INVESTIGATORS

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JOHN DONOVAN, PHD, SOCIAL PSYCHOLOGY
STUDY DESIGN

- 21 YEARS
- 16 YEARS
- 14 YEARS
- 10 YEARS
- 6 YEARS
- 3 YEARS
- 18 MONTHS
- 8 MONTHS
- DELIVERY
- 7TH PRENATAL MONTH
- 4TH PRENATAL MONTH 1982-1985
# Study Follow-Up Rates

<table>
<thead>
<tr>
<th>Interviewed</th>
<th>Birth</th>
<th>8 Month</th>
<th>18 Month</th>
<th>3 Year</th>
<th>6 Year</th>
<th>10 Year</th>
<th>14 Year</th>
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<tbody>
<tr>
<td></td>
<td>595</td>
<td>465</td>
<td>509</td>
<td>526</td>
<td>522</td>
<td>490</td>
<td>460</td>
</tr>
<tr>
<td>Rate</td>
<td>96%</td>
<td>81%</td>
<td>91%</td>
<td>95%</td>
<td>94%</td>
<td>90%</td>
<td>84%</td>
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### DOMAINS OF DATA: MATERNAL

<table>
<thead>
<tr>
<th>Demographic Factors</th>
<th>Psychological Factors</th>
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<tbody>
<tr>
<td>Race</td>
<td>Depression</td>
</tr>
<tr>
<td>Age</td>
<td>Anxiety</td>
</tr>
<tr>
<td>Marital Status</td>
<td>Hostility</td>
</tr>
<tr>
<td>Education</td>
<td>Self-Esteem</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Medical Factors</th>
<th>Diagnostic Interview Schedule</th>
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<tbody>
<tr>
<td>Pregnancy and Labor</td>
<td>History of Childhood Abuse</td>
</tr>
<tr>
<td>Current Health Status</td>
<td></td>
</tr>
<tr>
<td>Medications</td>
<td></td>
</tr>
</tbody>
</table>
MATERNAL FACTORS

SOCIAL FACTORS
- Dyadic Adjustment
- Social Support
- Life Events
- Religion
- Neighborhood
- Exposure to Violence

ENVIRONMENTAL FACTORS
- Family Environment
- Household Structure
- Parental Warmth
- Supervision
- Discipline
## MATERNAL FACTORS

<table>
<thead>
<tr>
<th>COGNITIVE MEASURES</th>
<th>PARENTING PRACTICES</th>
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</thead>
<tbody>
<tr>
<td>MATERNAL IQ</td>
<td>WARMTH</td>
</tr>
<tr>
<td></td>
<td>SUPERVISION</td>
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<tr>
<td></td>
<td>DISCIPLINE</td>
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PARENTAL SUBSTANCE USE

PRENATAL DRUG AND ALCOHOL USE
MARIJUANA, TOBACCO, OTHER ILLICIT DRUGS, ALCOHOL
EACH TRIMESTER AND EACH MONTH OF THE FIRST TRIMESTER

POSTNATAL DRUG AND ALCOHOL USE
DRUG AND ALCOHOL USE OF THE FATHER AND THE MALE IN THE HOUSEHOLD
HISTORY OF USE AND ABUSE
CURRENT USE
DIAGNOSIS OF SUBSTANCE USE DISORDERS (DSM-IV)
Prevalence of Alcohol Use During Pregnancy

12.5% OF WOMEN DRINK DURING PREGNANCY

3% DRANK AT LEAST 7 DAYS / WEEK

3.4% OF WOMEN BINGE DURING PREGNANCY

DRINKING RATES HAVE NOT CHANGED SINCE 1991.

