



## **LENA Foundation Early Assessment Achievements**

**Jill Gilkerson, PhD**

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# LENA Screening Potential

## 1. LENA environmental measures

- ✓ Adult Work Count - daily percentiles
- ✓ Conversational Turns - daily percentiles
- ✓ Child Vocalizations - daily percentiles
- ✓ TV/electronic media - daily percentiles



Client Manager

LENA  
ReportsDevelopmental  
SnapshotDigital Language  
Processor

Settings

Language Delay

Doe, Elsa

## Composite View

HOURLY  
August 13, 2007

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1. LENA environmental measures
  - ✓ Adult Work Count - daily percentiles
  - ✓ Conversational Turns - daily percentiles
  - ✓ Child Vocalizations - daily percentiles
  - ✓ TV/electronic media - daily percentiles
2. LENA Developmental Snapshot
  - ✓ Developmental age for language skills

# LENA Developmental Snapshot

**LENA Pro**

Client Manager   LENA Reports   **Developmental Snapshot**   Automatic Vocalization Assessment   Digital Language Processor   Settings

## Developmental Snapshot

Jones, Evan

### LENA Developmental Snapshot

The LENA Developmental Snapshot is an age-appropriate questionnaire that gives you an estimate of your child's developmental age up to 36 months.

We suggest that you administer the LENA Developmental Snapshot once every other month to track your child's developmental progress.

Please check the box for each question indicating whether or not your child is consistently demonstrating the task.

