AUTISM SPECTRUM DISORDER

COMMUNICATION AND LANGUAGE DEVELOPMENT

PhD – VOZ, LINGUAGEM E COMUNICAÇÃO

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PHD MEETING 2016
Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder that is characterized by deficits in:

- **Social interaction/ Communication:**
  - social and emotional reciprocity; non-verbal communication; peers relationships;

- **Behaviour:**
  - Stereotyped or repetitive movements; routines and ritualized behaviour; restricted and intensive interests; hyper or hypo reactivity.
INTRODUCTION

- **ASD:**
  - Clinical entity well documented and defined in *Diagnostic and Statistical Manual of Mental Disorders (DSM -5)*, Fifth Edition; United States, 2013.
  - Frequent neurodevelopment disorder with a world prevalence of 1%, in USA a prevalence of 1/68² children 2010 (USA-CDC)
  - About half the population does not acquire verbal language

- ASD disorder with an early start (in first year of life), but
  - Diagnosis in preschool age (3 and 4 years old).
INTRODUCTION

Early diagnosis

More effective intervention

Identify warning signs at earlier ages

Studies point to diagnosis at 2 years

AAP*
Screening at 18 months

INTRODUCTION

Language delay

Main reason for referral (at 2/3 years)

Delay/disturbed pre-linguistic markers
INTRODUCTION

Typical developmental of communication:

1º year of life – “critical period”
The baby has the early capacity to discriminate all the speech sounds independently of his native language.
INTRODUCTION

- This mechanism of “tuning” to the sounds of native language allows babies to learn a specific language;

- The research has shown that the longer the baby remains in the initial phase of universal perception the later is language development (Tsao et al 2004; Kuhl 2004).

Tsao et al, 2004
6 months- two vowels discrimination (tea/two) -
Strong correlation with later language development (13,16,24 m)

Kuhl, 2004
7,5 months – discrimination of native (/pa/,/ta/) and non native contrast (/çi/; /tçʰi/) -
Strong correlation with later language development(14,18,24 e 30 m)
INTRODUCTION

- Word recognition in the continuous string of speech is an ability that emerges early over the first year of life (Saffran et al. 1996).

- Between 12 and 15 months of age, babies are able to learn new words and to associate this to new objects or images (Werker & Yung 2005).
INTRODUCTION

In children with ASD there is absence of or delay in communication and language skills:

- **Eye contact**
  - Doesn’t look
  - Do not follow the eye contact of others
  - Failed coordination of eye contact and others communicative acts (gesture and expressions)

- **Vocalizations**
  - Babbling delay acquisition
  - Failed reciprocity between the child's vocalizations and parental verbalization
  - Decrease in the frequency and quality of vocalizations

- **Gesture/imitation**
  - Failure in pointing
  - Failure in show or give when asked
  - Failure to make social gesture: goodbye
  - Do not nod for yes / no
  - Failure to imitate gestures

Experimental research: Vocalizations

- At 12 and 18 months of age, children with ASD have less frequent vocalizations and have a lower proportion of vocalizations with consonants. They use more atypical vocalizations and higher stress (Plumb, 2008; Schoen, E., Rhea P., and Chawarska, 2011).

- Delay in first words acquisition, (38 months is an average age of acquisition in children with ASD) (Howlin, 2003).

- There are changes in vocal quality – ASD children produce greater number of syllables with atypical vocal quality (Sheinkopf et al 2000)
INTRODUCTION

- Experimental research: Vocalizations
  - Study of siblings of children with ASD followed for a period of 24 months. (6, 9, 12m and 24m); later separated into three samples: ASD; LD; TD.
  - A perceptive classification was made of 50 utterance produced by each children:
    1. Delight: Laughing or giggling.
    2. Distress: Crying, whining or fussing.
    3. Atypical: High-pitched squeals, low-pitched growls, yells, grunts

