Alaska Comprehensive & Specialized Evaluation Services

FAS Evaluation

Relationship of IQ to Fetal Alcohol Spectrum Disorder

(FAS Report Technical Report No. 23)

Relationship of IQ to Fetal Alcohol Spectrum Disorders

Prepared by BHRS Staff
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Executive Summary

Using data submitted to the Alaska State Office of FAS by 10 FAS Diagnostic Teams from across the state of Alaska, the following questions were addressed:

a. Do individuals with static encephalopathy-FAS/FAE score lower on overall IQ, verbal IQ, and performance IQ than individuals without such a diagnosis, such as individuals with static encephalopathy-non-FAS/FAE or individuals with neurobehavioral disorders?
b. Do a greater proportion of individuals with static encephalopathy-FAS/FAE than individuals with static encephalopathy-non-FAS/FAE or individuals with neurobehavioral disorders score below 70 on the overall IQ?
c. Do a greater proportion of individuals with static encephalopathy-FAS/FAE than individuals with static encephalopathy-non-FAS/FAE or individuals with neurobehavioral disorders show a significant difference between verbal and performance IQ?

Data analyses utilized Wechsler Intelligence Test data and FAS diagnosis information based on the Four Digit Code system developed at the University of Washington. The sample for these analyses consisted of 106 individuals, 42 females and 64 males with an average age of 11 years. Findings were as follows:

1) Individuals with static encephalopathy-FAS/FAE or static encephalopathy-non-FAS/FAE had significantly lower mean IQ scores than individuals with neurobehavioral disorders. However, even for these individuals, means remained in the borderline (*not* the mental retardation) range of intelligence for the full scale, verbal, and performance IQs.
2) As brain dysfunction increased, full scale and verbal IQ decreased and skill discrepancies increased.
3) A full scale IQ of 70 or lower was obtained by 39% of individuals in the static encephalopathy-FAS/FAE group; 29% in the static encephalopathy-non-FAS/FAE group; and 6% in the neurobehavioral disorders group.
4) A VIQ-PIQ split of 12 or more points was obtained by 12% of individuals in the static encephalopathy-FAS/FAE group; 13% in the static encephalopathy-non-FAS/FAE group; and 10% in the neurobehavioral disorders group. In almost all cases PIQ significantly exceeded VIQ.
5) Fewer than 35% of the individuals in the neurobehavioral disorders group would have qualified for special education given current criteria of an IQ under 71 or a VIQ-PIQ split of 12 points or more; 67% in the static encephalopathy-FAS/FAE group and 62% of the static encephalopathy-non-FAS/FAE would have qualified for special education.

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Background Information

The State of Alaska Department of Health and Social Services (1990) has reported that 12% of all Alaskan adults have current alcohol-related mental health or other problems and that per capita consumption of alcohol was 3.21 gallons per person per year, the fourth highest rate in the nation. According to a report by the Municipal Health and Human Services Commission in Anchorage (1994), the acute drinking rate (percent of people having five or more drinks at least once per month) in Alaska was 23.9% in 1992, as compared to a national rate of 14.3%. The chronic drinking rate (60 or more alcoholic drinks per month) was 5.25% as compared to the national rate of 2.91%. Approximately one-quarter of all alcohol and drug dependent individuals in Alaska are women, a proportion that is rising steadily (Alaska State Office of Alcohol and Drug Abuse and Addiction, 1989; Brems, 1996; Hisnanick, 1992). Data reported by the Alaska Regional Hospital indicated that 16% of all women admitted for childbirth had detectable alcohol or drug levels in their blood during labor and/or delivery (Phillips, 1995).

These high rates of alcohol use in the state of Alaska have resulted in some of the nation's highest Fetal Alcohol Spectrum Disorders (FASD) rates. The *2002 Fetal Alcohol Syndrome Prevalence in Alaska: New Findings from the FAS Surveillance Project* published by Department of Health and Social Services (DHSS, 2002) reported a statewide population FAS prevalence rate of 1.4 per 1,000 live births in Alaska, based on all recorded births between 1995 and 1998. The population prevalence rate of 1.5 per 1,000 live births in Alaska between 1995 and 1997 was approximately four times higher than the prevalence rates in Arizona, Colorado, and New York – other states in the CDC Fetal Alcohol Syndrome Surveillance Network (FASSNet; CDC, 2002). The higher prevalence rates in Alaska are reflective of higher prevalence rates among children born to Alaska Native mothers, which may be attributed to increased awareness and documentation of maternal alcohol use by Alaska Native health organizations (CDC, 2002; DHSS, 2002).

Recognizing the importance of addressing the issue of FASD in the state of Alaska, in the year 2000, the State of Alaska Department of Health and Social Services (DHSS, 2001) applied to the Substance Abuse and Mental Health Service Administration (SAMHSA) for funding to support a statewide Alaska FAS Prevention Project. The proposal was successfully reviewed and funded and a Alaska State Office of FAS was developed in Juneau. SAMHSA awarded the Alaska FAS Prevention Project $5 million per year for five years, spanning calendar years 2000 to 2005. The project has several components, including the funding of FAS Multidisciplinary Community Diagnostic Teams for screening children at high risk for FASD, prevention of FASD, interventions targeted to high-risk women and families, and delivery of services and treatment to families and individuals already diagnosed with FASD. The diagnostic teams, perhaps the most central aspect of the Alaska FAS Prevention Project overall, were envisioned by the Alaska State Office of FAS to fulfill several missions. Specifically, funding of their applications was contingent on clear plans to provide prevention, intervention, screening, diagnosis, and treatment. In particular, the grant also mandates the screening and diagnosis for FASD among children in state custody. Several diagnostic teams are fully functional in the state of Alaska and several additional teams are being developed; two teams have been disbanded. The functional teams are in various stages of development and implementation. It is anticipated that all teams will be fully functional and financially self-supporting by the end of the SAMHSA granting period in 2005.

