An Encounter Between 4e Cognition and Attachment Theory

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This paper explores a constructive revision of the conceptual underpinnings of Attachment Theory through an encounter with the diverse elements of 4e cognition. Attachment relationships involve the development of preference for one or a few carers and expectations about their availability and responsiveness as a haven of safety and a base from which to explore. In Attachment Theory, mental representations have been assigned a central organising role in explaining attachment phenomena. The 4e cognition approaches in cognitive science raise a number of questions about the development and interplay of attachment and cognition. These include: (1) the nature of what Bowlby called "internal working models of attachment"; (2) the extent to which the infant-carer dyad functions as an extension of the infant's mind; and (3) whether Bowlby's attachment control system concept can be usefully re-framed in enactive terms where traditional cognitivist representations are: (3i) substituted for sensorimotor skill-focused mediating representations; (3ii) viewed as arising from autopoietic living organisms and/or (3iii) mostly composed from the non-contentful mechanisms of basic minds?. A theme that cross-cuts these research questions is how representations for capturing meaning, and structures for adaptive control, are both required to explain the full range of behaviour of interest to Attachment Theory researchers.

1. Introduction

The infant-caregiver relationship plays a central role not only in social and emotional development, but also in exploration and learning (Ainsworth, Blehar, Waters, & Wall, 1978; Bowlby, 1969, 1988). A traditional cognitivist approach to explaining these phenomena would emphasise internal information processing, located within the individual mind. So this approach in Attachment Theory would focus on symbolic representations that can be operated upon according to syntactic rules. A theoretical approach that keeps cognition within the infant's mind is seductive because of its conceptual simplicity and because this approach is more easily implemented in cognitive models that focus on the creation and transformation of internal representations (Petters, 2004, 2005, 2006b). The elements of 4e cognition - viewing cognition as embodied, embedded, extended, and enacted - all reject or radically reconfigure traditional cognitivism (Menary, 2010).

The embodied approach asks whether cognitive processing, using internal 'mental' representations, is influenced or replaced by the use of non-neural physical structures, such as parts of an organism's body in interaction with its environment (Rowlands, 2010). The embedded and extended approaches are both variants of situated cognition (Rupert, 2010, p. 3-6) and ask the same question about the role of structures and processes outside the bounds of an organism's body. The enactivist approach views psychological activity

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as occurring in the dynamic engagement between organisms and their physical and social context rather than within themselves (McGann, Jaegher, & Paolo, 2013). Enactivism asks about the role of action in understanding the nature of cognitive processing and subjective experience. Whilst the core ideas in Attachment Theory were set out by John Bowlby in a series of papers and books between 1958 and 1988 (Bowlby, 1958, 1969, 1969 | 1982, 1973, 1980, 1988), the elements of 4e cognition are more recently defined (Menary, 2010; Rowlands, 2010), but have many earlier conceptual antecedents (Clancy, 2008; Clark & Chalmers, 1998; Gibson, 1986; Shapiro, 2010; Varela, Thompson, & Rosch, 1991).

Bowlby's formulation of Attachment Theory includes cognitivist constructs, like Internal Working Models (IWMs) and hierarchical plans, through which relationship patterns are represented and processed internally as symbols. However, he was also inspired by Systems Theory (Bowlby, 1969, p. 102), emphasising that an infant's main caregiver is the most salient part of the infant's environment. So Attachment Theory conceptualises the infant-mother relationship as being between two active partners. Therefore, contemporary approaches from situated cognition can form a natural updating for Bowlby's systems approach, and may also help refocus and reformulate cognitivist elements that Bowlby proposed within Attachment Theory. How then should Attachment Theory respond when viewed through the lens provided by 4e cognition approaches in cognitive science? And which elements of 4e cognition provide the best match for the requirements of a theoretical revision for Attachment Theory?

1.1. *Embodiment*

The embodied approach covers a broad range of theories about what embodied cognition is and how it differs from cognitivism (Shapiro, 2010). In general, this approach views the body and physical world as the "context or milieu" for cognition, rather than cognition conceived as the operation of disembodied algorithms (Petters, 2014; Shapiro, 2010). In their reviews, Shapiro (2010) and Rowlands (2010) presents conservative to more radical embodied interpretations for cognitive phenomena. A conservative approach to embodiment explains that we cannot understand how organisms can gain and hold information about themselves and the world without thinking about how central processing structures and mechanisms are affected by their embodiment. In this view embodiment merely provides constraints on the concepts an organism can acquire within a computational and representational understanding of the mind. Or more radical embodied interpretations replace cognitivist representations and processing with bodily interactions, and can even suggest that the non-neural aspects of body and world become the constituents of cognitive processes (Rowlands, 2010, p 54-56). These reviews also show there are different ways to be radically embodied. For example, by either focusing on replacing representations (Shapiro, 2010, p. 114-157), or an anti-cartesianism which focuses on the location of cognition (Rowlands, 2010, p 10-13). This paper will consider how close Attachment Theory is, as actually set-down by Bowlby, to the embodied cognition approach within 4e cognition. It will also consider the future prospects for embodied thinking in the attachment domain.

1.2. *Embeddedness and Extension*

The hypotheses of embedded and extended cognition are competing theories in situated cognition that both give greater emphasis to the role that situations and context play

in human cognition than traditional cognitivism (Clark, 2008; Clark & Chalmers, 1998; Rowlands, 2010; Rupert, 2004, 2010). The extended approach is more radical, claiming that external supports become part of a person's cognitive apparatus. In extended cognition, what constitutes cognition extends far out into the environment, beyond the boundaries of brain and of body. The embedded approach is still strongly anti-cognitivist, but sees cognition embedded in external support rather than constituted of external structures (Rowlands, 2010). The embedded approach suggests that internal cognitive processes depend on the way that the environment outside of the body is structured. In an embedded view of the cognitive processes underlying attachment interactions, internal cognitive processes that guide interpersonal attachment behaviours would only run effectively in 'tandem' with particular arrangements of the external environment, and without this tightly coupled scaffolding internal processes would work less well or not at all (Rowlands, 2010). A key question is: whether attachment relationships can sometimes be conceived as extending cognition or are better thought of as embedding cognition?

