.27	21.00	Intellectual Disability	Multiple	36.00	ABS-SE	Caregiver
Scattone, Raggio, & May (2011)	Journal	65	.64	0.91	0.95	0.75	2.75	Developmental Delay	Bayley-III	76.30	Vineland-II	Parent/Caregiver
Simonoff et al. (2013)	Journal	81	.60	0.94	0.94	1.16	12.00	Autism	WISC-III UK	84.60	Vineland Screener	Parent
Sparrow, Balla, & Cicchetti (1984)	Manual	719	.32	0.94	0.94	1.00	7.00[g]	n.a.	K-ABC	103.00	VABS	Parent/Caregiver
Sparrow, Balla, & Cicchetti (1984)	Manual	165	.33	0.90	0.94	0.65	35.00[g]	Intellectual Disability	SB3	26.50	VABS	Parent/Caregiver
Sparrow, Balla, & Cicchetti (1984)	Manual	99	.38	0.97	0.94	0.62	35.00[g]	Intellectual Disability	WAIS, WAIS-R	51.70	VABS	Parent/Caregiver
Sparrow, Balla, & Cicchetti (1984)	Manual	45	.43	0.90	0.94	0.71	35.00[g]	Intellectual Disability	Leiter	32.90	VABS	Parent/Caregiver
Sparrow, Balla, & Cicchetti (1984)	Manual	252	.44	0.93	0.94	0.56	35.00[g]	Intellectual Disability	Slosson	13.70	VABS	Parent/Caregiver
Sparrow, Balla, & Cicchetti (1984)	Manual	147	.30	0.90	0.94	0.62	35.00[g]	Intellectual Disability	SB3	26.70	VABS	Parent/Caregiver
Sparrow, Balla, & Cicchetti (1984)	Manual	92	.41	0.97	0.94	0.63	35.00[g]	Intellectual Disability	WAIS, WAIS-R	51.60	VABS	Parent/Caregiver
Sparrow, Balla, & Cicchetti (1984)	Manual	43	.46	0.90	0.94	0.69	35.00[g]	Intellectual Disability	Leiter	32.60	VABS	Parent/Caregiver
Sparrow, Balla, & Cicchetti (1984)	Manual	187	.44	0.93	0.94	0.52	35.00[g]	Intellectual Disability	Slosson	15.20	VABS	Parent/Caregiver
Sparrow, Balla, & Cicchetti (1984)	Manual	18	.48	0.90	0.94	0.88	35.00[g]	Intellectual Disability	SB3	24.60	VABS	Parent/Caregiver
Sparrow, Balla, & Cicchetti (1984)	Manual	65	.52	0.93	0.94	0.58	35.00[g]	Intellectual Disability	Slosson	9.30	VABS	Parent/Caregiver
Sparrow, Balla, & Cicchetti (1984)	Manual	46	.46	0.97	0.94	0.70	35.00[g]	Intellectual Disability	WAIS, WAIS-R	54.80	VABS	Parent/Caregiver