### Questionnaire

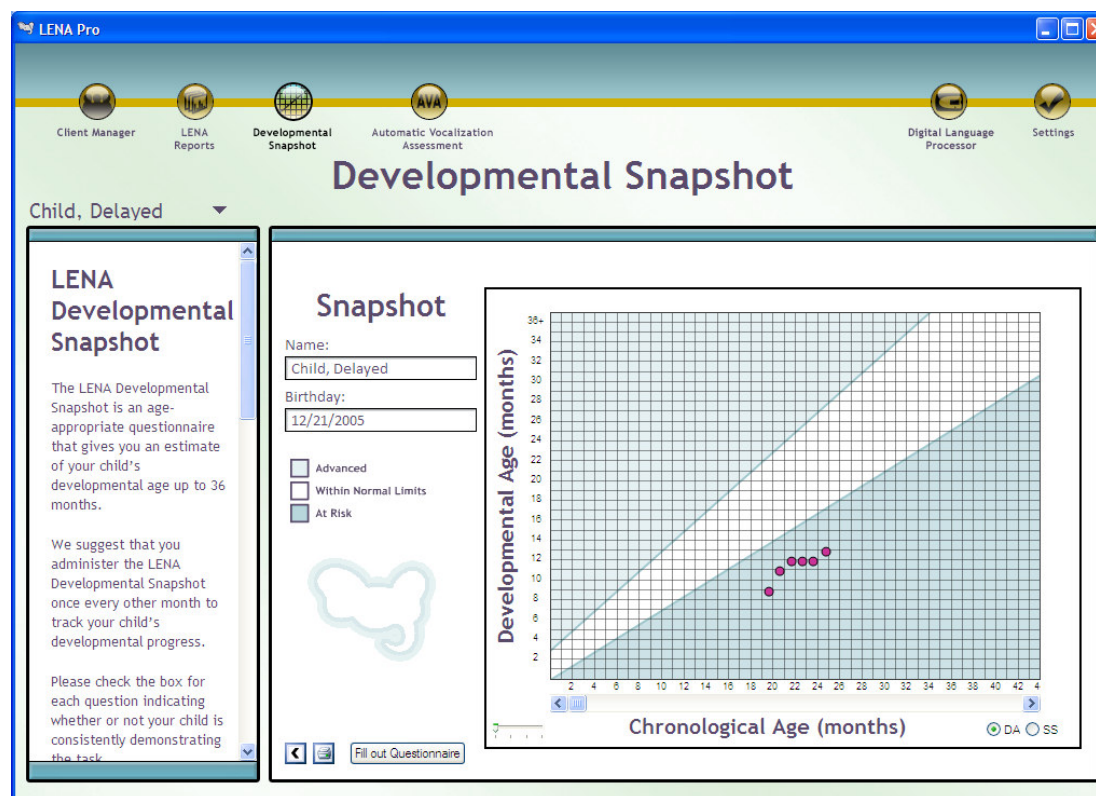
Jones, Evan   4/22/2007

3. Does your child have different cries to indicate different needs? For example: Does your child's "hungry cry" sound different from the cry he/she makes when tired?	Yes <input checked="" type="checkbox"/>	Not Yet <input type="checkbox"/>
4. Does your child express pleasure or displeasure by using sounds other than crying or laughing? For example: Does your child make "happy" sounds or sounds of frustration?	Yes <input checked="" type="checkbox"/>	Not Yet <input type="checkbox"/>
5. Does your child bring toys or objects to his/her mouth? For example: Does your child mouth objects or place objects in his/her mouth?	Yes <input checked="" type="checkbox"/>	Not Yet <input type="checkbox"/>
6. Does your child laugh?	Yes <input checked="" type="checkbox"/>	Not Yet <input type="checkbox"/>
7. Does your child engage in "vocal play" by producing a wide variety of sounds? For example: Does your child produce sounds that range from very high pitch (squeals) to very low pitch (growls) and does he/she produce "raspberries" by putting lips tightly together and blowing air to produce a vibrating play-like sound?	Yes <input checked="" type="checkbox"/>	Not Yet <input type="checkbox"/>
8. Does your child produce two or more vowel sounds, such as /ah/ or /ooh/ ?	Yes <input checked="" type="checkbox"/>	Not Yet <input type="checkbox"/>
9. Does your child recognize his/her name (or nickname)? For example: When you say your child's name (or nickname) does it interrupt his/her activity such that he/she stops and looks toward you?	Yes <input checked="" type="checkbox"/>	Not Yet <input type="checkbox"/>
10. Does your child shout or use vocalizations/make sounds to get your attention?	Yes <input checked="" type="checkbox"/>	Not Yet <input type="checkbox"/>
11. Does your child imitate sounds you or others make?	Yes <input type="checkbox"/>	Not Yet <input type="checkbox"/>

Start Over

Thursday, May 07, 2009

# LENA Developmental Snapshot



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## 1. LENA environmental measures

- ✓ Adult Work Count - daily percentiles
- ✓ Conversational Turns - daily percentiles
- ✓ Child Vocalizations - daily percentiles
- ✓ TV/electronic media - daily percentiles

