Affective HRI: a potential impedance mismatch

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ABSTRACT

This position paper explores algorithmic considerations underlying affective Human Robot Interaction (HRI) with attention given to the case of individuals unable to communicate rationally. First we follows Dennett's algorithmic conception of Mind before elaborating an alternative by which Affect gains the role of co-founding constituent. This raises the prospect of an impedance mismatch for Affective HRI where non-algorithmic qualities get pursued on a purely algorithmic basis. Possible consequences are weighed.

CCS CONCEPTS

• Computing methodologies~Evolutionary robotics • Computing methodologies~Cognitive robotics

KEYWORDS

HRI, Affective Interaction, User Illusion, Algorithms

ACM Reference format:

1 Introduction

HRI has long pursued more natural, efficient and intuitive means by developing "a rich tightly coupled dynamic between robot and human, where each responds contingently to the other on an affective level" [1]. Today the field is closer to developing robots capable of detecting, interpreting and responding to human expressions and gestures while simultaneously mimicking such expressions themselves – thus 'closing the loop'. This acceptance of the central importance of human affects, housed beneath the face or inside the gesturing body, re-expresses an anthropomorphic tendency: One that runs counter to the scientific orthodoxy that has long advocated the 'disanthropomorphization of the world' [2] – whereby knowledge-seeking individuals methodically suppress or demote their affective internal conception of the world in favor of external, scientific means of expression. Wilfred Sellars [3] formalized the latter world-view as the *Scientific Image*, with the former termed the *Manifest Image*: A distinction further developed in Dan Dennett's reasoning that *User-Illusions* [4] can account for any phenomenological experience conveyed within our Manifest Image: Effectively implying that robots which seek meaning in affective signals are no longer directly dealing with material reality, but are instead interacting with an illusory construct – one which may, or may not, be understood or even expressible in the algorithmic terms amenable to robotics. Although this may seem outlandish it stems from algorithmic consideration, as discussed below.

2 Algorithmic considerations

The algorithmic processing of data, familiar to workers in HRI, belongs firmly within the Scientific Image. When explaining the scientific nature of Mind Dennett invokes algorithmic considerations [4]: Table 1 illustrates the layering of one algorithmic substrate upon another: progressing from, representational learning, reinforcement learning, hypothesis generate-and-test, hierarchical bayesian predictive-coding [5] and finally to nested virtual machines. Each added layer facilitates a newly evolved form of agency (or creature) that Dennett identifies as Darwinian, Skinnerian, Popperian and Gregorian: each bringing further selective advantage for survival [4] From an informational stance, such behaviors are feasible without need to invoke affects such as pain, hunger and fear within the agent. Yet anthropomorphically it is hard to dissuade ourselves that when, for example,as newborn infants, we exhibited analogous behavior we did not feel such affects. We each have a credible path from our earliest existence until the present where we are convinced we do feel them – however our notion lies in the Manifest rather than the Scientific Image. Awareness of self, of the type implicit in affect, must wait – in Dennett's account – until the emergence of User-Illusions: following the transit from Popperian to Gregorian creature which requires the upper algorithmic substrate and language-like interactions and thus duly occurs later in childhood [6]. In brief, hierarchical bayesian predictive-coding instantiates perceived object-models within the brain [7] which then emerge as things that we can express to others – and in the act of

expression gain our own awareness of them and the hypotheses they regard. As Dennett puts it: the 'practice of sharing information in communicative actions with others, giving and demanding reasons, is what creates our personal user-illusions' [4]. Essentially, such user-illusions involve the projection on to the body of mood, emotion and affect, rather than them having an effect on the mind/brain.

3 Affect as co-founding constituent

A diametric alternative is to consider affect as a co-founding constituent rather than the projection of user-illusions. Yet how might this be achieved with minimum impact on Dennett's well-considered position? The goal is important when considering Affective Interaction involving infants, and people with autism: i.e. where 'giving and demanding reasons' is infeasible. Might those individuals harbor 'proto-reasons' *grounded* by specific affects – which duly elicit 'proto-user-illusions'? Detailed consideration of the grounding by affects of pain, hunger and fear is beyond the scope of this article – where we consider only the most basic affect: touch-contact, in the hope it may provide insights for such other affects.

Felt touch is here posited as the 'proto-reason' that grounds awareness of a material reality comprising macroscopic solids and which simultaneously elicits a 'proto-user-illusion' – i.e. a tactile sentience. This could first emerge when an infant can no longer occupy the same physical space as its mother – on first encountering empty space and returning into contact with outside surfaces: e.g. mother's arms [8]. This would occur at the developmental onset of Popperian, rather than Gregorian agency, and would constitute the instantiation of a Bayesian hyper-prior, in the predictive-coding substrate: in particular the one that requires no two solids occupy the same physical space [7]. Ontologically this would anchor explicit spatial comprehension [6] and ground later empirical knowledge acquired via evidential chains [9]. Here, affect is no longer projected purely from the brain to body but rather exists in the "resonant loop between body states and brain states" [10] 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.

4 Conclusion – an impedance mismatch

Upon this tentative basis, one might posit further couplings to ground the neuro-physiological loops implicated in other affects such as pain and hunger – with, in each case, a qualitative aspect being 'seeded' early in life and being of an ostensibly non-algorithmic nature. This view, invites the prospect of an impedance mismatch for Affective HRI where non-algorithmic qualities get pursued on a purely algorithmic basis.

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 [11]. 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. 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 [12].

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		

Table 1. Dennett's progression (ascending the table) of creatures each conceived by layering additional algorithmic substrates upon those below. For Dennett awareness and rationality only emerge at the higher layer but in the guise of a *User Illusion* – conceptually realized within nested VMs carrying out Hierarchical Bayesian Predictive Coding.

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