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Appendix 1. *(continued)*

Author (year)	Study Source	n^a	r^b	r_{xx}[c]	r_{yy}[d]	u_x[e]	Age	Disability Type	IQ Measure	IQ	Adaptive Measure	Adaptive Respondent
Sparrow, Balla, & Cicchetti (1984)	Manual	86	.52	0.95	0.94	1.02	35.00[g]	Emotional Disturbance	WISC, WISC-R	95.00	VABS	Parent/Caregiver
Sparrow, Balla, & Cicchetti (1984)	Manual	23	.70	0.95	0.94	1.00	35.00[g]	Visually Impaired	WISC, WISC-R	92.50	VABS	Parent/Caregiver
Sparrow, Balla, & Cicchetti (1984)	Manual	21	.82	n.a.	0.94	1.60	35.00[g]	Visually Impaired	Hayes-Binet	94.20	VABS	Parent/Caregiver
Sparrow, Balla, & Cicchetti (1984)	Manual	23	.71	n.a.	0.94	1.65	35.00[g]	Visually Impaired	Perkins-Binet	87.20	VABS	Parent/Caregiver
Sparrow, Balla, & Cicchetti (1984)	Manual	99	.47	0.95	0.94	1.33	35.00[g]	Hearing Impaired	WISC, WISC-R	94.40	VABS	Parent/Caregiver
Sparrow, Cicchetti, & Balla (2005)	Manual	28	.09	0.94	0.95	1.00	35.00[g]	n.a.	WISC-III	105.70	Vineland-II	Parent/Caregiver
Sparrow, Cicchetti, & Balla (2005)	Manual	83	.15	0.98	0.95	1.00	42.50g	n.a.	WAIS-III	110.60	Vineland-II	Parent/Caregiver
Sparrow, Cicchetti, & Balla (2006)	Manual	43	.40	0.94	0.98	1.00	9.00[g]	n.a.	WISC-III	107.80	Vineland-II	Teacher
Sparrow, Cicchetti, & Balla (2006)	Manual	51	.17	0.97	0.98	1.00	13.50[g]	n.a.	WISC-IV	109.50	Vineland-II	Teacher
Springer (1941)	Journal	130	.72	n.a.	0.86	0.79	17.42	Adolescent Delinquents	SB1	89.81	VSMS	n.a.
Swanson, Bradley-Johnson, Johnson, & Rubenaker (2009)	Journal	20	.61	0.94	0.97	0.91	2.13	n.a.	CAS-2	104.10	ABAS-II	Parent
Szatmari, Archer, Fishman, & Streiner (1994)	Journal	83	.59	0.90	0.94	1.38	5.44	Pervasive Developmental Disorder	Leiter	87.60	VABS	Parent/Caregiver
Szatmari, Archer, Fishman, & Streiner (1994)	Journal	83	.60	0.90	0.94	1.38	5.44	Pervasive Developmental Disorder	Leiter	87.60	VABS	Teacher
Terrasi & Airasian (1989)	Journal	100	.11	1.00	1.00	0.90	9.22	Unspecified Special Needs	WISC-R	89.68	ABIC	Parent
Trista, Lincoln, Bellugi, & Searcy (2015)	Journal	100	.30	0.94	0.98	0.68	28.23	Williams Syndrome	Abbreviated Wechsler Scales	76.10	SIB-R	Parent/Caregiver
Trista, Lincoln, Bellugi, & Searcy (2015)	Journal	21	.27	0.94	0.98	0.51	21.24	Unspecified Disability	Abbreviated Wechsler Scales	73.55	SIB-R	Parent/Caregiver
Vacc & Atwell (1980)	Journal	37	.50	0.96	0.97	1.09	7.58	n.a.	WISC-R	83.00	ABIC	Parent
Vig & Jedrysek (1995)	Journal	443	.75	n.a.	0.94	n.a.	3.42	Developmental Delay	Multiple	n.a.	VABS	Parent/Caregiver
Wechsler (2003)	Manual	122	.41	0.97	0.96	1.00	11.20	n.a.	WISC-IV	99.70	ABAS-II	Parent/Caregiver
Wechsler (2003)	Manual	139	.58	0.97	0.99	1.00	10.40	n.a.	WISC-IV	100.50	ABAS-II	Teacher
Wechsler (2014a)	Manual	61	.01	0.96	0.95	1.00	11.80	n.a.	WISC-V	99.40	Vineland-II	Parent
Wechsler(2014b)	Manual	93	.26	0.96	0.95	1.00	12.10	Intellectual Disability	WISC-V	58.80	Vineland-II	Parent/Caregiver
Witt (1981)	Journal	95	.76	0.90	0.86	n.a.	28.30	Intellectual Disability	SB3	21.25[g]	VSMS	Caregiver
Wright (2010)	Dissertation	48	.30	n.a.	0.90	n.a.	15.00[g]	Intellectual Disability	Unspecified	62.25[g]	ABI	Teacher
Zagar et al. (2013)	Journal	89	.87	0.97	0.95	1.16	14.70	n.a.	WISC-IV	90.13	Vineland-II	n.a.
Zagar et al. (2013)	Journal	147	.73	0.98	0.95	1.03	36.20	n.a.	WAIS-IV	91.60	Vineland-II	n.a.

