

## Well-Connected: The nature of human connection and how to work with it.

Dr. Jonathan Delafield-Butt

Engage with Strathclyde, Strathclyde's Children:  
Working Together to Improve the Lives of Children and Young People

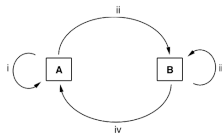


Monday 28<sup>th</sup> April 2014  
University of Strathclyde

## Core concepts

- **Humans are social animals**
  - we have an highly evolved social biology that demands social engagement
- **Engagements of all kinds are meaningful**
  - even non-verbal social interaction is rich in emotion and it affects our vital physiology
- **Humans require social connection for development, health, and well-being**
  - social deprivation decreases vitality; social isolation is employed as a punishment

## Co-operation from the Start

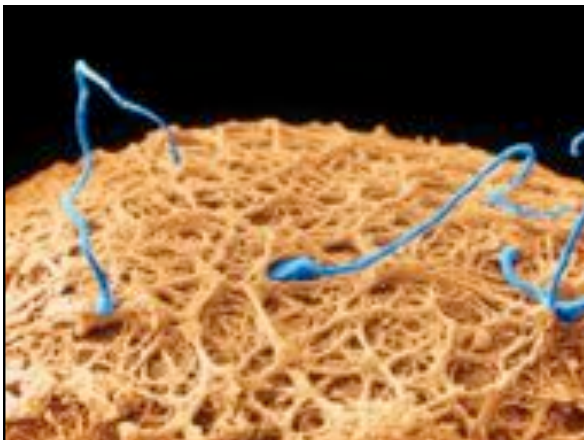


## The Start Requires...

1. Copulation
2. Sperm migration to fallopian tube to meet egg
3. Capacitation (preparation) of sperm for fertilization
4. Fertilization, *i.e.* conception
  - this is not the old story of 'male seduces passive female, sperm swims to waiting egg, sperm *penetrates* egg, egg now fertilized and complete'
  - rather, conception requires the *co-operation* of the male spermatozoa with elements of the female genital tract and oocyte

## Co-operation from the Start

1. Copulation
  - requires courtship & two active bodies
  - with two complementary sex organs and sex systems
  - there is deep evolutionary complementarity
2. Sperm migration to fallopian tube
  - requires muscular uterine contractions & sperm motility
  - sperm are found in the oviduct within 30 minutes of deposition, a time "too short to have been attained by even the most Olympian sperm relying on their own flagellar power" (Stores, 1995).
3. Capacitation is pre-selection of sperm
  - a biochemical process between female ampullary fallopian region and sperm that charges some sperm for final fertilization



### Co-operation from the Start

4. Fertilization

- is a co-operative process
- sperm docks parallel with -- not penetrates -- the egg (Baltz *et al.*, 1988)
- egg actively tethers sperm
- egg sperm-binding proteins cross-link (Leyton *et al.*, 1992)
- ovum cross-links with sperm receptors to 'twist open' its acrosomal sac
- acrosomal sac dissolves zona pelucida
- sperm and egg fuse

Trevarthen C. *et al.* (2006). Collaborative regulations of vitality in early childhood: Stress in intimate relationships and postnatal psychopathology, in Cacchetti and Cohen (Eds.) *Developmental Psychopathology*. New Jersey: John Wiley & Sons

### Co-operation from the Start

female sex organs, sex cells, and sex systems

male sex organs, sex cells, and sex systems

### Co-operation between Parts

embryonic region alpha

embryonic region beta

### Limb development

- a co-operative process of reciprocal gene expression

e.g. see Edelman, G.M. (1988). *Topology: An introduction to molecular embryology*. New York: Basic Books.

