Affective HRI: a potential impedance mismatch

cAESAR 2020

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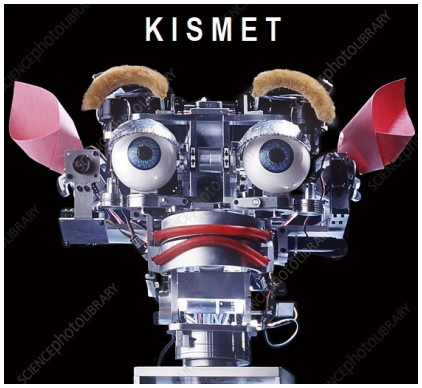
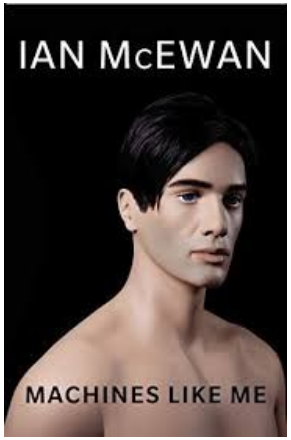
Affective HRI . . .

"... our approach is designed to support a **rich and tightly coupled dynamic between robot and human**, where each responds contingently to the other **on an affective level**."

Cynthia Breazeal 2001.



... progress



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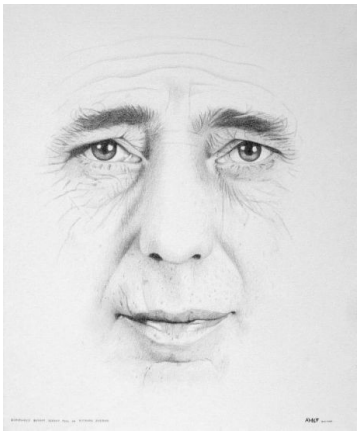
Human | Robot

wetware
neurons

hardware
connectivity



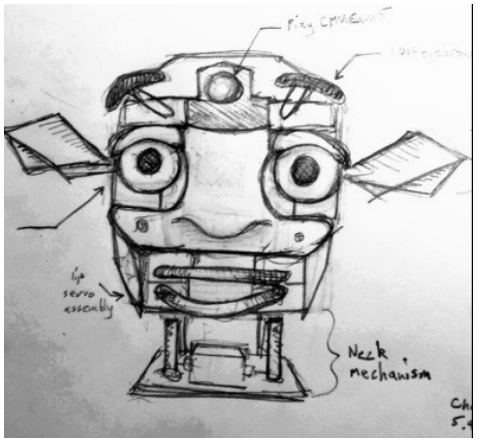


exhibit & recognise emotions

simulate & recognise emotions

Perceptual data
+ algorithms

Data
+ algorithms

+ **extra** **?**

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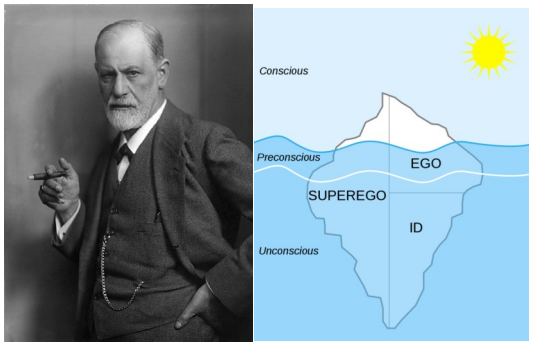
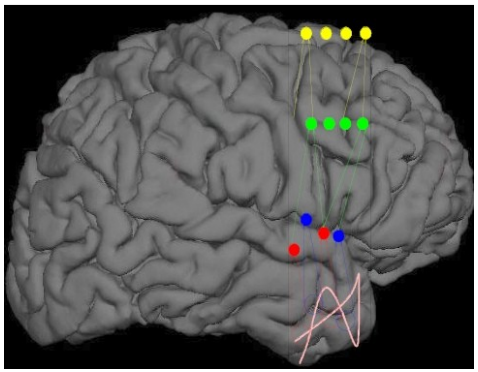
Two approaches …



Psychiatric / psychology
expansive basis

V.

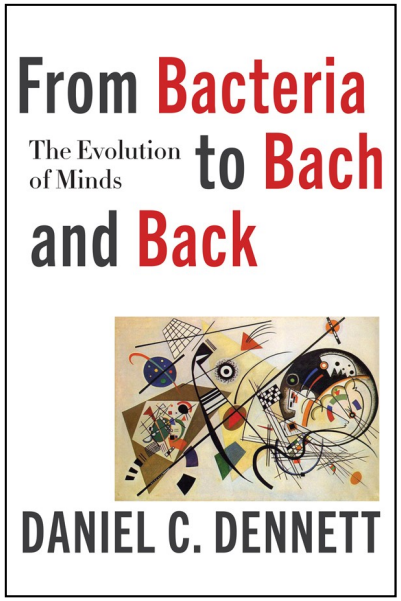


Physical, chemical
algorithmic reductionist
basis

We'll maintain an **algorithmic, reductionist approach**
by adopting **Dan Dennett's** conception of **algorithmic substrates**

Algorithmic basis for humans?

