A Practical Testing Battery to Measure Neurobehavioral Ability among Children with FASD

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Abstract

AIMS—To determine a brief, practical battery of tests that discriminate between children with a fetal alcohol spectrum disorder (FASD) and unexposed controls.

DESIGN—Children received dysmorphology exams, a targeted battery of cognitive and behavioral tests, and their mothers were interviewed about maternal risk factors. Children diagnosed with an FASD and children unexposed to alcohol prenatally were compared on cognitive/behavioral test results.

SETTING—A community in The Western Cape Province of South Africa.

PARTICIPANTS—Sixty-one, first grade children with FASD and 52 matched normal controls.

MEASURES—Statistical analyses of maternal drinking behavior and their child's test performance.

FINDINGS—Self-reported maternal drinking patterns before during and after pregnancy were used to confirm prenatal exposures to alcohol in the group of children diagnosed with FASD. With this sample of children diagnosed with FASD and completely unexposed controls, the adverse effects of maternal drinking on children's performance are reported. Results of the battery of standardized cognitive and behavioral tests indicate highly significant differences (p < .001) between groups on: intelligence, perceptual motor, planning, and logical, spatial, short term, long term, and working memory abilities. Furthermore, a binary logistical regression model of only 3 specific cognitive and behavioral tests, including Digit Span A+B (Wald = 4.10), Absurd Situation (Wald = 3.57), and Word Association (Wald = 4.30) correctly classified 79.1% of the child participants as FASD or controls.

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CONCLUSIONS—A brief, practical set of tests can discriminate children with and without FASD and provide useful information for interventions for affected children.

Keywords

fetal alcohol spectrum disorders (FASD); cognitive/behavioral testing; diagnosis; alcohol abuse

INTRODUCTION

Fetal Alcohol Spectrum Disorders (FASDs) have been the focus of collaborative studies in South Africa (ZA) for over 15 year and have contributed to an enhanced cross-cultural and population-based understanding of FASD. Because prenatal alcohol exposure impacts the developing fetus in a complex manner and the diagnosis of the spectrum of disorders is not straightforward, study of large groups of heavily alcohol-exposed children in ZA has advanced understanding of the range of affects on children and their ability to function effectively in the world. This article presents data from a study in the Western Cape Province (WCP) of ZA where a practical battery (commonly used and easily administered) of standardized tests was used to investigate the cognitive and behavioral patterns in a group of children diagnosed with FASD using the Revised IOM Diagnostic criteria (Hoyme et al, 2005)..

Since the diagnosis of fetal alcohol syndrome (FAS) was formalized and published in 1973 (Jones and Smith, 1973), further diagnostic delineation continues today. There is considerable agreement regarding important individual physical and behavioral components constituting the syndrome (Sokol and Clarren, 1989; Aase, 1994; Aase, et al., 1995; Stratton et al., 1996; Astley and Clarren, 2000; Chudley, 2005; Hoyme, et al. 2005).

According to the Institute of Medicine (IOM), children with FAS have a characteristic pattern of: 1) facial and body dysmorphology, 2) delayed physical growth and development, and 3) specific mental and behavioral deficits (Stratton et al.,1996). For a diagnosis of FAS, all three categories of problems must be present and the diagnosis should be made only after excluding other genetic and teratogenic anomalies (Hoyme, et al., 2005). All IOM-prescribed diagnoses of the FASD spectrum were utilized in this population-based study: FAS and partial fetal alcohol syndrome (PFAS), alcohol-related neurodevelopmental deficits (ARND), and alcohol-related birth defects (ARBD) (Warren et al., 2004).

Prenatal alcohol exposure can lead to brain damage resulting in cognitive and behavioral impairments. Specific deficit areas in the population of individuals exposed to alcohol prenatally (Conry, 1990; Kodituwakku, 2006), include: ***general intelligence*** (Streissguth et al., 2004; Mattson and Riley, 1998; Jacobson, et al., 2004; Bailey, et al., 2004), ***executive functioning*** (Kodituwakku, et al.1995, 2001; Kopera-Frye, et al., 1996; Mattson, et al., 1999(a); Schonfeld, et al.. 2006), ***information processing*** (Aragon, et al., 2008; Burden ,et al., 2005; Streissguth, 2007), ***attention*** (Steinhausen and Spohr,1998; Coles, et al., 1997; Coles, et al., 2002; Mattson, et al., 2006), ***language (both receptive and expressive)*** (Mattson, et al.. 2002; McGhee, et al., 2008; Janzen, 1995), ***learning and memory*** (Mattson and Riley, 1999(b); Roebuck, Spencer and Mattson, 2004; Kaemingk, et al., 2003), ***motor***

skills (Kalberg, et al., 2006; Korkman, 2003; Adnams, 2001), and ***behavior*** (Nash, et al., 2006; Whaley, et al., 2001; Thomas, et al., 1998; Bishop, et al., 2007).

