Cognitive Phenomenology: a Challenge for Neuromodelling

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Abstract. Cognitive Phenomenology (CP) is the suggestion that conventional (or Sensory) Phenomenology (SP) only deals with the "what it's like" of sense/feeling experience (such as being conscious of a red rose or having a headache) but is silent on the "what it's like" of cognitive experience (such as 'understanding' a mathematical equation) that is, a cognitive type of phenomenology. The existence or otherwise of CP is the subject of a contemporary controversy and the nature of this is briefly discussed in order to show that modelling via neural automata suggests a resolution of the controversy. To achieve this, previously introduced neural automata models used with SP are recalled to indicate that CP might be identified as a particular use of the state structures of the SP neural automaton.

1 INTRODUCTION

Bayne and Montague [1] and Galen Strawson [2] among others contend that cognitive experiences and experiential, sense/feeling ones are mutually exclusive. That is, there is something it is like to understand an image which is different from the something it is like to be conscious of that image. Finding computational models of this is important as cognitive mechanisms of understanding, thinking and finding meaning are areas of weakness in computational domains. Dissenters object to CP for several reasons ranging from assertions that cognitive experiences have no phenomenology (i.e. there is nothing it is like assign meaning to a perception) to the belief that cognitive states are conscious only by virtue of their association with perceptual events (the cognitive assignation of meaning is part of the perceptual act). These diverging views are summarised further in section 2 of this paper. In section 3 we trace earlier work on neural automata models of consciousness. It is indicated that these are based in the creation of experience-representing attractors in the state space of the neural automaton and that these are the basis for the presence of SP. In section 4 we extend the state space analysis to CP indicating that unconventional trajectories between attractors and experience-representing trajectories may support the cognitive element. In the summary of section 5 we indicate how this result might affect the cognitive philosophy debate.

2 PROS AND CONS OF COGNITIVE PHENOMENOLOGY

Cognitive Phenomenology has come into philosophical discussion as being a form of phenomenology of non-sensory, non-affective, non-bodily mental event. This is distinct from but complementary to phenomenology which can be said to be of a sensory, feeling, or bodily mental experience, that is SP. So it is convenient to recall that the word 'phenomenology' entails 'the something it's like to be in a conscious mental state'. There is something it is like to be conscious of a beautiful sunset, as there is something it is like to recall last night's movie. CP is then the study of 'the something it is like' to have understood a phrase spoken in a known language as there is something it is like to not understand a phrase in an unknown language and other cognitive events of this kind. Essentially, the something it is like to have understood a sentence is separate from the content of the sentence (which is dealt with by SP) and is present whenever language is understood. In common with SP, verbal reports can express CP events. In [1] (Introduction) one finds examples such as 'I want to eat an ice cream'; 'I am a fine fellow'; 'Sept 2 is the date I fell in love', which refer to events that are not a form of immediate SP. More recently, Chudnoff [3] provided a useful illustration in quoting the well-known example of the image of black and white dots in which one suddenly discovers the presence of a Dalmatian hound. This is entirely an experiential change in the SP domain. However the step from seeing "If $a<1$, then $2-2a>0$" and being able to report that it is true, is entirely due a cognitive "what it's like" change that goes under the heading of *understanding* in the CP domain. Indeed, following Strawson [2] it is accepted here that there are three central CP experiences that define the concept: *understanding*, *meaning* and *thought* and it is these that feature in the modelling targets of this paper.

So far we have addressed CP from the point of view of those who deem that the sensory nature of classical phenomenology does not adequately cater for the phenomenology of conceptual thought. But there are also strong voices against this view. One attack comes from Carruthers and Veillet [4]. Primarily, they argue that phenomenology as a concept is not entirely meaningful in conjunction with cognitive content, having been defined for sensory/bodily/emotional content in the first place. As evidence, they point out that there is an 'explanatory gap' relationship between a perceptual external source and phenomenological sensation, which seems not to exist for an internal cognitive source and phenomenology should there be any. In earlier contributions it was suggested that the explanatory gap can be bridged through a formal assessment of physical structure, learned functions and resulting informational structure in a machine (see, for example Aleksander [5]). More of this later. Also, Tye and Wright [6] argue that thoughts have no phenomenology as they are processes rather than states. Here it is argued that thoughts are phenomenal states that are detached from perceptual influence.

3 NEURAL AUTOMATA AND PHENOMENOLOGY

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Here, the hypothesis that a neural automaton can have internal states that are phenomenological by virtue of being depictive of perceptual experience, is developed beyond previous work. As explained below, for the automaton there is 'something it is like' to perceive a red rose precisely because there are groups neurons that actually depict the red rose. Chrisley and Parthmore [7] have defined 'synthetic phenomenology' and what is proposed fits in with the role of this concept as "any attempt to use an artefact to help specify phenomenal states independently of whether such states are possessed by a naturally conscious being or an artefact". The description of the function a neural automaton (more precisely, a *neural finite state machine*) chosen here is shown in Fig. 1.

