The Emotional & Embodied Nature of Human Understanding: Making meaning in shared projects of discovery

Friday 9th September 2016

Children's Voices in Contemporary Australia

University of Melbourne

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Preamble.

In the end is the beginning….

"We choose to go to the moon,

because that goal will serve to organize and measure the best of our energies and skills,

because that challenge is one that we are willing to accept, one we are unwilling to postpone,

and one which we intend to win…"

(J. F. Kennedy, Rice University Speech, 12 September 1962)

Kennedy's Principle of Goal-Directed Social Organisation

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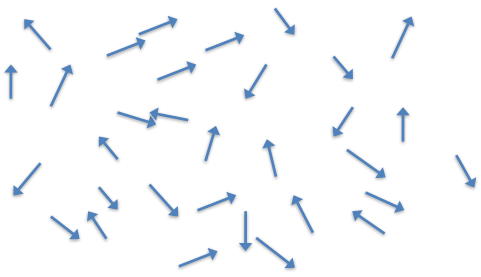
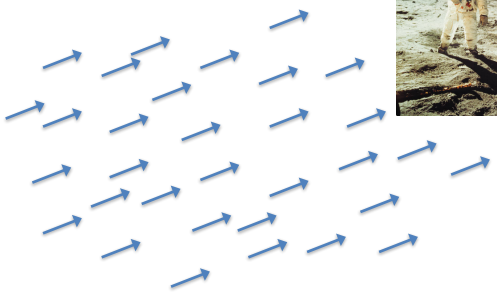
Kennedy's Principle of Goal-Directed Organisation

Independent Americans



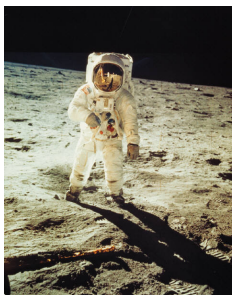
Kennedy's Principle of Goal-Directed Organisation

Americans with a Shared Goal



Organisation is Goal-Directed

- Common principle **within** and **between** individuals
- Generates **coherence** and synergistic **efficiencies**
- Enabled by **shared timing** and **coordination** of action
- Gives **value**, **understanding**, and **meaning** in **common purpose** (everybody belongs)



Overview – Fundamental Psychological Principles

- Principle 1: I like to move it!
  - Satisfaction in movement in acquiring 'goals'.
- Principle 2: I like to move it with you!
  - Satisfaction in coordinated interpersonal sensorimotor acts, *e.g.* dancing
- Together: This gives meaning-making and social understanding in intersubjective engagement

Overview – Fundamental Psychological Principles

- Principle 1: Movements are self-generated, affect-driven, prospective, intentional acts.
  - Satisfaction in movement in acquiring 'goals'.
- Principle 2: Movements are made in concert with social others, sharing intentions.
  - Satisfaction in coordinated interpersonal sensorimotor acts, *e.g.* dancing
- Together: This gives meaning-making and social understanding in intersubjective engagement.

Mind in Movement

"Every mental phenomena is characterised by what the Scholastics of the Middle Ages called the **intentional** (or mental) inexistence of an object, and what we might call... reference to a content, direction toward an object... or immanent objectivity." (Franz Brentano, 1874, p. 88).

Standard Model of Motor Intentionality as Means-Ends Relation

- Bower, Broughton, and Moore (1970) demonstrated that when a newborn infant's reach-to-grab was thwarted, by a visual illusion, distress ensued
- infants adjust the pattern of their kick to elicit action in an overhead mobile, if the conditions are manipulated so that minimal response is given, distress ensues (Angulo-Kinzler, 2001; Fagen and Rovee, 1976; Rovee-Collier et al., 1978; Rovee-Collier and Gekoski, 1979; reviewed in Zeedyk, 1996)
- even neonates move their arms to achieve particular sensory effects (van der Meer, 1997; van der Meer and van der Weel, 2011; van der Meer et al., 1995)

Standard Model of Motor Intentionality as Means-Ends Relation

Standard Motor Intentionality Development:

1. First, any spontaneous action generates sensory effect
2. Then, a particular intentional action generates a particular sensory effect

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But these experiments look at external sensory effects produced by objects…

Toward a Primary Sensorimotor Intentionality

Actions are Prospective by Necessity

- biomechanical inertial forces necessitate prospective control (Bernstein, 1967; von Hofsten, 1993; 2004)
- actions are expensive; to act economically and with adaptive effect they must be guided by prospective perception (von Hofsten 1993; 2004; Lee, 1998; 2009)
- all units of action must be 'goal'-directed (Lee 1998; 2009)

Toward a Primary Sensorimotor Intentionality

Brentano makes it clear that

"every mental phenomena includes something as object within itself" (1874, p. 88).

