Imitation as a social and cognitive ‘measure’

— What I have learned from infants and children with autism — so far

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Keep in mind…

Everything you know might already be wrong
(Jimmy Iovine, ISC commencement 2013)

No references before 95 is needed.…
(unknown reviewer 2012)

To be covered

• Neonatal imitation
  — Individual differences
  — evolves prenatally
  — affect the dynamics of the early mother-infant interaction.

• Deferred imitation:
  — TD: longitudinal consequences.
  — Autism: DI might be impaired

• Imitation as intervention (Autism)
  — sensitive to being imitated.
  — how this observation can be used clinically
    — Compare Intensive Imitation and Intensive Behavior Therapy (TAI).

Let’s take a step back in time — does this exist?
Let's take a step back in time - does this exist?

Contrasting views: Not possible

Thus, while it is not possible to show that newborn infants cannot imitate, research has not established that they are capable of this complex form of behaviour.

Contrasting views: Possible

Nature designed a baby with an imitative brain

Contrasting views: Possible

Culture consists of massive collections of complex skills and knowledge which are transferred from person to person through two core mediums, language and imitation. We would be nothing without savant-like ability to imitate others.
Even monkeys do it

But...complicating factors

- Immediate response ≠ always imitation. It takes time!
- MO ≠ TP
- Strong TP’ s ≠ always imitation
- Individual differences:
  - short-term stability
    - 2d to 3w: r = .68 for MO and .49 for TP
  - NI = related to im beyond 3 months
    - But: im at 3 mos show some corr with im at 12 mos (TP to vac im, r = .42; MO to object im, r = .38)
- Link to temperament (activity an attentiveness)
  Thus difficult to construct standard procedure....

Neonatal imitation.... What is it for?

- Facial imitation at birth: Mothers do recognize imitation
- Social importance: Mutual imitation
- Preparedness for intersubjective encounters
- Person identity?
- Gaze aversion inversely related to NI

Example: Different response patterns for TP and MO at 2 days

Heimann, unpublished

Ferrari PF

Link to Individual differences:

– Visalberghi

Even monkeys do it

# –

Heimann, 1988; 1991; 2001

hap://www.plosbiology.org/article/info:doi/10.1371/journal.pbio.0040302

Thanks Psychology, Suvinen, with neonates

Heimann, son, Jacobson, (Scandinavian Journal statistically significant protrusion and infants

Mikael seriously first over week-olds

Heimann mouth opening expressions.

individual variability,

Allan

The

It takes time!

standard at 12 procedure #

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individual variability,
NI and mother-infant interaction

- Children displaying high im tend to show fewer instances of brief gaze aversion
- Possible regenerative function of im in the early mother-infant relationship
- Im facilitates sensitivity to social cues
- Better memory from low levels of gaze aversion

(Heimann, 1989)

Early individual differences: an idea:

- ...might emerge from patterned movement representations formed before birth
- ...networks build up over time as the fetus moves around in the uterus
- ...newborn children differ in how these patterned movement representations are constructed.
- ...comparative processes between own movements and other movements are involved in neonatal imitation then this comparison must lead to different outcomes between children.
- ...relatively stable characteristics of the network architecture and thus signs of early individual differences.

(Heimann, 2002, p. 81)

Some old (?) ideas:
The ability to imitate is dependent on

- Unknown subcortical and cortical processes (Stein & Meredith, 1993; Dawson & Fischer, 1994)
- Mirror neurons similar to the ones found in the rostral part of the ventral premotor area (Rizzolati & Arbib, 1998)
- The child’s ability to represent both perception and production within a single amodal or supramodal neural network (Meltzoff & Moore, 1997)
- The child’s ability to detect facial configurations (eyes and mouth) and moving stimuli (Johnson & Morton, 1991; Blais, 1999)
- Motivational processes that direct the child’s attention to the relevant aspects of the environment (Trevarthen et al., 1998)
- Transactional interactions with the environment (Fogel, 1993; Thelen & Smith, 1994)

(Heimann, 2002, p. 80)

But...