(continued on next page)

Note. n.a. = not available.
[a] Sample size.
[b] Correlation between IQ score and adaptive behavior composite score for included sample.
[c] Reliability of the IQ test.
[d] Reliability of the adaptive behavior measure.
[e] Information on range departure.
[f] Composite correlation for the sample calculated for the main meta-analysis
[g] Estimated from sample information

Appendix B

<u>Coding Guide</u>
Citation: Enter full study/source citation

Brief Citation: Enter APA in-text citation

Pub. Year: Enter year of study publication

Study source:
Enter the number preceding each of the following:
1. Manual
2. Journal
3. Dissertation/Thesis

National Origin: Enter country of study/source origin

***r*:** enter reported correlation between IQ and adaptive behavior.

n: Enter reported correlation sample size

Participant Age:
Code the mean age of the sample whenever available. The coding of average age requires clarification as this value is not always reported. If a school grade, or grades, is given, then the age variable will be coded based on the average age of students in that grade, or grades using an approach similar to Voyer et al. (1995) and Voyer and Voyer (2014). For example, children in first grade are typically 6 years old, whereas an average age for a Jr. High student (grades 7 and 8) is 12.5. In the event that only an age range is reported, then the midpoint will be used. In some cases subjects are listed as either 18-and-older or simply as “adults.” In such cases, age will be recorded as 35. Estimated ages should be noted with an asterisk.

For subgroup analysis:
1. Age 0 to 4
2. Age 5 to 12
3. Age 13 to 18
4. Age 19 and older

Racial Composition: Enter a brief breakdown of the source’s racial composition as reported in the source.

For subgroup analysis:
Following an approach similar to Goldberg, Prause, Lucus-Thompson, and Himsel (2008), and Voyer and Voyer (2014), U.S. samples shall be coded as composed of subjects that are 75% or more White, 75% or more Black, 75% or more Hispanic, racially diverse (no majority), or not reported. Samples from countries other than the United States shall be coded as non-U.S. samples so that the whole sample of retrieved correlations can be considered in the analysis.

1. ≥75% White

2. ≥75% Black
3. ≥75% Hispanic
4. Racially diverse (no majority)
5. Not U.S. sample

Disability Type:
Samples shall be coded as composed of subjects with disabilities aligning with those defined by IDEA, samples with subjects both with and without IDEA disabilities, and samples comprised primarily of non-disabled subjects.

1. ≥75% Intellectual Disability
2. ≥75% Autism
3. ≥75% Sensory Disabilities (Deaf-Blindness, Deafness, Hearing Impairment, Visual Impairment)
4. ≥75% Developmental delay
5. ≥75% Learning Disability
6. ≥75% Emotional Disturbance (Include Behavioral Disorders)
7. Sample composed of subjects with other or unspecified disabilities (or no majority)
8. ≥75% No disability
9. Sample composed of subjects with and without disabilities (or no majority)

Sample Source:
1. Institutionalized/Residential
2. Clinical
3. Non-Clinical
4. Forensic (incarcerated sample)
5. Special Education
6. Other

IQ Measure: Record the IQ test(s) used in the study. If not reported, record "Unspecified."
For subgroup analysis:
1. Full Stanford-Binet
2. Full Wechsler
3. Full Bayley
4. Full Leiter
5. Abbreviated/Short Form
6. Other/Unspecified

IQ Publication Date: Record the IQ test date of publication. When IQ test is unspecified or multiple IQ measures were used, record as "Unspecified."

Mean Sample IQ: Enter the sample's reported mean IQ. If not reported, enter "n.a."