In return for funding their services, the Alaska State Office of FAS receives quarterly summary data and occasionally solicits additional data of interest from all FAS Diagnostic Teams across the state of Alaska. These data are generally entered and analyzed for purposes of feedback to the teams about their productivity and outcomes, or to answer questions of interest. For the current study, the Alaska State Office of FAS requested intelligence test data from all FAS Diagnostic Teams who have been actively engaging in FAS diagnosis. This data was solicited in response to a request by the federal funding agency, SAMHSA, to assist with answering the question about whether a diagnosis of FAS was related to intelligence. This question is deemed important because of eligibility criteria that schools across the nation tend to use to determine special education placements. In most areas of the country, for children to qualify for special education, they must either have an overall IQ of 70 or below (thus, qualifying for a diagnosis of mental retardation) or they must evidence a significant discrepancy between performance and intelligence or between different aspects of intelligence, such as a 12-point difference between a verbal versus performance IQ. These eligibility criteria are independent of diagnosis and can result in a significant portion of children in need of special education due to FASD not to receive such needed services.

To address these issues, the following hypotheses were to be explored by the current study:

a. *Hypothesis 1*: Individuals with static encephalopathy-FAS/FAE will score lower on overall IQ, verbal IQ, and performance IQ than individuals without such a diagnosis, such as individuals with static encephalopathy-non-FAS/FAE or individuals with neurobehavioral disorders.

b. *Hypothesis 2:* A greater proportion of individuals with static encephalopathy-FAS/FAE than individuals with static encephalopathy-non-FAS/FAE or individuals with neurobehavioral disorders will score below 70 on the overall IQ. However, a large proportion of individuals with FASD will not score below 70.

c. *Hypothesis 3*: A greater proportion of individuals with static encephalopathy-FAS/FAE than individuals with static encephalopathy-non-FAS/FAE or individuals with neurobehavioral disorders will show a significant difference between verbal and performance IQ. However, a large proportion of individuals with FASD will not evidence a significant difference.

Extant Literature Relevant to the Current Study

Fetal alcohol spectrum disorders (FASDs) are the neurological, behavioral, and other consequence of prenatal alcohol exposure resulting in a range of growth deficiencies, characteristic facial malformations, and damage to the central nervous system (CNS). The assignation *FASD* replaces and subsumes many other terms that have been used to describe this phenomenon, including fetal alcohol syndrome (FAS; coined by Jones and Smith in 1973), fetal alcohol effects (FAE), possible fetal alcohol effects (PFAE), and alcohol-related neurodevelopmental or neurobehavioral disorders (ARND). Fetal alcohol syndrome (FAS) has been identified as the leading <u>known</u> cause of mental retardation, resulting in more cases of mental retardation than all other genetic disorders combined (Hagberg, Hagberg, Lewerth, & Lindberg, 1981; NIAAA, 1987). However, "mental retardation has never been a defining characteristic of FAS" (Streissguth, 1997, p. 103), as children with seemingly normal IQs can have specific neuropsychological and cognitive impairments that interfere with daily life in a variety of ways despite not registering on an IQ test. The extant literature suggests that FASD-related central nervous system deficits, whether or not they are fully diagnosed as FAS, are often debilitating, enduring into adulthood, and inexplicable by IQ scores alone. Psychiatric disorder often is part of the clinical picture of individuals presenting with fetal exposure to alcohol. A brief, chronological overview follows of literature published in the United States about the relationship between fetal alcohol exposure and intelligence. Many of the studies listed here have been preceded and succeeded by similar work across the globe. This international work, carried out in Germany, France, the Scandinavian countries, and other locations, has confirmed findings from the US and is not included here.

A longitudinal study assessing effects of moderate prenatal alcohol exposure on 482 school-aged children (evaluated during first or second day of life, at 8 and 18 months, and again at 4 and 7 years), (Streissguth et al., 1990) discovered that two drinks a day or more by the mother during pregnancy could lead to a 7-point decrease in IQ of the offspring at 7 years of age; consumption of at least 5 drinks on at least one occasion was predictive of future learning problems. These findings led to the conclusion that even moderate prenatal alcohol exposure can have drastic effects on children's IQ scores, achievement test scores, learning problems, attention, and speed of central processing (Streissguth, et al., 1990).

To shed light on the relationship between fetal alcohol effects and performance (including, but not limited to intelligence), physical characteristics, intellectual functioning, academic and adaptive functioning, and family environments were assessed in a sample of 61 12- to 40-year old individuals with FAS/FAE by Streissguth, et al. (1991). Most relevant to our current work, Streissguth, Aase, et al., (1991) found that 42% of their assessed individuals presented with IQs above 70 and therefore many did not qualify for special community services after finishing school. Individuals exhibited deficits in adaptive skills (which were often masked by poor verbal skills); poor judgment; lack of independent living skills; deficits in attention, comprehension and abstraction; and general life dysfunction (Streissguth, Aase, et al., 1991). These authors also noted based on follow-up work 5 to 12 years later that even though after puberty FAS facial features and fetal alcohol effects (FAE) become less distinct, manifest microcephaly with deficits in IQ and academic function, especially in arithmetic, remained (Streissguth, et al., 1991).

The effects of the CNS damage are enduring, as indicated by the stable IQ scores in an 8-year test-retest study of intelligence in 40 subjects, 27 of whom had FAS and 13 of whom had FAE (Streissguth, Randels, & Smith, 1991). The long-range prognosis was found to be poorer for patients with FAS than for those with FAE; however, due to a wide range of IQ scores in both groups, cognitive deficits related to FAS/FAE often go unnoticed. The authors concluded that the IQ scores obtained at an early age were useful in predicting intellectual level in adulthood and in assisting with community planning and patient management. They added that although IQ scores are a good predictor of later intellectual functioning, assessment should also include functional and adaptive skills evaluations to plan more accurately for future intervention, individualized to each individual's needs (Streissguth, Randels, & Smith, 1991).