That 'something as object' is the born of the necessity of prospective control.

Every action anticipates a 'goal', *ie. an object* or its consequent effect

Every action presumes a motor-sensory contingency

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

Primary Sensorimotor Intentionality

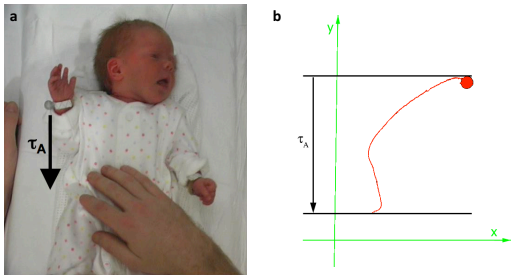
Pre-reflexive, pre-conceptual.

Future-oriented.

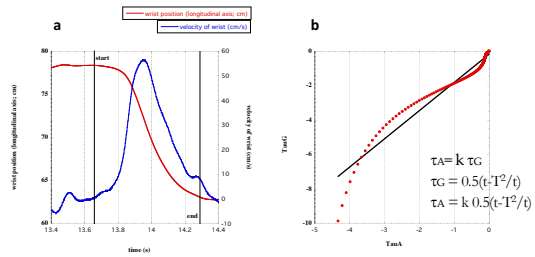
Simple.

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

Testing for Prospective Control

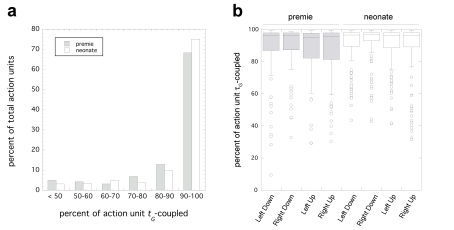


Testing for Prospective Control



Prospective Control in Limb Displacements

10 Normal Term Birth Babies; 480 movements
8 Prematurely Born Babies 'At Risk' for Neurodevelopmental Disorder, 384 movements



Primary Sensorimotor Intentionality:

A pre-reflective, pre-conceptual
motor intentionality,
perceptually prospectively controlled.

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

Intentional Agency Evident at Start of 2nd Trimester

- 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)
- anticipation of self-directed actions (Myowa-Yamakoshi & Takeshita, 2006)
- behavioural evidence of 'bicycling', reaching, grasping, exploring, etc. (Piontelli, 2010)

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Prospective control in Foetal Movements

- indication at 8-10 weeks in the first 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)
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- behavioural evidence of 'bicycling', reaching, grasping, exploring, etc. (Piontelli, 2010).

Primary Sensorimotor Intentionality

- motor intentionality of
  - a pre-conceptual, pre-reflexive, perceptually prospective kind
- that enables
  - development from a primary anoetic (not knowing/without intelligence) consciousness to
  - a secondary noetic (knowing/intelligence) consciousness (*cf.* Vandekerckhove & Panksepp 2010; Panksepp, 2011)
- perceptually aware:
  - (i) a viscerоceptive awareness of vital, somatic need;
  - (ii) a proprioceptive awareness of the body-in-action;
  - (iii) an exteroceptive awareness of the world of objects and other animals

Primary Sensorimotor Intentionality

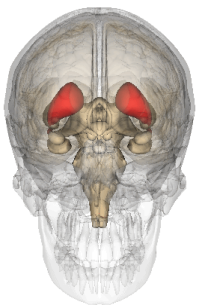
- enables development of 'sensorimotor intelligence' (Piaget, 1953; 1954)
- through repetition of successful intention action
  - this is what Baldwin (1895) called the 'circular reaction'

"The self-repeating or 'circular' reaction... is seen to be fundamental and to remain the same, as far as structure is concerned, for all motor activity whatever: the only difference between higher and lower function being, that in the higher, certain accumulated adaptations have in time so come to overlie the original reaction, that the conscious state which accompanies it seems to differ per se from the crude imitative consciousness in which it had its beginning."

(Baldwin, 1895, p. 23).

The Centrencephalic Me

- upper brain stem and midbrain region is seat of the integrative 'core self' (Merker, 2007; Northoff & Panksepp, 2008; Panksepp & Northoff, 2009; Panksepp, 2011)
- the core SELF at the midbrain and upper brain stem is
  anatomically subcortical, but
  functionally supracortical.
- connected to skeletomusculature by *ca.* 14 weeks G.A.
- controls primary prospective action
- conscious and acts with felt appraisal (Penfield & Jasper, 1954)
- site of affective learning and memory (Winn, 2012)
- evidenced in anencepaphalic children
- and foetal prospective motor control before cortical lamination