(Floyd & Sidhu, 2004)
RISK FACTORS FOR DRINKING DURING PREGNANCY

EARLY PREGNANCY: White, Single, Better educated, Employed

CONTINUED THROUGHOUT PREGNANCY: African-American, Other substance use,
PATTERN OF MARIJUANA USE

1st Trim 2nd Trim 3rd Trim 14 Years

None Light Moderate Heavy
<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
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<tr>
<td>FAS</td>
<td>FETAL ALCOHOL SYNDROME</td>
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<tr>
<td>FAE</td>
<td>FETAL ALCOHOL EFFECTS</td>
</tr>
<tr>
<td>FASD</td>
<td>FETAL ALCOHOL SPECTRUM DISORDER</td>
</tr>
<tr>
<td>ARND</td>
<td>ALCOHOL-RELATED NEURODEVELOPMENTAL DISORDER</td>
</tr>
<tr>
<td>ARBD</td>
<td>ALCOHOL-RELATED BIRTH DEFECTS</td>
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DEFINITION OF FAS

PRENATAL AND/OR POSTNATAL GROWTH DEFICIENCY

CHARACTERISTIC MINOR FACIAL ANOMALIES

EFFECTS ON THE STRUCTURE OR FUNCTIONING OF THE CENTRAL NERVOUS SYSTEM
DEFINITION OF GROWTH DEFICITS

BELOW THE 10TH PERCENTILE IN WEIGHT AND/OR LENGTH ADJUSTING FOR GESTATIONAL AGE.
FACIAL FEATURES

SHORT PALPEBRAL FISSURES
ELONGATED MIDFASE
LONG AND FLATTENED PHILTRUM
THIN UPPER LIP
FLATTENED JAW
DEFINITION OF CNS INVOLVEMENT

NEUROLOGIC ABNORMALITIES
DEVELOPMENTAL DELAYS
BEHAVIORAL BEHAVIORS
COGNITIVE DEFICITS
DEFICITS IN HEAD SIZE
CHANGES IN THE BRAIN ON IMAGING.
FAE AND FASD

DESCRIBE PEOPLE WHO HAVE SOME OF THE FEATURES OF FAS, BUT WHO DO NOT HAVE ENOUGH FEATURES TO MEET THE DIAGNOSTIC CRITERIA.

ARND AND ARBD

DESCRIBE SUBSETS OF THE SYMPTOMS OF FAS GROUPED BY BIOLOGICAL SYSTEMS
## Predictive Value of Head Circumference <10th Percentile and One Morphological Anomaly

<table>
<thead>
<tr>
<th></th>
<th>Affected</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IQ</strong></td>
<td>85.5</td>
<td>95.9</td>
</tr>
<tr>
<td><strong>Math (WRAT-R)</strong></td>
<td>80.0</td>
<td>03.3</td>
</tr>
<tr>
<td><strong>Spelling</strong></td>
<td>79.0</td>
<td>89.2</td>
</tr>
<tr>
<td><strong>Reading</strong></td>
<td>89.2</td>
<td>93.9</td>
</tr>
<tr>
<td><strong>Average Daily Volume – 1st Trim</strong></td>
<td>1.37</td>
<td>0.57</td>
</tr>
<tr>
<td><strong>Average Daily Volume – 3rd Trim</strong></td>
<td>1.28</td>
<td>0.10</td>
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</table>
PERCENT OF OFFSPRING WITH HEAD CIRCUMFERENCE <10TH PERCENTILE AND ONE MORPHOLOGICAL ABNORMALITY BY THIRD TRIMESTER ALCOHOL EXPOSURE
A BRIEF LESSON IN TERATOLOGY