## 2. LENA Developmental Snapshot

- ✓ Developmental age for language skills

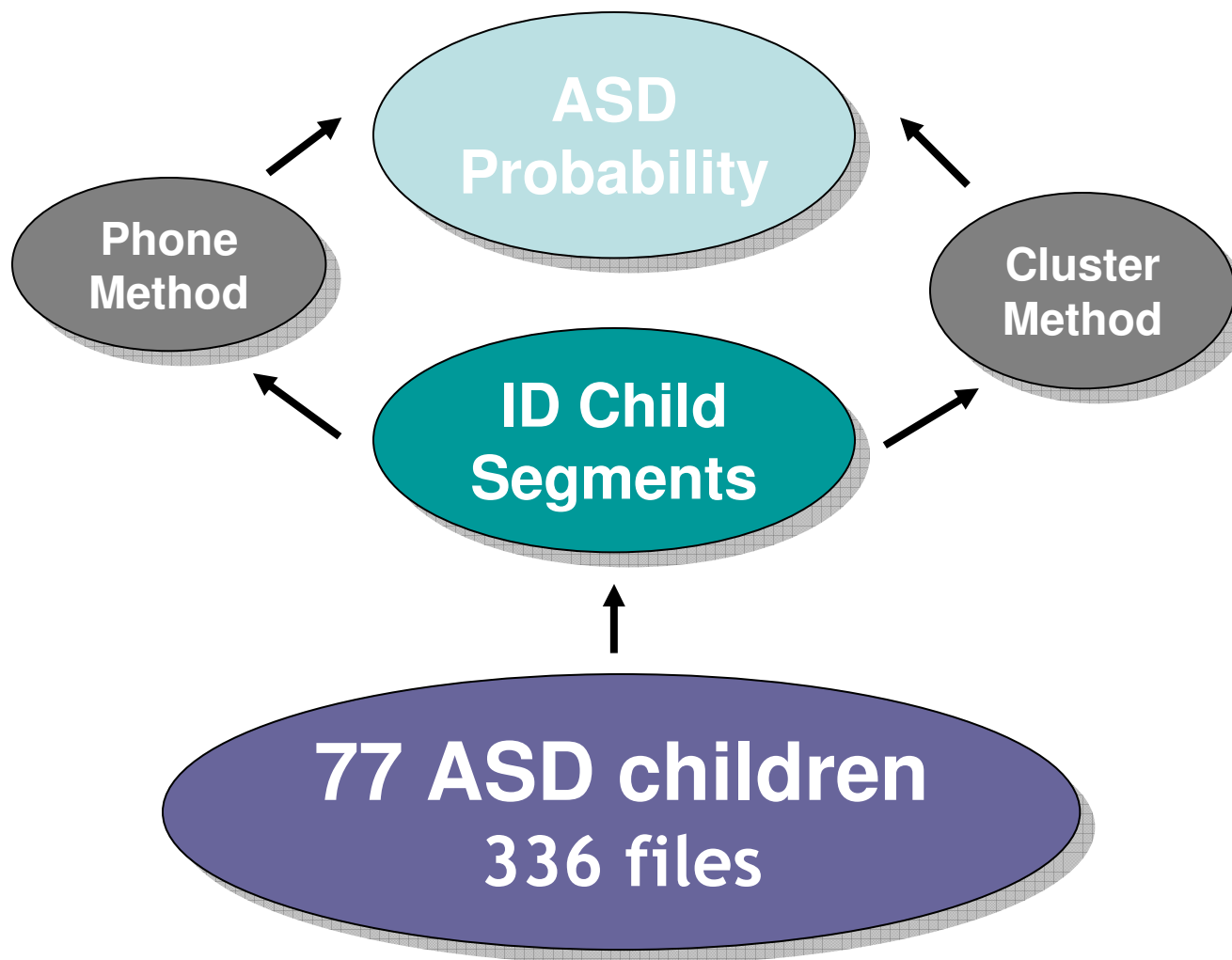
## 3. ASD Risk probability

- ✓ Automatic ASD-risk score (based on automatic analysis)
- ✓ Behavior Questionnaire score (based on behaviors characteristic of autism -communication, social interaction, restrictive and repetitive behaviors)

## Automatic Autism Screen

- Based on the science established in PNAS, Oller et al. (2010).
- Uses acoustic properties in child's vocal output to predict risk for ASD
- Extends 12 parameter method to 113 parameters - determined based on statistical analysis of database





## Bottom up - Final Algorithm

- Combine 50 bi-phones + 63 clusters = 113 features
- Linear discriminant analysis (LDA) with 113 different features

$$\mathbf{w}_1\mathbf{F}_1 + \mathbf{w}_2\mathbf{F}_2 + \dots + \mathbf{w}_{113}\mathbf{F}_{113} \rightarrow \text{posterior probability}$$

# Validation Sample

	Typically Developing	Language Delay	ASD
Sample Size →	N=106	N=49	N=77
Ages →	8 - 46 mo.	12 - 44 mo.	17 - 48 mo.
Recording Hours →	12,813	5,317	5,585

## Accuracy Identifying ASD Risk [Cross-Validation Results]

		LAS Classification		Total
		ASD	Non- ASD	
Criterion Classification	ASD	68	9	77
	Non-ASD	18	137	155
	Total	86	146	232

# Accuracy Identifying ASD Risk [Cross-Validation Results]

## LAS Classification

		ASD	Non-ASD	Total
Criterion Classification	ASD	68	9	77
	Non-ASD	18	137	155
	Total	86	146	232

Sensitivity:     68/77 = 88%

Specificity:   137/155 = 88%

Positive Predictive Power:     68/86 = 79%

Negative Predictive Power:   137/146 = 94%

# Accuracy Identifying ASD Risk [Cross-Validation Results]

## LAS Classification

		ASD	Delay	Total
Criterion Classification	ASD	66	11	77
	Delay	7	42	49
	Total	73	53	126