In a study by Steinhausen et al. (1994), 158 FAS patients ranging from newborns to 11.5 years of age were assessed for predictors of psychopathology. Severity of morphological damage, type of milieu, sex, and IQ were found to be strong predictors of psychopathology in preschool-aged children with FAS, whereas only morphological damage and IQ predicted psychopathology in school-aged children (Steinhausen, et al., 1993). However, variability in IQ scores was not found to account for all deficits exhibited by individuals with heavy prenatal alcohol exposure.

Streissguth, Barr, Kogan, and Bookstein (1996) conducted a follow-up study of 473 individuals who had received intellectual assessments over a 23-year period. Individuals with fully diagnosable FAS obtained mean IQ scores of 70; individuals with fetal alcohol effects, possible fetal alcohol effects (FAE), or alcohol-related neurodevelopmental disorders (ARND) obtained a mean IQ of 90. The authors pointed out that given their findings only approximately 25% of the individuals with FAS and 10% of the individuals with other alcohol-related disorder qualified for special education services that use a diagnosis of mental retardation as its primary prerequisite.

In a study by Kerns et al. (1997), a group of 16 individuals with an FAS diagnosis (ages 16 to 27) was divided based on IQ scores (average to above average IQ versus borderline to low IQ). The above-average to average IQ group and the borderline to low-average IQ group (none with scores lower than 70) exhibited deficits in complex attention, verbal learning, and executive function with frequency and severity much greater than what could have been predicted by IQ scores alone (Kerns et al., 1997). The deficits in learning that were observed in the above-average to average IQ group were less pronounced if mastery of learned material was demonstrated before moving on to learn new material (Kerns et al., 1997). The borderline to low-average IQ group's learning benefited from the use of cues and organization of teaching materials (Kerns et al., 1997). Overall, the study showed that the discrepancy between academic performance and IQ, which is what qualifies most students for learning disability services, does not accurately predict or reflect other cognitive and executive function deficits (Kerns et al., 1997).

Mattson et al. (1997) compared 34 individuals with FAS to 13 alcohol-exposed individuals who did not have the physical characteristics needed for the diagnosis of FAS (FAE), and 47 non-exposed individuals matched for age and gender. Participants' verbal and nonverbal abilities were assessed using the WISC-R. The children with FAS did not differ statistically significantly from the children with FAE and the two groups were functionally very similar (Mattson et al., 1997). The importance of looking into the prenatal history of alcohol exposure of children with intellectual deficits was therefore emphasized by the authors considering that the FAE participants did not display all features needed for the diagnosis of FAS (Mattson et al., 1997).

An exploratory study by Olson et al. (1998) compared a group of teens diagnosed with FAS (aged 14 to 16) with a group of teens who had minimal or no prenatal alcohol exposure, all with IQ scores in the average to borderline range. Deficits that were measured and identified as characteristic patterns of adolescents with FAS included impairments in visual-spatial skills marked by disorganization and perseveration. Adaptive behaviors were also found to be related to an FAS diagnosis, marked by high levels of behavior problems, as well as decreased school competence, with the degree of behavior problems related to the level of prenatal alcohol exposure. Overall, the deficits noted among adolescent with FAS were more severe than would have been predicted by their high functional IQ scores (Olson et al., 1998), again suggesting that IQ is not the best predictor of performance in daily life.

A study by Thomas et al. (1998) divided 45 children ages 5 years to 12 years into three groups: children with FAS, children without FAS but matched for verbal IQ, and children without FAS and average to above average verbal and full scale IQ scores. Interpersonal relationship skills deficits were most pronounced in FAS patients, even when IQs were matched, emphasizing that low IQ scores alone cannot explain deficits in social abilities (Thomas et al., 1998). The authors suggested that because social development appears to be arrested among children with FAS, social deficits become more pronounced with age and therefore older patients with FAS may be more impaired than younger patients (Thomas et al., 1998).

A study by Schonfeld et al. (2001) of 28 children (ten with heavy prenatal alcohol exposure with FAS, eight with heavy prenatal alcohol exposure without FAS, and 10 nonexposed controls) revealed impairments in verbal and nonverbal fluency, as well as executive function in patients who, although not necessarily formally diagnosed with FAS, had experienced heavy prenatal alcohol exposure. Socioeconomic status and overall IQ did not influence general fluency, whereas prenatal alcohol exposure did, leading the authors to conclude that for children with fetal-alcohol-related disorders or symptoms the measurement of executive function was more predictive of performance of daily life tasks than IQ (Schonfeld et al., 2001).

O'Connor et al. (2002) found in their work with 23 children referred for assessment due to known prenatal alcohol exposure that those with fully diagnosed FAS had an average IQ of 93, as compared to an IQ of 86 for the FAE/ARND group. These means suggest that few of the 23 children with known exposure would qualify for special services using IQ as the qualifying criterion, despite the fact that these authors showed that 87% of these children met criteria for a psychiatric disorder. Of these children, 61% had mood disorder and only about a quarter had a disorder more commonly diagnosed in childhood (such as attention deficit, attachment, or pervasive developmental disorders).

The current study explored the relationship between intelligence quotient as measured by the Wechsler Intelligence scale (version depending on age of participant) and diagnostic presentation of 106 children referred for assessment for possible fetal alcohol spectrum disorder. Diagnosis was derived using 4-Digit Diagnostic Code developed in 1997 by researchers at the University of Washington (described below).

