What Information SPARK Collects, and Why

LeeAnne Green Snyder, Ph.D.
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Acknowledgements

SPARK Families
SPARK Team
Clinical Sites

Libby Brooks, M.S.
Agenda for today’s webinar

I. Define phenotyping

II. Describe some of our research goals in SPARK

III. Describe our measures and what they are about

IV. Review some of our first findings in SPARK
What is phenotyping?

- Phenotyping refers to measuring and describing the traits—behaviors, personality, abilities, medical conditions and appearance—that result from your genotype (our genes) and your environment.

Core symptoms:
- Challenges with social-communication
- Presence of stereotypic/repetitive behaviors

Specific Learning Difficulties
- ADD/ADHD
- Oppositional Defiant Disorder
- Gifted
- Seizure Disorders
- GI Problems

Sleep Disturbances
- Anxiety Disorders
- Tourette’s

Sensory Disorders
- Diet/Feeding Issues

Depression

Autism Spectrum Disorder

Gifted

Depression

Sensory Disorders

Diet/Feeding Issues

ADD/ADHD

Oppositional Defiant Disorder

Specific Learning Difficulties

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Autism Spectrum Disorder

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Depression

SPARK
### An individual phenotypic profile

<table>
<thead>
<tr>
<th>Trait</th>
<th>Common in ASD:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sociable</td>
<td>Withdrawn</td>
</tr>
<tr>
<td>Verbose</td>
<td>Minimally verbal</td>
</tr>
<tr>
<td>No sensory habits</td>
<td>Sensory seeking</td>
</tr>
<tr>
<td>No motor habits</td>
<td>Motor mannerisms</td>
</tr>
<tr>
<td>Variety, flexible</td>
<td>Restricted interests, perseverative</td>
</tr>
<tr>
<td>Even or flat affect</td>
<td>Mood swings, meltdowns</td>
</tr>
<tr>
<td>Underactive</td>
<td>Hyperactivity</td>
</tr>
<tr>
<td>Flexible</td>
<td>Rigid, sameness</td>
</tr>
<tr>
<td>Comfort with sensory</td>
<td>Sensory and food aversions</td>
</tr>
<tr>
<td>Strengths in memory</td>
<td>Specific learning challenges</td>
</tr>
<tr>
<td>Organized</td>
<td>Executive functioning challenges</td>
</tr>
<tr>
<td>Takes things in stride</td>
<td>Fears and anxiety</td>
</tr>
</tbody>
</table>
→ Can we group individuals into “types” of ASD based on similar clusters of traits?

→ Do these types of ASD have different genetic bases, and different paths to well-being?
Summary: Goals of phenotyping

Autism is different for everyone, but many different types of people are lumped under the umbrella term of “ASD”

→ How and why are some people with ASD different from others? - What is underlying these differences?

→ Do some traits tend to cluster together, and do they link to particular genes?

→ Are there other factors in the environment that interact with our genes to contribute to ASD?
A few of our questions in SPARK

• **Who** is in SPARK?
• How and why are **boys and girls** with autism different?
• What are **early signs** of autism, and how do **babies** with autism develop?
• What are **predictors** of improved language and independence?
• What other **medical** issues are common in autism?
• How do children with autism **change** as they grow into adulthood?
• What are the **needs of adults** with autism?
What information we collect through SPARK surveys

• Registration questions
  • Age when diagnosed
  • Who made the diagnosis
  • Current language level and cognitive level
  • Any services?

• Basic Questionnaire - Medical Screening

• Background History Form
What we collect through standardized measures

- **What is a standardized measure?**
  - A standardized measure is a questionnaire or test that aims to **combine or compare** many people on the same trait, and so it must use the **same** methods.
    - Same questions and same scoring for everyone
    - Better quality if information is measured or asked more than once, in different ways

- There are many published standardized tests out there!

- **Current SPARK Standardized measures:**
  - Social Communication Questionnaire – Lifetime (Rutter)
  - Repetitive Behavior Scale – Revised (Bodfish)
  - Coordination Questionnaire (Wilson)
Why do we collect these measures?

- Core **ASD traits**
- **Other** behavior diagnoses
- **Impact** of ASD behaviors
- **Markers** of rare genetic variants
- **Environmental factors**
  - Demonstrate the strength of our diagnosis data
  - Check if **siblings** have signs of ASD
  - Other important factors
    - Developmental level
    - Socioeconomic status

**SPARK Measures**

- Diagnosis details
- Social Communication Questionnaire
- Repetitive Behavior Scale-Revised
- Social Responsiveness Scale (2020)
- Background History
- Basic Medical Screening Questionnaire
- Vineland Adaptive Behavior Scales (2019)
- Child Behavior Checklist (CBCL) - Adult (ABCL) (2019)
Where does your SPARK data go?