1.3. *Enactivism*

In an enactivist view mind and subjective experience are not seen as inherent in, or arising from, the individual, but as emerging, from the interaction between organisms and their surroundings (McGann et al., 2013). This includes interaction with elements of embodiment such as dynamical and whole-body actions (Fuchs & Jaegher, 2009). Rather than relying on disembodied passive representations, how an organism acts on the world and the resulting ways in which the world reacts are key to explaining the nature of cognition (Rowlands, 2010). Enactivism also holds that organisms actively participate in the generation of meaning which arises from a *"dialogue between the sense making activity of an agent and the responses from its environment"* (Fuchs & Jaegher, 2009, p. 470). Some variants of enactivism are also concerned with explaining how subjective experience can only arise from autonomous systems that self-produce and self-maintain. So other key questions we can ask in an encounter between Attachment Theory and 4e cognition are: whether enaction, rather than traditional forms of representation, is a better way to think about how previous experiences mediate ongoing adaptive behaviour?; and, can the attachment control system be revised to act as an enactive *"lived experiential structure"* (Petters, 2014)(Thompson, 2007, p. xvi)? This paper will follow Hutto and Myin (2013) in presenting contemporary enactivism as comprised three varieties: sensorimotor enactivism, autopoietic enactivism and radical enactivism. These approaches provide a particularly broad perspective on how anti-cognitivist approaches may provide new directions for Attachment Theory.

1.4. *Why 4e cognition?*

This paper is the latest in a series of papers to explore how the information processing underpinnings for Attachment Theory as set out by Bowlby between the 1950's and 1980's may be updated (Petters, 2005, 2006a, 2006b; Petters & Waters, 2010). Previous attempts at revision have focused on revising the attachment control system in terms of internally located disembodied structures and mechanisms. For example, Petters (2005, 2006a, 2006b) describes autonomous agents which simulate infant attachment behaviour patterns and the ontogenetic development of individual difference attachment categories. Whereas Petters and Waters (2010) describes how the attachment control system maybe in part composed of Bayesian mechanisms. In each of these papers, the intention in

challenging Attachment Theory with recent ideas from cognitive science was to revise rather than replace or reject the core elements of Attachment Theory. So these papers maintain Bowlby's core idea that there are high level attachment representations like natural language which operate alongside lower level attachment control structures. The current attempt in this paper to re-imagine the information processing foundations of Attachment Theory by comparing it to all four strands of 4e cognition aims to broaden and deepen this programme of constructive revision.

However, the question might be posed, why revise Attachment Theory in response to all the separate strands of 4e cognition? The four strands of 4e cognition are certainly not a longstanding categorisation and are brought together as much by the traditional cognitivism they oppose than what they have common. Rowlands (2010, p. 219) recounts how the term was coined by Shaun Gallagher over lunch in 2006. There has since been a conference and a special issue focused on 4e cognition(Rowlands, 2010, p. 219). As Menary notes, one might view the separate strands of 4e cognition as not possessing any homogeneity and when treated together it may cause us to *"miss out on the nuances and sometimes genuine incompatibilities between them"* (Menary, 2010, p. 459). However, it is the diversity of 4e cognition approaches that adds value to the analysis set out in this paper, allowing different components of the 4e cognition approaches to provide contrasting insights and benefits for the Attachment Theory framework. This paper will see how see how diverse elements from 4e cognition emphasise embodied and situated perspectives, and sensorimotor skills, in attachment interactions. These perspectives will also highlight the requirement for an explanation of subjective experience in the attachment domain and explain how mechanisms for adaptive control and linguistic mediation of behaviour can be combined in an integrated attachment control system.

1.5.   *Bowlby formulated the attachment control system concept but did not specify it in detail*

John Bowlby's interest in developmental psychology started early in his career (van der Horst, 2011). After working with maladjusted children, he was training as a medical doctor when he added psychoanalysis to his studies. Melanie Klein acted as his supervisor during this psychoanalytic training. His initial research focus was towards understanding particular normative social and emotional phenomena such as separation distress and bereavement (Bowlby, 1960). In explaining these phenomena, Bowlby initially worked from within a broad psychoanalytic explanatory framework. However, Bowlby disagreed with the mental energy and drive reduction models that psychoanalysis proposed to explain such internal complexity and continuity across development (Waters, Kondo-Ikemura, Posada, & Richters, 1991). He also disagreed with the retrospective research method of clinical reconstructions and the idea that behaviour is driven by internal phantasy that is de-linked from current experience (van der Horst, 2011). Bowlby did want to consider how individuals imagine good and bad future outcomes. He just believed that the reality of the current moment and real day to day past experiences around emotionally valenced possible attachment outcomes like loss, separation and reunion anchor predictions about future attachment related outcomes. Therefore Bowlby placed far more emphasis on the observation of current behaviour than did Melanie Klein and other psychoanalysts (van der Horst, 2011). All these factors led to him rejecting psychoanalytic theory and its related research methods as a basis for explaining social and emotional development. Instead, he formulated a new explanatory framework by combining scientifically respectable ideas that originated across different disciplines.

One of Bowlby's goals was to construct a motivation theory that could account for infant behavioural sensitivity to social context. However, whilst he wanted to abandon some of the aspects of the psychoanalytic framework with which he disagreed, he wanted to conserve some key insights of psychoanalysis such as the ideas that the cognitive and emotional life of human infants is complex and that the nature of early attachment relationships have a lasting impact, acting as prototypes of later romantic and caregiving relationships (Waters et al., 1991). Bowlby also wished to conserve the idea that the phenomena of interest in social and emotional bonding are bigger than the 'proxy' of behaviour. For both Psychoanalysis and Attachment Theory, overt behaviour (for example, duration of protest following separation) does not equate with strength of emotional connection (Waters et al., 1991). In both of these frameworks, responses are guided by rich internal structures and mechanisms.

In his first presentation of Attachment Theory proper, Bowlby (1958) provided an alternative motivational basis for attachment by replacing a psychoanalytic explanation based on Freudian instincts with a framework based on ethological behaviours. In this evolutionary ethological framework for attachment, Behaviour Systems control behaviours such as proximity seeking to the mother, sociality, fear, and exploration, which are inherently motivated and so do not need to be activated as the by-product of any more fundamental process (Harlow, 1958). Each of these behaviours carry out a species specific function that has survived in the genome because its functions have contributed to biological fitness.

Two limitations that arise from conceiving of the attachment system as an instinctive behaviour system are that: (1) this framework is too simple to explain different stages in attachment development; and (2) it gave too much emphasis to observable triggers for behaviour rather than seeing behaviour arising from richer internal states and the ability to engage in imaginative 'what if' reasoning when an individual looks ahead to possible futures.