Conclusion:

| Table VIII. Nonspeech Productions Produced by ASD, TDA, and TDL Groups |
|--------------------------------------------------|----------------|
| Production type     | M (SD) | TDA (n = 11) | TDL (n = 23) | M (SD) |
| Laugh               | 4.73 (0.82) | 1.73 (2.10) | 0.65 (1.34) | 3.01 |
| Atypical            | 5.07 (5.20) | 1.09 (1.92) | 0.81 (1.33) | 8.69 |
| Squeal              | 3.37 (4.53) | 0.18 (0.86) | 0.26 (0.88) | 7.75 |
| Growl               | 1.27 (2.32) | 0.91 (1.81) | 0.36 (1.94) | 1.61 |
| Distress            | 3.07 (7.57) | 0.36 (0.67) | 3.57 (5.93) | 1.01 |

| Table IX. Comparison of Consonant and Syllable Shape Variables in ASD, TDA, and TDL Groups |
|--------------------------------------------------|----------------|
| Group    | M (SD) | Range          |
| ASD (n = 30) | TDA (n = 11) | TDL (n = 23) | ASD vs. TDL 1.08 |
| Consonant inventories                       | 6.73 | 3.16 | 2-12 | 13.82 | 2.93 | 8-18 | 7.52 | 4.13 | 0-15 | 17.14* |
| Different consonants                        | 5.50 | 2.13 | 1-8  | 7.36 | 0.92 | 5-8  | 4.57 | 2.39 | 0-8  | 6.69* |
| Number of early-8 consonants                | 2.27 | 1.36 | 0-5  | 4.18 | 1.78 | 1-8  | 1.83 | 1.44 | 0-4  | 10.01* |
| Number of middle-8 consonants               | 0.87 | 1.07 | 0-3  | 3.09 | 1.51 | 0-6  | 1.09 | 1.20 | 0-4  | 14.49* |
| Different consonant blends                  | 0.97 | 1.47 | 0-5  | 3.00 | 3.72 | 0-10 | -   | -   | -    | -    |
| Syllable structure                         | 1.69 | 0.41 | 1.0-2.4 | 2.28 | 0.26 | 1.9-2.7 | 1.36 | 0.027 | 1.0-2.0 | 25.94* |

Rhea Paul, Yael Fuerst, Gordon Ramsay, Kasia Chawarska, and Ami Klin. 2011
Out of the mouths of babes: Vocal production in infant siblings of children with ASD
INTRODUCTION

- What are the marker of pre-verbal communication that are related to the acquisition and development of language in ASD?
Investigate communication and language development in children with ASD, in order to define early markers for prognosis in:

- Communication
- Speech perception
- Speech production
OBJECTIVE

Battery of psychometric assessment tools
Speech production tools (digital video camera, acoustic analysis software)
Speech perception tools (eye tracker)

Typical development infants

ASD Toddlers

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METHODOLOGY

- **Longitudinal prospective study** (approved by ethics commission of HSM) with data collection of:
  - **Toddlers with ASD**
    - Assessed in 8 time points:
      - a) Diagnosis time
      - b) 4, 8, 12, 14, 16, 20 and 24 months
  - **Typical development infants**
    - Assessed in 11 time points:
      - 4, 6, 8, 10, 12, 14, 16, 18, 20, 22 and 24 months

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**METHODOLOGY - Sample**

- **ASD toddlers**: recruited in Santa Maria Hospital and LógicaMentes neurodevelopmental clinics:
  - 20 toddlers

- **Inclusion criteria**:
  - All children with formal diagnoses of ASD
  - Chronological age up to 48 months
  - No oral language (0 to 5 words at first collection)

- **Exclusion criteria**:
  - Global development quotient < 25
  - Moderate to severe sensory deficits (visual and auditory)
  - Epilepsy.

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**METHODOLOGY - Sample**

- **Typical development (TD) infant recruited in Portuguese educational schools**
  - 20 infants

- **Inclusion criteria:**
  - Infants from 4 months of age
  - Apparently healthy
  - Typical psychomotor development.

- **Exclusion criteria:**
  - ASD symptoms (positive M-CHAT and/or positive clinical observation)
  - Psychomotor development delay (<-2dp),
  - Perinatal risk factors (prematurity - gestational age of 37 weeks, very low-birth weight <1500 g)
  - Identified genetic syndromes and sensory deficits.
**METHODOLOGY - tools**

- **Procedures: Instruments assessment:**
  - **ASD diagnosis and symptoms characterization**
    - Modified Checklist for Autism in Toddlers (M-CHAT),
    - Childhood Autism Rating Scale (CARS),
    - Autism Diagnostic Interview – Revised (ADI-R),
    - Diagnostic and Statistical Manual of Mental Disorders (DSM5)
  - **Psychomotor assessment**
    - Ruth Griffiths Developmental Scale (Griffiths).
    - Denver II
  - **Communication assessment**
    - Scale translation: Communication and Symbolic Behaviour Scales (CSBS DP) Infant-Toddler Checklist,
    - Analysis of videotaped sessions
  - **Language assessment:**
    - Communicative development inventory (CDI – Portuguese version)
    - Teste de Avaliação da Linguagem na Criança (TALC)
    - Speech production analysis
    - Speech perception
METHODOLOGY – assessment times