Dan Dennett's conception of **human beings** in terms of layered **algorithmic substrates.**



Dennett's Progression	Algorithmic Substrate		Awareness?
4. Gregorian	Nested Virtual Machines		User Illusion (awareness/ rationality)
3. Popperian	Hypotheses generate & test	Hierarch-ical Bayesian Predictive coding	Feasible Automata
2. Skinnerian	Reinforcement learning		
1. Darwinian	Representational learning		

Extra

Here the difference between **exhibiting** and **simulating emotion** may eventually **dissolve** if emotions are just emergent features of complex systems

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Dan Dennett: Awareness as an Evolved User-Illusion

Given those layers of algorithmic substrates – the personal awareness characteristic of **affect/emotions** in addition requires the **trading of reasons** within **encounters**:

the practice of sharing information in communicative actions with others, **giving and demanding reasons,** is what **creates our personal user-illusions**

User-illusion: the projection on to the body of mood, emotion and affect, rather than them having an effect on the mind/brain.

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User-Illusion ... but

… but for **infants,** and people such as those with **dementia**

‘***giving and demanding reasons***’ is **infeasible**.

Why not consider **affect as a co-founding constituent** rather than mere projection of user-illusions.

How to do that with minimum impact on Dennett’s well-considered position?

Might each of us harbour ‘**proto-reasons**’ **grounded** by specific affects which duly elicit ‘**proto-user-illusions**’?

Grounding by affect

Here we consider **grounding** only the **most basic affect**: **touch** in the hope it may provide insights for such other affects such as pain, hunger, fear heat.

Touch is posited as the '**proto-reason**' that grounds awareness of a material reality comprising macroscopic solids and which simultaneously elicits the '**proto-user-illusion**' of tactile sentience.

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Algorithms, infant development

Evolutionary mechanism	Trial & Error	Natural Selection / genetic replication					Memetic replication, Language, Thinking tools	
Dennett's Creature		**Darwinian**		**Skinnerian**		**Popperian**	**Gregorian**	
Algorithmic substrates		Representational Learning						
				Reinforcement Learning				
						Predictive Coding / Bayesian networks		
							Nested Virtual Machines	
Infant development			CONCEPTION	Reflexive agency	BIRTH	Sensor-motor stage	Preoperational stage	Hands-on-Science

Onset of trading reasons

How about:
proto-reasons
proto-User-Illusion?

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Ontological impetus

On first encountering empty space and returning into contact with external surfaces: mother's arms etc. Three factors may coalesce in an infant:

- **instantiation** of the Bayesian **hyper-prior**, in the PC substrate, to stipulate no two solids occupy the same physical space – see A.Clarke 2013

- '**proto-reason**': grounding of explicit spatial **comprehension** – anchoring subsequent empirical learning from evidential chains.

- '**proto-user-illusion**': onset of **contact-**/tactile- **sentience** in the circuits that mediate the "resonant loop between body states and brain states" – e.g. those serving fingers, lips and body surfaces – providing an 'ontologically underwriting/grounding', at least while those loops are not inhibited by sleep or adaptation.

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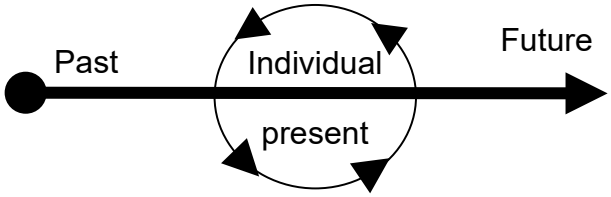
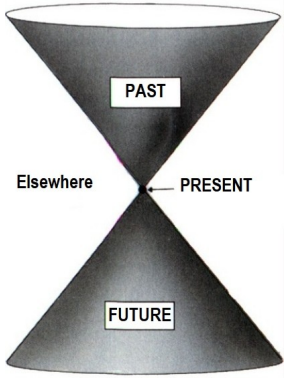
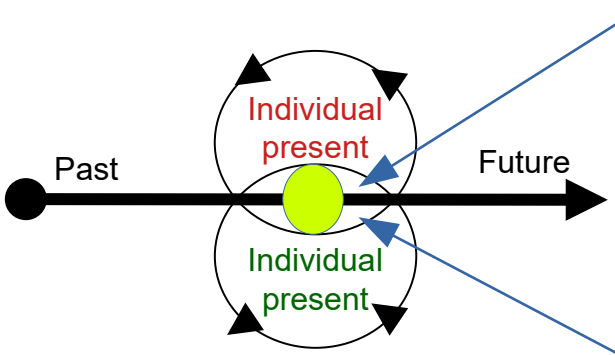
The phenomenal present

Individual experiential timeline





Encounter



window of opportunity to **trade reasons**

+ dynamic contingent **affective interaction**

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Impedance mismatch

Affect is no longer projected purely from the brain to body but rather exists in the "**resonant loop between body states and brain states**" with coupled **{grounding, sentience}** persisting in the loop – at least while uninhibited by sleep or adaptation.