Additionally, Mattson et al. (2010) indicated that tests of executive functioning and spatial processing distinguish children with prenatal alcohol-exposure and the physical features of FASD from children with no prenatal exposure. Aragon et al (2008) and Kodituwakku (2009) summarized the cognitive-behavioral phenotype associated with FASD as a generalized deficit in processing complex information, stemming from deficiencies in recruiting multiple regions of the brain to complete complex tasks.

South African FASD Epidemiology Studies

The first population-based study in this community produced the highest rates of FAS ever reported at that time, over 40.5 -46.4 per 1,000 (May, et al., 2000; Viljoen, et al., 2002). Two subsequent studies in this same community also found extremely high rates of FAS and PFAS 65.2 to 74.2 per 1,000 (Viljoen, et al., 2005; May, et al., 2005) and 68.0 to 89.2 per 1,000 (May, et al., 2007, 2008) as have other studies using similar methods in other ZA communities (Viljoen, et al., 2001; Urban, et al., 2008). These studies have raised many questions about the universal characteristics of FASD (Adnams, et al, 2001). For example, are deficits seen in children with FASD in ZA the same as deficits in children with FASD from other western countries? Adnams, et al, (2001) demonstrated that, while controlling for socioeconomic status, maternal depression, low parental education, violence and social disruption, children with FASD in a ZA community demonstrated a pattern of cognitive-motor deficits similar to those reported in the literature. This article summarizes testing results of a well-matched sub-sample of children with FASD and unexposed controls from a second, active-case ascertainment epidemiology study in a first grade cohort. The goal of the study was to define a battery of tests that discriminates between children with an FASD and unexposed controls. The rationale for the chosen battery was to determine a brief and practical set of cognitive and behavioral measures that identify the deficits common to all children with confirmed prenatal exposure to alcohol and a diagnosis of FASD and that are commonly used and available to school psychologists and developmental clinicians.

The hypothesis was that children with FASD perform poorly on tests that require greater mental effort and complex thinking. For example, cognitive planning tasks require conceptual set shifting and working memory, logical memory, and later recall. Although other studies have demonstrated that a set of neuropsychological measures can discriminate between exposed children and unexposed controls, the battery of tests used in many of those studies are extensive, quite time-consuming, expensive, and often are not readily available to those working in schools and communities (Mattson, 2010).

Many children affected with FASD are currently without appropriate educational and learning supports. Therefore, it is necessary to create bridges between the empirical evidence and real world practice to help the affected children. Evaluation of deficits for the affected children is the first step in determining a need for services. The field will benefit from empirically-determined evaluation guidelines for deficit areas of children with FASD. This study examines a battery of tests that are commonly available to school psychologists and developmental clinicians that target the known deficits in this population.

METHODS

Identifying Children with FASD in Schools

In the parent epidemiology study, 96% of all enrolled students in the targeted community's schools received guardian consent to participate. Screening and dysmorphology exams were completed for all consented children. After dysmorphology examinations, 92 children were developmentally tested and maternal prenatal risk factor questionnaires were completed. Those administering the developmental tests and the maternal interviewers were blinded to the reason for study entry and any results from the other study domains. Full methodology for the parent study is found in Viljoen, et al. (2005).

Child Control Group

Control children for the parent epidemiology study (n = 146) were randomly selected from consented first grade students enrolled in the same schools. Identical exams and testing were performed on subjects and potential controls (Viljoen, et al., 2005). After going through the examination and testing process and the selected child did not have an FASD, then he/she served as a control. Since some of the mothers of the normal controls were subsequently found to have consumed alcohol during the index pregnancy, and because prenatal alcohol exposure may impact performance on neuropsychological tests, a matching process was initiated to make sure that one completely unexposed control was matched to each child with an FASD by age (within 12 months) and sex. This necessitated recruitment of 25 additional, unexposed children who met age and sex criteria. These children were provided the same diagnostic exams and testing as the 36 children who originated from the random selection. This resulted in a sample of 61 seemingly <u>unexposed</u> controls; but, after a closer look at the maternal interviews, 9 of those 61 mothers drank some during pregnancy and after their children were eliminated, the result was the 52 <u>unexposed</u> control children reported on here.