In his more mature theoretical work, Bowlby still included ethological mechanisms but also drew increasingly on currently popular concepts from control systems theory, cybernetics, artificial intelligence, and Piagetian theory. Bowlby replaced Freud's concept of psychical energy and its discharge (Bowlby, 1969, p. 18), with the concept of an attachment control system. He presented reflex behaviours and behavioural chaining of fixed action patterns as an example of a simple organising principle for control systems, and hierarchical planning as much more complex and flexible (Bowlby, 1969, p. 76). Bowlby showed how 'simple' mechanisms could interact in complex ways by chaining and alternation. Behavioural patterns arising when fixed action patterns have been trained into complex sequences can be mistaken for behaviours directed by more complex goal corrected mechanisms because of the sensitive matching of response to stimuli. According to Bowlby simple plans can be formed when several goal corrected steps are chained together, and each step must be completed before the next step is taken. More complex plans were also proposed where simple plans were formed into plan hierarchies. Ultimately plans come to be represented linguistically (Bowlby, 1969, p. 77). Goal corrected feedback mechanisms were also introduced by Bowlby from control systems theory and cybernetics to play an important part in the 'purposiveness' of the attachment control system framework (Bowlby, 1969, p. 54). Whereas younger infants may produce complex behaviour by chaining and training of simple mechanisms like reflexes and fixed action patterns, older infants, children and adults use more complex control mechanisms such as plans represented in natural language. But simple and complex mechanisms co-exist, with each sometimes overridden by the other. Internal Working Models (IWMs) and natural language allowed higher level processes of integration and control (more on IWMs

in section 2).

Attachment behaviours range from non-verbal actions to the verbal narratives that people construct about their relationships, and can be observed from infancy to adult contexts including caregiving and romantic relationship. So it is unsurprising that to explain diverse behaviours a diverse range of information processing structures and mechanisms have been invoked within the attachment control system - which we might today term a cognitive architecture.

2.   From Internal Working Models to Embodied Working Models

Internal working models (IWMs) have in the past often been presented in Attachment Theory as cognitivist constructs like schemas or scripts (Bretherton & Munholland, 2008). The purpose of this section is two-fold: firstly to show that despite the fact that Bowlby's later writing and much contemporary attachment research views attachment representations as symbolic and abstract, Bowlby's early formulations were broader in scope; and, secondly, to report empirical evidence for the importance of bodily sensation and embodied representation in the attachment domain.

Throughout his career, Bowlby restricted the term 'Internal Working Models' (IWMs) to models of self and other in attachment relationships. Their principal information processing function is to allow predictions to be made about the likely outcomes of taking actions within a given environment. Bowlby explicitly compared the role of IWMs to the imaginative function of the Internal Worlds of psychoanalysis:

> *"The environmental and organismic models described here as necessary parts of a sophisticated biological control system are, of course, none other than the internal worlds of traditional psychoanalytic theory seen in a new perspective."* (Bowlby, 1969, p. 81)

Bowlby's IWMs are information processing constructs which store, manipulate, and transmit attachment related world knowledge and expectations about its caregiver's availability and responsiveness. They allow the individual to *"conduct small scale experiments within the head"* (Bowlby, 1969, p. 81). The information storage role of IWMs includes capturing the relation-structure of attachment phenomena, not every aspect of reality but enough to formulate plans and make decisions in relation to attachment goals, and make possible the evaluation of alternative actions. These expectations are derived from the carer's past performance. At a finer grain of analysis, IWMs are storing spatio-temporal causal relations among the events, actions, objects, goals and concepts represented. Bowlby emphasises the requirements for IWMs to be updated. He also observes that pathological sequelae of separation and bereavement can be understood in terms of out of date models or half revised models which may contain consistencies and confusions (Bowlby, 1969, p. 82).

IWMs of self and attachment figure develop in a complementary manner (Bowlby, 1969). For example if the carer is responsive the self is valued. Their operation can be seen when an attached individual is in an anxious state and considers how to gain proximity to their attachment figure. IWMs allow the individual to predict the outcomes of possible actions to achieve their set-goal of proximity. They can then choose an action likely to increase security and not provoke a negative response from their attachment figure (Bowlby, 1973, p. 254-263).

Bowlby invokes IWMs at early stages in development and also later on, when linguistic skills and conscious reflection can enable models to become more adequate ((Bowlby,

1969), p 84). So IWMs have been presented as transforming from sensorimotor representations in pre-linguistic infants to manipulable internal simulations in older children and adults that can enable short-term predictions, and conscious reflections on past, ongoing and future relationships ((Bretherton & Munholland, 2008), p 102). Current attachment research frequently investigates IWMs through studies of memory talk, narrative completion, semi-projective measures and story-telling, with adults and children (Bretherton & Munholland, 2008; Dallos, 2006) - naturally linking IWMS to symbolic constructs from Artificial Intelligence like schemas and scripts (Petters & Waters, 2010). In his later writing Bowlby described IWMs in symbolic terms, for example:

> *"In reaching the decision to utilise certain actions rather than others the attachment system is conceived as drawing on the symbolic representations or working models, of the attachment figure, the general environment and the self, which are already stored and available to the system"*
> ((Bowlby, 1969 | 1982), p. 373).

So Bowlby proposed IWMs as structures accessible to language and which sometimes allowed conscious simulation of attachment outcomes and the ability to reflect through language about their attachment interactions and status (Dallos, 2006). However, in earlier writing, Bowlby compared IWMs to analogue representations. For example, in his 1969 formulation of IWMs, when Bowlby suggested that they can be used to conduct 'small-scale experiments within the head' he notes that this notion would be an obvious possibility to electrical engineers familiar with analogue computers. Bowlby also refers to anti-aircraft guns that operate using cybernetic control mechanisms ((Bowlby, 1969), p 44) to exemplify how analogue control systems can set their own goals.

