



# Developing Early Diagnosis of Infant Neuropathology Using Movement Technology

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## Developmental Pathologies

**Early Detection = Early Treatment = Greater Recovery**

- Psychopathologies
  - with behavioural (*i.e.* movement) component
  - **e.g. Autism Spectrum Disorders (ASD) (6 in 1000 babies)**
    - no genetic, no neurological abnormalities, how to detect before it's too late?
- Neuropathologies
  - with motor components
  - **e.g. Cerebral Palsy (4 in 1000 babies)**
    - higher incidence in ART





## Movement Analysis is a Novel, Promising Early Diagnosis

TACT is an E.U. NEST Adventure Project

- 3 years, 6 institutions, 26 researchers, 2 million Euros
- Prof Flavio Keller, TACT director, Campus Biomedico, Rome
  - Flavio is a neurobiologist and medical doctor, running an engineering and developmental psychology project
  - Campus Biomedico is a Vatican-funded medical and engineering university
- TACT ends December 2008, to be followed by TACT2

# TACT Project

Thought in Action



## engineering motion analysis toys



Università' Campus Bio-Medico - Italy

- \* Developmental Neuroscience and Neural Plasticity Lab
- \* Biomedical Robotics & EMC Lab

1. Flavio KELLER (Project Coordinator)
2. Eugenio GUGLIEMELLI
3. Domenico CAMPOLO
4. Giulio IANNELLO
5. Fabio Massimo FRATTALE MASCIOLI
6. Sylviane SAPIR
7. Dario SACCHINI
8. Vittoradolfo TAMBONE



Scuola Superiore Sant'Anna - Italy

- \* Advanced Robotics Technology and Systems Laboratory (ARTS Lab)

1. Paolo DARIO
2. Cecilia LASCHI

## infant movement research



University of Edinburgh - U.K.

- \* Perception Movement Action Research Centre

1. David N. LEE
2. Jonathan DELAFIELD-BUTT
3. Jon PERKINS



Uppsala Universitet - Sweden

- \* Department of Psychology

1. Claes von HOFSTEN
2. Kerstin ROSANDER
3. Terje Falck Ytter

## engineering and movement databasing



Ecole Polytechnique Fédérale de Lausanne (EPFL) - Switzerland

- \* Learning Algorithms and Systems Laboratory (LASA)

1. Aude BILLARD
2. Lorenzo PICCARDI
3. Olivier BARBEY

## paediatric application



IRCCS E. MEDEA - Associazione "La Nostra Famiglia" - Italy

- \* Polo Scientifico di Bosisio Parini

1. Massimo MOLTENI
2. Maria NOBILE
3. Elisa MANI
4. Laura VILLA
5. Luigi PICCININI
6. Rinaldo ZANINI



## SENSORS SENSING NATURAL MOVEMENTS IN NATURAL SETTINGS

- Ecological Paradigm
- Natural Situations
- Both in Solo, at Play, and in Inter-subjective Communication (*e.g.* mother-infant dyad dynamics)
- Limb, Head, and Voice Movements Monitored
- Requires:
  - **wireless wrist/ankle sensors** -- wireless triaxial inertial sensors
  - **wear-cam** -- wireless hat-mounted camera with eye-tracking and face and object recognition
  - **wear-mike** -- wireless microphone