DEVELOPMENT DURING PREGNANCY IS SEQUENTIAL

EXPOSURE AT ANY GIVEN TIME WILL AFFECT THE SYSTEM/FUNCTION THAT IS DEVELOPING AT THAT TIME

THE EFFECT ON EACH DEVELOPING SYSTEM/FUNCTION IS RELATED TO THE DOSE OF THE EXPOSURE

LARGER EXPOSURES CAN LEAD TO EFFECTS ON MORE SYSTEMS/FUNCTIONS

EXPOSURE OVER A LONGER TIME WILL LEAD TO EFFECTS ON MORE SYSTEMS/FUNCTIONS
TERATOLOGIC MODEL

- CNS
- GROWTH
- MORPHOLOGY
- MORTALITY

DOSE
GROWTH
OFFSPRING WEIGHT BY FIRST TRIMESTER ALCOHOL EXPOSURE

Level of Alcohol Use

- **Abstainer:** No use
- **Light:** >0 and <1.5/week
- **Moderate:** >1.5/wk and <1/day
- **Heavy:** 1 or more/day

<table>
<thead>
<tr>
<th>Weight (lbs.)</th>
<th>Abstainer</th>
<th>Light</th>
<th>Moderate</th>
<th>Heavy</th>
</tr>
</thead>
<tbody>
<tr>
<td>150-155</td>
<td>151.72</td>
<td>149.44</td>
<td>142.59</td>
<td>135.71</td>
</tr>
</tbody>
</table>
OFFSPRING WEIGHT BY SECOND TRIMESTER ALCOHOL EXPOSURE

Level of Alcohol Use

- **Abstainer:** No use
- **Light:** >0 and <1.5 drinks/week
- **Moderate:** >1.5/wk and <1/day
- **Heavy:** 1 or more/day

<table>
<thead>
<tr>
<th>Level of Alcohol Use</th>
<th>Weight (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstainer: No use</td>
<td>149.47</td>
</tr>
<tr>
<td>Light: &gt;0 and &lt;1.5 drinks/week</td>
<td>139.58</td>
</tr>
<tr>
<td>Moderate: &gt;1.5/wk and &lt;1/day</td>
<td>140.94</td>
</tr>
<tr>
<td>Heavy: 1 or more/day</td>
<td>130.47</td>
</tr>
</tbody>
</table>
OFFSPRING HEAD CIRCUMFERENCE BY SECOND TRIMESTER EXPOSURE

<table>
<thead>
<tr>
<th>Circumference (mm.)</th>
<th>Abstainer: No use</th>
<th>Light: &gt;0 and &lt;1.5 drinks/week</th>
<th>Moderate: &gt;1.5 drinks/wk and &lt;1/day</th>
<th>Heavy: 1 or more/day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>562.74</td>
<td>558.12</td>
<td>556.95</td>
<td>556.12</td>
</tr>
</tbody>
</table>
OFFSPRING SKINFOLD THICKNESS BY SECOND TRIMESTER ALCOHOL EXPOSURE

Level of Alcohol Use

- **Abstainer: No use**
- **Light: >0 and <1.5 drinks/week**
- **Moderate: >1.5 drinks/wk and <1/day**
- **Heavy: 1 or more/day**

<table>
<thead>
<tr>
<th>Level of Alcohol Use</th>
<th>Thickness (mm.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstainer: No use</td>
<td>15.82</td>
</tr>
<tr>
<td>Light: &gt;0 and &lt;1.5 drinks/week</td>
<td>14.34</td>
</tr>
<tr>
<td>Moderate: &gt;1.5 drinks/wk and &lt;1/day</td>
<td>13.69</td>
</tr>
<tr>
<td>Heavy: 1 or more/day</td>
<td>10.06</td>
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</tbody>
</table>
Patterns of Maternal Substance Use Across Time

- Heavy Thru
- Reduce
- Increase
- Low Dur
- Low Thru

Prior | First | Third | 18 Mo | 3 Yrs | 10 yrs
Head Circumference at 10 Years by Maternal Alcohol Use Across Time
GROWTH < 10\textsuperscript{th} PERCENTILE FOR LENGTH, WEIGHT, OR HEAD CIRCUMFERENCE

GROWTH IN LENGTH, WEIGHT, HEAD CIRCUMFERENCE THROUGH AGE 10, LINEAR RELATION BETWEEN EXPOSURE AND SIZE
CHARACTERISTIC FACIAL FEATURES THAT DEFINE FAS