The Centrencephalic Me

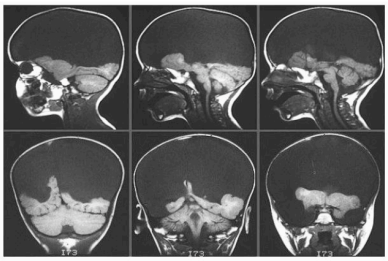


Figure 8. Saggittal and frontal magnetic resonance images of the head of a child with hydranencephaly. Spared ventromedial occipital and some midline cortical matter overlies an intact cerebellum and brainstem, while the rest of the cranium is filled with cerebrospinal fluid. Reprinted with the kind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

The Centrencephalic Me

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

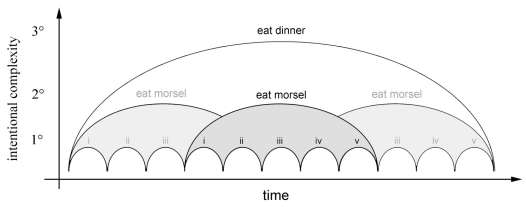
- a cortex is not necessary to
  - be conscious,
  - have feelings,
  - act with intentions,
  - perceive and appraise the environment,
  - engage socially and purposefully,
  - learn
- *c.f.* surgically decerebrate cats and rats (Wood, 1964)

Low, P. (2012). The Cambridge Declaration on Consciousness. J. Panksepp, D. Reiss, D. Edelman, B. Van Swinderen, P. Low & C. Koch (Eds.), *Francis Crick Memorial Conference on Consciousness in Human and non-Human Animals*. Churchill College, Cambridge.

Development of Sensorimotor Intentionality

- cognitive development is a development from *single* action intentions (discreet actions) to *projects* of action units (serially ordered actions) (Pezzulo, 2011)
- serially-ordered action units organised from the beginning to produce distal goals (Jeannerod, 1999; Fogassi et al, 2005)
  - e.g. reach to grasp to place *vs.* reach to grasp to throw
  - n.b. deficit in prospective control in autism

Hierarchical Organisation of Sensorimotor Intentionality



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Hierarchical Organisation of Sensorimotor Intentionality

Table 1
Units of sensorimotor intentionality.

Level	Unit type	Description	Temporal range (ms)
Primary	Action unit	A single continuous velocity to a goal, for e.g. an arm movement to a body-space or physical object goal	*ca.* 200–1200
Secondary	Proximal project	Coordination and serial organisation of multiple action units for a proximal goal, for *e.g.* reach-to-grasp or reach-to-grasp-to-eat	*ca.* 1000–3000
Tertiary	Distal project	Coordination and serial organisation of proximal projects to achieve a higher, abstract, distal goal, for e.g. cooking a dinner	>3000

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Sensorimotor Intentionality

- Sensorimotor Intentionality develops:
  - first intentionality in single 'action units' (**primary**)
  - then envelopes multiple action units to make (**secondary**) projects
  - then projects of projects of action units (**tertiary**)
  - and so on as the child develops further cognitive skills, enable sophisticated planning for prospectively controlling the present moment to achieve future goals
- Tools of memory, planning, abstract reasoning and creative imagination enable more complex and abstract sensorimotor projects.

Neonatal Sensorimotor Intentionality

- **Tertiary Sensorimotor Intentionality – NOT YET PRESENT**
  - very rudimentary, vague
  - requires memory, planning, abstract reasoning and imagination
  - enables distant goals to organise action in the present.
    - e.g. studying now for a degree or job in the future
- **Secondary Sensorimotor Intentionality – RUDIMENTARY**
  - establishing and developing
  - enables simple sensorimotor projects, e.g. walking or grasping
    - e.g. motility toward the breast, coordinated motor acts in social engagements
- **Primary Sensorimotor Intentionality – EVIDENT**
  - established and developing
  - developing precision with improved muscle tone and experience-dependent neuromotor maturation
  - simple intentional action
    - e.g. arm gesture, sucking control, gaze & head orientation

Toddler Sensorimotor Intentionality

- **Tertiary Sensorimotor Intentionality – ESTABLISHING**
  - rudimentary beginnings becoming substantiated
  - requires memory, planning, abstract reasoning and imagination
  - enables distant goals to organise action in the present.
    - e.g. studying now for a degree or job in the future
- **Secondary Sensorimotor Intentionality – EVIDENT**
  - established and developing
  - enables simple sensorimotor projects, e.g. walking or grasping
    - e.g. motility toward the breast, coordinated motor acts in social engagements
- **Primary Sensorimotor Intentionality – ESTABLISHED**
  - established and improving
  - developing precision with improved muscle tone and experience-dependent neuromotor maturation
  - simple intentional action
    - e.g. arm gesture, sucking control, gaze & head orientation

