Brain, Child, Self and Toy Robots: Enrobotment

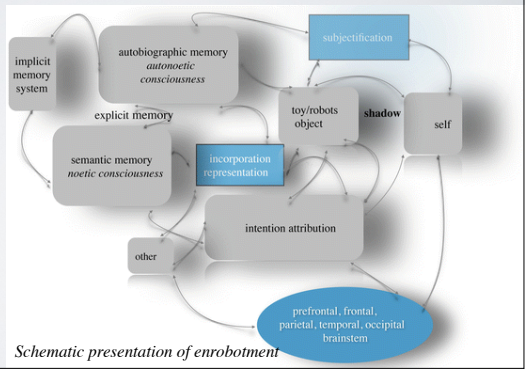
Irini Giannopulu, Ph.D & Dr.Sc
Cognitive Neuroscience
Pierre & Marie Curie University, Paris

Venise 24, 2016 ACHI-IARIA

Outline

- Enrobotment as a concept
- Embryogenesis of the Brain
- Child verbal, nonverbal and emotional neurocognitive development and the "self"
- Self-conscious and unconscious development and toy robots

Emanating from an interdisciplinary approach, enrobotment is a new concept. Enrobotment is a state of mind that mirrors the internalisation, incorporation and representation of animate and inanimate objects (toys or toy robots) and their shadows, i.e., "imperceptible" and "insignificant" parcel of each object. Enrobotment is intimately associated with the development of verbal, nonverbal (e.g. visual, haptic, motor) and emotional processes. As the echo of the "self", it facilitates self-consciousness.



Giannopulu (2016)

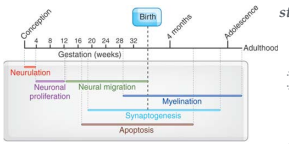
Schematic presentation of enrobotment

Brain, i.e., Nervous System

structure (areas)
function (processes)
interconnectivity (areas and processes)

dynamic & plastic: environment, i.e., external and internal world

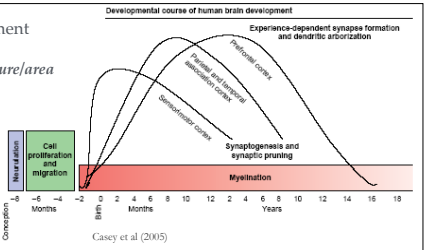
Timeline of major events in brain development



Giedd (1999)

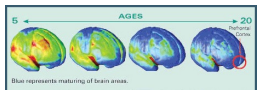
structure/area

interconnectivity

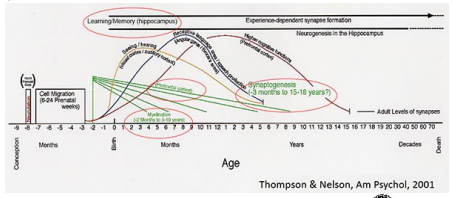


Casey et al (2005)

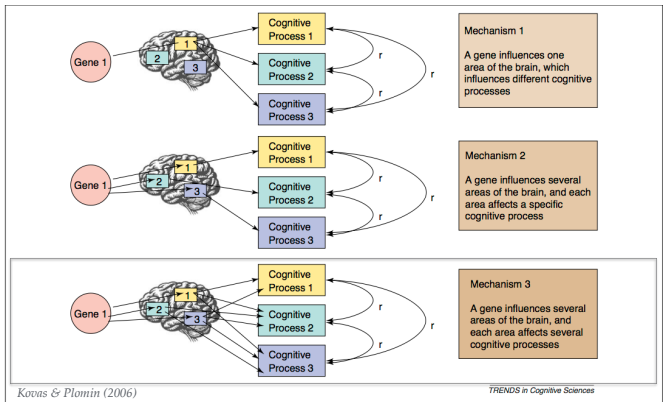
function/process



Gogtay, Giedd, et al., 2004.