A. For an early behavior...the initial emergence of a behavior pattern may simply represent an epiphenomenon reflecting the 'anticipatory' onset of a function that will become adaptive at some later age...

B. Early behavior may...represent necessary antecedents to later behavior which when suppressed...result in...atypical development...

C. Finally, early behavior may serve some immediate adaptive role for the...infant (ontogenic adaption).
What with children developing along different paths?

Down syndrome: Imitative responses

<table>
<thead>
<tr>
<th>Child</th>
<th>TP</th>
<th>MO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>+1.8</td>
<td>+5.2</td>
</tr>
<tr>
<td>2.</td>
<td>+1.3</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>+1.2</td>
<td>+7.3</td>
</tr>
<tr>
<td>4.</td>
<td>+3.8</td>
<td>+1.6</td>
</tr>
<tr>
<td>5.</td>
<td>+3.2</td>
<td>+5.7</td>
</tr>
</tbody>
</table>

- At 5 weeks
- Responses during the presentation period

Heimann, Ullstadius & Swerlander, 1998

DS and 'typical' neonates: Similar or different?

<table>
<thead>
<tr>
<th>Area</th>
<th>Similar</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>N overall</td>
<td>Yes</td>
<td>Sign effects</td>
</tr>
<tr>
<td>TP vs MO</td>
<td>Yes</td>
<td>Im both but TP easier to elicit</td>
</tr>
<tr>
<td>Resp type</td>
<td>No</td>
<td>Clear vs 'weak'</td>
</tr>
<tr>
<td>Latency</td>
<td>No</td>
<td>Pre period vs resp periods</td>
</tr>
<tr>
<td>Frequency</td>
<td>No</td>
<td>Higher frequency</td>
</tr>
</tbody>
</table>

(Heimann et al., 1989; Heimann, 1998; Heimann et al., 1998; Heimann, unpublished)
**Deferred imitation**

**Indicators** needed to... (at Di)

- High
- Low

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**DI: Individual differences: Early memory as a marker of cognitive development?**

- Longitudinal findings
  - From 9 to 14 months: DI to DI
  - From 9 to 50 months: DI to cognition
- Electrophysiological correlates
  - ERP and DI at 14 months

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**DI at 6 months**

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**DI at 9 and 14 months: DI to DI**

<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>High</th>
</tr>
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<tbody>
<tr>
<td>14-months</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>9-months</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>17</td>
</tr>
</tbody>
</table>

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**Requests**

- This is how it might look when a child responds
- 15 minutes earlier we demonstrated:
  1. Break in cup
  2. Pull toy
  3. Collapsible cup

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(Heimann & Meltzoff, 1996)

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(Immersa & Meltzoff, 1996)
**DI and gestural communication at 14m**

- Memory I: Visual recognition at 6m
  \[ r = .43 \]
- Memory II: Deferred imitation at 9m
  \[ r = .60 \]
- Communication skills: Turn-taking or joint attention at 14m

\[ \text{Adj } R^2 = .41 \]

- Gestures produced at 14m

**DI and cognition**

- Low DI at 9m
- Low DI at 14m

\[ N = 26 \]

**Preliminary findings from ongoing study**

**And maybe: DI to language**

- Memory I: Visual recognition at 9m
  \[ r = .37 \]
- Memory II: Deferred imitation at 9m
  \[ r = .31 \]

\[ \text{Adj } R^2 = .19 \]

- Words understood at 16m

**DI =**

...probably a marker of early cognitive development

...that relates to both cognitive and communicative development
DI and ERP

What we did:

Combined an associative learning paradigm with DI.

The idea being that that deferred imitation, besides being indicative of early representational abilities (Meltzoff, 2004) also require the child to associate an action with an outcome and that the association learning paradigm we used to measure ERP might, to some degree, tap similar learning processes as the deferred imitation paradigm does behaviorally.