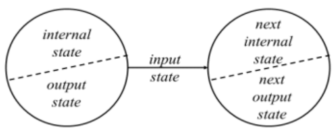

Figure 1. State diagram of a generic finite state neural automaton.

The *internal state* is the firing pattern of a set neurons. As a modelling choice here this *internal state* is in the same circle as the *output state* (that which the automaton communicates to the external world) which is another set of neurons, the *output set,* the circle indicating that the *output set* is closely coupled to the *internal set* in te sense that while many *internal states* can have the same *output state,* every *internal state* has only one *output state.* The *input state* is a representation of all external influences of the world on the automaton which is due to the firing of an *input set* of neurons. Note that fig 1 does not relate to brains – it is the beginning of some theory.

To make this useful to a discussion of being conscous, the *internal state* is made depictive of the *input state* and *output state* (note that this is specific to the model that is being developed in this paper and not a feature of our earlier work). The way that such depictions are achieved for the *internal state* (described in some detail in [8] (Chapter 5)) can briefly be indcated in what follows. The key issue is that the *input state* not only feeds the inputs of the *internal set* of neurons but also forces the perceptual pattern on the outputs and the mapping between the two is learnt. The situation is shown in Figure 2 (a).

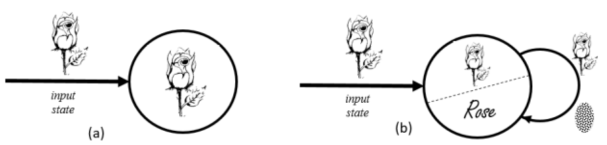

Figure 2: Making the state depictive of a rose.

In 2(b) it is indicated that hrough a similar process, an output state ('Rose' as speech, or writing action) can become part the internal state. Also further iconic training can make the state persist even in the absence of input, that is a presence of noise at the input (shown as an oval). This creates a stable inner state that given the right connectedness among neurons (a carefully studied topic as *integrated information,* see, [8]) becomes an *attractor* in the sense that similar perceptions may lead to a stable entry into the one depictively acquired state.

At this point phenomenology is illustrated purely as it might exist in a neural automaton which gathers experience on the basis of the creation of state spaces that relate intentionally to an external world through the process of depiction as illustrated above. It is assumed that the neual automaton is a robot that can articulate speech and execute outward actions that include motion. As an illustration, the system in Figure 3 is examined.

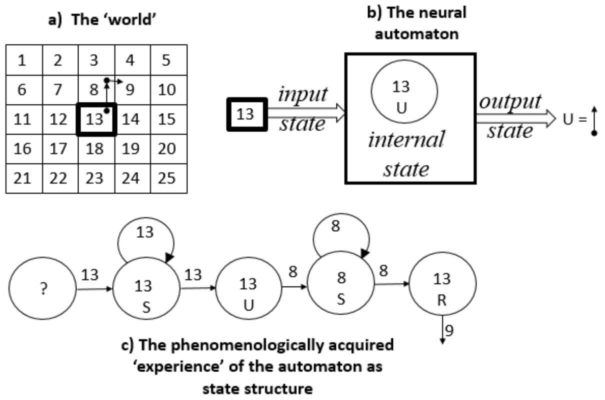

Figure 3. Example of experience acquisition in an exploratory robot

In 3(a) a 'world' is shown to consist of numbered areas where the number indicates an item that is perceived. This perception (currently 13) is an input to a neural automaton as shown in 3(b). In 3(c), the leftmost state is an initialisation where (?) refers to some arbitrary coding. The input state (13) causes an entry into a state which by iconic learning has been encoded as the phenomenal depiction of the input 13. As this is an exploratory automaton, the direction in which it will move is selected at random in the action part of the internal state. Here it is assumed that either through learned or through inherited (that is, designed in the artificial domain) constraints, there are only five actions that can be learned (U)p, (D)own, (L)eft, (R)ight and (S)till. In figure 3(c), the automaton is 'perceiving' 13 and therefore iconically learns to encode 13 and being (S)till . It is assumed that the salient action part of the state is S which causes a re-entry into the 13 inner state creating S a stable internal state (an attractor). The automaton will remain in state 13 until the action indication changes. Arbitrarily this is U and 13 U is entered and iconically learned and the consequently the automaton moves to 9.

