



Child Motor Development

Two Case Studies

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May 17, 2021



Outline

1. Introduction
2. Background
3. Collected Material





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Motivation for Work in Intelligent Systems Research

A current consensus among AI researchers goes

“Chess is easy. But what a two-year old can do is difficult.”

In my experience robotics students/researchers rarely look at what that actually is! Few young researchers have family of their own.

Multiple colleagues expressed their interest in samples.



Disclaimer

All presented photo/video material concerns my immediate family and must not be recorded or passed on.

If you are interested in particular material please talk to me.



My Children

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Every Child is Different

While life sciences try to find underlying rules to child development, the process is highly diverse, starting with obvious things such as

- ▶ birth weight/size (2.5-4.5kg, 45-54cm)
- ▶ sleep pattern
- ▶ amount of crying (colickies / “Schreikind”)
- ▶ exploration strategies
- ▶ age of first ...
 - ▶ use of referential words
 - ▶ turning on belly
 - ▶ steps
 - ▶ ...



Data Collection is *Expensive*

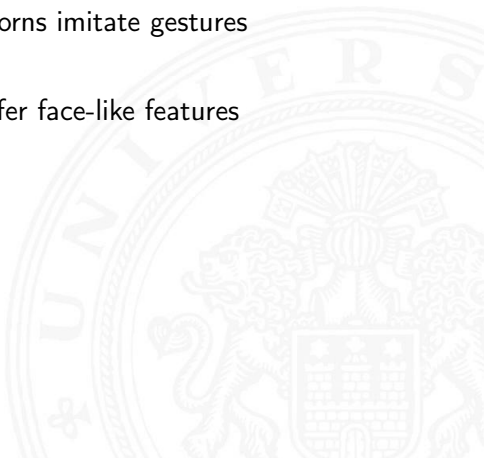
Many developmental studies are based on few participants.

Meltzoff and Moore, 1989 - newborns imitate gestures

- ▶ 40 participants (<72h old)

Goren et al., 1975 - newborns prefer face-like features

- ▶ 40 participants (9min old)





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Farroni et al., 2002 - newborns prefer direct gaze

- ▶ 15 participants / 9 excluded (2- to 5-day-old)

van de Rijt-Plooij and Plooij, 1992 - regressions/transitions

- ▶ 15 participants (for full first two years)
- ▶ many unobserved periods
- ▶ (18 participants in Sadurní and Rostan, 2002) (1-14 months)



Growth Rate

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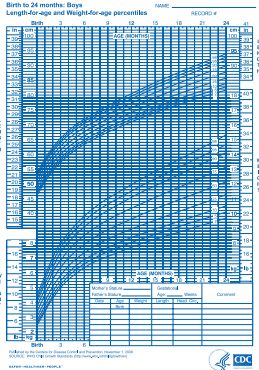
Child at 0.5 months

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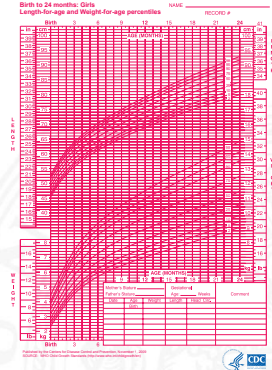
Child at 4 months



Growth Rate - WHO Charts



male



female

Growth rate during the first two years differs notably by gender.



Maturation and Learning

As children grow more actions become available.

This process is highly coupled with learning, but not entirely synchronized.

- ▶ Some action would be physically possible, but cannot be coordinated yet
 - ▶ e.g., throw/catch, opening doors...
- ▶ Some actions could be coordinated but cannot be actuated yet
 - ▶ e.g., use door handles, pedal bikes

The boundary between these is fuzzy.



Local Minima

Behavior during learning often exhibits local minima

- ▶ Crying to be picked up(?)
- ▶ Thumb sucking
- ▶ Stretching for objects over moving towards them
- ▶ Rely on parents for “difficult” actions
- ▶ ...



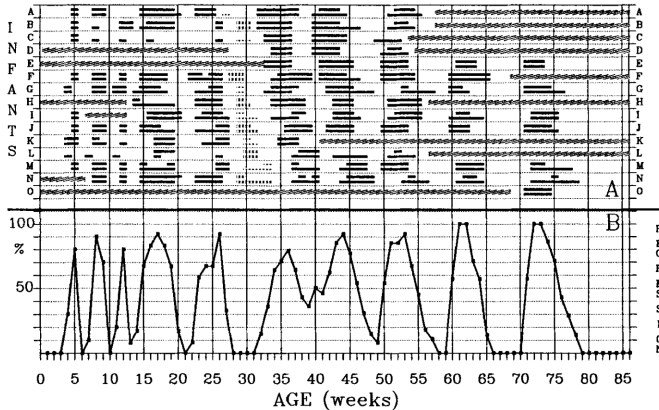
Regression/Transition Periods

Regression periods indicate time of “more difficult” behavior of the child. E.g., they eat less or worse, sleep less and cry more often, seek more attention from their parents, ...

Transition periods indicate times during which the child exhibits novel behavior it was unable to produce before that time. E.g., follow objects fluently with their eyes, focus attention of objects/events for more than a few seconds, turn on their belly, crawl, articulate referential words, ...