# Neonatal Expressive Movements

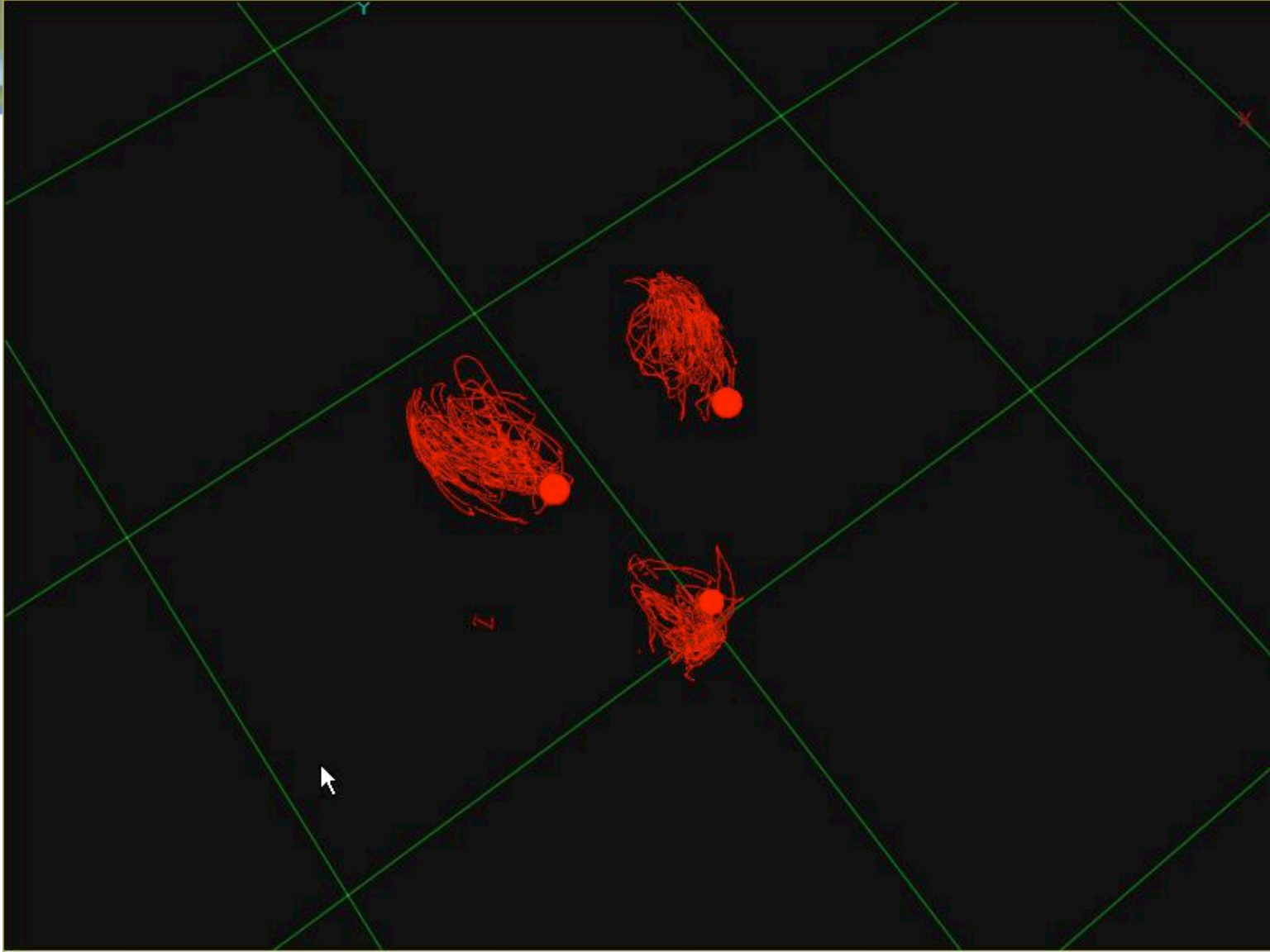
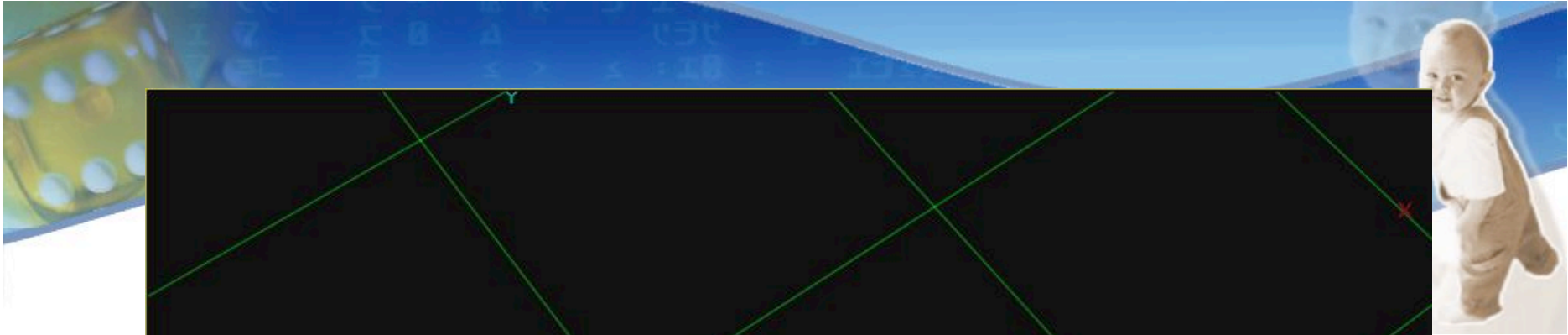
- Edinburgh project
- ‘At risk’ premature infants and ‘Normal’ term-birth infants
- Infants recorded at birth and 12 weeks of age
- Recorded using Qualisys at the Neonatal Intensive Care Unit, Royal Infirmary of Edinburgh
- Movement data analysed for early indicators



## Methodology: Dyadic Table

- Arm movements (motion capture at 500Hz)
- Audio (omnidirectional lavalier microphones to digital capture)
- Video (two video, one on mother, the other on baby)







# $\tau_G$ Analysis

Poor  $\tau_G$  **guidance** is indicative of a developing psycho- or neuro-pathology

$$\tau_A = k \tau_G$$

$$\tau_G = 0.5(t - T^2/t)$$

$$\tau_A = k 0.5(t - T^2/t)$$





## Future Work

1. Improve motion tracking technology to enable mobile movement detection (*ie.* with wireless kinematics sensors, not optical detection)
2. Develop and refine the diagnostic criteria through ongoing clinical research.



**TACT Project**  
*Thought in Action*

## The Edinburgh Group

*Prof Dave Lee, Director, PMARC and Psychology*

*Prof Colwyn Trevarthen, PMARC and Psychology*

*Prof Ian Laing, Consultant Paediatrician, Simpson's NICU*

*Dr. Yvonne Freer, Neonatologist, Simpson's NICU*

*Dr. Benjamin Schogler, PMARC and Music*

*Mr. Jon Perkins, PMARC*

## TACT E.U. Consortium