Child Sensorimotor Intentionality

- **Tertiary Sensorimotor Intentionality – ESTABLISHED**
  - rudimentary beginnings becoming substantiated
  - requires memory, planning, abstract reasoning and imagination
  - enables distant goals to organise action in the present.
    - e.g. studying now for a degree or job in the future
- **Secondary Sensorimotor Intentionality – ESTABLISHED**
  - established and developing
  - enables simple sensorimotor projects, e.g. walking or grasping
    - e.g. motility toward the breast, coordinated motor acts in social engagements
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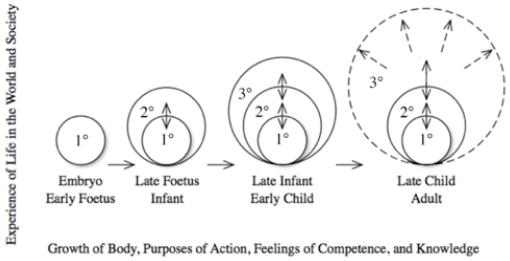
    - e.g. arm gesture, sucking control, gaze & head orientation

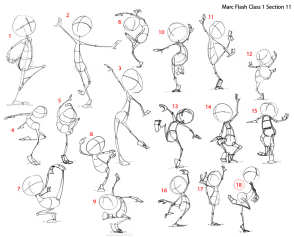
Sensorimotor Satisfaction: Joy in Successful Secondary Sensorimotor Intentionality

Development of Human Consciousness



Trevarthen, C., & Delafield-Butt, J. T. (2016). Development of Consciousness. In B. Hopkins, E. Geangu & S. Linkenauger (Eds.), *Cambridge Encyclopedia of Child Developmnet*. Cambridge: Cambridge University Press.

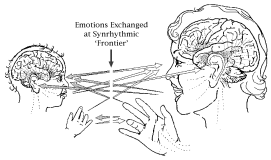
Principle 1: I like to move it.



inherent satisfaction or joy in successful solo sensorimotor acts

(moving, grasping, walking, skiing, climbing, tight-rope walking)

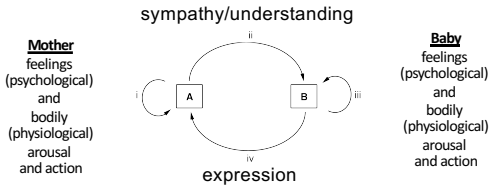
Principle 2: I like to move it with you.



requires two sensorimotor systems with two timing systems to be **in step and in tune** with each other to generate shared meaning and joy.

Trevarthen, C., Aitken, K. J., Nagy, E., Delafield-Butt, J. T., & Vandekerckhove, M. (2006). Collaborative Regulations of Vitality in Early Childhood. In D. Cicchetti & D. J. Cohen (Eds.), *Developmental Psychopathology* (pp. 65-126). New York: John Wiley & Sons.

Co-operation after birth to share meaning



These events are made in cycles and when completed successfully, **satisfaction and joy** emerge.

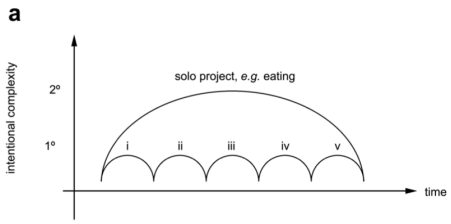
From solo sensorimotor projects to shared meaning-making

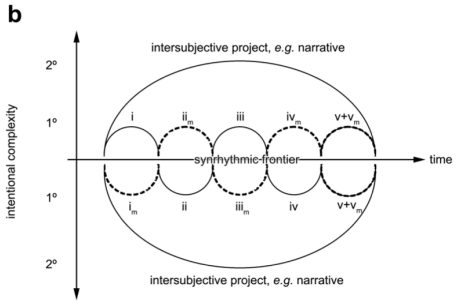
"There is a series of hierarchies of organization; the order of vocal movements in pronouncing the word, the order of words in the sentence, the order of sentences in the paragraph, the rational order of paragraphs in a discourse. Not only speech, but all skilled acts seem to involve the same problems of serial ordering, even down to the temporal coordination of muscular contractions in such a movement as reaching and grasping. Analysis of the nervous mechanisms underlying order in the more primitive acts may contribute ultimately to the solution even of the physiology of logic."