Clues to discovering new autism risk genes, to report to families and to the world

Data for the community: Snapshots

Research Match
Approved researchers look for certain characteristics in individuals to join new studies

Ongoing SPARK phenotypic research
- Predictors of outcomes in adulthood
- Differences between males and females
- A method to rate the effect of genetic changes
- What factors affect parent stress

Share with approved researchers around the world, to make new discoveries
Pregnancy, Birth History and Associated Conditions

Percent with Birth Complications

7%

SPARK families reported many concerns about pregnancy and birth for their children, but serious complications causing brain injury are no more likely than they are in the general population.

Percent Born Prematurely

12%

Premature birth occurs slightly more often in babies who are later found to have autism than it does in other babies. Birth complications such as prematurity are known to increase the risk for developmental disability, and some research says it increases the risk for autism.

Associated conditions reported by Dependent Adults with ASD

- 20% have a diagnosis of depression
- 33% anxiety disorder
- 40% ADHD

Associated conditions reported by Independent Adults with ASD

- 49% have a diagnosis of depression
- 39% anxiety disorder
- 40% ADHD

Pregnancy, Birth History and Associated Conditions

Associated Conditions in Children with Autism

- 5% have a diagnosis of depression
- 18% have anxiety
- 36% have ADHD
- 14% have cognitive impairment
- 59% have sleep problems
- 58% have eating problems

The rate of attention deficit (ADHD) in SPARK is over 3 times higher than it is in the general population. Diagnoses of conditions like ADHD and anxiety may rise now that the new diagnostic system used by doctors encourages all other conditions to be documented. Over half of parents report that their child has problems with sleep and eating.

Seizures

The rate of seizure disorders in SPARK is higher than it is in the general population. But SPARK's reported rate is much lower than the rates reported by other autism studies. We need everyone in SPARK to finish their basic medical screening survey to give us a complete picture.
What are we finding in SPARK?
<table>
<thead>
<tr>
<th>Measure</th>
<th>Purpose</th>
<th>Subject</th>
<th>How many families completed it</th>
<th>How many in our last Data Release</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Communication Questionnaire-Lifetime</td>
<td>Core behavior ASD risk</td>
<td>ASD children &amp; NASD sibs</td>
<td>65%</td>
<td>43,184</td>
</tr>
<tr>
<td>Basic Screening</td>
<td>Medical markers Complications</td>
<td>All family members</td>
<td>66%</td>
<td>90,549</td>
</tr>
<tr>
<td>Round 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetitive Behavior Scale-Revised</td>
<td>Core behavior RRBs</td>
<td>ASD children/dependents</td>
<td>51%</td>
<td>23,011</td>
</tr>
<tr>
<td>Coordination Questionnaire</td>
<td>Motor delays</td>
<td>ASD children</td>
<td>51%</td>
<td>16,705</td>
</tr>
<tr>
<td>Background History Questionnaires</td>
<td>Demographics Development</td>
<td>ASD kids</td>
<td>49%</td>
<td>23,488</td>
</tr>
<tr>
<td></td>
<td>Family background</td>
<td>ASD adults</td>
<td>54.5%</td>
<td>1,660</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NASD sibs</td>
<td>48.5%</td>
<td>10,302</td>
</tr>
</tbody>
</table>
Registration and Background History
### Who is in the SPARK community?

<table>
<thead>
<tr>
<th>Category</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Everyone in SPARK</td>
<td>150,064</td>
</tr>
<tr>
<td>ASD (age 1-85 years)</td>
<td>59,218</td>
</tr>
<tr>
<td>Adults over 18</td>
<td>8,713</td>
</tr>
<tr>
<td>Adults with guardians</td>
<td>5,025</td>
</tr>
<tr>
<td>Adults without guardians</td>
<td>3,688</td>
</tr>
<tr>
<td>Children under 18</td>
<td>50,505</td>
</tr>
<tr>
<td>Male/Female probands (%)</td>
<td>80/20%</td>
</tr>
<tr>
<td>Individuals with intellectual disability</td>
<td>10,527 (19%)</td>
</tr>
<tr>
<td>Adults with guardians</td>
<td>2,241 (46%)</td>
</tr>
<tr>
<td>Children</td>
<td>8,286 (16%)</td>
</tr>
<tr>
<td>Minimally verbal children/dependents (single or no words)</td>
<td>14,432 (26.6%)</td>
</tr>
<tr>
<td>Multiplex families (2+ ASD members)</td>
<td>6,552</td>
</tr>
<tr>
<td>Siblings without ASD</td>
<td>24,076</td>
</tr>
</tbody>
</table>
Race and ethnicity (Total 25,281)