### Brain development

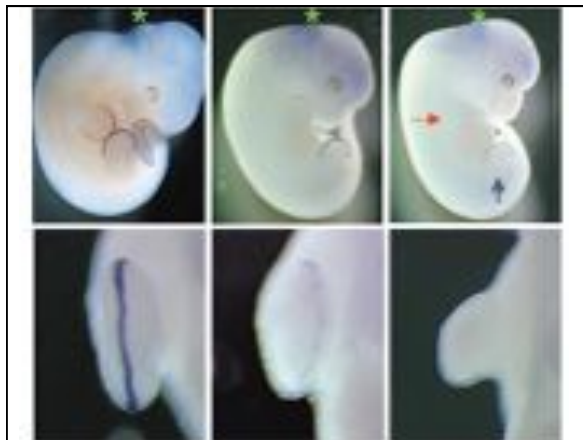
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e.g. see Edelman, G.M. (1988). *Topology: An introduction to molecular embryology*. New York: Basic Books.

*Fgf8<sup>+/+</sup>*      *Fgf8<sup>CGN</sup>*      *Fgf8<sup>CGN</sup>*

**Embryonic development is a process of co-operative (molecular) activity**

- removing any one of the components in these areas causes a cascade of 'downstream' effects
- genesis will continue, but with alternative paths, some that lead to pathology
- reciprocal relationships in biology are ubiquitous, hundreds can be named just in the embryo at many levels



**Principles of Human Connection**


**1. Co-operation is a cornerstone of relations.**

Packard, A. (2006). Contribution to the whole (H). Can squids show us anything that we did not already know? *Biology and Philosophy*, 21, 189-211.  
 Packard, A., & Delafeld-Butt, J. T. (2014). Feelings as agents of selection: putting Charles Darwin back into (extended neo-) Darwinism. *Biological Journal of the Linnean Society*, in press.



**Communicative Movement**

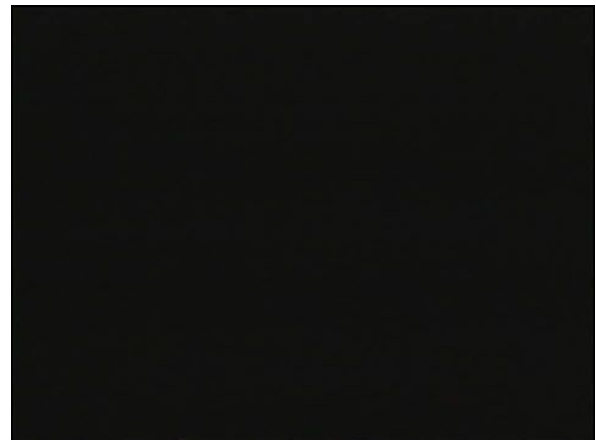
- All movements are communicative (to receptive partners)
- All communications are movements (by their nature)
- All animal movements are muscle movements:
  - face, hands, arms, legs, thorax, larynx, vocal cavities, etc.



## Feeling Vitality in Movement

exploding	surging	accelerating
swelling	bursting	fading
drawn out	disappearing	fleeting
forceful	powerful	weak
cresting	pulsing	tentative
rushing	pulling	pushing
relaxing	languorous	floating
fluttering	effortful	easy
tense	gentle	halting
gliding	swinging	tightly

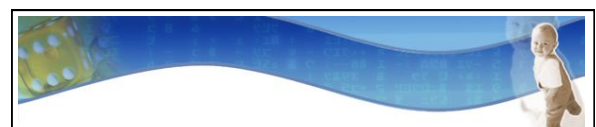
Stern, D. N. (2010). *Forms of Vitality*. Oxford: Oxford University Press.



## Principles of Human Connection

1. Co-operation is the cornerstone of relations.
2. **Movement is the root of communication.**

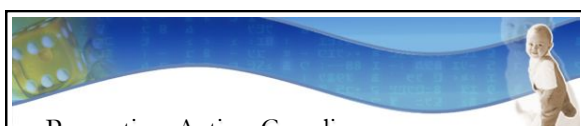
DeLafeld-Butt, J. T., & Trevarthen, C. (2013). Theories of the development of human communication. In P. Copley & P. Schultz (Eds.), *Handbook of Communication Science*. Berlin: Grayer Mouton.  
Lee, D. N. (2009). General Tau Theory: Evolution to date. *Perception*, 38, 837-858.