Method

Sample

At the time of this study, 10 fully functional diagnostic teams were conducting FASD diagnoses in the state of Alaska, five additional teams were in developmental stages, and two teams had been disbanded, for a total of 17 diagnostic teams that functioned in the State of Alaska since 1999. Using a data collection report for the Alaska State Office of FAS, 12 of these 17 diagnostic teams had submitted completed datasheets for 457 individuals who had been assessed since 1999. Of these 457 datasheets, two did not include a four-digit diagnosis leaving a total of 455 usable datasheets. Of the 455 individuals for whom diagnoses were submitted, 47 (10.3%) were diagnosed with FAS or atypical FAS; 232 (50.9%) were diagnosed with Static Encephalopathy; 154 (33.8%) were diagnosed with Neurobehavioral Disorder; and 22 (4.8%) were found to have no evidence of organic brain damage. The sample for the current study was randomly selected from these 455 individuals (see Procedures).

The final sample for the study consisted of 106 individuals with an average age of 11.4 years (SD=4.9). There were 42 females and 64 males. Ethnic distribution was as follows: two African American; 77 Alaska Native or Native American; three Hispanic/Latino; 21 White; and three Other.

Instruments

Wechsler Intelligences Scales (Wechsler, 1989; 1991; 1997)

Three versions of the Wechsler Intelligence Scale are currently in use by the diagnostic teams submitting data to the Alaska State Office of FAS, each chosen based on the age of the individual to be assessed. The Wechsler Preschool and Primary Scale of Intelligence (WPPSI-R; Wechsler, 1989; WPSSI-3; Wechsler, 2002) is normed for young children ages 3 to 7; the Wechsler Intelligence Scale for Children – 3rd Edition (WISC-3; Wechsler, 1991) is normed for children ages 6 to 16; the Wechsler Adult Intelligence Scale – 3rd Edition (WAIS-3; Wechsler, 1997) is normed for individuals 16 and older. All three scales were carefully developed with large nationwide samples (>2000 for each scale) and have good reliability and validity. All scales render an overall or full-scale intelligence quotient (FSIQ), a Verbal IQ (VIQ), and a Performance IQ (PIQ). These IQ's have a mean of 100 and a standard deviation of 15. The information derived from the Wechsler scale is multifold. Most obvious is the overall interpretation of the individual's Full Scale IQ that provides an estimate of the child's general intellectual functioning as defined by Wechsler (namely as the overall capacity to cope with and understand the world). Next, the individual's performance can be divided into Verbal and Performance with information being derived not only about the person's skills in each area, but also about any discrepancies between these two subareas of intellectual functioning. Subscales (e.g., Information, Similarities, or Arithmetic in the Verbal IQ area; Picture Completion, Picture Arrangement, or Block Design in the Performance IQ area) are available but were not used in the current study.

*The University of Washington (UW) FAS Diagnostic Prevention Network (DPN) 4-Digit Diagnostic Code (*Astley & Clarren, 1999)

Although the 4-Digit Diagnostic Code, developed in 1997, is consistent with the 1996 Institute of Medicine (IOM) guidelines, it provides a more detailed case definition than that method (Astley & Clarren, 1995). The UW method employs a four-digit diagnostic code, reflecting both the *magnitude of expression* of potentially FAS-related symptoms and the *strength of evidence* to support the presence of an organic cause for brain dysfunction. For each assessed individual, one code is derived for each of the following four areas of assessment:

1. growth deficiency
2. facial phenotype
3. gestational alcohol exposure
4. identifiable organic cause for brain dysfunction

Each of these four key diagnostic features is ranked separately using a 4-point Likert scale, ranging from *complete absence of expression* (1) to *strong presence of the FAS feature* (4). Diagnosis using the 4-Digit Diagnostic Code method lends itself for a multidisciplinary team approach as it involves the assessment of multiple symptom complexes in the assessed individual. This diagnostic system conveys the diversity of outcomes among individuals with prenatal alcohol exposure, clearly separating exposure from outcome (or symptoms). Twenty-two (22) of the 256 possible 4-digit diagnostic code combinations meet criteria for and are categorized as Fetal Alcohol Syndrome. The other 234 4-digit diagnostic code combinations further describe the full spectrum of possible outcomes among individuals with prenatal alcohol exposure. Four primary diagnostic categories can be extracted: static encephalopathy-FAS/FAE; static encephalopathy-non-FAS/FAE, neurobehavioral disorder, and no diagnosable disorder.

Growth Deficiency. Information about growth deficiency is typically collected by a medical provider, preferably a pediatric nurse, pediatrician, or developmental pediatrician (Astley & Clarren, 1999). Determination of growth delay is based on evidence using the individual's assessed height and weight (adjusted for age and gender, and parental height when available), each measured independently. The height and weight values are each assigned a score based on three defined percentile rankings representative of the degree of deficiency, using normal growth charts. The combined scores are then assigned a 4-digit code rank based on the level of deficiency. This Likert scale score ranges from *no deficiency* (1) to *severe* (4).

Facial Phenotype. Information about facial phenotype is typically collected by a physician. The 4-digit ranking of the FAS facial phenotype is determined by using three pre-identified features (palpebral fissure, philtrum, and upper lip). Each feature is measured on a Likert scale, assessing magnitude of expression through the use of case-defined, objective, quantitative, and ordinal or continuous measurement scales (Astley & Clarren, 2001). Specifically, palpebral fissure length is ranked according to a z-score; philtrum is ranked on an ordinal 5-point Likert scale; and upper lip circularity is measured on a continuous Likert scale, ranging from a minimum of *35* (1) to a maximum of *178* (4). Based on scores for each three features, one overall score is assigned that can range from *absent* (1) to *severe* (4).