- White: 78%
- African American: 5%
- Asian: 2%
- Native American/Hawaiian: 4%
- Other: 10%
- More than one race: 1%
- Hispanic: 17%

Source: Spark–Visualizing Gender Research
Language levels

- No speech: 13%
- Single Words: 13%
- Phrase Speech: 17%
- Fluent Speech: 57%
Background History

- Early development
- School and services
- Family history of ASD
- Adult supports
- Employment
- Relationships
- Interests and hobbies
Early development in 21,253 Children with ASD

<table>
<thead>
<tr>
<th>Development Stage</th>
<th>Average Age</th>
<th>On Time?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sitting up</td>
<td>6 months</td>
<td>✓</td>
</tr>
<tr>
<td>Walking</td>
<td>14 months</td>
<td>✓</td>
</tr>
<tr>
<td>Single words*</td>
<td>21 months</td>
<td></td>
</tr>
<tr>
<td>Phrase speech (over age 2)</td>
<td>33 months</td>
<td></td>
</tr>
</tbody>
</table>

- Some children who were late to talk were still able to learn after age 7

First concern

- Typically in the 1st or 2nd year of life
- Average age of first concern was 22 months

<table>
<thead>
<tr>
<th>Concern</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>late speech</td>
<td>28%</td>
</tr>
<tr>
<td>social</td>
<td>19%</td>
</tr>
<tr>
<td>repetitive behavior</td>
<td>9%</td>
</tr>
<tr>
<td>mood</td>
<td>9%</td>
</tr>
<tr>
<td>other</td>
<td>12%</td>
</tr>
<tr>
<td>late walking</td>
<td>11%</td>
</tr>
<tr>
<td>regression</td>
<td>10%</td>
</tr>
<tr>
<td>unusual speech</td>
<td>2%</td>
</tr>
<tr>
<td>unusual speech</td>
<td>2%</td>
</tr>
</tbody>
</table>
Regression

- **Affects 44% of children**

  - Usually, the 2nd year of life
  - Average age, 22 months
  - Lasts 1-2 years
  - *1/3 not resolved
  - Likely to show later cognitive delays

  - 33% lost speech
  - ~40% lost both

  - 27% social, play, other skills

  - Average age, 34 months

  - *1/3 not resolved
Adults in SPARK
Age at first diagnosis

Males
Age at first diagnosis

- Under 5: 28%
- 6 - 17: 33%
- 18+: 39%

Females
Age at first diagnosis

- Under 5: 21%
- 6 - 17: 25%
- 18+: 54%
Adults in SPARK
Education & Employment

Education Level:
- Bachelor's degree: 23%
- High school diploma or GED: 17%
- Graduate or professional degree: 15%
- Some college: 10%
- Associate's degree: 9%
- Trade school: 6%
- Current college student: 4%
- Some high school: 16%
- Did not attend high school: <1%

Employment:
- Employed full time: 30%
- Employed part time: 15%
- Not currently working or retired: 16%
- Full-time caregiver: 7%
- Student: 16%
- Part-time: 32%

1,660 adults
Basic Questionnaire: Medical Screening
Basic Questionnaire
Medical Screening

I. Medical and environmental complications

- **Pregnancy & birth** complications: prematurity, insufficient oxygen, brain hemorrhage, alcohol or drug exposure
- Severe **vision or hearing** impairments
- **Neurological problems**: traumatic brain injury, brain infection (such as meningitis), lead poisoning

II. Major medical issues that commonly occur in **genetic syndromes**

- Seizures
- Growth conditions – diagnosed short stature, underweight, obesity, microcephaly and macrocephaly
- Birth defects

III. **Other diagnoses**

- For example, development, language, ADHD

IV. Previous **genetic diagnosis** or genetic study
What we’ve learned about other diagnoses

- Depression
- Anxiety
- ADHD

Bar charts for Independent Adults, Dependent Adults, and Children.
Current Standardized Measures:
Social-communication development
Repetitive behavior
Motor coordination
Social-Communication Questionnaire (SCQ)

What is it?