## The Embodied Mind

- body and mind are entwined
- perceptions, feelings, and actions are coupled together and inter-dependent
- the form and actions of the body shape consciousness and cognition
- Nobel laureate Neurologist Roger Sperry (1952) reminds us “the sole product of brain function is motor coordination” (p. 297).


Varela, Francisco J., Thompson, Evan T., and Rosch, Eleanor. (1992). *The Embodied Mind: Cognitive Science and Human Experience*. Cambridge, MA: The MIT Press.  
Clark, Andy (1997). *Being There: Putting Brain, Body and World Together Again*. Cambridge MA: The MIT Press



## Perception-Action Coupling

- **Perception** and **Movement** are coupled together and interdependent.
- **Action** is the result of coupling perceptual information to movement formation
- **Perception** and **Movement** are two sides of the same coin, **Action**.
- Swinging Room Paradigm...
  - reveals the tight coupling between perception and movement

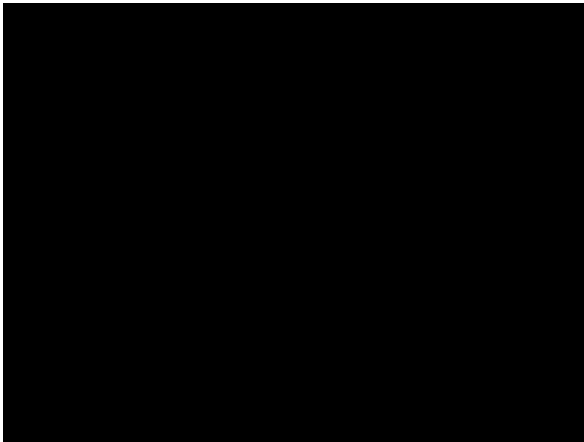
Gibson, 1967; 1979



## The Psychology of Perception-Action

- Evidence for perception-action coupling
- Swinging Room Paradigm
  - reveals the tight coupling between perception and movement

Lee, D. N. & Aronson, E. (1974). Visual proprioceptive control of standing in human infants. *Perception and Psychophysics*, 15, 529-532.



### The Optical Flow Field: a foundation for exproprioception

Lee, D. N. & Aronson, E. (1974). Visual proprioceptive control of standing in human infants. *Perception and Psychophysics*, 15, 529-532.

### Action is always mindful

- An action is NOT a mindless reflex, but is **enacted** by the organism through structured neuromuscular activity.
- An action is neural activity and it is muscular activity and it is physical body activity. It is the mind-in-action, the expression of mind through movements the body.

Delafeld-Butt, J. T., & Gangopadhyay, N. (2013). Sensorimotor intentionality: The origins of intentionality in prospective agent action. *Developmental Review*, 33(4), 399-425.

### Prospective Control

- Actions are future-oriented, they are **'prospective'**
- Actions move one from,

**'where one is now'**  
to  
**'where one wants to be'.**

Von Hofsten, C. (2004). An Action Perspective on Motor Development. *Trends in Cognitive Sciences*, 8, 266-272.

### Prospective Control


- Actions are driven by  **motive forces**, essential to all organisms
- Actions are the outward, physical presentation of the mind: feelings of
  - (i) perceptions of a bodily self (viseral, somatic, proprioceptive, and ex-proprioceptive)
  - (ii) perceptions of a self-in-relation to the environment.
- Actions couple the body to the environment
- Actions engage the environment to satisfy internal needs.

Von Hofsten, C. (2004). An Action Perspective on Motor Development. *Trends in Cognitive Sciences*, 8, 266-272.  
Reed, E. S. (1996). *Encountering the World. Toward an Ecological Psychology*. Oxford: Oxford University Press.

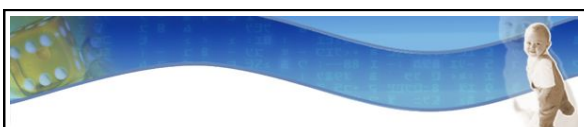
### Principles of Human Connection

- Co-operation is the cornerstone of relations.
- Movement is the root of communication.
- We seek satisfaction through movement.**

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Lee, D. N. (2009). General Tau Theory: Evolution to date. *Perception*, 38, 837-858.