Looking back prior to 1969 to Bowlby's sources for the IWM concept provides added detail on how analogue representations can be conceived as mental models. Bowlby adopted the concept of Internal Working Models from the biologist J.Z. Young, whose 1964 treatment of Working Models is decidedly unambiguous in its preference for analogue over digital representations as a basis for Working Models in natural systems. As Young noted:

> *" What we commonly call the structure of the nervous system determines what it does. It is not a general purpose computer at all. [...] the machine may be itself a representation of the environment and its parts are pre-selected to perform certain calculations in relations to the latter."*
> ((Young, 1964), p 39)

So analogue working models do not possess the representational property of arbitrariness, and can require no transduction or abstraction because they can use the physical substrate of the body to act as embodied representations or embodied control mechanisms. Going back further in time, Young acquired the working model concept from its original source - the cybernetician Kenneth Craik. In The Nature of Explanation (Craik, 1943), Craik first discussed how working models can be used in science. Physical systems can act as models which help scientists explain natural phenomena because their physical operation captures key aspects of how the target system operates:

> *"By a model we thus mean any physical or chemical system which has a similar relation-structure to that of the processes it imitates. By 'relation-structure' I do not mean some obscure non-physical entity which attends the model, but the fact that it is a physical working model which works in the same way as the process it parallels, in the aspects under consideration at any moment. Thus, the model need not resemble the real*

> *object pictorially; Kelvin's tide-predictor, which consists of a number of*
> *pulleys on levers, does not resemble a tide in appearance, but it works in*
> *the same way in certain essential respects"* ((Craik, 1943), p 51)

According to Craik, an organism can then possess working models that rely on physical structure to represents its self and environment, it may configure the working model to act as memories of past events and then run this model forward in time to make predictions or imagine the results of differing actions (Craik, 1943, p. 61). Bowlby incorporated this representational and simulative aspect of working models into Attachment Theory (Bowlby, 1969, p. 80).

The distinction between analogue and typical cognitivist representations like (discrete, arbitrary) symbols is important because analogue representations are much less flexible, are tied to the physical (embodied) properties of the medium in which they are implemented, and cannot easily be used to reason generally about a space of all possible actions. So analogue computation relies on a physical or embodied substrate in a manner in which discrete symbol processing computations do not. These distinctions matter for computational modelling of attachment behaviour in artificial systems and for clinicians who are concerned to activate, de-activate, measure and transform attachment representations as part of research or therapy with humans (Dallos, 2006). Many attachment responses are non-linguistic reactions to ongoing dynamic interplay between attached partners, and may be effectively mediated by less flexible analogue representations. Linguistic reflection on attachment issues will require a more flexible representation. What interconnections are required (if any) between these kinds of representation is an area requiring further research. It may be that mechanisms for adaptive behavioural control and mechanisms for conscious linguistic reflection operate in parallel without any 'cross-talk'.

That Bowlby would invoke analogue computation and representations in his first formulation of IWMs might seem surprising given the contemporary predominance of the linguistic/symbolic approach to IWMs in Attachment Theory. It is in part explained by the waning popularity of analogue computers and cybernetic notions. In the period between the end of the second world war and the late 1960s when Bowlby's initially adoption of the working models concept, digital computing had gained a leading position but analogue computing and cybernetic theories remained a significant alternative to digital computing and the new Artificial Intelligence approach (Boden, 2006; Small, 2000). In addition, the seeming change in emphasis from analogue representations in 1969 to symbolic in 1982 may not represent a completely radical change in Bowlby's conceptualisation because Bowlby was vague in the representational details he proposed. As Bretherton and Mulholland note, Bowlby's formulation of the representational basis for attachment *"was a promising conceptual framework to be filled in by others"* ((Bretherton & Munholland, 2008), p 103). However, perhaps the key issue was that in the 1960s Artificial Intelligence was less prominent in comparison with Cybernetics than it would be in the future. So the cybernetic view on issues like meaning and control held greater sway. This was consequential because researchers in Cybernetics under-emphasised representational distinctions and the challenges arising from consideration of high level processes. As Boden notes:

> *"most cyberneticians seemed to see no difference between pure self-*
> *equilibration (as in homeostasis), purposive behaviour directed to some*
> *observable object (as in guided missiles), and goal seeking directed to some*
> *intentional end (as in human deliberation and planning)*((Boden, 2006),
> p 220)

The eclipse of Cybernetics by Artificial Intelligence may have led to Bowlby's switch from invoking an analogue basis for IWM in 1969 to symbolic basis for IWMs in 1982. So further research needs to integrate the findings of embodied working models with research on higher level linguistic and reflective processes. So providing an approach which brings diverse representational forms together in the attachment control system, bringing back together a adaptive control and fully intentional thought and reasoning (Petters & Waters, 2010).

Analogue representations are not what researchers in embodied cognition usually refer to as examples of embodiment (Shapiro, 2010). Instead, they give instances of how actual body parts or neural areas specialised for bodily sensation or action are important for cognition. Although Bowlby and many other attachment researchers often refer to IWMs in cognitivist terms (Bretherton & Munholland, 2008), there is strong empirical evidence for the importance of embodiment in attachment processes. In the first Strange Situation study (Ainsworth et al., 1978), visual ratings of physical contact between mother and infants show 'sinking in during contact' is a key distinguishing variable for insecure avoidant and insecure ambivalent/resistant infants in the home observations (Petters, 2006a, page 185). The complex and vital role of physical contact in the development of attachment has also been highlighted by studies of attachment in rats (Hofer, 1995). Close physical contact has been shown in rats to act as a hidden regulator of an infant rat's behaviour. When rat pups are separated from their mothers they showed slowed heart rate and decreased temperature and activity. However if the rats were kept warm their temperature still fell but they became much more active. After a series of systematic experiments it was found that different stimuli from the mother rat, such as tactile, nutritional and thermal stimuli, regulate different infant behavioural and physiological systems.

Links have also been drawn with IWMs and recent neuroscience research which presents IWMs as affording embodied simulation of the intentions of others ((Bretherton & Munholland, 2008), p 109). Bretherton and Munholland (2016) review recent neuro-imaging findings relevant to the functions of an attachment IWM. They present studies which investigate functions relevant to working model construction and operation, including processes of: emotional appraisal, multi-model integration, self-other distinction, social observation matching, behavioural monitoring and behaviour choice, and processes of prospection and imagining of social outcomes. They show that these functions are often linked to and rely on brain sites specialised for supporingt perceptual and motor functions. So an increasing number of brain imaging studies are confirming an embodied view of IWMs (Bretherton & Munholland, 2016). So viewing IWMs as embodied simulations is not only fully in the 'spirit' of Bowlby's original conception for IWMs, but also matches the 'word' of what he wrote about IWMs when he first introduced them (Pouw & de Jong, 2015).

3.   Attachment relationships and situated cognition

Rupert (2010) presents embeddedness and extension as two varieties of situated cognition. So before looking at these competing hypotheses in the next section, this section will consider how Attachment Theory can be enhanced by ideas from situated cognition. The idea that infants, older children and even adult attachment partners all look to their carers as information sources about the broader world is a familiar one. For example, from the perspective of the socially situated mind, infant social referencing and joint attention between infant and carer may be seen as physical actions that make the infant's

mental computations faster, more reliable or less effortful by intimately linking internal infant cognition with external support (Clark & Chalmers, 1998; Petters & Waters, 2013; Tomasello, 1999). So taking a situated cognition approach enriches attachment theory by providing a more complete view of how infants gain information about environments from their caregivers.