Thompson & Nelson, Am Psychol, 2001



Kovas & Plomin (2006) *TRENDS in Cognitive Sciences*

internal world, i.e., “self”

From 0 to 2 years old: children start to represent objects/toys via manipulation

From 2 to 7 years old: children play with objects/toys by pretending that the objects/toys represent something else, *i.e., symbolic play,* (e.g. a pencil is a microphone) that they like or not. They are very imaginative

From 7 to 11 years old: they understand the roles and the strategies symbolically via objects/toys

Toys provide an interesting account of "how" physical objects presented in the external world are able to act as support for the symbolic play of children, i.e., the internal world

UPMC PARIS UNIVERSITAS

岡山県立大学 OKAYAMA PREFECTURAL UNIVERSITY

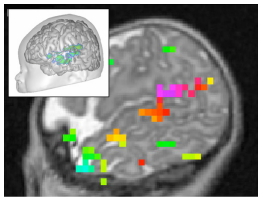
FONDATION FRANCO JAPONAISE SASAKAWA

Symbolic play, i.e., the emergence of the "self", is the developmental echo of language and emotion

Giannopulu (2016)

UPMC
IRMI PARISUNIVERSITAS

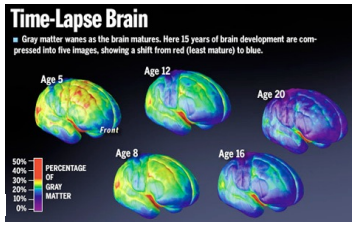
Language learning in typically developing children aged 5 to 6 years



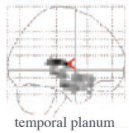
Dehaene-Lambertz et al. (2002; 2007)

1. The brain is genetically pre-programmed (Pinker, 1994; Bishop, 2006 p.e)

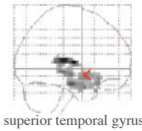
2. Plasticity allows the immature brain to organise progressively (Elman *et al*., 1996; Koizumi, 2004; Christiansen, Chater, 2008 p.e)



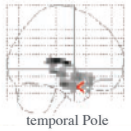
Gogtay, Giedd, et al., 2004.



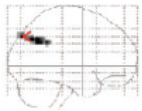
temporal planum



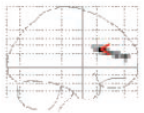
superior temporal gyrus



temporal Pole

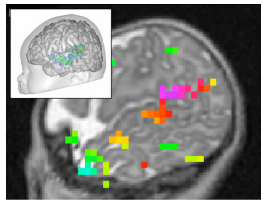


angular gyrus



pre-frontal cortex

Language
Perception
Action
Emotion



Dehaene-Lambertz et al. (2002; 2007)

Language could be thought as a system
of symbolised objects in the external world.

These objects can be:

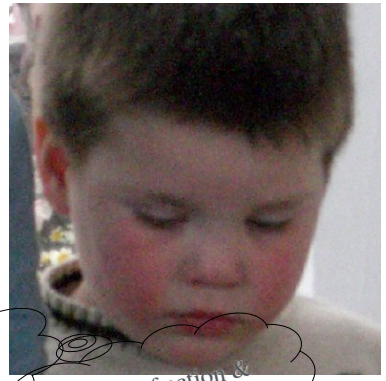
seen (letters)
heard (sounds)
touched (toys)
manipulated (actions with toys)

Language learning is possible because of the interaction between different information, i.e., nonverbal information (Bates, 1999).

children aged 5 to 6 years

Oculo-motor activity

Oral language



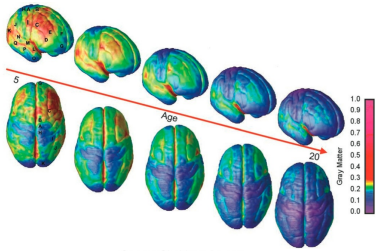
Haptico-visual recognition of objects

Imitation of action & gestures

Giannopulu (2013a)

Common components would exist between verbal comprehension-expression tasks and nonverbal action-perception tasks (haptic, visual, motor imitation and oculomotor).

These components would be associated with the “self”.

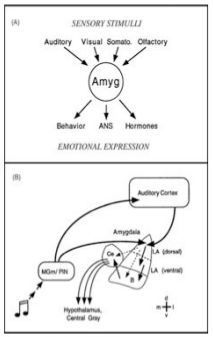


Gogtay, Giedd, et al., 2004.