NUMBER OF MINOR MORPHOLOGICAL MALFORMATIONS, INCLUDING THE FACIAL FEATURES OF FAS
EFFECTS ON THE BRAIN
EFFECTS OF GESTATIONAL ALCOHOL EXPOSURE ON THE BRAIN

IMAGING STUDIES
SMALLER BRAIN VOLUME
ABNORMALITIES IN SHAPE
ASYMMETRY
INCREASED GRAY MATTER DENSITY
DECREASED WHITE MATTER DENSITY

(SOWELL ET AL., 2001, 2002)
BRAIN AREAS AFFECTED

DORSAL FRONTAL CORTEX
ORBITAL REGIONS
[FUNCTIONS: EXECUTIVE FUNCTIONING, ATTENTION, BEHAVIORAL CONTROL]
BASAL GANGLIA
CORPUS CALLOSUM
CEREBELLUM
[FUNCTIONS: COGNITION, MOVEMENT, TIMING]

Sowell et al., 2001, Mattson et al., 1996, Riley 1995
Cerebrum
Largest portion of the brain, including the cerebral hemispheres (cerebral cortex and basal ganglia); involved in controlling consciousness and voluntary processes

Corpus Callosum
A bundle of fibers connecting the brain’s hemispheres

Hippocampus
Part of the limbic system, which is involved in emotional aspects of survival behavior; also plays a role in memory

Basal Ganglia
A group of structures lying deep in the brain involved in movement and cognition

Cerebellum
Involved in maintenance of posture, balance, and coordination

Cortex
Outer layer of gray matter covering the surface of the cerebrum and the cerebellum

Neocortex
Outermost portion of the cerebral cortex that contains the most structurally complex brain tissue

Diencephalon
- Septal area—related to the limbic system, which is involved in emotional aspects of survival behavior
- Thalamus—a communication center that relays information to the cerebral cortex
- Hypothalamus—important in maintaining the body’s internal environment, or homeostasis, through the receipt of sensory and chemical input
<table>
<thead>
<tr>
<th>EF Test</th>
<th>1&lt;sup&gt;st&lt;/sup&gt; TRIMESTER</th>
<th>2&lt;sup&gt;nd&lt;/sup&gt; TRIMESTER</th>
<th>3&lt;sup&gt;rd&lt;/sup&gt; TRIMESTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRAIL MAKING</td>
<td>ALCOHOL</td>
<td></td>
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<td>CCT</td>
<td>ALCOHOL</td>
<td></td>
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<td>MAZES</td>
<td>ALCOHOL</td>
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<td>Block DESIGN</td>
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<td>ALCOHOL</td>
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<td>CODING</td>
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<tr>
<td>PICTURE ARRANGEMENT</td>
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NEUROPSYCHOLOGICAL EFFECTS: Memory and Learning Age 10

Wide Range Assessment of Memory and Learning (WRAML):

- Screening Test: Age 10
- Story
- Verbal
- Design
Learning and Memory at Age 14

Children’s Memory Scale

Learning
- Global Deficits
- Auditory/Verbal

Memory
- Global Deficits
- Auditory/Verbal
GENERAL MEMORY SCORES OF OFFSPRING OF BINGE AND NON-BINGE DRINKERS

- Binge
- No Binge

Levels: Light, Mod, Heavy

Scores:
- Binge: Light (95), Mod (85), Heavy (80)
- No Binge: Light (90), Mod (95), Heavy (85)
VERBAL DELAYED INDEX SCORES AMONG OFFSPRING OF BINGE AND NON-BINGE DRINKERS DURING PREGNANCY
Neuropsychological Effects

Continuous Performance Test

Age 14

Errors of Omission
MOOD AT AGES 6 AND 10

Child Report (RCMAS)

Mother’s Report (CBCL)