- Lashley, 1951, The problem of serial order in behavior. in Jeffress (ed.) *Cerebral Mechanisms in Behavior.* Wiley

Embodied, Non-verbal Narratives

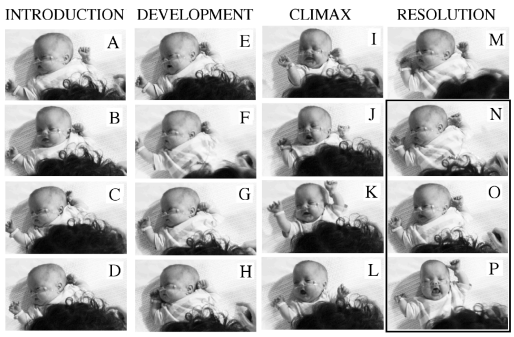
- narratives have a discreet, finite nature like goal-directed sensorimotor projects
- they
  (i) initiate toward a shared, intersubjective 'goal'
  (ii) build in intensity as the project proceeds
  (iii) reach a climactic point of maximal tension and release,
  (iv) conclude and appropriate the effect of their activity, giving something new.
- the intersubjective 'goal' is the 'coming together' of two agencies in common meaning, creating coherence of affect, intention, and action between them (Stern, 1985; Trevarthen & Delafield-Butt, 2013)





Baby B & His Mother in the Neonatal Unit (born at 28 wks, now at 36 wks GA)

Delafield-Butt, J.T., & Trevarthen, C. (2015). The ontogenesis of narrative: From moving to meaning. *Frontiers in Psychology, 6.* doi: 10.3389/fpsyg.2015.01157



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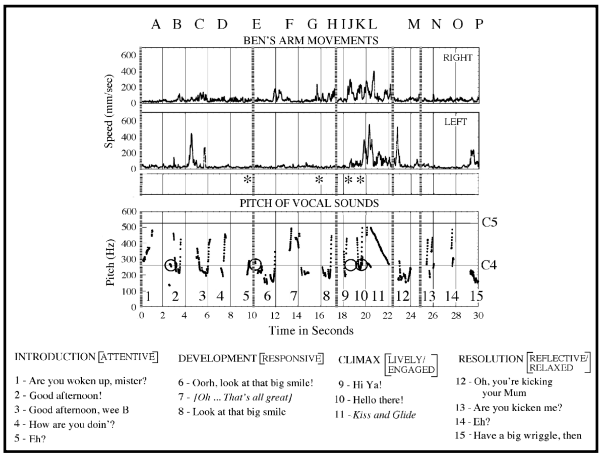
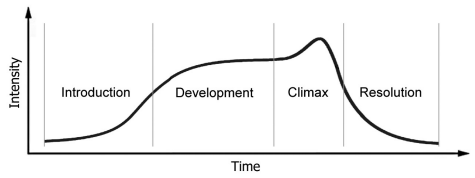


Narrative Cycle



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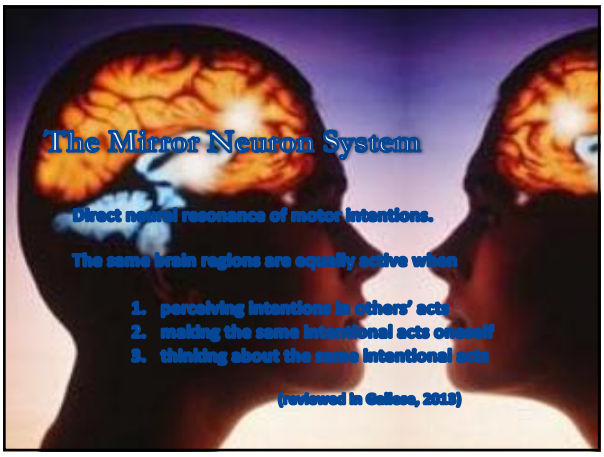
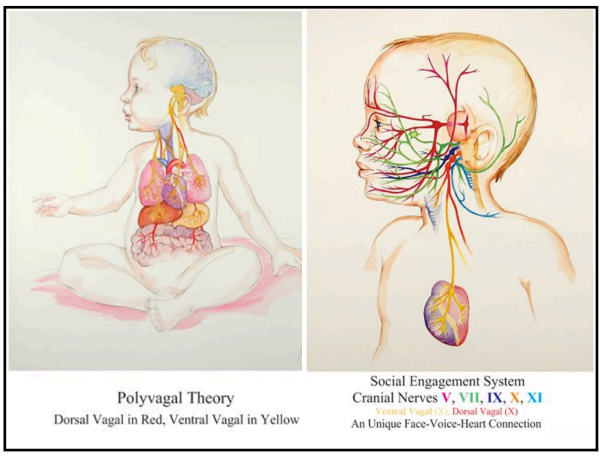
Neurobiology of Embodied Social Meaning-Making

1. Mind in action
   - generative, affective, intentional engagement
2. Mirror Neuron System
   - mind reading by 'direct neural resonance'
3. Polyvagal System
   - direct social autonomic regulation





The Polyvagal System

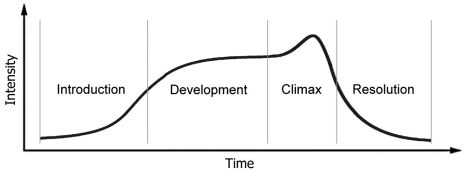
Direct social regulation of autonomic systems through facial expression and gesture (Porges & Furman, 2011)

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

Altogether we **feel the other's feelings and intentions** through direct social perception.