An evolutionary stance and situated cognition approach are clearly complementary. We should expect that at every age, but especially in infancy and childhood, an effective attachment figure who is a primary caregiver should possess the goal to enhance and enrich their cared for individual's mental capacities - elevating ongoing activities and supporting development to higher performance over time. This might be taken to mean that an attachment figure aids those they care for by providing certain affordances in the social environment. This will be more important in infancy. In moment to moment interactions, a carer (if she recognises what her infant is up to and is skilful and motivated) adapts her support (including extending and transforming it through the course of the interaction). She may reach for the approaching infant, then make adjustments as it comes close and makes efforts to be picked up. Much the same may occur in her support for exploration. Caregivers also help to label, conceptualise, and structure information (Clark, 2008, p.44)(Petters & Waters, 2013).

The dialogic nature of the infant-mother relationship is exemplified by many types of intimate and dynamic interaction, including: the infant's active participation in co-operative games, the infant directing the mother's attention to acts by itself, use of objects as topics in infant-mother dialogues, and social and emotional referencing. The mutually contingent nature of these dialogues is demonstrated by experimental studies which perturb the contingency of caregiver or infant responses, and in observational research of infant interactivity with depressed mothers (Reddy, Hay, Murray, & Trevarthen, 1997). A benefit to taking a situated cognition approach to attachment phenomena is therefore that it places the interaction between mother and infant centre-stage. We can view such close-coupled partners as being situated within action loops, with both partners subserving the active partnership and the focus of action criss-crossing between partners (Clark, 1998; Wilson & Clark, 2008). In such systems, caregivers can support 'soft assembly' of developing attachment competencies because secure attachment patterns are described in terms of response to set-goals rather than set actions ((Clark, 1998), p 44). So soft assembly of attachment behaviour routines can be arrived at by multiple paths but are planful because they are driven by the infant's goals and the carer's support towards those goals. Caregivers can also help scaffold infant development by directing the child toward a correct/established outcome/solution/attitude or belief. When co-constructing they also help the child take a course toward own-defined ends or end points. Ainsworth's maternal sensitivity scales, particularly 'sensitivity to signals', and 'cooperation vs. interference with ongoing behaviour', (Ainsworth et al., 1978) show how Attachment Theory has operationalised measures that are relevant to the kinds of situated interactions that exist in the attachment domain. Infants adapt to the particular pattern of responsiveness that caregivers provide (Ainsworth et al., 1978). So part of the reason that individual differences in attachment patterns in infancy and childhood change so little through development is the stabilising effect of being situated in such a closely coupled caregiving relationship with a carer that responds with a particular pattern that can extend over ontogenetic development (Waters, Merrick, Treboux, Crowell, & Albersheim, 2000).

Importantly, situated support by caregivers can be at the level of behaviour and at the level of information provision and explicit theories about the world. Bowlby describes how caregivers support infants by manipulating the environment and providing information directly through language use so that *"instead of each one of us having to build his*

environmental and organismic models entirely for himself, he can draw on models built by others" (Bowlby, 1969, p. 82).

4.   Deciding between two hypotheses in situated cognition: embeddedness and extension

The previous section of the paper has shown a possible beneficial pay-off for Attachment Theory of an encounter with situated cognition. This is because the situated approach provides a good match for the kinds of intimate interactions that are of interest within Attachment Theory. From this point on in this section we will consider the relative merits of re-framing Attachment Theory in terms of the hypotheses of embedded and extended cognition. These are competing and mutually exclusive explanations from within situated cognition that in the attachment domain can explain how caregivers provide cognitive support. The hypothesis of extended cognition suggests that in some of the above examples of attachment interactions, if the infant's ongoing computational needs are met by sensitive and timely support from his or her carer in such a way that the infant treats this support as part of their own cognitive processes then we might say that the carers cognitive support has become part of the infant's extended mind (Clark, 2008; Clark & Chalmers, 1998). For these examples to count as mind extension, caregiver cognitive support and information provision to the infant must be strongly trusted, relied upon and accessible (Petters & Waters, 2013). If these criteria are met then what is occurring is extension of mental states from an infant onto their caregiver. So in this view, the carer is actually extending the infant mind by incorporating the carer's help within the infant's cognitive operations - the carer's help becomes part of the infant's mind (Petters & Waters, 2013). For these same examples of intimately integrated interactions between infant cognition and carer support, the hypothesis of embedded cognition views infant cognition and carer support of that cognition as clearly demarcated and separate. This hypothesis considers that *"cognitive processes depend very heavily, in hitherto unexpected ways, on organismically external props and on the structure of the external environment in which cognition takes place"* ((Rupert, 2004) p 393). and that *"certain cognitive processes lean heavily on environmental structures and scaffoldings but not thereby include those structures and scaffoldings themselves"* ((Clark, 2008), p 111). So for this encounter between Attachment Theory and 4e cognition, accepting the hypothesis of embedded cognition means accepting a more conservative interpretation of the situated cognition approach than the more radical hypothesis of the extended mind.

Rupert (2004) sets out two main reasons for preferring embedded explanations over extended explanations which arise from considering non-social cognitive extension (Clark, 2008). Most examples of extended cognition involve inorganic objects in the environment (such as a mathematician doing their 'working' on paper) providing the cognitive extension. The first criticism of extended cognition highlights the profound differences that appear to distinguish inner and outer contributions in extended cognition when cognition is extended onto such inorganic objects (Clark, 2008). However, this criticism is much weaker when applied to the social case as it is a carer that does the extending. So there are not such profound differences in the supporting substrate for cognition between cognition inside the infant's brain and cognitive support originating from inside the carer's brain. It is just that messages or other information have to cross from the carer's brain through the non-neural, non-embodied external environment before supporting the infant's cognition. A second criticism is the apparent scientific cost of any wholesale endorsement of extended cognition onto a motley collection of inorganic objects because

it gives undue attention to transient external props and aids. In this view, following the extended mind hypothesis means scientists are not researching a suite of integrated persisting organismically grounded capacities (Clark, 2008; Wilson & Clark, 2008), and looking at developmental examples of cognitive extension onto inorganic objects is a series of separated developmental segments with external cognition onto different objects. Using a ball or balance beam may be a good example of mind extension at one age, but a year later the best example may involve a completely different object in a different task or action. Again, the social case of mind extension in the attachment domain mitigates this criticism. Extended cognition does not only deal with transient external props and aids when a main carer provides enduring support and continuity between otherwise disparate contexts.