Sensitivity:     66/77 = 86%

Specificity:     42/49 = 86%

Positive Predictive Power:     66/73 = 90%

Negative Predictive Power:     42/53 = 79%

# Behavior Questionnaire

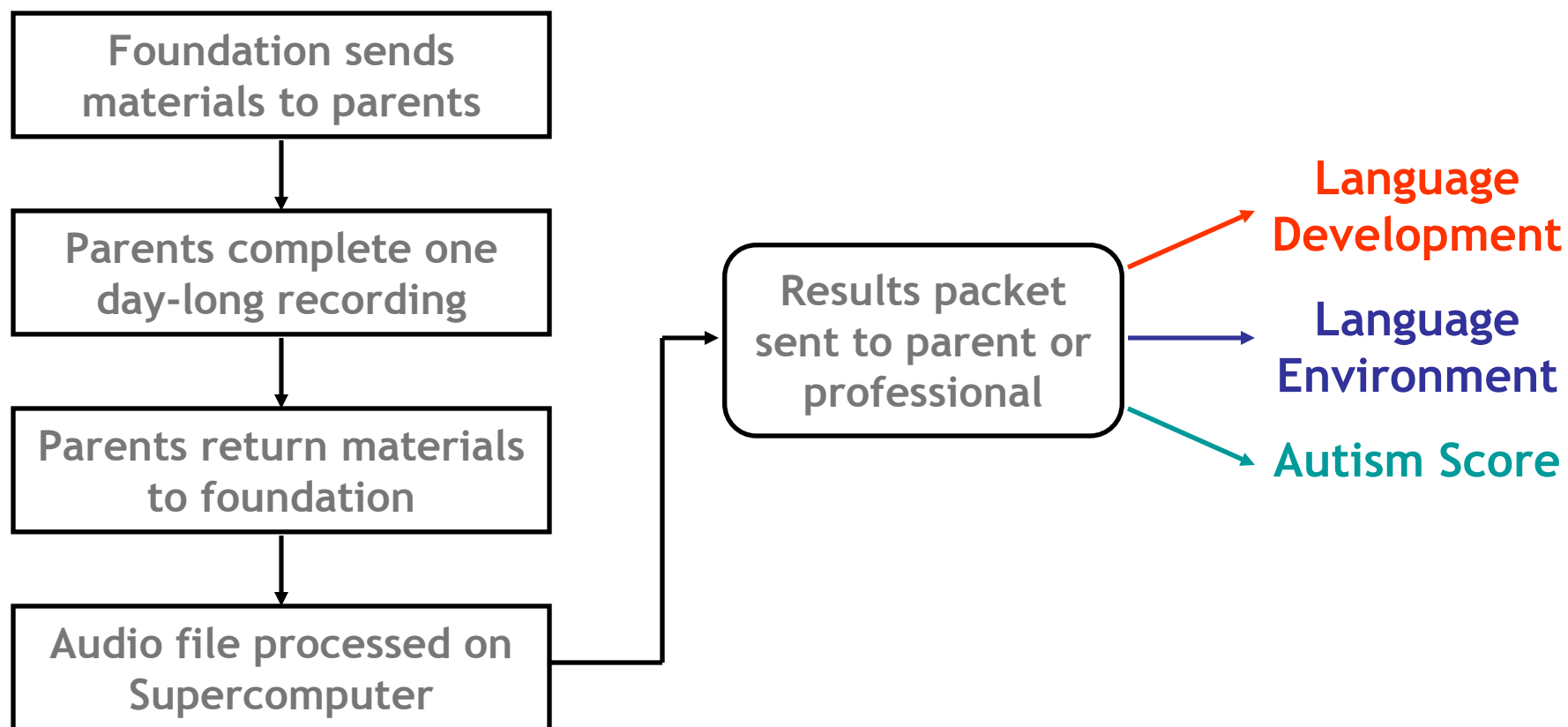
- Modeled after DSM IV ASD criteria
  1. Communication - 4 items
  2. Social Interaction - 4 items
  3. Restrictive & Repetitive - 4 items
- Scoring
  - At-risk = endorse 4 items in at least 2 subscales

# Autism Risk Assessment

Automatic	Questionnaire	Overall Risk
6 or 7	Fail	High Risk
6 or 7	Pass	Moderate Risk
<6	Fail	Moderate Risk
<6	Pass	Low Risk