Teacher’s Report (TRF)
PSYCHIATRIC STATUS AT AGE 16 AS MEASURED BY THE DIAGNOSTIC INTERVIEW SCHEDULE

• PRENATAL ALCOHOL EXPOSURE SIGNIFICANTLY PREDICTED:
  • CONDUCT DISORDER
  • MAJOR DEPRESSIVE DISORDER
  • NOT ALCOHOL USE DISORDER
ANXIETY MEDIATES THE EFFECTS OF PRENATAL ALCOHOL EXPOSURE AT AGE 10

Date are presented as standardized coefficients.
TEMPERAMENT AT 3, 6, AND 10 YEARS

- Emotionality
- Shyness
COGNITIVE DEVELOPMENT AT AGE 3 ON THE STANFORD-BINET

Short-Term Memory Above 1.5 drinks/day
COGNITIVE DEVELOPMENT AT AGE 6 ON THE STANFORD-BINET

Composite
Short-Term Memory
Verbal Reasoning
COGNITIVE DEVELOPMENT AT AGE 10 ON THE STANFORD-BINET

- Composite Score
- Short-Term Memory
- Verbal Reasoning
- Abstract/Visual Reasoning
- Quantitative Reasoning

ONLY AMONG AFRICAN-AMERICANS
RELATIONS BETWEEN PRENATAL ALCOHOL EXPOSURE AND CHILD’S IQ SCORE AT AGE 10

Data are presented as standardized coefficients.

Indicates a correlation.
• AT AGE 14, THERE WERE NO SIGNIFICANT ASSOCIATIONS BETWEEN PRENATAL ALCOHOL EXPOSURE AND COGNITIVE DEVELOPMENT AS MEASURED BY THE WISC-III
BEHAVIOR
BEHAVIOR AT AGE 6

Child Behavior Checklist and Teacher’s Report Form

**CBCL**
- Externalizing
- Withdrawal
- Delinquency

**TRF**
- Externalizing
- Anxiety
- Total
EFFECTS OF PRENATAL ALCOHOL EXPOSURE ON BEHAVIOR AT AGE 3 MEASURED BY THE TODDLER BEHAVIOR CHECKLIST

HIGHER RATE OF IMMATURITY
<table>
<thead>
<tr>
<th>CBCL</th>
<th>TRF</th>
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</thead>
<tbody>
<tr>
<td>Externalizing</td>
<td>Total</td>
</tr>
<tr>
<td>Withdrawn</td>
<td>Externalizing</td>
</tr>
<tr>
<td>Delinquency</td>
<td>Anxiety/Depression</td>
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</table>
## Behavior at Age 10

<table>
<thead>
<tr>
<th>CBCL</th>
<th>TRF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>Total</td>
</tr>
<tr>
<td>Internalizing</td>
<td>Externalizing</td>
</tr>
<tr>
<td>Anxiety/Depression</td>
<td>Anxiety/Depression</td>
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<tr>
<td>Attention</td>
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SCHOOL ACHIEVEMENT

- Reading, Spelling, Math (WRAT-R) Age 6
- Reading Recognition (PIAT-R) Age 10
- Reading Recognition (PIAT)
- Math Achievement (WRAT-R): Age 14
SUBSTANCE USE AMONG THE OFFSPRING

Age 10 | Age 14 | Age 16
---|---|---
Alcohol | Tobacco | Marijuana

Legend:
- Red: Alcohol
- Purple: Tobacco
- Yellow: Marijuana
CENTRAL NERVOUS SYSTEM DEFICITS

NUMBER OF NEUROLOGICAL CHANGES MANIFESTED AS NEUROPSYCHOLOGICAL DEFICITS, BEHAVIORAL PROBLEMS AND DECREASES IN PERFORMANCE
SUMMARY

PRIMARY OUTCOMES
• Concept Formation
• Ability to Learn New Information
• Memory
• Attention
• Mood

SECONDARY OUTCOMES
• Behavior Problems
• Academic Achievement