Gestational Alcohol Exposure. Level of exposure to alcohol in utero is measured on a 4-point Likert scale ranging from *confirmed no exposure* (1) to *confirmed exposure with a pattern consistent with the medical literature placing a fetus at high risk* (4). This information is obtained through interviews with caregivers, biological parents, or similar informants; or alternatively, and perhaps preferably, is extracted from neonatal medical chart data (Astley, Bailey, Talbot, & Clarren, 2000).

Identifiable Organic Cause for Brain Dysfunction. Drawing on the specialized expertise of psychologists, neuropsychologists, speech and language pathologists, and similarly-trained professionals, individuals are assessed on several dimensions of performance related to brain functioning (Astley & Clarren, 1999). Multiple cross-disciplinary assessments of the presence and number of structural, neurological, and functional anomalies are then used to determine the strength of evidence to support the presence of an organic cause for any identified brain dysfunction. Deficiencies are defined by the specialized professionals if the assessed individual's performance falls outside of normal limits, determined via standardized testing procedures. This system allows clinicians to differentiate between individuals with clear evidence of brain damage (static encephalopathy) and individuals without evidence of brain damage. This information is integrated to provide scores ranging from *absent* (1) to *definite* (4).

Procedures

After receiving a request for information about the relationship between IQ and FASD-related diagnosis from SAMHSA, the Alaska State Office of FAS solicited IQ information from 11 teams that had been submitting diagnostic data on a regular basis. In determining what data to request, first the number of submitted datasheets was determined for each team. For teams that had submitted fewer than 10 datasheets to date, IQ information was requested for all represented individuals. For teams with more than 10 datasheets, data on 10% of the total number of individuals diagnosed were requested. This 10% included data on all individuals diagnosed with an FAS diagnosis (static encephalopathy-FAS/FAE) and a random sample of the rest of the diagnosed individuals (categorized into static encephalopathy-non-FAS/FAE, neurobehavioral disorder, and no disorder). IQ information was then requested for all of these selected individuals. Of the 11 teams who received requests, 10 complied and provided a total of 132 sets of IQ information. The subsequent analysis was limited to the 106 individuals for whom Wechsler Intelligence Scale data were made available as other IQ testing methods were not represented to a degree that allowed for statistical analyses.

Data Analyses

Preliminary analyses in the form of *t*-tests were calculated to explore if there were differences in IQ by gender (male versus female) or ethnicity (Alaska Native versus non-Alaska Native). Each *t*-test was calculated three times: once each for FSIQ, VIQ, and PIQ.

Main analyses compared diagnostic groups (static encephalopathy-FAS/FAE, static encephalopathy-non-FAS/FAE, and neurobehavioral disorder), using analyses of variance, one each for FSIQ, VIQ, and PIQ. Main analyses also included correlations between the four diagnostic digits (growth, face, brain, and alcohol exposure) and the three types of IQ (FSIQ, VIQ, and PIQ), as well as the VIQ-PIQ difference (using absolute [non-directional] values).

Follow-up analyses explored how many individuals in each of the three diagnostic groups met criteria for special education, using either the FSIQ criterion (FSIQ less than or equal to 70) or the VIQ versus PIQ criterion (a VIQ-PIQ split of 12 or more points). Significant differences between diagnostic groups regarding VIQ-PIQ split were also assessed statistically via analysis of variance, using the VIQ-PIQ difference score (absolute value) as dependent variable.

Results

Preliminary Analyses

Of the 106 usable protocols, 18 (17.0%) individuals were diagnosed with static encephalopathy-FAS/FAE, 53 (50.0%) with static encephalopathy-non-FAS/FAE, and 32 (30.2%) with neurobehavioral disorders; three (2.8%) had no evidence of organic brain disorder. This distribution reflects a slight oversampling of individuals with a static encephalopathy-FAS/FAE who made up only little more than 10% of the population of individuals assessed by diagnostic teams in Alaska to date.

T-tests for gender revealed no statistically significant differences between males and females for FSIQ, $t(1,104)=-.59$, $p=.56$, for VIQ, $t(1,103)=.14$, $p=.89$, or for PIQ, $t(1,103)=-.94$, $p=.33$. Similarly, no statistically significant differences were revealed in *t*-tests comparing Alaska Native ($n=77$) individuals with individuals of other ethnicities ($n=29$), either for FSIQ, $t(1,104)=-0.45$, $p=.65$, VIQ, $t(1,103)=-0.76$, $p=.45$, or PIQ, $t(1,103)=0.44$, $p=.66$. Given these non-significant findings, gender and ethnicity were not considered in the main and follow-up analyses.

Main Analyses

All main analyses were calculated omitting the "no evidence" group due to its low n. Analyses of variance revealed a significant main effect for diagnosis (i.e., encephalopathy-FAS/FAE , encephalopathy-non-FAS/FAE, versus neurobehavioral disorders) for all three types of IQ (i.e., full scale, F(2,100)=8.81, p=.0003, verbal, F(2,99)=7. 46, p=.0008, and performance IQ, F(2,99)=5.08, p=.008). Post hoc analyses using pairwise comparisons revealed that for all types of IQ, significant differences emerged between individuals with static encephalopathy-FAS/FAE and individuals with neurobehavioral disorder and between individuals with static encephalopathy-non-FAS/FAE and individuals with neurobehavioral disorder. Individuals with static encephalopathy-FAS/FAE did not differ from those with static encephalopathy-non-FAS/FAE. Table 1 shows means and analysis of variance findings, demonstrating the lower IQ scores among individuals with static encephalopathy as compared to individuals with neurobehavioral disorders only.