However, an important question of sequentiality now arises and this has to be considered before a general expression of experience acquisition may be suggested. The question is 'what if the automaton returns to a previously visited position in the world'. As part of our phenomenology we have a keen sense of time and event (see [9] for a philosophical discourse and [10] for a neurological one). An evening memory of being on the bus in the afternoon is not the same as the memory of the same bus in the morning or even less the previous day or further in the past. It is therefore necessary to associate a sense of occasion with the inner state. Interestingly, issues of time and sequence centrally occupied the thought of classical phenomenologists. Michael Kelly [11] points out that Husserl, embraced a notion of 'internal' time that achieves a moment to moment experience of events in the world. In other words within the CP debate, being conscious of time would be seen as a speial form of Sensory Phenomenology. Internal time is recognised in the further development of our model as follows.

It is suggested here that internal time should have two components within the internal state: *epoch* and *sequence* (within an *epoch*). This is inspired by the fact that as living entities experience *epochs* within one can build experience occur during periods of conscious existence, that is, between periods of unconscious existence such as sleep or anaesthesia, or simply a change of location. But then, during an epoch, an event-driven sequentiality cuts in. So, ignoring many facets that could reate epochs (context, location etc.) a highly simplified scheme for the automaton to have a sense of time and event it is suggested. Despite being oversimplified, ths indicates ways in which more relistic 'chunking' of experience may be tackled in future work on CP. Say that the encoding of this information The involves P and Q, two fields of neural firing patterns of e(P)och and se(Q)uence. Therefore every state contains a neural firing encoding of elements of the following sets:

I, a set of depictions of I' the set of perceptual world inputs (this includes all modalities and assumes successful chunking – e.g. words such as *rose* in figure 2).

P, an epoch indicator

Q, a sequence indicator

and A, a set of actions that includes Φ the element for no actions at all.

To complete the description of experience gathering one needs to note that, as in figure 2, an attractor for a depictive representation of an external percept is created when no action is taken *and* the perceptual inputs are randomised. Therefore the experience of the automaton may be described as a state-space structure of ordered (by Q) strings of phenomenal states interspersed by action states, one string for each epoch P. That is, looking at figure 3, the entire experience of the automaton is a collection of state structres such as that shown but extended to the end of the epoch, there being as many state structures as epochs. To help the discussion this can be generalised and stylised as shown in fig. 4 where only attractors are shown.

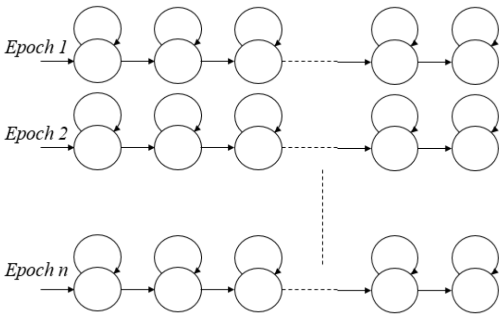

Figure 4 A stylised sketch of acquired expeience in the neural automaton. It is not implied that the epochs have the same length.

Something needs to be said about this structure and its growth with respect to language. So far it has been suggested that the structure grows in respect to actual experienced events. Language however creates new mechanisms. As in fig. 2, an experienced state that forms an attractor may also be named. Without demonstration it is also possible to assert that non-noun terms form part of such structures. This is part of current research.

A comment on the nature of attractors is necessary. Their major content is the internalization (i.e. phenomenal nature of) some external event. Now, there can be many attractors that share the same or similar content but are found in different epochs. For content G of an attractor, the set thst contains similar attractors is said to be the ON(G) set . There are also most epochs that do not contain this particular attractor. This fact features in the next section

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Now it is assumed that the eperience of the automaton is mature, that is, the structure in figure 4 does not suffer many more changes. To discuss CP it is assumed that the three major CP types raised in [2] need to be addressed. These are *meaning experience, understanding experience* and *thought experience*. Bearing in mind the state structure that represents gained experience (Figure 4) it is necessary to ask whether, and if so, how, within this structure, an act of sensory phenomenology (SP) may differ from a cognitive one (CP). Take an SP act that is characterised by the statement: "I am conscious of *X* ". In terms of experiential state structure and assuming that all states in that state structure lead to conscious experience, the functional description behind the above statement is that the entity has entered a depictive attractor state *X* (from I) for a perceptual input *X*' (from I'). In contrast, the report of a related *thought experience* CP act might be: "While being conscious of observing *X* , I thought of *Y* ". Thought not related to current perception is in the CP category [2]. This means that in the experiential state space, the state has 'jumped' to an attractor representing *Y*. There are many technical reasons that make such jumps possible (noise and inattention to input, for example). But it is not primsrily the content *X* or *Y* that determines CP but ….

…. the central contention of this paper is that a sense of the shape of the state trajectory when the input becomes unattended causes the 'thought' CP.

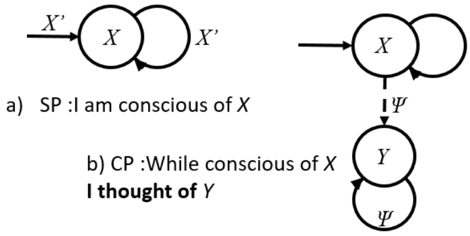

Figure 5: A sketchy illustration of a 'thought' experience.