However, a similar issue of transient and possibly inconsistent cognitions arises when thinking of social mind extension in the attachment domain. This is because infants and children do not attach to just one single carer (Howes, 1999) but may attach closely to mother, father, nanny, sibling, and others. So when infants who use their carers minds to extend their own mind, are they constituted of the minds of more than one person over time if they have more than one attachment figure? Do the infant's attitudes and beliefs change depending on who they are engaging with?

Social interactions in infant-carer dyads are likely to be asymmetric - with caregivers providing the extra support and the infant being supported. Over the long-term caregivers attempt to socialise and indoctrinate infants in many ways, both positive and negative, that will impact the developing meaning a child gains of their attachment history (Petters & Waters, 2013). Healthy, unhealthy or outright pathological beliefs about the infant's self and relationships can enter into a infant's mind because of what they see, hear or experience with their caregiver. Their caregivers may simply present beliefs which the children then adopt. However, in these cases the caregiver might be the original source of beliefs, but it is not justified to say that these are extended cognitions (Petters & Waters, 2013). This is because the infant's internal memory is where these beliefs are constituted over time, the infant no longer accesses these beliefs from their carer once the carer is no longer presenting them.

Infants learn to trust how well their carers provide security, and respond accordingly. Research has shown that young children do not just hold sensorimotor representations of the quality of their attachment relationships. For example, attachment relationship quality can be assessed by the simple drawings young children make of their families (Main, Kaplan, & Cassidy, 1985). A more novel recent finding is that infants and young children may filter information that they get from their carers according to how reliable the carer is as a secure-base provider. Securely attached children aged 4-5 years are shown to hold a more nuanced and realistic view of their caregiver as a provider of information than insecure children do (Corriveau et al., 2009). We can say that secure 4 year olds tend to use their carers more in 'epistemic actions' (where the action is not intended to change the state of the world but gain information about the world) (Clark, 2008). Insecure 4 year olds not only trust their carers less to provide security, they also seem to trust their carers less to just provide accurate knowledge about the world (Corriveau et al., 2009). Does this finding provide support for the extended mind hypothesis rather than that infants are merely embedded in a caregiving environment? Corriveau et al. (2009) does show that some children trust their carers as information providers more than other children do. But the extended mind hypothesis requires a very high level of trust. After the first six months of age infants or children might trust their caregivers this much, but equally, even if in secure relationships, they might have high levels of trust that fall short from this standard.

In early childhood through to adolescence we might characterise attachment development as a gradual lessening in the strength of attachment bonds, with an increase in autonomy, and increase in the questioning of information from the caregiver by the child. If attachment bonds are lessening as autonomy increases should we still view infants as using their carers as mind extenders - when mind extension involves such a decrease of autonomy and lessening of the boundaries between different selves? The age at which there is likely most justification for attributing mind extension is the earliest ages where attachment proper is not formed or only just forming. We should be more accepting of claims to extended cognition in infants and younger children, because the caregiver's interactions are more long-lasting, they are relied upon more, and when there are less infant cognitive resources and routines for not believing (Gilbert, 1991). So making acceptance of information from the carer as if it were an infant's own beliefs easier and more likely.

A number of recent papers (Greenwood, 2013; Krueger, 2013; Varga, 2015) propose that closely coupled synchronous interactions between mothers and young infants can involve cognitions that extend beyond the individual. Varga (2015) argues that a form of 'emergent extended cognition' is needed to capture dyadic synchronic interactions early in infancy like temporal and affective coordination of non-verbal microbehaviours including facial expressions, voice tone matching, and bodily interactions. Varga emphasises that these interactions are not controllable by one or other participant in the way that a tool like a pen or notepad could be controllable by its user. Neither are they reducible in the sense of relying on part of a system. Instead, these interactions possess 'continuous reciprocal causation' that relies upon emergent extended cognitions between both participants. These kinds of interactions are germane to attachment development but attachment interaction describes a broader range of different ways that mothers and infants interact, and describes how relationship interactions change through the life-span (Petters & Waters, 2013). Greenwood (2013) argues that deep functional integration of carers in the cognition of their infants can be considered a form of contingent transcranialism which shapes emotional ontogenesis. Similarly, Krueger (2013) links the fine grained details of physical interventions and shared attention with cultural norms and practices in his normative account of the ontogenesis of the socially extended mind. However, as Petters and Waters (2013) discuss, caregivers vary greatly in responsiveness and sensitivity but all infants in normative (non-abusive) caregiving environments end up becoming attached. So unless the requirements for mind extension are greatly weakened mind extension should not be seen as a pre-requisite for normative emotional ontogenesis.

Varga and Greenwood make similar points about the direction of control in socially extended cognition. For Varga, extension emerges by both partners relinquishing control to better mirror their partner's response. For Greenwood, extension is an example of a 'world-to-brain transcranial event'. However, more work needs to be done in distinguishing Greenwood's world-to-brain interactions from Rupert's view of the brain as embedded-in-the-world in a way that intimately structures cognition. Both Varga and Greenwood draw upon a conception of mind extension which focuses *"on the complementarity of the internal and external resources and their consequent integration into cognitive wholes"* (Greenwood, 2013, p. 424). So they put the 'cognitive whole' produced by a dyad in primary focus because it is contributed to by both parts of the dyad. This is reminiscent of Winnicott's well-quoted saying: *"There is no such thing as a baby, only a baby and a mother"* (Winnicott, 1965, page 39). It is also consonant with psychoanalytic ideas on the absence of self-other distinction (Hughes, 1989). Attachment Theory is clear that infant and caregiver behavioural predispositions complement each other and are evolved to do so. For example, infant secure base behaviour complements caregivers pro-

vision of safety. So we should expect complementarity leading to functional integration. However, even at young ages we should remember the lessons of evolutionary psychology and in particular parent-offspring conflict (Simpson, 1999; Trivers, 1974). Infants and caregivers disagree about much - when to eat, what to eat, where to crawl, and what to play with. So young children do spend quite a lot of time in explicit behavioural conflict with their caregivers, and unseen implicit conflicts are also likely to occur, even in the womb (Haig, 1993). So as an evolutionary design principle, having infants trust their caregivers so much that they regularly and routinely extend their minds onto them might be questioned. So Rupert's criticism of the extended mind - that, whilst there may be some examples of extended mind use, they do not form a comprehensive suite of tools - may apply to the attachment domain. Infants may occasionally off-load cognitive processes onto their carers, but as they get older, this support may be more like scaffolding in line with the hypothesis of embedded cognition (Rupert, 2010). They may also form 'cognitive wholes' but this will happen in isolated episodes early in development.