Table One
IQ Differences by Diagnostic Groups

Group or Analysis	*FSIQ*	*VIQ*	*PIQ*
Overall Sample Means and Ranges	81.6 (49 to 113)	79.5 (50 to 122)	87.9 (52 to 117)
Static Encephalopathy-FAS/FAE	73.9 (51 to 99)	71.0 (50 to 99)	80.8 (60 to 102)
Static Encephalopathy-Non-FAS/FAE	79.0 (49 to 108)	77.2 (55 to 110)	85.7 (52 to 117)
Neurobehavioral Disorders	88.5 (57 to 109)	86.2 (58 to 108)	92.9 (64 to 117)
F-Test Results	**F(2,100)=8.81, p=.0003**	**F(2,99)=7. 46, p=.0008**	**F(2,99)=5.08, p=.008**
Post Hoc Findings (pairwise comparisons)	Static Encephalopathy-FAS/FAE = Static Encephalopathy-Non-FAS/FAE	Static Encephalopathy-FAS/FAE = Static Encephalopathy-Non-FAS/FAE	Static Encephalopathy-FAS/FAE = Static Encephalopathy-Non-FAS/FAE
	Static Encephalopathy-FAS/FAE < Neurobehavioral Disorder	**Static Encephalopathy-FAS/FAE < Neurobehavioral Disorder**	**Static Encephalopathy-FAS/FAE < Neurobehavioral Disorder**
	Static Encephalopathy-Non-FAS/FAE < Neurobehavioral Disorder	**Static Encephalopathy-Non-FAS/FAE < Neurobehavioral Disorder**	**Static Encephalopathy-Non-FAS/FAE < Neurobehavioral Disorder**

Note: Significant findings are in bold typeface; alpha level was set at .05

Correlations between IQ scores and the four digits (growth, face, brain, and alcohol exposure) revealed a significant relationship between the brain digit and two of the three IQs, namely, FSIQ, r=-.24, p=.01, and VIQ, r=-.31, p=.001, but not with PIQ, r=-.12, p=.23. The brain digit also had a significant correlation with the VIQ-PIQ split, *r*=.23, p=.02. No other digit was significantly correlated with IQ or with the VIQ-PIQ split. The full set of correlations is shown in Table 2.

Table Two
Correlations Between IQ Scores and the Four Digit Codes

Digit		*FSIQ*	*VIQ*	*PIQ*	*VIQ-PIQ Split*
Growth	*r*	-.13	-.17	-.07	.12
	p	.19	.09	.50	.22
Face	*r*	-.12	-.19	-.003	.15
	p	.21	.06	.98	.12
Brain	*r*	**-.24**	**-.31**	-.12	**.23**
	p	**.01**	**.001**	.23	**.02**
Alcohol Exposure[1,2]	*r*	-0.02	-0.11	0.10	0.07
	p	.88	.32	.37	.54

Note: Significant correlations are in bold typeface; alpha level is set at .05.
[1]*The Alcohol Exposure digit may be unreliable as it is based solely on patient or guardian self-report; all other digits are based on clinician assessments*
[2]*Correlations for Alcohol Exposure were based on three points of the rating scale for this digit, omitting the rating for "unknown exposure"*

Follow-Up Analyses

Frequency distributions for FSIQ for the sample overall and for the three subgroups separately revealed that overall only 22% of represented participants obtained a Full Scale IQ score that fell at 70 or below. Among the subgroup with static encephalopathy-FAS/FAE, this proportion reached 39%, as compared to 29% in the static encephalopathy-non-FAS/FAE, and 6% in the neurobehavioral disorder group. With regard to verbal versus performance IQ differences, overall 41% of participants had a split of more than 12 points, with 4% having a higher VIQ than PIQ and 37% having a higher PIQ than VIQ. Among the subgroup with static encephalopathy-FAS/FAE, 50% had a significant VIQ-PIQ split, as compared to 46% in the static encephalopathy-non-FAS/FAE, and 31% in the neurobehavioral disorder group.

Despite the wide range in percentages from group to group, the *mean* absolute VIQ-PIQ difference scores were 12.1 for the static encephalopathy-FAS/FAE group, 12.7 for the static encephalopathy-non-FAS/FAE group, and 10.3 for the neurobehavioral disorder group, a difference that did not reach statistical significance, $F(2,99)=0.73$, $p=.48$.

Among individuals with Static Encephalopathy-FAS/FAE, almost 67% met either the IQ criterion or the VIQ-PIQ split criterion used for special education placement; this was true for 62% of individuals with Static Encephalopathy-FAS/FAE and for only 35% of individuals with neurobehavioral disorders. Table 3 shows exact numbers and percentages of individuals who reached criteria for special education placement by group and type of criterion. It also shows the percentage of individuals who meet neither criterion for special education placement.

Table Three
Findings Regarding Special Education Placement Criteria

Criterion	*Sample Overall (n=105)*	*Static Encephalopathy - FAS/FAE (n=18)*	*Static Encephalopathy – non-FAS/FAE (n=52)*	*Neurobehavioral Disorders (n=32)*
Percent with FSIQ of 70 or Lower	25 (23.8%)	7 (38.9%)	15 (28.8%)	2 (6.3%)
Percent with any VIQ-PIQ Split of 12 or More	45 (42.3%)	9 (50.0%)	24 (46.2%)	10 (31.3%)
Percent with VIQ > PIQ (by 12 or more points)	4 (3.8%)	0 (0.0%)	3 (5.8%)	0 (0.0%)
Percent with PIQ > VIQ (by 12 or more points)	41 (39.0%)	9 (50.0%)	21 (40.4%)	10 (31.3%)
Mean VIQ-PIQ Split (absolute value)	12.16	12.06	12.67	10.25
Percentage Meeting Neither Special Education Criterion	45.3%	33.3%	37.7%	65.6%

Discussion

Findings from this study reveal that males and females in this sample did not differ with regard to their full scale, verbal, and performance IQ scores. Similarly, individuals from across a variety of ethnic groups did not produce statistically significantly different IQ scores. Findings did reveal significant IQ score differences when comparing individuals from different diagnostic groups, specifically, individuals with static encephalopathy-FAS/FAE, static encephalopathy-non-FAS/FAE, or neurobehavioral disorders. Specifics about these findings follow.