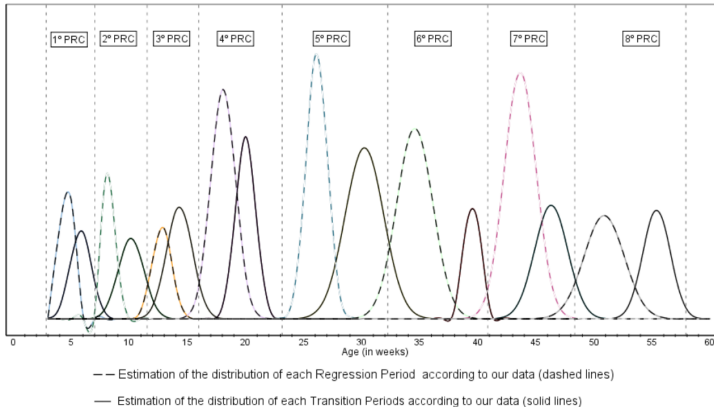
Regression/Transition Periods



van de Rijt-Plooij and Plooij, 1992



Regression/Transition Periods



Sadurní et al., 2010



The 10 Transitions by Rijt and Plooij, 1998

1. Percepts
 - ▶ Focus on sensory stimulation
2. Pattern
 - ▶ Object interaction / recurring scenes
3. Transitions
 - ▶ Fluent eye and limb motions
4. Events
 - ▶ Observation of simple events
5. Connections/Interactions
 - ▶ Sensory/Coupling (Peekaboo!)
6. Categories
7. (Causal) Order
8. Programs
9. Principles
10. Systems



Servoing for Breast

Placed on their mother's chest, newborns can move to suck on their mothers breast *within the first hour of their life*.

- ▶ Investigated in multiple studies, Varendi et al., 1994
- ▶ Gradient based on olfactory sense
- ▶ Nipples smell of amniotic fluid
- ▶ First time the body experiences gravity!
- ▶ Few actual movements to get there!
- ▶ Hints at basic innate motor behavior

Here is an example run captured as a photo trail over ~ 1 h.



Servoing for Breast



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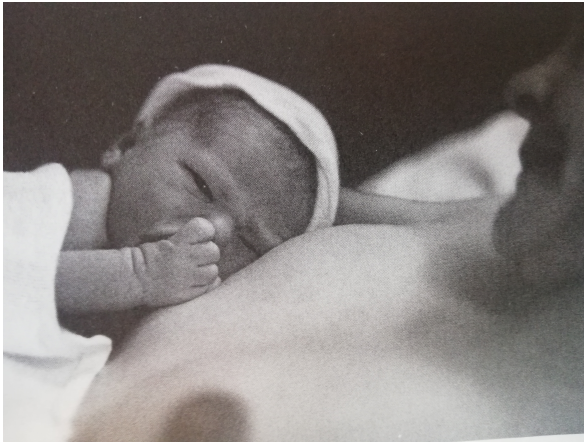


Servoing for Breast



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Servoing for Breast



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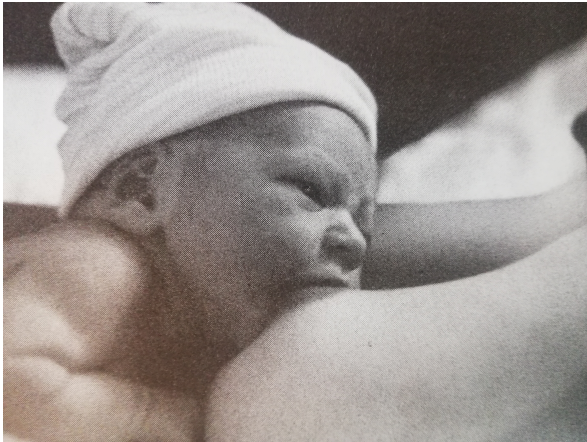


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Photographer Bias

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Smiling child

Smartphones allow recording in (almost) every situation, still

- ▶ Photos capture (mostly) happy children, though children are definitely crying just as much
- ▶ Videos usually start *after* first interesting actions, unless event was anticipated



Photographer Bias

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Crying child - recorded seconds later

Smartphones allow recording in (almost) every situation, still

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How to overdo it?

https://www.ted.com/talks/deb_roy_the_birth_of_a_word



View Material





Where is
Robotics/AI/ML/DeepML in
comparison?

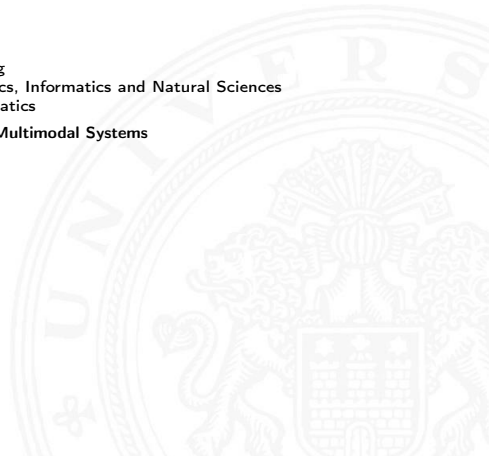


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