Maternal Data for Cases and Controls

Available mothers of children with an FASD and controls were interviewed. Fifty-three of the 61 mothers of the FASD children included in this study were interviewed. For the remaining 8, prenatal alcohol consumption data were obtained via collateral sources (May, et al, 2005, May, et al., 1983; Streissguth, et al., 1985). Maternal data presented here focus primarily on confirmation of maternal drinking for case assessment/diagnosis. A detailed profile of maternal risk factors for FASD in this community are reported elsewhere (Viljoen, et al., 2002; May, et al., 2005; 2008). Structured maternal interviews contained items covering: reproduction; alcohol use before, during and after the index pregnancy; socio-economic status (SES); demographic variables; diet and nutrition; and physical status of the mother. Protocols utilized drinking questions in a timeline follow-back methodology (Sobell, et al., 1988; 2001) to elicit accurate reporting of alcohol consumed. All interviews were administered by experienced, Afrikaans-speaking interviewers.

Case Conferences for Final Diagnoses

Final diagnoses for all children (cases and controls) were made at a case conference based on dysmorphology exams, developmental testing, and maternal interviews documenting alcohol exposure and other risk factors (see Hoyme, et al., 2005; Viljoen, et al, 2005; May et al., 2000; 2007).

Test Battery

Intelligence tests, perceptual motor tests, planning tests, and logical, spatial, short term, long term, and working memory tasks were selected (see figure 1). The tests are normed and standardized except for the Personal Behavior Checklist, a frequently used checklist of children with FASD (Streissguth, 1998). The battery of standardized tests chosen and administered measure abilities shown to be affected in prenatally-exposed children, yet are generally available and practical to use by school and clinic staff.

Intellectual Abilities

The test battery selected included a measure of fluid intelligence, The Raven Progressive Matrices (Raven, 1947), for children 6 through 16 years measuring a person's ability to form perceptual relations and reason by analogy. This nonverbal test of intelligence was chosen for this South African population to offer a fluid intelligence measure that minimized the verbal comprehension load on the subject. The Raven has been used extensively for studies in diverse cultures because of the culturally-fair aspect of the measure (Sizemore and Amler, 1996; Sattler, 2001; Chiappedi, et al., 2012; Edwards, et al,, 2010). The Test for the Reception of Grammar (TROG) (Bishop, 1989), measures a child's ability to understand grammatical constructs using a multiple choice format which requires a minimal effort from the child. This is desirable for this student population for it provides an opportunity for the child to demonstrate his/her understanding of grammatical constructs separate from verbal abilities.

In addition, selected subtests from the Junior South African Individual Scales (JSAIS) (Robinson, 1989) were administered: Story Memory, Absurd Situation, Word Associations and Digit Span (forward and backward). The JSAIS was developed to provide a profile of an English or Afrikaans speaking child's cognitive abilities. The battery is standardized for school-aged Coloured, Afrikaans-speaking children from 6 years to 8 years, 11 months, making it very applicable for these children. The selected subtests were chosen to target empirically-based deficit areas in prenatally exposed children. It was hypothesized that these subtests tax the brain by requiring the involvement of multiple brain regions to successfully complete abstract reasoning, logical thinking, and simple memory/working memory tasks.

Motor and Visual-Perceptual Abilities

The Beery-Buktenica Developmental Test of Visual-Motor Integration (VMI) (Beery et al., 2003) was used to assess visual and motor integration abilities and evaluate visual perception. The VMI is a non-verbal test that is used among diverse environmental, educational, cultural, and linguistic groups.

Behavior

Behavior was assessed using the Personal Behavior Checklist (PBCL-36, Teacher Report Form) translated into Afrikaans (Streissguth et al, 1998). The PBCL-36 is a checklist developed to assess the behavior of children with FASD. The 36 questions resulted from the most commonly reported behaviors among families of children with FAS. The tool is not standardized, but it has adequate test-retest reliability.