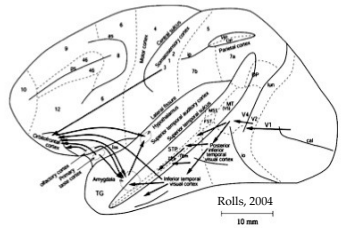
Giannopulu (2013a)

Positive emotion and decision making process in a/typical developing children aged 8 years

The capacity to feel and express emotions develops early but the ability to name emotions appears between 2 and 10 years old
(Siegel, 1999; Russel, 1991)



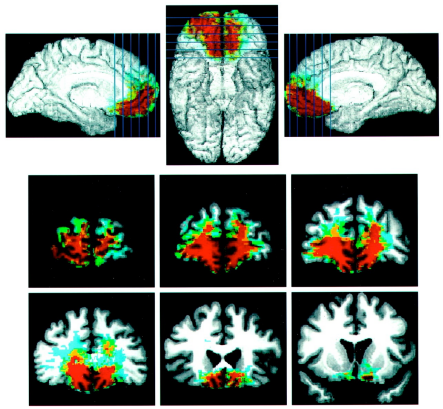
Le Doux, 2000



Amygdalo-orbitofrontal complex

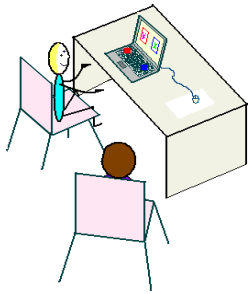
Expression and emotional feeling

Emotional feeling and decision-making: orbitofrontal cortex



Overlap of lesions in the VM patients (n=13), Bechara et al. (2000)

Two groups of 11 children aged 8 years (sd=5 months)
- atypical group - psychotic dysharmonia
- typical group

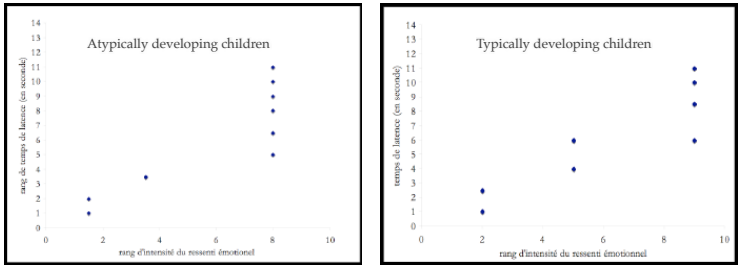


two phases

- 1st phase : immersed to an acoustic environment, i.e., listen to a story with visual support and find the end of the story (i.e., key click)
- 2d phase: auto-evaluation of feeling (from 1 to 5)

Positives Emotions (Lazarus, 1991)
- *love*
- *joy*
- *pride*

Sagot & Giannopulu (2007)

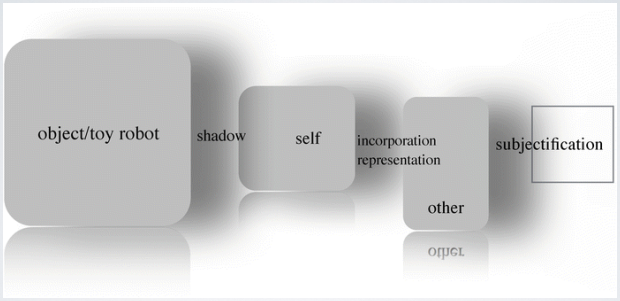


Cognitive processes involved in action could be embedded with some positive emotion in a/typically developing children.

Both processes are associated with the "self".

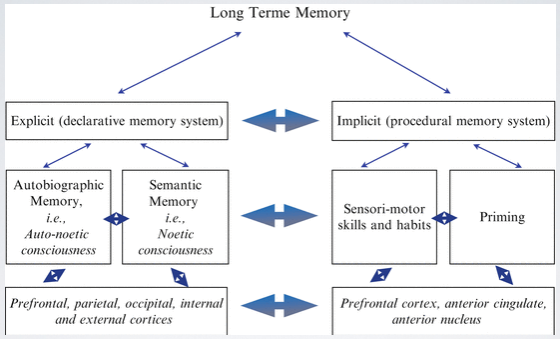
Giannopulu & Sagot (2010); Sagot & Giannopulu (2007)

In other words, the external world made by animate/inanimate objets/toys (including shadow), i.e., *the other*, that children like or not, is associated with the neurocognitive verbal/nonverbal and emotional development, i.e., the capability to incorporate/represent the objects/toys.
It cannot be separated from the *"self"*. Subjectification is based on.