This is an affective and embodied social understanding.

Narrative Cycle



Trevarthen, C., & Delafield-Butt, J. T. (2013). Biology of Shared Meaning and Language Development: Regulating the Life of Narratives. In M. Legerstee, D. Haley & M. Bornstein (Eds.), *The Developing Infant Mind: Integrating Biology and Experience*). New York: Guildford Press.

Co-created Narrative Projects

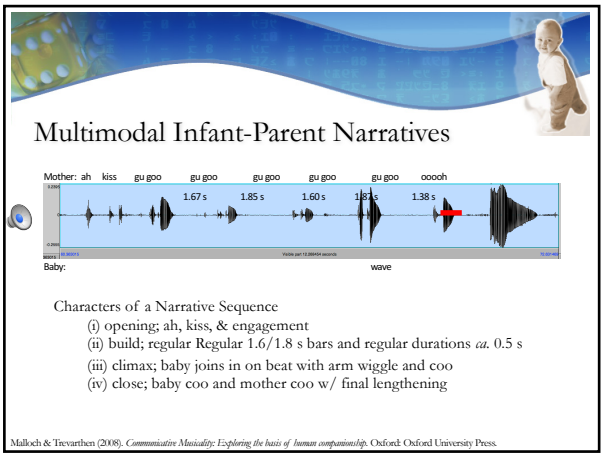
- narratives are units with a discreet, finite structure like goal-directed sensorimotor projects
- they
  (i) **initiate** toward something, a 'goal'.
  (ii) **build** in intensity as the project proceeds
  (iii) **climax** with maximal tension and release,
  (iv) **conclude** and appropriate the effect of their activity, giving something new.
- the 'goal' is mutual understanding, creating coherence of affect, intention, and action between.

Co-created Narrative Projects

- these form social schemas (*c.f.* Piaget)
- experience with individuals in contexts gives discreet goals and expectancies
  - enabling anticipation and prospective planning
- their experience is held in memory
- they enable learning the patterns and rituals of a culture
  - e.g. classroom culture, nursery room culture, primate lab culture
- they enable learning the patterns of individuals, made in special relationship
  - can build trust, confidence, and for the foundation of learning.

Sharing Intentions and Sharing Time in a Common Project

- individual sensorimotor intentions directly perceptible by the other by direct neural resonance (Gallese et al., 2009; Gallese, 2000; Gallese and Sinigaglia, 2010)
- enables the experience of the other within the oneself, direct intersubjectivity (Bråten, 2009, Gallagher, 2008)
- arousal, interest, and intention between individual coordinated through the polyvagal system



Narratives Are Embodied Projects of Meaning-Making

- the same narrative structure is found in all shared projects, even with objects and in learning
- shared goals structure the project
- they are produced through rhythmic cycles of action, expression, or gesture
- they reach a moment of peak excitation at their goal
- they conclude to quiescence again
  - the memory of the act held in special memory

Embodied Narrative in Learning: Descending the Stairs, and Counting

The case of a Nurture Group teacher and her student descend the stairs.

- **Introduction** as the teacher explains the task ahead.
- **Development** as they descend the stairs, their footsteps falling into rhythm as they count the stairs together.
- A **climax** marked by excitement in vocal pitch as they reach end, quickly
- **concluding** as they depart.

Delafield-Butt, J., & Adie, J. (2016). The Embodied Narrative Nature of Learning: Nurture in school. *Mind Brain & Education*, in press.

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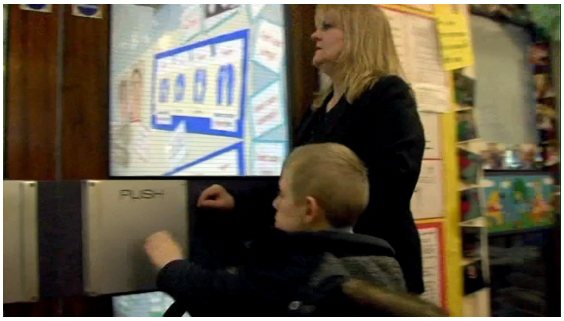