• Parent report of social, communication, and play behaviors both currently and in a past critical period (age 4)

Why collect the SCQ in research?

✓ Commonly used by researchers to confirm the presence of signs of autism in participants
✓ Shows 2 major types of traits in individuals: social-communication, and repetitive behavior
✓ We can look at how these traits, and how the overall number of signs, link to genetics and heritability (for example, in twins; Frazier et al., 2014)
✓ We can look at how these traits can predict other abilities
• 86% of children with ASD in SPARK are at or above 15
Repetitive Behavior Scale-Revised (RBS-R)

What is it?
• Measures the amount and impact of repetitive behaviors and special interests seen in children and adults with autism
• Includes body movements, special routines, and fascination with certain subjects

Why study the RBS-R?
✓ One reliable subtype - insistence on sameness (IS) - is considered unique for genetic research: it may occur regardless of your other autism traits, language level, or IQ (Hus, Pickles, Cook, Risi, & Lord, 2007) (Bishop, Richler, & Lord, 2006; Cannon et al., 2010; Cuccaro, et al., 2003; Richler, Huerta, Bishop, & Lord, 2010; Szatmari et al., 2006)
✓ Insistence on sameness has been linked to specific genetic findings and runs in families (Buxbaum et al., 2001; Cannon, et al., 2010; McCauley et al., 2004; Shao et al., 2003; Silverman et al., 2008; Sutcliffe et al., 2005; Abramson et al., 2005; Silverman et al., 2002; Szatmari, et al., 2006)
SPARK children have a high number of significant repetitive behaviors.

**TIGER'S RESULTS**

You were asked to rate each behavior on the RBS-R as a mild, moderate or severe problem. The behaviors are then grouped into six major categories. The results below show how you rated Tiger's behaviors, and what other parents said in SPARK. When behaviors are more severe, parents may find it helpful to talk to their doctor for a referral to a behavior specialist.

- **COMPULSIVE BEHAVIOR**: MILD
- **SELF-INJURIOUS BEHAVIOR**: NOT A PROBLEM
- **RESTRICTED BEHAVIOR**: MILD
Coordination Questionnaire

What is it?

- Parent report of specific **fine motor** and **gross motor** skills (such as writing and running)
- Clinicians compare a child’s score to what is expected for typically developing children of the same age, to screen for motor delays

Why study motor function in autism?

- Basic motor skills allow children to explore the world and interact with others
- Very early fine motor skill delays in infancy predict the extent of autism traits later
- Motor delays in infancy often go along with speech delay (Landa)
- In one of the first large genetic studies in autism -the Simons Simplex Collection- delays on the Coordination Questionnaire correlated most strongly with genetic changes (Buja)

We’ve only just begun to understand the importance of motor function in autism.
Coordination Questionnaire:
Children with ASD in SPARK who have motor delays

How many children were reported to have delays in each age group?

- Age 5-7: 79%
- Age 8-9: 91%
- Age 10-15: 91%
How your data is helping research: Beyond SPARK
Researchers around the world are using SPARK data to study:

- Single genes that link to specific ASD behaviors
- Role of the oral microbiome
- Genetic syndromes
- Other issues, like ADHD
- Predicting risk factors for ASD
- Predicting risk for genetic variants using phenotype/traits
- Sex differences
- Motor skills
- Social-emotional skills
- Repetitive behaviors
- Neurological conditions
What's Next?
SPARK Measures coming to a dashboard near you

Social Responsiveness Scale
(John Constantino)
Core ASD social and repetitive behaviors

Vineland Adaptive Behavior Scales
(Celine Saulnier & Sara Sparrow)
Development and everyday skills

Child Behavior Checklist
Adult Behavior Checklist
(Achenbach)
Other behavior issues, attention and mood

Autism Impact Measure
(Steve Kanne & Micah Mazurek)
Core ASD social and repetitive behaviors

Aberrant Behavior Checklist
(Aman)
Challenging behaviors

Children's Sleep Habits Questionnaire
(Judith Owens)

Modified-Checklist for Autism in Toddlers
(Debby Fein & Dianna Robbins) Early signs

SPARK Annual Update

Quality of Life
(World Health Organization, ASD-UK Newcastle)

Communication & Symbolic Behaviors Scale
(Amy Wetherby) Early signs

Sensory Profile
(Dunn)
Thank You