Schematic configuration of the object/toy related to its shadow and the "self-other" subjectification

Giannopulu (2016)

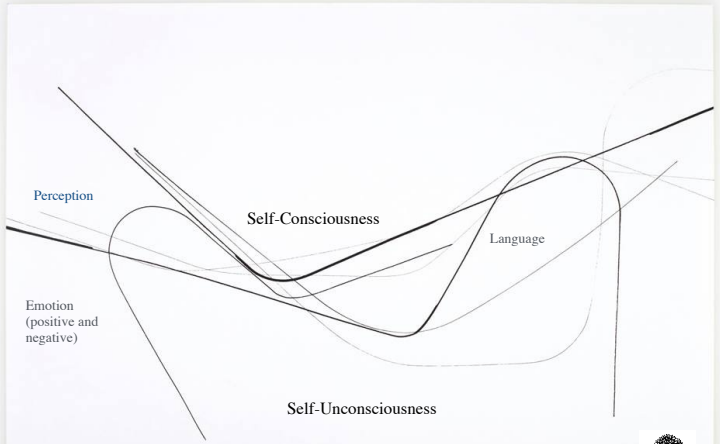


Cognitive and neuroanatomical components of long term memory

Giannopulu (2016)

The "self" is intimately associated with self-consciousness

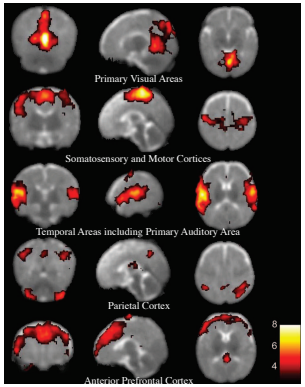
Human self-consciousness is defined as the having of perception, feelings and thoughts of the internal, i.e., “self” and the external world, i.e., “other” that can be verbally expressed (e.g. Bering & Shackelford, 2004).



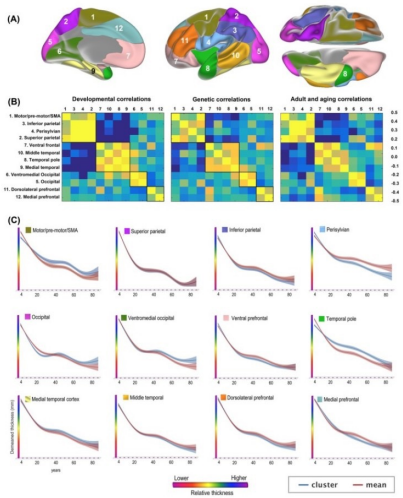
Rba Silvia Bacchi

1 Importance of a neural network in temporal, parietal, frontal, pre frontal areas and brainstem

2 The dynamic cortical thickness associated with language, emotion and self-consciousness increases gradually from early childhood (5 years) to mid childhood (9 to 11 years): inter individual cortical differences between young and old children



Fransson et al. (2007)



Fjell et al. 2015

Hypothesis: Difference between self-conscious verbal expression and self-unconscious nonverbal emotional expression. The lesser the brain maturity, the more the unconscious expression

Method *Paradigm of "Speaker-Listener"*

Young group

20 children (10 boys & 10 girls)
Mean chronological age:
6 years & 3 months
Mean developmental age:
6 years & 1 month

Old group

20 children (10 boys & 10 girls)
Mean chronological age:
9 years & 5 months
Mean developmental age:
9 years & 2 months

Without any neurological, cardiac and/or psychiatric disorders

UPMC PARIS UNIVERSITAS

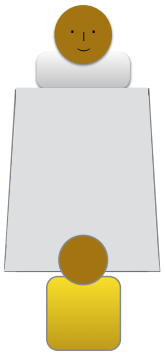
岡山県立大学 OKAYAMA PREFECTURAL UNIVERSITY

FONDATION FRANCO JAPONAISE SASAKAWA

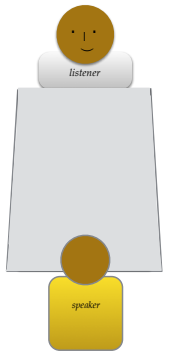
Sakura: Miraikan Museum, Tokyo

Watanabe (2011)