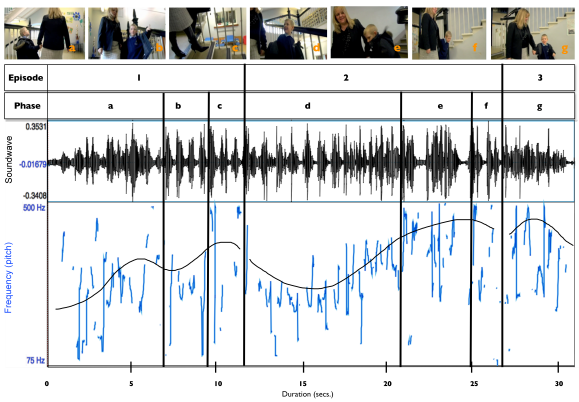

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Embodied Narrative: Learning to Play Connect 4

A Nurture Group teacher and her student engage in Connect 4 gameplay:

- 5 games are played, each with a narrative structure of introduction, development, climax, and resolution
- focus on 1 game to illustrate its musicality and rhythm
- shared joy on completion leads to learning these patterns
- learning is process

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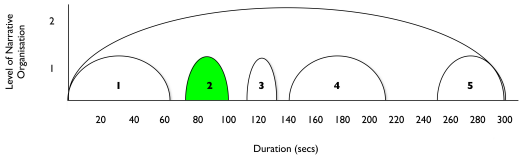
Over-arching narrative of the complete game play session



- each gameplay makes a narrative
- and altogether they make a narrative of game playing that lasts just over 4 minutes

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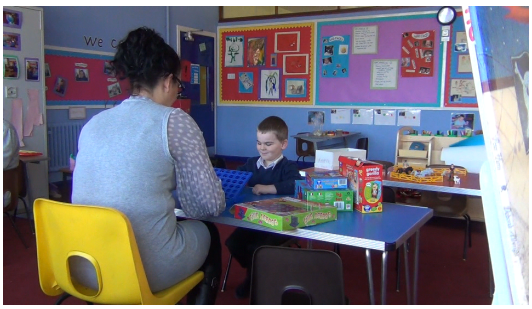
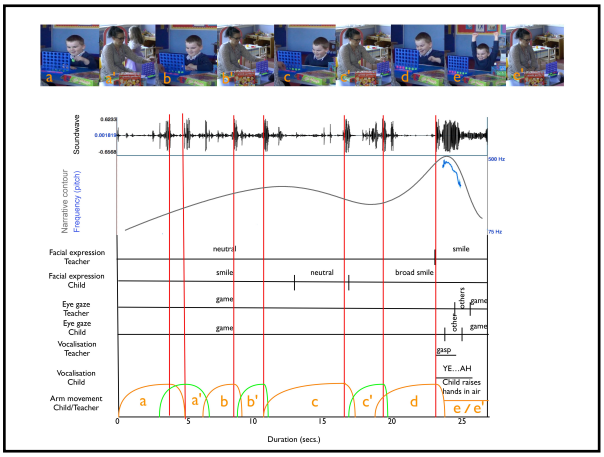
Embodied Narrative: Learning to Play Connect 4





Two Types of Cognition (Bruner, 1990)

(1) Narrative

- 'line mode' (Donaldson, 1992)
- proceeds through time
- necessarily embodied
- built on the structure of experience
  - Situation, motivation, perception, action, and its result
- always coloured with vital affectivity

(2) Logico-scientific

- conceptual
- static, timeless
- becomes disembodied
- built on knowledge from experience
  - accumulation of the result of action
- abstract, generalised facts
  - not necessarily situated, affective, motivated, etc.

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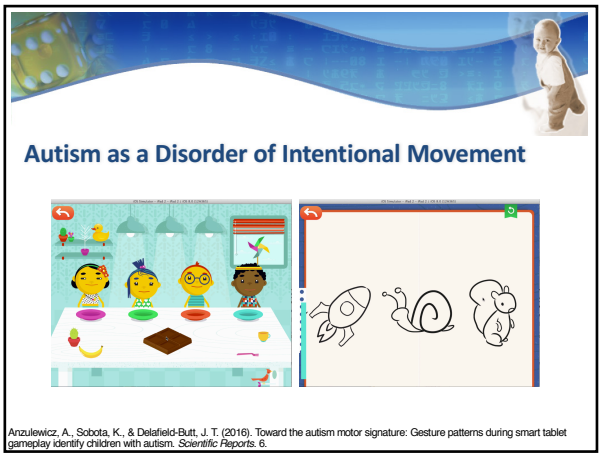
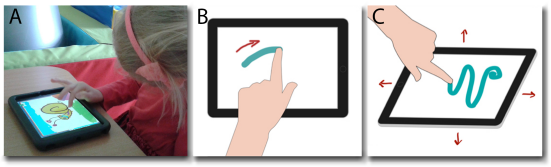