Does the neonate use prospective control?


### Neonatal Movements

- Appeared coherent, coordinated, and possibly 'purposive'.
- Not chaotic, random reflex actions.
- Are they 'prospectively' guided?

Von Hofsten, C. (2004). An Action Perspective on Motor Development. *Trends in Cognitive Sciences*, 8, 266-272.


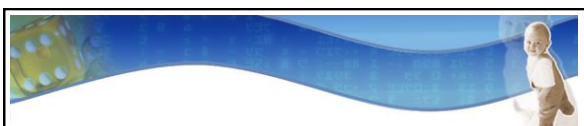


### Neonatal Perception-Action



**Neonatal Unit Studio**  
Parent-infant motion, video, and audio capture:

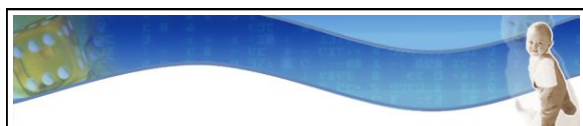
- 500Hz Qualisys
- Double digital video
- Double digital audio

### Testing for $\tau$ in Limb Displacements

**a**

**b**

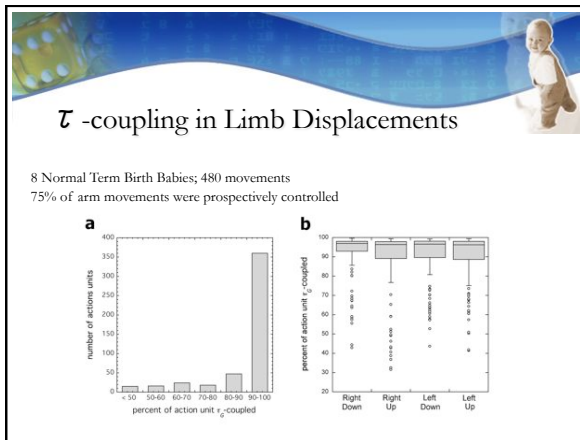


### Testing for $\tau$ in Limb Displacements

**a**

**b**





### Prospective Control of Movement in the Neonate

**$\tau_c$  Actions:**  
 $\tau_c$  guidance can thus account for (i) limb displacement control, (ii) intra-oral pressure control, and (iii) vocal control

(see Craig *et al.*, 1999)

Does the foetus use prospective control?



### Development of Prospective Control in Foetal Movements

- first tentative signs **at 8-10 weeks** in the first spontaneous, coordinated limb movements (de Vries, Visser, & Prechtl, 1982; Prechtl, 1986)
- discrimination in action patterns of limbs in **14 week GA** twins between twin-object-, and self-directed movements (Casteillo *et al.*, 2010)
- action-planning evident in kinematics by **18-22 weeks GA** (Zoia *et al.*, 2007)
- behavioural evidence of 'bicycling', reaching, grasping, exploring, etc. (Piontelli, 2010)

### 'Sensorimotor Intentionality'

- Actions are prospectively controlled by biomechanical necessity.
  - they must act 'ahead in time' to compensate for forces of momentum of the effector and whole body (von Hofsten, 1993; 2004)
- Actions are goal-directed movements (Lee 2005, 2009)
- Successful acquisitions, however abstract, brings 'satisfaction' on their completion, on so-called 'goal acquisition'.

## 'Sensorimotor Intentionality'

- intentionality of
  - a non-conceptual, non-reflexive, primary type
  - an anoetic conscious action (Vandekerckhove & Panksepp 2010)
- nevertheless,
  - imbued with feeling
  - perceptually aware of the vital self-in-relation to its world through (i) a viscerosensitive awareness of vital, somatic need; (ii) a proprioceptive awareness of the body-in-action; and (iii) an exteroceptive awareness of the world of objects and other animals

## The Centrencephalic Me

- the seat of the integrative 'core self' at the upper brain stem and midbrain region (Merker, 2007; Northoff & Panksepp, 2008; Panksepp & Northoff, 2009)
- the core SELF (Simple Ego-type Life Form) at the midbrain and upper brain stem is
  - anatomically subcortical, but*
  - functionally supracortical.*
- it is connected to skeletomusculature by *ca.* 14 weeks G.A.
- it is common and fundamental to vertebrates
- it is likely to control primary prospective action
- it is conscious and acts with felt appraisal
- it is still present in anencephalic children