Robot InterActor: Pekoppa



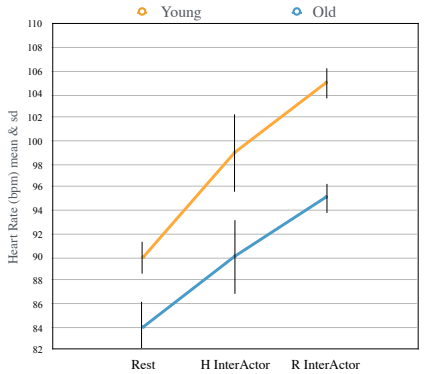
Rest Condition



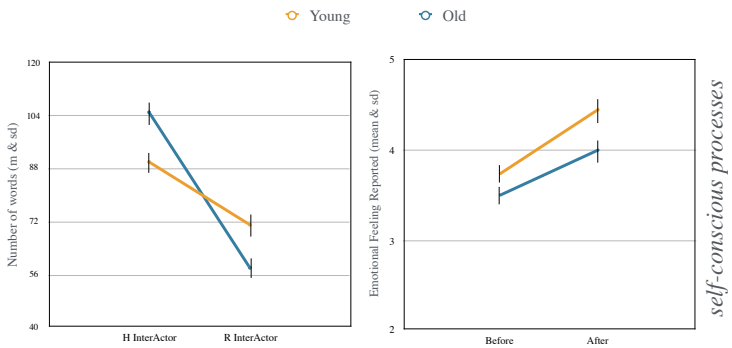
Human InterActor Condition

Robot InterActor Condition

Results



Self-unconscious process



self-conscious processes

Discussion

nonverbal emotional expression

1

Young > Old *Robot InterActor*

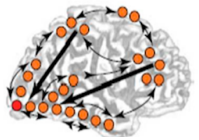
verbal expression

Young < Old *Human InterActor*

verbal emotional expression

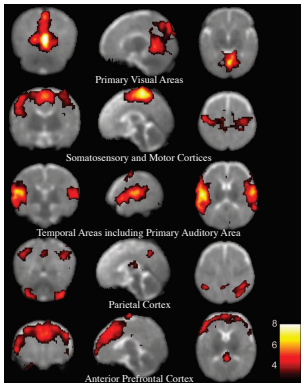
2

Young = Old *Before/After Robot*

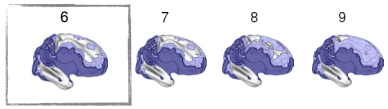


Dehaene et al. (2006)

Self-unconscious process: inter individual differences



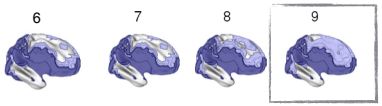
Fransson et al. (2007)



The results would signify a differential degree of self-unconscious nonverbal emotional maturity that would reflect inter individual differences in cortical and sub-cortical areas.

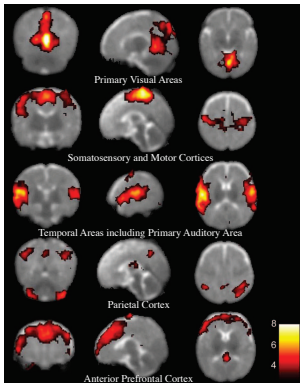
In other words, young children would be more reliant to the external artificial environment, i.e., the toy robot, than old children

Self-conscious process: inter individual differences



Based on differential degree of brain maturity and self-consciousness:
linguistic functions continue to mature at 6 and grow up to adulthood.

In both neurotypical groups self-conscious verbal expression is more important when the InterActor is the human, likely because of the human complexity



Fransson et al. (2007)

Conclusion

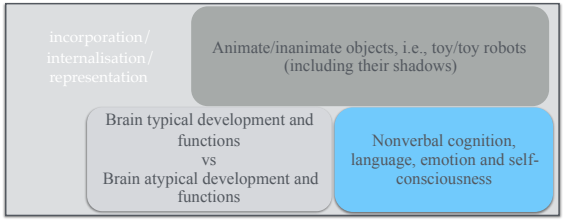
Nonverbal emotional behavior expressed by heart rate is an self-unconscious automatic activity which would depend on an external "artificial" world: the InterActor Robot.

Verbal behavior expressed by the words (nouns and verbs) is a self-conscious activity which would depend on an external "natural" world: the Human InterActor.

Self-Conscious and self-unconscious processes would not only depend on natural external world but also on artificial external world, i.e., toy robots.

Giannopulu & Watanabe, (2015)

Conclusion



Nonverbal cognition, language, emotion and self-consciousness would arise from the dynamic interaction between the developing brain and the object/toy robot (including shadow), i.e., the enrobotment. Enrobotment mirrors the triadic relationship between the "object/toy, self and other". At the antipode, children with autism cannot mirror the triadic relationship of "object/toy, self and other".

Giannopulu (2016)

Thank you for your attention

FONDATION FRANCO JAPONAISE SASAKAWA

UPMC PARIS UNIVERSITAS

岡山県立大学 OKAYAMA PREFECTURAL UNIVERSITY