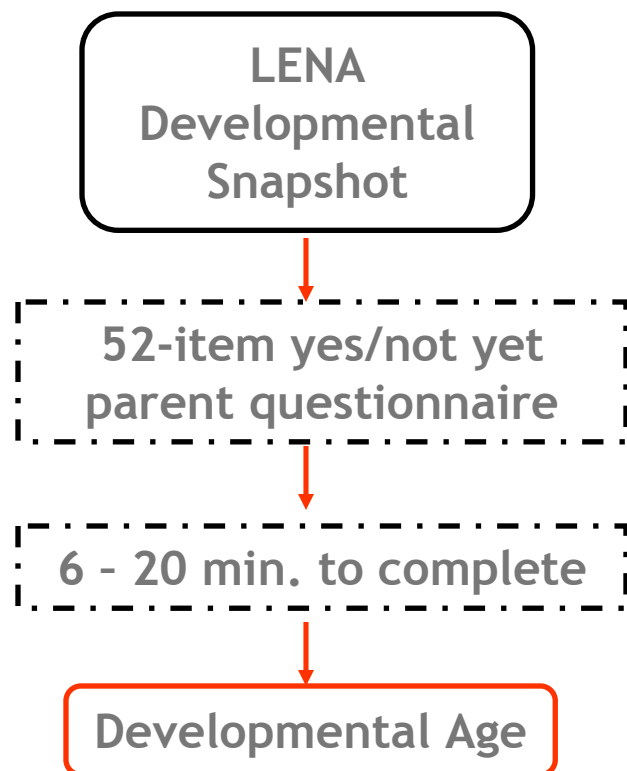
## LENA Language and Autism Screen (LLAS)



## Language Development

## Language Environment

## Autism Screen



# LENA™ Language and Autism Screen (LLAS)

## LLAS Report



Dear Parent,

Thank you for completing the LENA Language and Autism Screen (LLAS). We have analyzed the data and summarized our findings below.

Child's Name: James Child's Date of Birth: 08/04/06

Date of Recording: 03/14/09 Length of Recording: 12 hours Child's Age on Day of Recording: 31 months

**Findings and recommendations:** Based on a review of all of the information collected from the online questionnaires and your child's vocalizations and interactions on the day of the recording, *there is an indication that your child is at-risk for a language delay and for autism.* Your child's expressive and receptive language skills are less than 75% of his/her chronological age. Your child also received a score indicating vocalizations and behaviors associated with high risk for autism on both sections of the autism-related sections of the screen: the automatic analysis of vocalizations and the Behavior Questionnaire. We recommend that you schedule an autism evaluation with a developmental pediatrician. There are a number of ways to schedule an evaluation. The most straightforward route is to obtain a referral from your pediatrician. For more detail on the four areas assessed (Language Development, Language Environment, Automatic Autism Screen, and Behavior Questionnaire) please review the following scores and summaries. If you have any questions, feel free to contact us.

Language Developmental Age	Language Environment <sup>B</sup>				Autism Screen Score	
Developmental Snapshot <sup>A</sup>	# of Child Vocalizations	# of Adult Words	# of Conversational Turns	Amount of Television and Electronic Sound	LENA Autism Score	Behavioral Questionnaire
13 months	1189 14th percentile	16,393 83rd percentile	428 39th percentile	0:05:56 19th percentile	6	High Risk

**Language Development:** Your child's overall (expressive and receptive language) developmental age, at the time of the recording, was 13 months, which is 40% of your child's chronological age of 31 months (DA/CA = 40%). A child whose ratio of Developmental/Chronological Age is less than 75% of his or her chronological age is considered to be at risk for language delay. In addition, our Automatic Vocalization Analysis (AVA), a statistical analysis of the sounds your child produced, suggests that your child's patterns of vocalizations are similar to those produced by children who have been diagnosed with a language delay.

<sup>A</sup> The Developmental Snapshot is a total language score encompassing both expressive and receptive language and is representative of a child's day-to-day observed language skills and behaviors (i.e., parent answers "yes" if the child has consistently demonstrated a skill).

<sup>B</sup> Normative percentile estimates for Adult Word Count, Conversational Turns, and Child Vocalizations are based on 12-hour days. Estimates for recordings fewer than 12 hours in duration may be less accurate, and percentile information is not available for recordings under 10 hours.

The LENA™ Language and Autism Screen is a product of the LENA Foundation – a not-for-profit organization.