(Heimann, Nordqvist, Johansson, Rudner & Lindgren, 2013)

But to be honest we’re not the first...

Several studies by others on the rel btw brain activity and deferred imitation:
Findings:
- a stronger fronto-central Nc response to new events possibly reflecting allocation of attention
- a negative late slow wave (SW) probably reflecting novelty detection.

BUT: Not based on observation only procedure.
- Allowed practice and narration
- Prediction based on recognition memory
- More intense modelling

(Bauer et al., 2003; 2006; Carver, Bauer, Nelson, 2000; Richmond & Nelson, 2007)

Stimuli

- One block = 16 items
- 5 x 2 to be learned
- 2 novel
- 2 recombinations
- 2 reminders
- Ideally 10 blocks
Learning phase

PRES 1-5

PRES 1-5

RCOMB

Test phase

NOV

REMIND

Grand mean amplitudes of Nc
The end of the learning phase (PRES 5) compared with test phase stimuli (recombined and novel object)

Nc: The amplitude was significantly higher during RECOMB as compared with PRES 5, $t(14) = 2.52, p = .024$, but not so for NOV COMB compared to PRES 5 ($p > .10$).

ERP and DI: what we actually found

1. Nc. A negative central 300-600ms, reflecting attention to novel stimulus.

2. Slow waves: 700-1500 ms. When new stimuli are registered or processed, characteristic slow wave patterns in the ERP are often observed.

3. ERP and DI: $r = .52 (p < .05)$

In sum, Deferred imitation

- ...is a robust measure of early declarative-like memory
- Individual differences
  - subgroup stability 9 to 14 months
  - DI predicts gestural communication and language
  - DI = marker of later cognitive ability
  - ERP measures of associative learning predict success on DI
  - Brain measures indexes behavioral recall
  - Also in obs only design
Autism and DI: Lower performance

- Investigating DI and social communication
- Two groups:
  - Autism, n = 20: CA = 66.8; VA = 29.7; MA = 45.2
  - Speaking, n = 13
  - Non-speaking, n = 7 (no phrase speech acc. to ADI-R)
- TD, n = 22: CA = 34.7; VA = 35.0; MA = 37.0

Measures
- DI: 5 tasks (egg, CC, beads, hinge & BB)
- Soc comm (ESCS): JA, req, SI (init & responding)

Deferred imitation emerges between 6 and 9 months of age (e.g., Heimann & Meltzoff, 1996; Heimann & Nilheim, 2004). Early recall memory in addition to being a test of imitation competence (i.e., children with low scores on deferred imitation have lower cognitive levels later in childhood). Researchers also have shown a positive relation between deferred imitation at 12 months and receptive and joint attention in infancy also had lower cognitive levels and joint attention were found to predict later cognitive competence (i.e., children with low scores on deferred imitation and joint attention had lower cognitive levels later in childhood).

Deferred imitation was observed on Autism and Other Developmental Disabilities.

Keywords

- Social communication
- Autism
- Speech
- Language
- Communication
- Joint attention
- Nonspeaking children with autism

Table A: Correct Response (IR and IDS) in Nonverbal Communication Measures for TD and Ns Group and for TD and 5 Children With Autism