ASD sample

Diagnosis
4, 8, 12 m
1 year
16, 20, 24 m
2 year

Clinical Psychometric battery. HSM

Speech perception and production
Lisbon Baby Lab

TD sample

4, 6, 8, 10, 12, 14, 16, 18, 20 m
18 m
24 m
30 m

CSBS; CDI; speech perception and production - LBL

M-CHAT

CSBS; CDI; speech production; Griffiths LBL+HSM

CSBS; CDI; speech production; TALC LBL + HSM

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SPEECH PRODUCTION
METHODOLOGY – Speech Production

- Recordings of speech productions in TD and ASD children:
  - Recordings made in Lisbon Babylab with the help of the team lab;
  - Each session was video recorded for a period of 20 minutes;
  - In infants with TD the recordings occurred at intervals of 2 months;
  - In toddlers with ASD recordings occurred at intervals of 4 months;
  - It was explained to parents the procedures and objectives of the experiment and asked to make an interaction with the child as natural as possible.
METHODOLOGY – Speech Production

**Procedures:**

- Production recordings in DT infants and ASD Toddlers

- **TD sample**
  - 4 months
  - 30 months

- **ASD sample**
  - 29 months
  - 53 months

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METHODOLOGY – Speech Production

- **Perceptive codification:**
  - Children’s productions in each 20mins sessions were segmented and classified as:

  - Silent periods: period of time < 300 ms (Oller et al 2010)
  - Utterances: production with one or more intonational phrase and with pauses inferior to 300 ms.
  - Productions were classified as:
    - Non speech production
    - Speech-like production
**METHODOLOGY – Speech Production**

- **Perceptual codification:**
  - **Productions Categories:**

<table>
<thead>
<tr>
<th>Non Speech Prod</th>
<th>Distress (cry, groan and whining)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The non speech category included productions characterized by non speech resonance (e.g. screams, laughter, crying) without recognizable consonants. (Rhea et al, 2010)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Speech-like Prod</th>
<th>Vocalization</th>
</tr>
</thead>
<tbody>
<tr>
<td>The speech-like events were characterized by the production of consonants and/or vowels that could be represented by phonetic symbols and contained speech like resonance. (Rhea et al, 2010)</td>
<td>Babbling</td>
</tr>
<tr>
<td></td>
<td>Vowel</td>
</tr>
<tr>
<td></td>
<td>Consonants</td>
</tr>
<tr>
<td></td>
<td>Syllable</td>
</tr>
<tr>
<td></td>
<td>Word</td>
</tr>
</tbody>
</table>
METHODOLOGY – Speech Production

- **Acoustic codification:**
  - All the production were classified according this criteria:
    - Intonational phrases:
      - Duration;
      - F0 values: maximal minimal, initial and final pitch values; pitch range
SPEECH PERCEPTION
METHODOLOGY – Speech perception

- We built two speech perception tasks with Eye Tracking (ET) methodology to assess the ability of children with TD and ASD.

- Eye Tracking provides a non-invasive method for assess a wide variety of cognitive processes, from visual-spatial attention to object perception, memory and language. (Karatekin, 2007)
METHODOLOGY – Speech perception

1 – Task 1 – Native VS non-native contrast

Frota, Severino, Butler, Bandeira de Lima, Vigário (in progress) Infants’ perception of native and non-native speech contrasts and later language development.


- The goal is to assess children’s ability at 6 months of age to discriminate native and non-native speech sounds, i.e. sounds that contrast/do not contrast in their native language.

- The auditory stimulus were selected based on previous research:
  - Native contrast: /pa/ - /ka/ (labial vs. velar)
  - Non native contrast - /da/ - /d’á/ (dental vs retroflex plosives)
1 – Task 1 – Native and non native-contrast contrast

- **METHODOLOGY – Speech perception**

- **Task 1**
  - **Learning phase**
    - 8 blocks
    - 6 trials
    - 3 trials of one sound /pa/ or /da/ (Right side)
    - 3 trials of one sound /ka/ or /d’a/ (Left side)
  - **Test phase**
    - 2 trials
    - Anticipatory look to the side that should appear the image of the sound heard
METHODOLOGY – Speech perception

Non native contrast (Portuguese/Hindi)
/də/ - /d´a/ 1contraste não nativo.mp4

Native contrast (Portuguese/portuguese)
/pa/ - /ka/ 2contraste nativo.mp4
2 – Word learning Task

- Previous work by Yoshida et al (2009)
  - Assess babies’ ability at 14 months of age to learn and discriminate two similar phonologic words and associate them to two new objects.