Considering a place for both the embedded and extended hypotheses in the attachment domain may facilitate valuable new thinking and promote further research. For example in exploring how children develop from implicit use of their mother as a cognitive support to explicit use. Questions include whether there are required sequences in these kind of changes, as opposed to trajectories that depend on various facts about the different genomes or different environments.

Earlier approaches to the extended mind hypothesis focus on demarcating extended and non-extended states or processes by considering the parity principle. This assesses whether if: *"a part of the world functions as a process which, were it done in the head, we would have no hesitation in recognizing as part of the cognitive process"* (Clark & Chalmers, 1998, p. 8). If the answer is 'yes' then the external state or process is considered a constituent part of the overall cognitive task or operation. This demarcation rules out examples where the external element supports the cognitive task with different properties and functions than would occur internally. Since complementing rather than strictly copying cognitive functions is often the point of relying on external entities (Heersmink, 2015), a complementarity principle for demarcating extended from brain-bound processes has been proposed in addition to the parity principle (Heersmink, 2015; Sutton, 2010). Varga summarises this newer principle: *"External entities, rather than being mereological parts, are seen as complementary tools that become integrated into one cognitive system"* (Varga, 2015, p. 2). Both complementarity and parity are likely to be important ways to look at attachment relationships. In an individual's ontogenetic development, complementarity may come first, as when an infant receives highly complementary support they are likely to 'rate' the caregiver high in terms of responsiveness and sensitivity, and these are the measures used in 'deciding' on whether the caregivers is a reliable secure-base from which to explore, and haven of safety. As was discussed above with regard to the research of Corriveau et al. (2009), infants and children can relate to their caregivers as more or less reliable elements of their own epistemic actions. If a child is very trusting of their caregiver then using their caregiver as an information source allows them to 'economise' on 'source checking' (Gilbert, 1991) and use information from their caregivers as their own reasoning or memories. Sutton, Harris, Keil, and Barnier (2010) provide a fitting example to illustrate this issue: *"A 12-year-old boy looks up from his homework and asks in a serious tone: 'Mom, what is my most important memory?',"*. The child could ask this question to someone else who knew him. But the answer would have a different status from his mother - who he trusts to a degree in part a result of the level of responsiveness/sensitivity/complementarity she has previously provided. The key issue is not to do with the complementarity of how he asks and she answers at that point

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in time, such as with matching voice tones or eye gaze. The key issue is: does the child accept the answer as if it is his own memory or not? Future work may provide further clarification on how the complementarity and parity principles link to different aspects of attachment phenomena and how concepts such as extended emotions (Carter, Gordon, & Palermos, 2016) can be accommodated in an integrated conceptual framework.

Whilst the hypotheses of the embedded and extended cognition can both provide new thinking for Attachment Theory, the extended mind seems too strong and too radical to re-frame Attachment Theory. Sometimes carers may be 'transparent equipment' for their infants (Clark, 2008, page 80). But these occasions will be the exception rather than the rule because the interests of infants and carers do not completely coincide (Haig, 1993; Simpson, 1999; Trivers, 1974). However, one of the strengths of both embedded and extended accounts is that both explain a range of social interactions, from adaptive control to linguistic self-reflection. So these approaches do not reject a core computational and representational mind. For example, close coordination in attachment behaviours ranges from close holding when infants 'sink-in' to their carers arms (Ainsworth et al., 1978), to linguistically mediated attachment discourse (Dallos, 2006).

5.   Enactivising Attachment Theory

The three varieties of enactivism considered in this section highlight various different aspects of adaptive control and subjective experience in the attachment domain.

5.1.   *Attachment Theory encounters Sensorimotor Enactivism*

Sensorimotor enactivism criticises the view that perception results in inner images or mental representations being produced. In the sensorimotor view, perception, action, and subjective perceptual experiences are all inescapably connected (Deganaar & O'Regan, 2014; Hutto & Myin, 2013). This approach allows that perceptual experience is grounded in knowledge and is therefore representationally contentful. But the kind of mediating knowledge in sensorimotor enactivist accounts is more like procedural or skill-based knowledge. It is 'know-how' rather than 'know-that', a kind of knowledge demonstrated by the skilled performance of its deployment rather than an independently queriable knowledge base (Hutto & Myin, 2013). Viewing attachment behavioural patterns in this enactivist manner - as social skills rather than arising as a result of internal representations - may provide a powerful spur towards new research hypotheses and clinical interventions.

Limitations of the sensorimotor enactivist approach are highlighted by describing a non-4e theoretical competitor - the Predictive Processing theoretical framework (Clark, 2014, p. 241). This shares with sensorimotor enactivism that it is centred around making predictions of the results of actions from what is known about the state of the world. However, where sensorimotor enactivism focuses on a shallow view of the world (and no representation of the internal states that map or model the world), the predictive processing framework proposes hierarchical generative probabilistic models that can capture complex causal relationships at multiple levels of abstraction (Clark, 2013, 2014). It posits the operation of a rich multi-level representational hierarchy but is opposed to the passivity of traditional cognitivist representations. This is because in predictive processing internal representations provide a constant stream of predictions about what the perceptual system should actually being perceiving from the basic sensory data the organism receives. All the time there is a mismatch between model derived prediction

and actual perception the model is updated to minimise the error. Because models in predictive processing are 'expectations' they can also be used to look forward in time - and hence are ready-made as simulation tools to imagine the outcomes of future actions. So a good match for Bowlby's concept of IWMs. Clark (2014) speculates that *"such mental simulations provide an appealing way of smoothing the path from basic forms of embodied response to abilities of planning, deliberation and offline reflection"*. (Clark, 2014, p. 240).

In conclusion, when individuals with insecure attachment gain secure status they can be viewed as gaining a skill which they can then use in other relationships. However, we should remember that whilst attachment phenomena includes skills and habits, any framework for explaining attachment behaviour needs to explain attachment interactions that are often mediated through language (Bretherton & Munholland, 2008; Dallos, 2006).

5.2. *Autopoeisis and representation from social interaction*

According to autopoietic enactivism, cognition, mentality and subjective experience all emerge from the self-organising and self-creating activities of autonomous entities (Hutto & Myin, 2013). Autopoiesis is a complex process that places the organism centre stage and is related to the simpler process of homeostasis. As with a system that shows homeostasis, an autopoietic organism actively monitors itself and reacts to perturbation, but it is also self-produced and self-distinct (Di Paolo, 2009). Autopoiesis takes the position that metabolism and life is essential for grounding intentional categories like cognition, consciousness, and emotions (Boden, 2006).