<table>
<thead>
<tr>
<th>Measure</th>
<th>TD (n = 22)</th>
<th>Autism (n = 20)</th>
<th>Autism (n = 13)</th>
<th>Autism (n = 7)</th>
<th>TD (n = 22)</th>
<th>Autism (n = 20)</th>
<th>Autism (n = 13)</th>
<th>Autism (n = 7)</th>
<th>P</th>
<th>P</th>
<th>F</th>
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<th>F</th>
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</thead>
<tbody>
<tr>
<td>Social attention</td>
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<td></td>
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</tr>
<tr>
<td>Interpreting (IR)</td>
<td>8.0 (2.7)</td>
<td>7.0 (2.1)</td>
<td>6.0 (2.7)</td>
<td>6.0 (3.5)</td>
<td>1.0 (1.7)</td>
<td>1.0 (1.7)</td>
<td>1.0 (1.7)</td>
<td>1.0 (1.7)</td>
<td>&lt; .05</td>
<td>&lt; .05</td>
<td>&lt; .05</td>
<td>&lt; .05</td>
<td>&lt; .05</td>
</tr>
<tr>
<td>Responding (IR)</td>
<td>1.0 (1.7)</td>
<td>1.0 (1.7)</td>
<td>1.0 (1.7)</td>
<td>1.0 (1.7)</td>
<td>1.0 (1.7)</td>
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<td></td>
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</tr>
<tr>
<td>Social interaction</td>
<td>1.0 (1.7)</td>
<td>1.0 (1.7)</td>
<td>1.0 (1.7)</td>
<td>1.0 (1.7)</td>
<td>1.0 (1.7)</td>
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</tr>
</tbody>
</table>

Note: T = TD, A = Autism; IR = interpreting; IDS = interpreting joint attention; P = responding in joint attention; SI = responding in social interaction; BB = responding in object response; SI = responding in social interaction. Group comparisons conducted using Mann-Whitney U test.

Lower on IJA and IOR
Autism and parent-child free play
DI and type of comments by parent

- Unsynchronized comments correlated neg with DI ($r = -0.53$)
- No sign corr btw DI and synchronized comments or language age
- Positive correlation btw MA and DI ($r = 0.53$)

(Strid, Heimann & Tjus, 2013)

Imitation, intervention and autism

Objectives

- How do young children with autism respond to Intensive Imitation
  - compared w. treatment as usual (Intensive Behavior Therapy)
  - first intervention after receiving an autism diagnosis.
- We knew beforehand that
  - Intensive Behavior Therapy = effective
- Thus
  - Goal ≠ which one is the best
  - Goal = tailor treatment to the individual child.
  - To what degree can Intensive Imitation be a compliment?

Intervention

- Intensive Imitation
  - Two sets of identical toys/objects available
  - 30 minutes/day ($\Sigma \approx 2-3$ hrs/week)
  - 4-5 times/week (4 = minimum)
  - 3-4 sessions by pre-school teacher
  - One session/week by member from the autism team
- Intensive Behavior Therapy
  - Structured training sessions
  - Goal = 25 hours/week
  - Initially = 10-15 hours
  - Conducted by pre-school teachers, parents
  - Autism team provides supervision
**Instruments**

- **Cognition**
  - Bayley scales of infant and toddler development
  - Visual recognition memory (Fagan)
- **Adaptive behavior**
  - Vineland Adaptive Behavior Scales
  - Psychoeducational Profile (PEP)
- **Communication**
  - Early Social Communication Skills (ESCS)
  - Still face procedure
- **Play observation**
  - Video clips

**Conclusion**
(tentative and based on analyses so far)

- **Gain**
  - Intensive Imitation (II) sign gain on six measures
  - Intensive Behavior Therapy (IBT) sign gain on all nine
- **ES: II > IBT on one: Expressive language (PEP)**
- **As expected: IBT =**
  - strong strategy that promotes gain
- **BUT: II**
  - unexpectedly strong in some areas
  - in spite of fewer hours
  - might suit some better?
  - might be an important additional strategy in the tool box

**How to tie this up…..**

- **Social imitation**
  - Neonatal imitation and M-I interaction
  - still not fully understood (how we define and measure…)
  - individual differences evident
- **Cognitive imitation**
  - Deferred imitation
  - early marker?
  - individual differences
  - children with autism differ
- **Imitation as intervention**
  - Makes the social world salient for children with autism
  - Activates dormant mirror neuron systems?
  - [imitation as mimicry]
  - Increases helpfulness and friendliness (?)

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