- Selection criteria for the auditory stimuli:
  a) the initial sound has a high frequency in European Portuguese (EP) (FrePOP database; Vigário, Frota & Martins 2011)
  b) contrast in place of articulation: bilabial/dental (Vigário, M., S. Frota & F. Martins (2011));
  c) distinguish only in a single segment;
  d) vowels have a high frequency in EP (FrePOP database; Vigário, Frota & Martins 2011))

- Visual stimuli of two objects were built without real representation and unknown to the children;
- Four visual familiar stimuli - distractors
2 – Word learning  

/bida/  
6 trials – image with movements (up/down – left/right)

Training  
12 trials

/dida/  
6 trials – image with movements (up/down – left/right)

Controls (baby, car, shoes, dog)  
8 trials

Test  
16 trials

Target - /bida/-  
/dida/  
8 trials

Each sound stimuli repeated 6 times, appears associated with an image alone

The visual stimuli are paired in pairs, but only an acoustic stimulus is heard and the child will have to look for the right image
METHODOLOGY – Speech perception

2 – Word learning


14m baby with TD
3word learning
bebe.mp4

ASD Children
4World Learning
PEA.mp4
RESULTS
# RESULTS - sample

## Sample:

<table>
<thead>
<tr>
<th>ASD</th>
<th>TD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inicial sample: 50</td>
<td>Inicial sample: 20</td>
</tr>
<tr>
<td>Sample selected: 21 without words and age bellow 48 months</td>
<td></td>
</tr>
<tr>
<td>Dropouts: 2</td>
<td>Dropouts: 7</td>
</tr>
<tr>
<td>Final sample: 19</td>
<td>Final sample: 13</td>
</tr>
<tr>
<td>Longitudinal follow up: Diagnoses to 2 years</td>
<td>Longitudinal follow up: 4m - 30m</td>
</tr>
<tr>
<td>Mean age of first collection: 29 m</td>
<td>Mean age of first collection: 4 m</td>
</tr>
<tr>
<td>Sex: 89,5% M; 10,5% F</td>
<td>Sex: 35,7% M; 64,3% F</td>
</tr>
<tr>
<td>ASD with language and intellectual impairment</td>
<td>Normal psychomotor development</td>
</tr>
</tbody>
</table>
RESULTS – Autism and neurodevelopment profile

Autism symptoms:
- Psychomotor development (N=19):
  - M-CARS 33 (dp 5,7)
  - M-CHAT 11,7 (dp 4,51)

All the ASD children had a delay in language and no word production in the first collection data.
RESULTS – Communication profile

Communication Profile (N=19)

The communicative level is significantly lower than that of TD children in the same age group (normative value=51).

Communicative level= p1
Mean values corresponding to those found in 9 month-old TD children.

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RESULTS – After 2 years of follow up

- Neurodevelopment profile in ASD after 2 years (N=19):
  - Psychomotor development
  - Language development

After 2 years of follow up, the QG decreased slightly, but there was an increase in language development parameters.

Increase in the number of words produced by the children, according to parental report.
RESULTS – After 2 years of follow up

- Neurodevelopment profile in ASD after 2 years (N=19):
  - Autism symptoms profile
  - Communication development

The autistic symptoms had a slightly decrease, but the communication and symbolic profile improved over time.

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## RESULTS – After 2 years of follow up

- After 2 years of follow-up results for the 19 ASD children:

<table>
<thead>
<tr>
<th>Data</th>
<th>19 ASD children 1ª collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (months)</td>
<td>29.57 m</td>
</tr>
<tr>
<td>Autism (CARS)</td>
<td>33.47</td>
</tr>
<tr>
<td>GQ (Griffiths)</td>
<td>66.59</td>
</tr>
<tr>
<td>Linguistic level</td>
<td>48.75</td>
</tr>
<tr>
<td>Non verbal cognitive level</td>
<td>78.72</td>
</tr>
<tr>
<td>Communicative level (CSBS)</td>
<td>24</td>
</tr>
<tr>
<td>Number of words (CDI)</td>
<td>0</td>
</tr>
</tbody>
</table>

Correlation with number of words produced after 2 years of follow up

The QG (p=0.03) and the non verbal cognition (p=0.01) were the data that best correlate with future language development. The communicative level had a strong correlation (p=0.09) (but not significate).
Communication areas that were predictive of language development after 2 years:

Communication and Symbolic Behaviour Scales (CSBS DP) Correlations with numbers of words after 2 years

<table>
<thead>
<tr>
<th>Social (P=0.08)</th>
<th>Language</th>
<th>Symbolic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotion and eye contact</td>
<td>Sounds</td>
<td>Comprehension</td>
</tr>
<tr>
<td>Communication (p=0.8)</td>
<td>Words</td>
<td>Use of object p=0.07</td>
</tr>
<tr>
<td>Gesture p = 0.03</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The social and symbolic areas (CSBS scale) were those that correlated the most with later language development.
RESULTS – Production speech analysis preliminary results

- For the analysis production type (non-speech/speech) evolution over time in 3 children with TD were analysed 18 sessions each lasting 20m = **1759 utterances**

Initially the speech and non-speech prod had similar proportions, but from six/eight months there has been a growing predominance of speech prod.
RESULTS – Production speech analysis preliminary results

- For the speech production analysis (non-speech/speech) evolution over time in 2 children with ASD were analysed 6 sessions each lasting 20 min = **984 utterance**

Initially the speech and non-speech prod had similar proportions, but after 1 year of follow up the *speech prod* was predominant. Development path corresponds to the evolution that happens in the DT children.
In children with DT at 24 months there are few non-speech prod and there are no atypical prod. In children with ASD at 29-37 month the atypical prod prevail.

Rhea Paul, Yael Fuerst, Gordon Ramsay, Kasia Chawarska, and Ami Klin. 2011
RESULTS – Production speech analysis

After 2 years of follow-up the ASD the speech prod were mainly words. The ASD 2 children had develop utterances of 5/7 words, and the ASD1 children only acquire utterances of 1/2 words.

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RESULTS – Production speech analysis

- **Latency time for the first production in TD and ASD:**

  - Children with ASD demonstrate much higher latency to the first word, but over time latency decreases significantly.
RESULTS – Production speech analysis

- Intonational phrases

The intonational phrases have similar values in the two samples.

ASD children show a higher pitch range.
Results – Speech Perception

Word Learning Task- TD N=11

Children with DT at 14 months are able to learn a new word, associating a new object. DIDA was the word with better learning outcomes.

<table>
<thead>
<tr>
<th></th>
<th>Controlos</th>
<th>Bida</th>
<th>Dida</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Test Statistics

<table>
<thead>
<tr>
<th></th>
<th>dida - bida</th>
<th>distractor - bida</th>
<th>distractor - dida</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z</td>
<td>-1.511b</td>
<td>-2.134b</td>
<td>-0.889b</td>
</tr>
<tr>
<td>Asymp. Sig. (2-tailed)</td>
<td>.131</td>
<td>.033</td>
<td>.374</td>
</tr>
</tbody>
</table>

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.
**Word Learning Task - ASD N=10**

Children with ASD are able to learn a new word, associating a new object.

### Test Statistics

<table>
<thead>
<tr>
<th></th>
<th>dida - bida</th>
<th>controlo- bida</th>
<th>controlo- dida</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z</td>
<td>-0.863</td>
<td>-1.000</td>
<td>-0.235</td>
</tr>
<tr>
<td>Asymp. Sig. (2-tailed)</td>
<td>0.388</td>
<td>0.317</td>
<td>0.814</td>
</tr>
</tbody>
</table>

- **a.** Wilcoxon Signed Ranks Test
- **b.** Based on negative ranks.
- **c.** Based on positive ranks.
There are no significant differences between the performance of the two samples. Children with ASD at 5 years old have an equal performance to DT babies with 14 months.
CONCLUSION

- The clinic psychometric data that correlate in an early stage with the future linguistic development were the communicative level, in specific the use of gestures and the nonverbal cognition.

- In ASD children a higher rate of atypical prod is found (High-pitched squeals, low-pitched growls, yells, grunts);

- The higher latency time for the first production in ASD may be an indicator of pathology as well as the higher pitch range.

- ET is a facilitative approach for the assessment of speech perception skills and can be applied at very early ages in child development

- In ASD children the ET methodology also proved facilitator of learning new words by associating sounds to images;


Acknowledgment

- Thanks for the team support in:
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    - Dra. Cátia Severino
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  - Hospital de Santa Maria/ Hospital Pediátrico de Coimbra
    - Prof. Dra. Guiomar Oliveira
    - Dra. Manuela Baptista
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