Overall Findings Regarding IQ Scores

Results from this study revealed that the average IQ for the overall sample was in the borderline range of intelligence, with a mean of 81.6 and a range from 49 to 113; VIQ ranged from 50 to 122 and had a mean of 79.5; PIQ ranged from 52 to 117 and had a mean of 87.9, which is in the low normal range of intelligence. **Individuals with static encephalopathy-FAS/FAE or static encephalopathy-non-FAS/FAE had lower mean IQ scores than individuals with neurobehavioral disorders. However, even for these individuals, means remained in the borderline (*not* the mental retardation) range of intelligence for the full scale, verbal and performance IQs.** Regardless of type of IQ (full scale, verbal, or performance), individuals with neurobehavioral disorders scored significantly higher than individuals with either form of static encephalopathy.

Relationship Between Intelligence and the Four Digits

The four-digit code that was most significantly related to intelligence and was, expectedly, the brain digit. A significant relationship was revealed between full scale and verbal IQ and the brain digit, but not between performance IQ and the brain digit. The brain digit also was significantly correlated with VIQ-PIQ split. The direction of these significant correlations indicated that **as brain dysfunction increased, full scale and verbal IQ decreased and skill discrepancies increased**. The brain digit findings are not surprising; however, it is interesting to note that there were no significant relationships between alcohol exposure, facial feature, or growth ratings and IQ scores. Although one would not expect a causal relationship between these variables and IQ, a correlation may be expected as poorer brain ratings, facial features, and growth abnormalities all should be a function of degree alcohol exposure and hence should be indirectly related to IQ. The strong relationship among the four diagnostic digits was confirmed via Pearson *r* correlation coefficients among the four digits, all of which were statistically significant, ranging from .42 to .62, with associated probabilities consistently falling below .0001.

Findings Regarding Meeting Special Education Criteria

Fewer than 7% of individuals with neurobehavioral disorders scored below a full scale IQ of 70, as compared to 39% among those with static encephalopathy-FAS/FAE, and 29% of those with static encephalopathy-non-FAS/FAE. A substantial percentage of individuals with neurobehavioral disorders (namely, 31%) had a significant discrepancy between their verbal and performance IQ; this percentage was much smaller than the percentages of individuals with either static encephalopathy-FAS/FAE (50%) or static encephalopathy-non-FAS/FAE (46%) who scored below 70 on the full scale IQ.

For the static encephalopathy-FAS/FAE and static encephalopathy-non-FAS/FAE groups the mean differences score between VIQ and PIQ was a 12-point split, indicating that *on average* such individuals will demonstrate significant discrepancies in their verbal versus performance skills. Interestingly, among all groups, the VIQ-PIQ discrepancy most commonly took the form of performance areas far exceeding verbal skills. In other words, it appears that affected individuals' verbal abilities were significantly more impaired than their performance skills.

Clearly, individuals with static encephalopathy are more likely to meet special education criteria than individuals with neurobehavioral disorders, suggesting the greater likelihood of individuals on the non-FAS end of the FASD spectrum to miss out on special education opportunities that may enhance their adjustment and quality of life in later years. **Fewer than 35% of the individuals in the neurobehavioral disorders group would have qualified for special education given current criteria of an IQ under 71 or a VIQ-PIQ split of 12 points or more; 67% in the static encephalopathy-FAS/FAE group and 62% of the static encephalopathy-non-FAS/FAE would have qualified for special education.**

Summary

1) Individuals with static encephalopathy-FAS/FAE or static encephalopathy-non-FAS/FAE had lower mean IQ scores than individuals with neurobehavioral disorders. However, even for these individuals, means remained in the borderline (*not* the mental retardation) range of intelligence for the full scale, verbal and performance IQs.
2) As brain dysfunction increased, full scale and verbal IQ decreased and skill discrepancies increased.
3) A full scale IQ of 70 or lower was obtained by 39% of individuals in the static encephalopathy-FAS/FAE group; 29% in the static encephalopathy-non-FAS/FAE group; and 6% in the neurobehavioral disorders group.
4) A VIQ-PIQ split of 12 or more points was obtained by 12% of individuals in the static encephalopathy-FAS/FAE group; 13% in the static encephalopathy-non-FAS/FAE group; and 10% in the neurobehavioral disorders group. In almost all cases PIQ significantly exceeded VIQ.
5) Fewer than 35% of the individuals in the neurobehavioral disorders group would have qualified for special education given current criteria of an IQ under 71 or a VIQ-PIQ split of 12 points or more; 67% in the static encephalopathy-FAS/FAE group and 62% of the static encephalopathy-non-FAS/FAE would have qualified for special education.

References

Alaska State Office of Alcoholism and Drug Abuse (1989). *Annual report to the legislature.* Juneau, AK: Author.

Astley, S. J., Bailey, D., Talbot, C., & Clarren, S. (2000). Fetal alcohol syndrome (FAS) primary prevention through FAS diagnosis: I. Identification of high-risk birth mothers through the diagnosis of their children. *Alcohol & Alcoholism, 35,* 499-508.

Astley, S. J. & Clarren, S. K. (1995). A fetal alcohol syndrome screening tool. *Alcoholism: Clinical and Experimental Research, 6,* 1565-1571.

Astley, S. J. & Clarren, S. K. (1999). *Diagnostic guide for Fetal Alcohol Syndrome and related conditions: The 4-digit diagnostic code*. Seattle: University of Washington Publication Services.

Astley, S. J. & Clarren, S. K. (2001). Measuring the facial phenotype of individuals with prenatal alcohol exposure: Correlations with brain dysfunction. *Alcohol & Alcoholism, 36,* 147-159.