Autism as a Disorder of Intentional Movement



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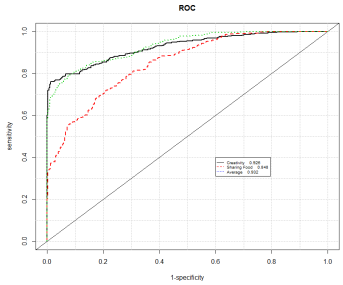
Autism as a Disorder of Intentional Movement

- **motor patterns in iPad play predict autism with 93% accuracy**



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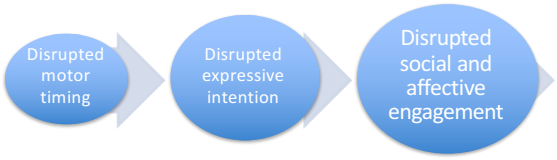
Autism: A Disorder in Intentional Movement and Affective Engagement



Trevarthen, C., & Delafield-Butt, J. T. (2013). Autism as a developmental disorder in intentional movement and affective engagement. *Frontiers in Integrative Neuroscience*, 7.

Initiation Through Imitation

Engagement 1

Initiation and Build Through Imitation.

Engagement 4

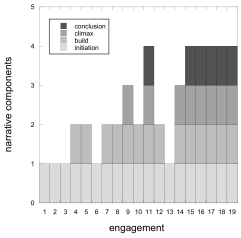
A Complete, Co-created Narrative

Engagement 11

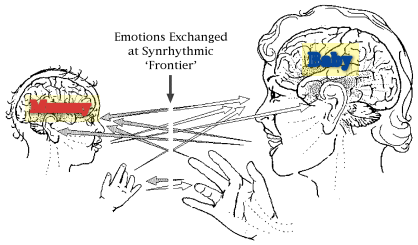
Mutual Joy in Intersubjective Unification

Engagement 15

Developing Trust and Meaning in Embodied Narratives



Shared Understanding – Mind Reading



Trevarthen, C., Aitken, K. J., Nagy, E., Delafield-Butt, J. T., & Vandekerckhove, M. (2006). Collaborative Regulations of Vitality in Early Childhood: Stress in Intimate Relationships and Postnatal Psychopathology. In D. Cicchetti & D. J. Cohen (Eds.), *Developmental Psychopathology* (pp. 65-126). New York: John Wiley & Sons.

Summary

- Agency
  - Action under one's own power for ones own purpose.
- Embodiment
  - Experience structured by the body, its needs and capacities made in motor action.
- Affectivity
  - Evaluative appraisals of vital value.
- Intelligence
  - Learning meaning of objects, persons and actions, through narratives of action

Making Contact

- one's feelings and intentions made in actions are mirrored in the mind of the other (*e.g.* Winnicott, 1971) by 'direct neural resonance' (Gallese 2001, 2004; Gallagher, 2008)
- they create a serial ordering that builds a shared sensorimotor project (Trevarthen & Delafield-Butt, 2013)
- intensity reaches a climax of where simultaneous expression is given on both sides – togetherness (Delafield-Butt & Trevarthen, 2013; 2015)
- this concludes the project, the two now holding that completed shared act in memory, generating attachment and companionship
- the shared act becomes an 'object'; a social sensorimotor schema giving social, affective value in embodied relations (Reddy, 2008; Delafield-Butt & Adie, 2016)

Conclusions

- There exists an *invariant* sensory-motor intentionality, disrupted in autism
  - structures experience-dependent learning and development of cognition and social cognition.
  - 1° Level, single intention-actions (pre-conceptual)
  - 2° Level, projects of intention-actions (becoming conceptual)
  - 3° Level, projects of projects of intention-action (conceptual)
- Sharing narratives with common goals generates meaning and value
  - generates learning, trust, and companionship
  - creates shared joy and understanding
  - giving embodied, affective meaning
  - these shared stories are necessary for human life to thrive

Narrative Structure is Invariant

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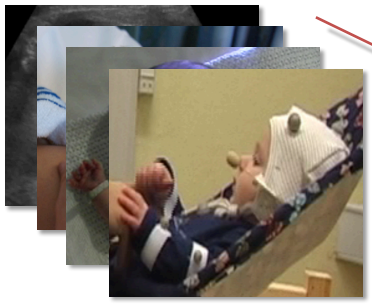

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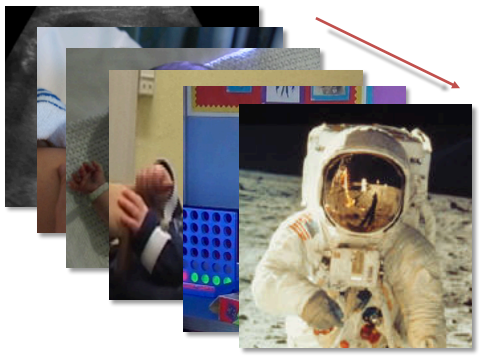


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