## The Centrencephalic Me



Figure 9. The reaction of a three-year-old girl with hydranencephaly in a social situation in which her baby brother has been placed in her arms by her parents, who face her attentively and help support the baby while photographing. (Merker, 2007)

## The Centrencephalic Me

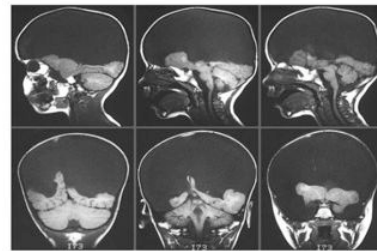


Figure 8. Sagittal and frontal magnetic resonance images of the head of a child with hydranencephaly. Spared ventromedial occipital and some midline cortical matter overlies an intact cerebellum and brainstem, while the rest of the cranium is filled with cerebrospinal fluid. Reprinted with the kind permission of the American College of Radiology (ACR Learning File, Neuroradiology, Edition 2, 2004).

## The Centrencephalic Me

- a cortex is not necessary to
  - be conscious,
  - have feelings,
  - act with intentions,
  - perceive and appraise the environment,
  - engage socially and purposefully
- *c.f.* surgically decerebrate cats and rats

## The Development of Intentional Projects

- Cortical tools of abstraction, memory, planning, *etc.* develop
- enabling complex sensorimotor projects



I like to move it: Joy in Successful 'Sensorimotor Intentionality'



### Principles of Human Connection

1. Co-operation is the cornerstone of relations.
2. Movement is the root of communication.
3. We seek satisfaction through movement.
4. **Meaning is co-created together in stories.**

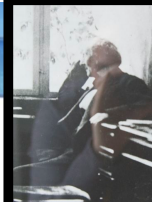
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Narratives Are a Story Told

They become an 'object' held on their completion.

"If you're ready, we'll begin. When we come to the end of this story, we shall know more than we know now."  
-- H. C. Andersen, from *The Snow Queen*


They are appropriated by the tellers, listeners, and all participants. They become a part of their being afterwards. They are an item produced and remembered from the transactions between two.



Narratives Are a Story Told

"If you're ready, we'll begin. When we come to the end of this story, we shall know more than we know now."

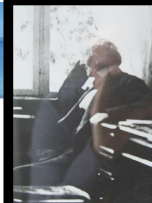
It takes two to be in agreement and ready to engage (a precondition for relation).



Narratives Are a Story Told

"If you're ready, we'll begin. When we come to the end of this story, we shall know more than we know now."


It takes two to be in agreement and ready to engage (a precondition)  
The beginning is mutual (i. initiation)





Narratives Are a Story Told

"If you're ready, we'll begin. When we come to the end of this story, we shall know more than we know now."

It takes two to be in agreement and ready to engage (a precondition).  
The beginning is mutual (i. initiation).  
We will travel and arrive together (ii. build and iii. climax).


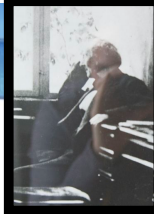


## Narratives Are a Story Told

“If you’re ready, we’ll begin. When we come to the end of this story, we shall know more than we know now.”


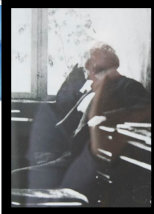
It takes two to be in agreement and ready to engage (a precondition).  
 The beginning is mutual (i. initiation).  
 We will travel and arrive together (ii. build and iii. climax).  
 We will have created shared knowledge (iv. satisfaction & objectification).

## Narratives Are a Story Told

“If you’re ready, we’ll begin. When we come to the end of this story, we shall know more than we know now.”

It takes two to be in agreement and ready to engage (a precondition).  
 The beginning is mutual (i. initiation).  
 We will travel and arrive together (ii. build and iii. climax).  
 We will have created shared knowledge (iv. satisfaction & objectification).  
 If you wish, we can be together and make meaning together.