Brems, C. (1996). Substance use, mental health, and health in Alaska: Emphasis on Alaska Native peoples. *Arctic Medical Research, 55,* 135-147.

Centers for Disease Control (2002). Fetal alcohol syndrome: Alaska, Arizona, Colorado, and New York, 1995 – 1997. *Morbidity and Mortality Weekly Report, 51(20),* 433-435.

Department of Health and Social Services (1990). *State of Alaska alcoholism and drug abuse plan 1990-1991*. Juneau, AK: Author.

Department of Health and Social Services (2001). *2001 status update: Alaska's response to fetal alcohol syndrome.* Juneau, AK: Author.

Department of Health and Social Services (2002). Fetal alcohol syndrome prevalence in Alaska: New findings from the FAS surveillance project. *Family Health Dataline*, *8(2)*. Juneau, AK: Author.

Hagberg, B., Hagberg, G., Lewerth, A., & Lindberg, U. (1984). Mild mental retardation in Swedish school children. *Acta Paediatrica Scandinavica*, 70, 441-444.

Hisnanick, J. J. (1992). The prevalence of alcohol abuse among American Indians and Alaska Natives. *Health Values, 16,* 32-37.

Jones, K. L., & Smith, D. W. (1973). Recognition of fetal alcohol syndrome in early infancy. *Lancet*, *2*, 999-1001.

Kerns, K. A., Don, A., Mateer, C. A., & Streissguth, A. P. (1997). Cognitive deficits in nonretarded adults with fetal alcohol syndrome. *Journal of Learning Disabilities, 30,* 685-693.

Mattson, S. N., Riley, E. P., Gramling, L., Delis, D. C., & Jones, K. L. (1997). Heavy prenatal alcohol exposure with or without physical features of fetal alcohol syndrome leads to IQ deficits. *Journal of Pediatrics, 131,* 718-721.

May, P. A., & Gossage J. P. (2001). Estimating the prevalence of fetal alcohol syndrome. A summary. *Alcohol Research & Health: The Journal of the National Institute on Alcohol Abuse & Alcoholism, 25,* 159-167.

Municipal Health and Human Services Commission (1994). *CORE Services Study: An assessment of Anchorage's physical, social, and environmental health.* Anchorage, AK: Municipality of Anchorage.

NIAAA (1987). *Sixth special report to the U.S. Congress on alcohol and health.* Washington, DC: U.S. Department of Health and Human Services.

O'Connor, M. J., Shah, B., Whaley, S., Cronin, P., Gunderson, B., & Graham, J. (2002). Psychiatric illness in a clinical sample of children with prenatal alcohol exposure. *American Journal of Drug and Alcohol Abuse, 8,* 743-754.

Olson, H. C., Feldman, J. J., Streissguth, A. P., Sampson, P. D., & Bookstein, F. L. (1998). Neuropsychological deficits in adolescents with fetal alcohol syndrome: clinical findings. *Alcoholism: Clinical and Experimental Research, 22,* 1998-2012.

Phillips, N. (1995, October 11). Message misses its mark: Booze, drugs found in 16% of new moms. *Anchorage Daily News*, p. A1, A12.

Schonfeld, A. M., Mattson, S. H., Lang, A. R., Delis, D. C., & Riley, E. P. (2001). Verbal and nonverbal fluency in children with heavy prenatal alcohol exposure. *Journal of Studies on Alcohol, 62*, 239-246.

Steinhausen, H. C., Willms, J., & Spohr, H. L. (1994). Correlates of psychopathology and intelligence in children with fetal alcohol syndrome. *Journal of Child Psychology and Psychiatry and Allied Disciplines, 35,* 323-331.

Streissguth, A. P. (1997). *Fetal alcohol syndrome: A guide for families and communities*. Baltimore: Paul H. Brookes.

Streissguth, A. P., Aase, J. M., Clarren, S. K., Randels, S. P., LaDue, R. A., & Smith, D. F. (1991). Fetal alcohol syndrome in adolescents and adults. *Journal of American Medical Association, 265,* 1961-1967.

Streissguth, A. P., Barr, H. M., Kogan, J., & Bookstein, F. L. (1996). *Understanding the occurrence of secondary disabilities in clients with fetal alcohol syndrome (FAS) and fetal alcohol effects (FAE): Final report to the Centers of Disease Control and prevention in Grant No. R04/CCR008515* (Technical Report No. 96-06). Seattle: University of Washington, Fetal Alcohol and Drug Unit.

Streissguth, A. P., Barr, H. M., & Sampson, P. D. (1990). Moderate prenatal alcohol exposure: effects on child IQ and learning problems at ate 7½ years. *Alcoholism: Clinical and Experimental Research, 14,* 662-669.

Streissguth, A. P., Randels, S. P., & Smith, D. F. (1991). A test-retest study of intelligence in patients with fetal alcohol syndrome: implications for care. *Journal of American Academy of Child and Adolescent Psychiatry, 30,* 584-587.

Thomas, S. E., Kelly, S. J., Mattson, S. N., & Riley, E. P. (1998). Comparison of social abilities of children with fetal alcohol syndrome to those of children with similar IQ scores and normal controls. *Alcoholism: Clinical and Experimental Research, 22,* 528-533.

Wechsler, D. (1989). *Manual for the Wechsler Preschool and Primary Scale of Intelligence-Revised*. San Antonio: The Psychological Corporation.

Wechsler, D. (1991). *Manual for the Wechsler Intelligence Scale for Children-Three*. San Antonio: The Psychological Corporation.

Wechsler, D. (1997). *Wechsler Adult Intelligence Scale-Three Administration and Scoring Manual*. San Antonio: Harcourt Brace & Co.