Such a coupling would bring a qualitative aspect to a loop viewed usually as conveying purely quantitative sensory information. This qualitative aspect being 'seeded' early in life is of an ostensibly non-algorithmic nature.

This invites the prospect of an **impedance mismatch** for Affective HRI where non-algorithmic qualities get pursued on a purely algorithmic basis.

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Affective HRI

Today this may involve **deep-learning** algorithms trained on large labeled data-sets of facial expression and gestures:

Where the expectation is that the **learnt labeling** will generalize even to those **individuals that have no capacity to label**. Here we have a duty to consider the limits of mechanistic / algorithmic explanation.

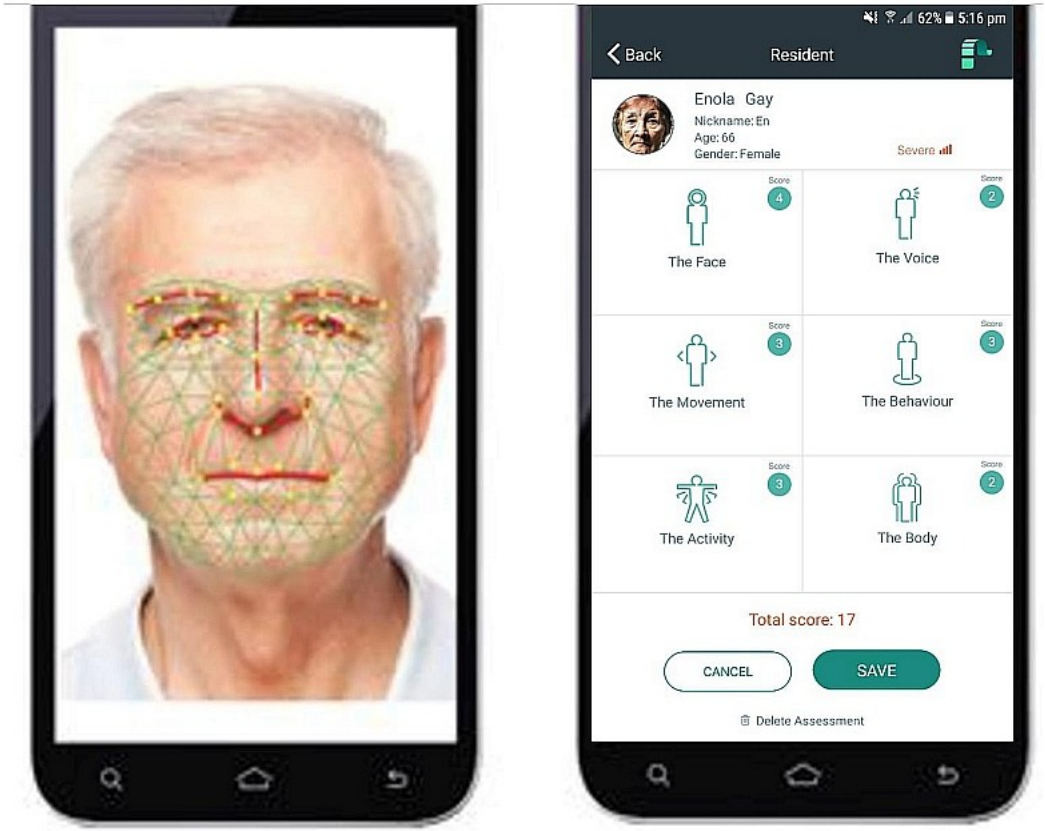
Indeed it may remain prudent when developing future robotic care-givers and nurses to ensure that any such learnt labeling continues to be **integrated into a wider context** that includes a significant human interpretive element.

Affective HRI

… integrated into a wider context that includes a significant human interpretive element.

Finally, it is heartening to see such wider context being adopted in the development of a healthcare app that seeks to estimate pain on the faces of individuals with moderate-to-severe dementia

ePAT Pain Assessment Tool 2017



M. Atee , K. Hoti, J.D.Hughes, 2017. Psychometric Evaluation of the Electronic Pain Assessment Tool: An Innovative Instrument for Individuals with Moderate-to-Severe *Dementia*. *Dement Geriatr Cogn Disord* 44:256–267. DOI: https://doi.org/10.1159/000485377.

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