The concept of an unattended input (indicated by *Ψ*) is therefore central to this discussion. This arose in Figure 2b and was described as noise at the perceptual input. Technically the inattention could be encoded at the perceptual input to the neural automaton through noise. The important issue is that, whatever the technique, it causes the generation of input-independent attractors as suggested in Figure 2.

Turning now to *understanding and meaning eperience*, consider two linguistic sentences, which, as hinted in section 3, can create epoch-like state sequences,

[The dog] [ate][a bone] ..

[Ian][shot][a buck]

The fact that these appear to 'make sense' which, in terms of figure 4, exist as linked structures. Now a sentence such as

[The cat][shot][a bone], despite the fact that the elements may well exist in the state structure, the shape of the trajectory (Figure 6) is felt as being illegitimate given that only transitions within epoch shapes or ON sets of epochs would be legitimate. In other words, the lack of legitimacy is not a sensory event, but a cognitive one. So, as suggestd earlier it is the shape of the trajectories that is a matter for CP and not necessarily the content of the states involved.

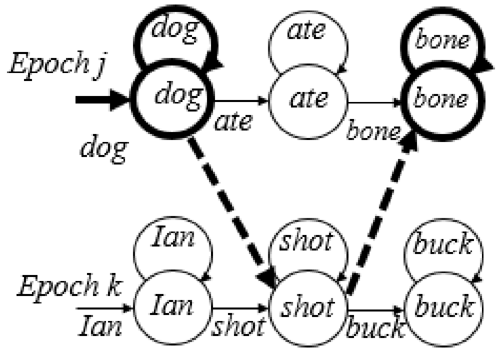

Figure 6: The input sequence that forces transitions that do not exist in the existing state structure are experiencced as 'not underrstood' and hence in CP (while trajectories that follow existing structure define SP).

On meaning in general, it is recalled that attractors carry both perceptual and linguistic representations hence understood sequences in figure 6 carry a meaningful (i.e. imagined or experienced) perceptual vignette, whereas one that is not understood would not do so. This is the subject of a current programme of demonstratinal simulations.

5 SUMMARY AND DISCUSSION

This paper is merely a sketch of how a learning neural automaton model might be helpful in searching for a functional distinction between Sensory Phenomenology (SP) and Cognitive Phenomenology (CP). It has been pointed out that CP is the basis of debate in philosophy as to whether such a concept needs to exist. Here it has been seen that this distinction can have physical correlates which is important not only because it contributes to a philosophical discussion, but also because issues of thought, meaning and understanding still raise important computational questions.

Phenomenology as previously studied through learning neural automata has been discussed showing that there is an iconic/depictive methodology that enables a dynamic neural automaton to create an inner state structure that is an accessible representation of an out-there world. Such a structure, it has been suggested, consists of attractor states that *depict* perceptual input in any modality, including linguistic coding. Such attractors are arranged into *epoch* sequences that have been encountered during perceptual wakefulness or literary activity. As it stands this models enacts Sensory Phenomenology (SP) (there is something it is like to be conscious of events in the out-there world or within bodily sensations). Then, the concept of Cognitive Phenomenology (CP) according to [2] assumed to be distinct from SP set the task for his paper: is there a distinction between the two seen in the state behaviour pertaining to each?

The answer given is that following the assertion that depictive attractor states and the learnt trajectories between them that is, the state structure laid down within the automaton as experience, is developing SP. That is, the entity is phenomenologically conscious of the world and some inner bodily processes, because existing state structure is entered in the act of being Sensorially Conscious and acting strictly according to the acquired state structures. The distinct nature of CP was first illustrated through the need for the entity to take state space trajectories not determined by the exiting state structure of past experience through mechanisms of inattention of the perceptual input. That is, if I am conscious of a rose I can unleash a de-attention mechanism that frees the automaton to jump to other parts of the state structure and know that this has happened. On the other hand meaning is discerned by a sensation of existing state structure being followed. Lack of meaning or understanding of something comes from the inability of the entity to follow incoming percepts within existing state structure leading to there being no *depiction* of input events.

In the controversy about the very existence of CP the automaton model shows that SP occurs as precepts map into depictive states and constitute conscious experience. But no depictive states exist for de-attention activity (thought), or a state path meandering (lack of understanding and lack of meaning). Therefore CP events like state jumps between epochs and the presence of de-attention are part of conscious experience within the automaton *not* related to depiction and is therefore distinct from SP. However, this paper only points to a framework for a great deal of further theoretical work and simulation that needs to be done to develop models of machine phenomenology that include the CP that appears to be helpful in human phenomenology.

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