Statistical Analyses

Data were analyzed using SPSS Version 19.0 (SPSS Inc., Chicago Ill, 2010). Chi square tests were performed on categorical level data, and one-way analysis of variance tests on interval level data, as noted in Tables 1, 2 and 3. Although we used standardized scores for the analysis, we also ran an analysis of covariance controlling for age to make certain our group significant differences were not accounted for by the age differential (see Table 3). Binomial logistic regression was used to determine which tests predict classification in either the FASD or Control group (see Table 4).

RESULTS

Sample

Sixty one children with an FASD diagnosis and 52 non-exposed controls were used for this analysis. Of the 61 affected children, 37 or (60.7%) were FAS, 16 or (26.2%) were PFAS, and 8 or (13.1%) were ARND (See Table 1); 28 were male (45.9%) and 33 were female (54.1%), with an average age of 73 months. The average age of the 52 unexposed control group was 82 months and 23 were male (44.2%) and 29 were female (55.8%).

Table 1 compares physical and dysmorphology variables between FASD and control children. With the exception of sex, all variables discriminate between FASD and Control children at p .001.

Table 2 compares self-reported alcohol use by mothers of FASD children with mothers of control children. Each maternal/paternal risk factor significantly discriminates between mothers of FASD children and of control children as well as drinking before and after the index pregnancy, average number of drinks per day and drinking by each trimester, and fathers' drinking problems.

Table 3 compares FASD and control children on developmental and behavioral tests. With the exception of the Story Memory Mental Age score, all neuropsychological test results are significant, including TROG, Raven non-verbal ability, and PBCL-36 personal behavior.

Binary logistic regression was performed to determine the cognitive and behavioral test variables that best discriminate between participants in the FASD and control groups. The Wald statistic, which is based on a *z* score, is used to test the significance of each predictor variable in the model (Table 4) showing the relative contribution of each. A model containing Digit Span A+B, absurd situation, and word associations correctly classified 77.6.1% of the child participants as either FASD or control.

DISCUSSION

Defining a battery of standardized tests that is useful for the FASD population is a vital goal; however, it is of particular importance in ZA and other under-served populations where resources are scarce and research has shown FASD to be both prevalent and severe. Most classrooms in ZA have multiple numbers of affected children enrolled, and children with an FASD can benefit from classroom and learning support (Adnams, 2008). The determination of needed supports begins with an accurate evaluation of each child's learning strengths and challenges.

Using maternal interview data, we were able to compare the testing results of definitively diagnosed children with those who were not exposed to alcohol at all. The battery of tests used was comprehensive, yet not lengthy or cumbersome. We included measures of verbal and nonverbal intelligence, visual-motor perception, behavior, and select subtests of the JSAIS felt to be discriminating for this population. With only one exception, the difference between the two groups was highly significant on all testing measures.

For the JSAIS subtests, The Absurd Situation, Word Association, and Digit Span subtests all discriminated well between the groups. The Absurd Situations subtest requires the subject to look at a picture and recognize what is going on in the picture. Each picture has incongruity that the subject is required to determine. In order to do this accurately, the subject must perceive detail correctly requiring alertness, attention and concentration, inference, knowledge of science, geography, and social understanding. Conceptually, the subject must have some understanding of what is right and wrong and must exhibit impulse control in order to correctly respond (Sattler, 2001).

To be successful with the Word Associations subtest, the subject must perceive the common elements of the paired words and bring those elements together into a concept. This measures concept formation and the ability to place objects and events together in meaningful groups (Lyon, 1995). In order to do this, the subject must organize, abstract, and find relationships that are not at first obvious. Memory is involved and success can be related to interests of the subjects and cultural opportunities.

Finally, Digit Span forward and Digit Span backward are considered separately as they tap into different abilities. Digit Span forward involves sequential processing and short-term memory. Digit Span backward involves planning, sequential processing and working memory (Borkowsi and Burke, 1996, Duncan et al., 2012). Working memory requires the subject to hold information in mind, manipulate the information into a different sequence or form before responding; requiring great mental effort and complex thinking.

The Story Memory subtest did not discriminate well between affected and unaffected children. The Absurd Situations, Digit Span, and Word Associations subtests, on the other hand, did discriminate well; they require more complex cognitive processes which is described by a number of researchers as a hallmark of children with an FASD (Aragon, et al., 2008, Kodituwakku, et al., 2006; Kodituwakku,2009; Duncan, et al, 2012).