## Narratives Are a Story Told

“If you’re ready, we’ll begin. When we come to the end of this story, we shall know more than we know now.”

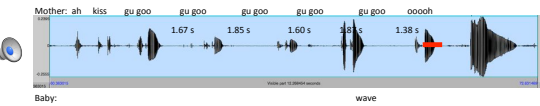
**narratives are a cornerstone of human relations**

## Co-created Narrative Projects

- narratives have a discreet, finite nature like goal-directed sensorimotor projects
- they
  - initiate** toward a (intersubjective) ‘goal’
  - build** in intensity as the project proceeds
  - climax** with maximal tension and release,
  - conclude** and appropriate the effect of their activity, giving something new.
- suggestion is the intersubjective ‘goal’ is the ‘coming together’ of two agencies in common meaning, creating coherence of affect, intention, and action between them (c.f. Tronick’s ‘dyadic states of consciousness’, 2005)

## Multimodal Infant-Parent Narratives



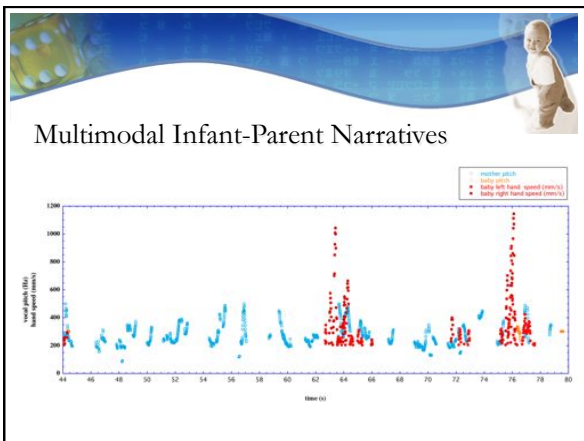
Characters of a Narrative Sequence

- opening; ah, kiss, & engagement
- build; regular Regular 1.6/1.8 s bars and regular durations ca 0.5 s
- climax; baby joins in on beat with arm wiggle and coo
- close; baby coo and mother coo w/ final lengthening

Mulick & Tivershen (2008). *Communicative Musicality: Exploring the basis of human companionship*. Oxford: Oxford University Press.

Narratives Are Shared Units of Meaning-Making

with a characteristic four-part structure:



Non-verbal Autist-Therapist Narratives

'Intensive Interaction' therapist with an autistic teenager

The teenager has been, for several years, almost non-verbal, violent, anti-social, and even dangerous. She would bite and scratch her care-takers. She was chronically hospitalized and taken into a special home.

This session is the first and only meeting with this therapist.

Initiation Through Imitation


Engagement 1

Initiation and Build Through Imitation.

Engagement 4


A Complete, Co-created Narrative

Engagement 11

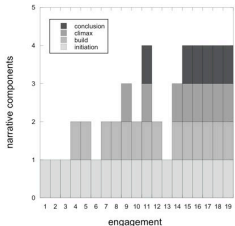


Mutual Joy in Intersubjective Unification

Engagement 15



Mutual Joy in Intersubjective Unification



Engagement	Initiation	Build	Climax	Conclusion	Total
1	1	0	0	0	1
2	1	0	0	0	1
3	1	0	0	0	1
4	1	1	0	0	2
5	1	1	0	0	2
6	1	1	0	0	2
7	1	1	0	0	2
8	1	1	0	0	2
9	1	1	1	0	3
10	1	1	1	0	3
11	1	1	1	0	3
12	1	1	1	1	4
13	1	1	1	1	4
14	1	1	1	1	4
15	1	1	1	1	4
16	1	1	1	1	4
17	1	1	1	1	4
18	1	1	1	1	4
19	1	1	1	1	4

### Making Contact

- one's actions are mirrored in the mind of the other
- they create a serial ordering that builds a shared sensorimotor project
- intensity reaches a climax of where simultaneous expression is given on both sides – togetherness.
- this concludes the project, the two now holding that completed shared act in memory.