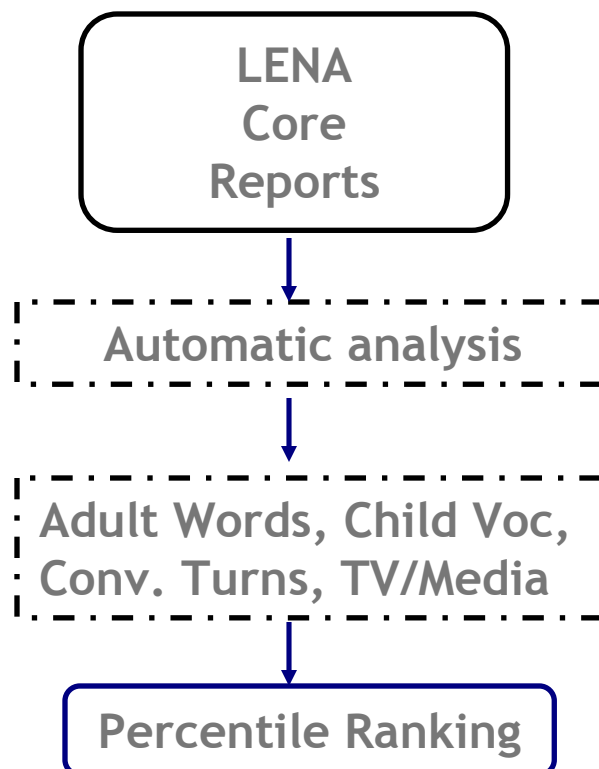
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# LLAS Components

Language  
Development

Language  
Environment

Autism  
Screen



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# LLAS Components

Language  
Development

Language  
Environment

Autism  
Screen

Probability Score  
+  
Behavior Questionnaire

Automatic analysis

17-item questionnaire

- ✓ Social Interaction
- ✓ Communication
- ✓ RRB

ASD Risk

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# LENA Language and Autism Screen

- Provides clinicians and researchers with comprehensive picture of language development and environment
- Data based on natural behavior collected unobtrusively throughout the day
- In addition to language development and environment, we now can obtain crucial screening for ASD risk through LENA recordings

**Additional slides**

# LLAS Decision Rules

## Language

Low Risk	Snapshot Dev Age > 75% of Chr Age
High Risk	Snapshot Dev Age ≤ 75% of Chr Age
High Risk+	Snapshot Dev Age ≤ 75% of Chr Age *and* AVA in Bottom 20%

## Turns

Low Risk	Turns in upper 80%
High Risk	Turns in lower 20%

## ASD Screen

Low	1, 2, 3
Moderate	4, 5
High	6, 7

## Behavior

Low Risk	<4 items from <2 subscales
High Risk	≥4 items from at least 2/3 subscales

Outcomes	Description
1: NC	No Concern
2: C-LD	Concern LD
3: S-ASD	Slight Concern ASD
4: C-ASD	Concern ASD
5: C-LD/S-ASD	Concern LD + Slight Concern ASD
6: C-LD/C-ASD	Concern LD + Concern ASD

# LLAS Decision Matrix

Scenario	Risk Factors				Outcomes		
	Language	Turns	ASD Screen	Behavior	Concern LD	Concern ASD	Overall
1	Low	Low	Low	Low	NC	NC	1: NC
2	Low	Low	Low	High	NC	S	3: S-ASD
3	Low	Low	Mod	Low	NC	NC	1: NC
4	Low	Low	Mod	High	NC	S	3: S-ASD
5	Low	Low	High	Low	NC	S	3: S-ASD
6	Low	Low	High	High	NC	C	4: C-ASD
7	Low	High	Low	Low	NC	NC	1: NC
8	Low	High	Low	High	NC	S	3: S-ASD
9	Low	High	Mod	Low	NC	NC	1: NC
10	Low	High	Mod	High	NC	S	3: S-ASD
11	Low	High	High	Low	NC	S	3: S-ASD
12	Low	High	High	High	NC	C	4: C-ASD
13	High	Low	Low	Low	C	NC	2: C-LD
14	High	Low	Low	High	C	S	5: C-LD/S-ASD
15	High	Low	Mod	Low	C	NC	2: C-LD
16	High	Low	Mod	High	C	S	5: C-LD/S-ASD
17	High	Low	High	Low	C	S	5: C-LD/S-ASD
18	High	Low	High	High	C	C	6: C-LD/C-ASD
19	High	High	Low	Low	C	NC	2: C-LD
20	High	High	Low	High	C	S	5: C-LD/S-ASD
21	High	High	Mod	Low	C	NC	2: C-LD
22	High	High	Mod	High	C	S	5: C-LD/S-ASD
23	High	High	High	Low	C	S	5: C-LD/S-ASD
24	High	High	High	High	C	C	6: C-LD/C-ASD