The binary logistic regression analysis revealed that the JSAIS subtests of word associations, absurd situation, and digit span correctly classified 77.6% of the subjects with an FASD. These types of subtests are embedded not only in the JSAIS but within most well-normed, easily accessible, and widely-used intelligence tests such as the Wechsler Scales (Wechsler, 2003) and can therefore be used in a sensitive fashion for other populations. It is important to note the limitations of this study. Although we attempted to administer a comprehensive, yet feasible battery of tests, there were some aspects of performance that were not or were minimally evaluated. For example, the battery did not include a testing tool that looked at mathematical ability, a known area of difficulty for children affected by prenatal alcohol exposure. In addition, we did not include a comprehensive measure of behavior. Evaluation and assessment for appropriate educational programming should also include measures of academic performance and behavior. It would, therefore, be recommended that a comprehensive measure of academic performance and a behavioral measure be paired with this proposed battery of tests.

CONCLUSION

It is possible to utilize a practical and readily available set of evaluation tools to determine a learning profile for children diagnosed with an FASD. In most school districts in the USA and ZA, evaluations are conducted to better understand an individual child's strengths and areas of need. Well-known, frequently used, comprehensive tools and subtests measuring the domains of executive functioning, information processing, abstract reasoning, and complex thinking can be used effectively to evaluate children with a diagnosis within FASD to determine if the child is indeed struggling with tasks that require higher order, more complex cognitive processes. This assessment information could assist the schools in providing the appropriate learning supports for the affected child.

Acknowledgments

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Type of Test and Specific Tests Used Within Each Category	Ability Tested
BEHAVIOR	
PBCL-36	• behaviors most often seen in children with FAS
GENERAL INTELLIGENCE	
Raven Progressive Matrices	*Fluid intelligence;* • general reasoning, problem-solving and induction
Test of Reception of Grammar (TROG)	*Crystallized intelligence;* • ability to understand grammatical constructs with little verbal effort required
Story Memory	• short term memory, verbal elaboration, and summarization
Visual-Motor Integration (VMI)	• visual-perception and the Integration of visual-perceptual and motor abilities
SUBTESTS REQUIRING GREATER MENTAL EFFORT *(self-monitoring, complex planning, attention, and maintenance of multiple pieces of information in working memory)*	
Digit Span A, Forward	• short-term sequential auditory memory and attention
Digit Span B, Backward	• conceptual set shifting and working memory, logical memory and later recall
Absurd Situation	• recognition of right and wrong and exhibition of impulse control
Word Association	• organize, abstract and find relationships that are not at first obvious

Figure 1.
Testing Battery and Ability tested

Table 1

Child Physical and Dysmorphology Comparisons: FASD Cases versus Controls.

Child Variables	FASD Children (n = 61)[a]	Control Children (n = 52)	Statistical Test	df	p
Sex (%)					
Males	45.9	44.2			
Females	54.1	55.8	$X^2 = .03$	1	1.000
Age (months)					
Mean (SD)	78.5 (7.6)	88.3 (11.0)	$F = 30.81$	1/111	.000
Height (cm)					
Mean (SD)	108.5 (4.6)	119.8 (7.9)	$F = 88.79$	1/111	.000
Weight (kg)					
Mean (SD)	15.7 (1.7)	22.5 (5.1)	$F = 93.61$	1/111	.000
Occipital Circumference (OFC; in cm)					
Mean (SD)	48.1 (1.3)	51.3 (1.6)	$F = 130.5$	1/111	.000
Palpebral Fissure Length (cm)					
Mean (SD)	2.25 (.12)	2.54 (.18)	$F = 97.16$	1/108	.000
Smooth Philtrum[b] (%)	78.7	34.7	$X^2 = 21.76$	1	.000
Narrow Vermilion Border[c] (%)	70.5	6.1	$X^2 = 46.27$	1	.000
Total Dysmorphology Score Mean (SD)	17.1 (4.5)	5.2 (4.3)	$F = 196.03$	1/108	.000

[a] Includes 8 ARND cases, 16 PFAS cases, and 37 FAS cases.

[b] Score of 4 or 5 on Astley's Lip Philtrum Guide.