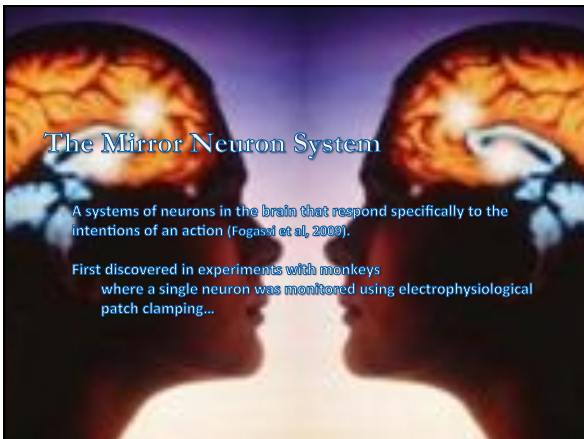
### Principles of Human Connection

1. Co-operation is the cornerstone of relations.
2. Movement is the root of communication.
3. We seek satisfaction through movement.
4. Meaning is co-created together in stories.
5. Humans are necessarily social creatures.

Delafield-Butt, J. T., & Trevarthen, C. (2013). Theories of the development of human communication. In P. Copley & P. Schultz (Eds.), *Handbook of Communication Science*. Berlin: Gruyter Mouton.

### Neurobiology of Social Connection

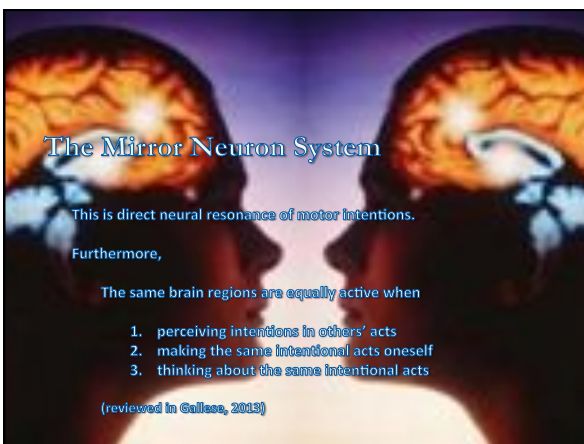
1. Expression of mind in action & cooperation
  - already discussed
2. The Mirror Neuron System
  - mind reading by 'direct neural resonance'
3. The Polyvagal System
  - social autonomic regulation



### The Mirror Neuron System

A systems of neurons in the brain that respond specifically to the intentions of an action (Fogassi et al, 2009).

First discovered in experiments with monkeys where a single neuron was monitored using electrophysiological patch clamping...

### The Mirror Neuron System

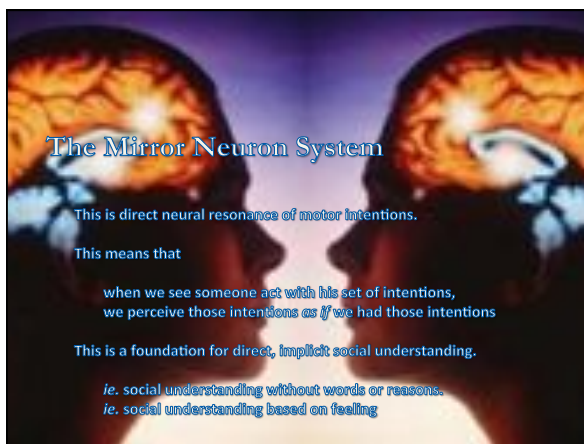
This is direct neural resonance of motor intentions.

Furthermore,

The same brain regions are equally active when

1. perceiving intentions in others' acts
2. making the same intentional acts oneself
3. thinking about the same intentional acts

(reviewed in Galasso, 2013)



### The Mirror Neuron System


This is direct neural resonance of motor intentions.

This means that

when we see someone act with his set of intentions, we perceive those intentions as if we had those intentions

This is a foundation for direct, implicit social understanding.