IQ Level:
The coding of IQ level requires clarification. In most instances, the reported mean sample IQ will be recorded. In the event that a range is provided, the midpoint will be entered. In the event

that outdated IQ classifications of mental retardation are reported (such as mild MR or trainable MR), then an estimate (noted with an asterisk) will be entered using the following values, which, for IQ scores in the ID range, are essentially midpoints derived from DSM-IV classifications (chosen for use because the classification scheme changed with the publication of the DSM-V):

- Profound: 12.50
- Severe: 30
- Moderate/Trainable: 45
- Mild/Educable: 62.25

If descriptive ranges are reported that are above the ID range, the following values will be entered and noted with an asterisk:

- Borderline: 77.5
- Average or above: 100

If a range of descriptors is given (i.e., Mild to Moderate), then the values listed above will be averaged and noted with an asterisk.

If sample is typically developing children or a standardization sample, then 100 will be entered. If none of the above are marked, enter "n.a."

For subgroup analysis:

1. Below 39
2. 40-49
3. 50-59
4. 60-69
5. 70-79
6. 80-89
7. 90-99
8. 100-109
9. 110 and above

Sample IQ *SD*: Enter the sample's reported IQ *SD*. If not reported enter "n.a." (Used in the calculation of the range variation value.)

IQ *SD* norm: Enter the normed standard deviation of the IQ used. This standard deviation is usually 15, but some tests (like some editions of the Stanford Binet) have a standard deviation of 16. This standard deviation is often reported in studies, but may need to be looked up in the test's manual (or in a test review if manual is unavailable). When multiple IQ tests are used, or are completely unspecified, enter 15. (Used in the calculation of the range variation value.)

IQ Reliability: Enter the average internal consistency coefficient for the test's full scale IQ. This coefficient is often reported in studies, but may need to be looked up in the test's manual (or in a test review if manual is unavailable). When multiple IQ tests were used, enter the average value. If test used is completely unspecified or internal consistency is unavailable (i.e., only interrater or test-retest reliability coefficients are reported) then mark "n.a."

IQ Publication Date: Enter the publication date of the IQ test used. If test was unspecified, mark "Unspecified."

Adaptive Measure: Record the adaptive measure used in the study. If unknown or multiple tests were used, record as "Unspecified."

For subgroup analysis:

1. VSMS
2. VABS/Vineland-II
3. SIB/SIB-R
4. CABS
5. ABS
6. ABIC
7. ABAS
8. Short Form/Screener
9. Other/Unspecified

Adaptive Publication Date: Record the adaptive measure date of publication. When adaptive measure is unspecified, record, "Unspecified."

Adaptive Behavior Informant:

1. Parent; Parent/Caregiver
2. Teacher
3. Self-Report
4. Direct-Assessment
5. Not Reported

Domain IQ Correlations:

1. Correlation coefficients between IQ and adaptive domains are reported in the study.
2. Correlation coefficients between IQ and adaptive domains are not reported in the study.

Adaptive Reliability: Enter the average internal consistency coefficient for the measure's full scale adaptive behavior score. This coefficient is often reported in studies, but may need to be looked up in the test's manual (or in a test review if manual is unavailable). When multiple adaptive measures were used, enter the average value. If measure used is completely unspecified or internal consistency is unavailable (i.e., only interrater or test-retest reliability coefficients are reported) then mark "n.a."

Overall Measure Quality: Both IQ and adaptive measures are full scale and psychometrically sound. Current or previous edition has been deemed adequate in the diagnosis or identification of intellectual disability. (McGrew (2015) reported that the CAS, DAS-II, KABC-II, SB5, WAIS-IV, WISC-IV, and WJIII/NU are comprehensive, nationally normed, individually administered IQ tests possessing satisfactory characteristics for use in the diagnosis or identification of ID. Tassé et al. (2012) identified the ABS-S:2, ABAS-II, SIB-R, and Vineland-II as comprehensive individualized, standardized, and psychometrically sound adaptive behavior scales developed specifically to aid in the diagnosis or identification of ID.

1. Yes
2. No

Latent vs. Observed:

1. Reported correlation is observed.
2. Methods used to calculate reported correlation are between the construct of intelligence and the construct of adaptive behavior (e.g. factor analysis). Reported correlation is latent. (If so, then IQ and AB reliability should be marked "1" also since measurement error will have been removed).