[c] Score of 4 or 5 on Astley's Lip Philtrum Guide.

Table 2

Maternal/Paternal Risk Factor Comparisons: FASD Cases versus Controls.

Maternal/Paternal Variables	Mothers of FASD Children ($n = 61$)	Mothers of Control Children ($n = 52$)	Statistical Test	df	p
Drinking before index pregnancy (%)	85.4	4.1	$X^2 = 65.00$	1	.000
Drinking Indicator - overall reported drinking during pregnancy (%)	92.0	0.0	$X^2 = 84.21$	1	.000
Average No. drinks per day (during pregnancy)	5.4	0.0	$F = 52.16$	1/93	.000
Consumed **3 drinks or more** per occasion during pregnancy (%)	68.0	0.0	$X^2 = 50.75$	1	.000
Consumed **5 drinks or more** per occasion during pregnancy (%)	60.0	0.0	$X^2 = 42.18$	1	.000
Current drinker in last year (%)	76.0	4.1	$X^2 = 53.16$	1	.000
Drank during trimesters (%)					
1st	92.0	0.0	$X^2 = 84.21$	1	.000
2nd	92.0	0.0	$X^2 = 83.23$	1	.000
3rd	88.0	0.0	$X^2 = 74.73$	1	.000
Father's data					
Fathers of Index Children with drinking problems in past (%)	35.7	3.4	$X^2 = 10.23$	1	.001

TABLE 3

Mean Standardized[a] Scores on Developmental and Behavioral Indicators of Children with FAS versus Controls: Wave II.

Child Variables	FASD Mean(SD) N = 61	Controls Mean(SD) N = 52	Test Score	d.f.	p	ANCOVA controlling for age Does test performance vary significantly by child's age?
Developmental Traits						
Verbal Ability[b]	6.6 (9.5)	20.3 (20.7)	F = 21.57	1/110	.000	No; F = .616, p = .434
Non-Verbal Ability[c]	13.0 (12.8)	24.2 (19.5)	F = 13.28	1/111	.000	No; F = .318, p = .574
PBCL-36	14.2 (8.1)	6.7 (6.4)	F = 21.96	1/94	.000	No; F = .304, p = .583
VMI	68.0 (12.4)	79.3 (19.3)	F = 14.10	1/111	.000	No; F = 3.32, p = .071
Digit Span A, Total Score	5.8 (2.2)	7.6 (2.3)	F = 18.29	1/111	.000	No; F = .995, p = .321
Digit Span B, Total Score	1.1 (1.4)	2.1 (1.7)	F = 11.17	1/111	.001	No; F = 1.23, p = .270
Digit Span AB, Scaled Score	6.9 (2.9)	10.3 (3.2)	F = 20.79	1/66	.000	No; F = .293, p = .590
Absurd Situation, Scaled Score	55.6 (13.1)	69.3 (15.7)	F = 25.20	1/111	.000	No; F = .926, p = .340
Word Association, Scaled Score	60.2 (14.9)	69.2 (13.6)	F = 11.00	1/111	.001	No; F = .290, p = .592
PBCL-36: Teacher-Rated	12.3 (7.5)	6.3 (5.9)	F = 21.10	1/110	.000	No; F = 1.01, p = .316
Story Memory, Scaled Score	65.9 (18.6)	70.9 (21.8)	F = 1.01	1/66	.318	No; F = .062, p = .805
Total Dysmorphology Score**	17.1 (4.5)	5.2 (4.3)	F = 196.03	1/111	.000	
Head Circumference (OFC)	48.1 (1.3)	51.3 (1.6)	F = 130.35	1/111	.000	

[a] All scores standardized for age of child at time of testing.

[b] Tests of the Reception of Grammar (TROG) percentile score used.

[c] Raven Colored Progressive Matrices percentile score used.

Table 4

Binary Logistic Regression of Cognitive and Behavioral testing to Predict Classification in FASD vs Control group.

Variable	Wald	df	p
Digit Span A+B, scaled score	3.90	1	.048
Absurd Situation, scaled score	4.73	1	.030
Word Association, scaled score	6.85	1	.009

R^2 = .36 (Cox & Snell), .48 (Nagelkerke). Model $X^2(3)$ = 30.10, p < .001

Overall ability of model to correctly classify participants as FASD or Control = 77.6%