*ie. social understanding without words or reasons.*  
*ie. social understanding based on feeling*



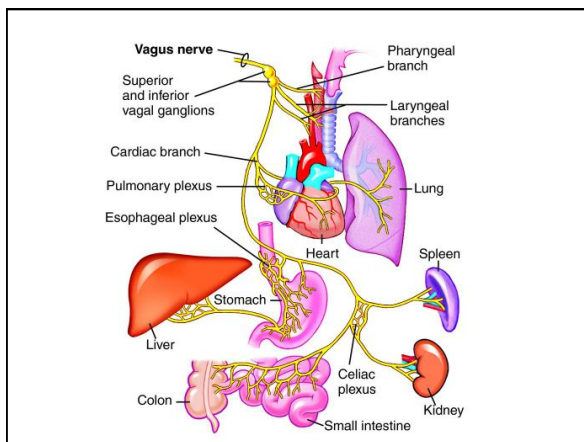
### The Polyvagal System

We also understand each other by **direct regulation** of one's autonomic system through facial expression (Porges & Furman, 2011)

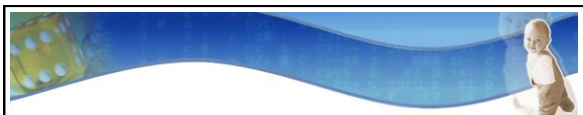
-- e.g. regulation of heart beat, arousal, anticipation to act, etc.

So that altogether we **feel the other's feelings and intentions**.

This is an affective and embodied understanding.



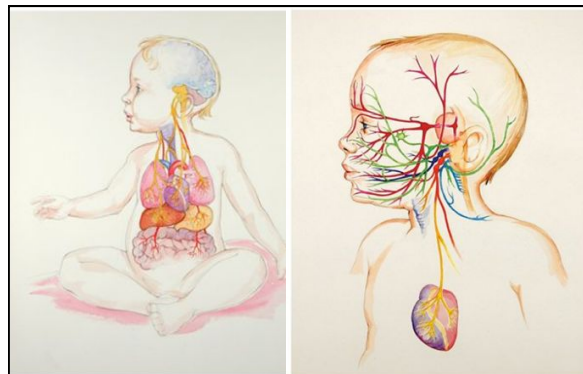




## The Polyvagal System


"... phylogenetic transitions resulted in brainstem areas regulating the vagus becoming intertwined with the areas regulating the striated muscles of the face and head. The result of this transition was a dynamic social engagement system with social communication features (e.g., facial expression, head movements, vocalizations, and listening) interacting with visceral state regulation."

(Porges, 2011, pp. 203)

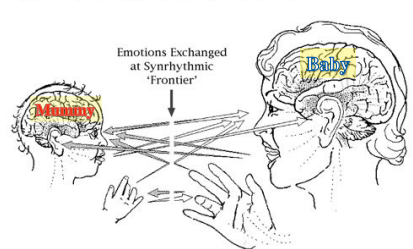


**Polyvagal Theory**  
Dorsal Vagal in Red, Ventral Vagal in Yellow

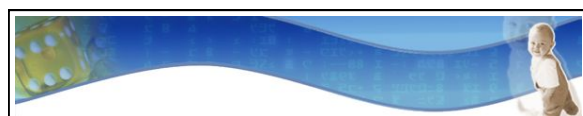
**Social Engagement System**  
Cranial Nerves V, VII, IX, X, XI  
Dorsal Vagal (X)  
An Unique Face-Voice-Heart Connection



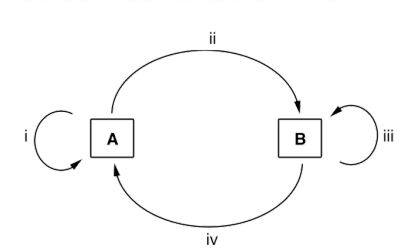
## How do we understand each other?



Emotions Exchanged at Synrhythmic 'Frontier'



## How do we understand each other?



**In sum:**

- Movement expresses our thoughts and feelings, and these are accessible to others.**
- Autonomic regulation of vital states are socially regulated (polyvagal system).**
- Cooperation with others achieves satisfaction in shared projects, understanding, and safety.**
- We are evolved inter-subjective creatures.**



*Thank you*  
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