Di Paolo (2009) proposes a concept of autopoiesis where behavioural habits, arise from 'within', coordinating with the intimate details of 'without'. So acting as a bridge between the inner and extended domains. This form of enactivism suggests that, because factors from 'within' and 'without' play equally important and necessary roles in creating cognition and behaviour, the distinction between organism and environment is viewed as only having a heuristic value rather than being a true metaphysical division (Hutto & Myin, 2013).

Bowlby described how 'inner' mechanisms of self-control and physiological maintenance are integrated with 'outer' behaviours, but a number of decades before Di Paolo. In the second Volume of the Attachment Trilogy, Bowlby adopted the biological concept of homeostasis for Attachment Theory and applied it to behavioural as well as physiological control systems:

> *"Looked at in this light the regulatory systems that maintain a steady relationship between an individual and his familiar environment can be regarded as an 'outer ring' of life-maintaining systems complementary to the 'inner ring' of systems that maintain physiological homeostasis."*
> (Bowlby, 1973, p. 149)

So physiological homeostasis which regulates food and sleep are an inner ring of control in the attachment control system. Attachment behavioural patterns that bring about proximity maintenance and exploration within overall secure-base patterns constitutes an outer behavioural ring which is a complement to this inner physiological control system (Bowlby 1973, chapter 9). However, Bowlby did not set out how the intimate engagement of these two rings could give rise to phenomenological experience. He did describe attachment feelings, but within an emotional appraisal framework ((Bowlby,

1969), chapter 7). Bowlby's departure from using a psychoanalytic framework meant jettisoning an approach directed towards explaining rich subjective experiences. Viewing Attachment Theory through the lens of autopoietic enactivism can act as a spur for a more comprehensive approach for Attachment Theory that unifies behaviour, cognition, and subjective experience in a single explanatory framework (Colombetti, 2014). Whether mechanisms incorporated from autopoietic enactivism are found to be the best way to do this within Attachment Theory is an open question. What an encounter between Attachment Theory and autopoietic enactivism highlights is that the cognitivist mechanisms within Attachment Theory do not explain the feeling of being attached.

5.3.   *A Radical Enactivist Manifesto for Attachment Theory?*

Hutto and Myin propose the thesis of radical enactive cognition (REC) that is a variant of enactivism that states that only a small proportion of cognitive processing is mediated by contentful representations. In their view, the majority of human cognition is basic and non-contentful information processing that controls behaviour for adaptive purposes but does not possess truth bearing properties like reference, accuracy or implication. According to REC, contentful representations do mediate some cognition, but these representations play a minor role in cognition overall. As Hutto and Myin (2013, p. 13) note *"Yet even the most radical of enactivists need not, and should not, deny the existence and importance of contentful and representationally based modes of thinking; it is just that these should be regarded as emerging late in phylogeny and ontogeny, being dependent in special sorts of shared practices"* (Hutto & Myin, 2013, p. 13). The 'shared practices' they refer to are exactly the kind of interaction that occurs in adult therapy or adult and child relationship-talk. So what Hutto and Myin have proposed is a novel variant of a dual process approach to cognition, with linguistically mediated representations that can interpret or receive narrative meanings, and basic structures and mechanisms that carry out adaptive control (Petters & Waters, 2010). However, whilst other dual process approaches make a distinction between self-reflective thought which is linguistically mediated and conscious, and processing which is not linguistically mediated and inaccessible to consciousness, REC 'carves things up' in a very different way (Petters & Waters, 2010). As Hutto and Myin note, *"Enactivists are concerned to defend the view that our most elementary ways of engaging with the world and others - including our basic forms of perception and perceptual experience - are mindful in the sense of being phenomenally charged and intentionally directed, despite being non-representational and content-free"* (Hutto & Myin, 2013, p. 13).

So according to a REC approach to Attachment Theory, an IWM that is formed early in ontogeny and has become inaccessible to linguistic self-reflection is not 'hidden', or 'behind' or 'beneath' other more linguistically accessible IWMs. Instead, REC reframes inaccessibility - so in REC this is just linguistic inaccessibility. Such inaccessible structures are still at the forefront of mind and are phenomenally charged and conscious. This re-framing can turn therapeutic ideas right around. Instead of therapy uncovering hidden structures it is about understanding how context and behavioural predispositions enact these structures in the moments they occur.

In addition, REC holds that an organism's current behavioural tendencies are not explained or structured by representations of the past but influenced more directly, just by its *"history of active engagement."* with the world ((Hutto & Myin, 2013), p 11-12). So an organism's behavioural predispositions do *"not inherently "say" anything about how things stand in the world"* ((Hutto & Myin, 2013), p 19). Rather, according to Hutto and

Myin, *"a truly radical enactivism - REC - holds that it is possible to explain a creature's capacity to perceive, keep track of, and act appropriately with respect to some object or property without positing internal structures that function to represent, refer to, or stand for the object or property in question"* (Hutto & Myin, 2013, p 82).

So if Attachment Theory follows REC it might reconceive internal states like working models to be just control states and break the link with the reality they are supposed to represent. In one view, an attachment control system that proposes internal control states are not truthful representations of reality is a profound shift from current Attachment Theory. No longer would attachment interventions be concerned to assess how individuals represented their past relationships but instead they would be more focused on how to move towards more adaptive behaviour patterns. However, in another view, seeing internal states as de-linked from contentful representation suggests a link back to part of the psychodynamic way of thinking from which Attachment Theory originated (but without going back to outdated aspects like Drive Theory). Attachment Theory was formulated to provide answers to several related questions: how are early experiences recorded in a way that they impact later experiences?; what changes as a result of previous experience?; and what changes during different timescales, over days, weeks or months? Ainsworth explored this issue when she discussed how what occurs over previous days may affect the sub-categories found in the Strange Situation (Ainsworth et al., 1978). One answer is the infant's persistent state. When a baby has become anxious or worried, 'on edge', this might be measured with a cortisol assessment. This is not the representation of information in memory. A second answer is that the baby has attached some kind of meaning to the experience. This 'meaning making' reaction might be mediated through information processing mechanisms such as encoding into memory that works through a longer period of time than physiological state. There is also another longer term way of recording experience which is that there is structural change in the form of the whole information processing architecture. This latter suggestion for how experience is recorded reminiscent of ideas comes from the psychoanalytic tradition and is the idea that experience was recorded in terms of building structures of mental energy and defence ((Horowitz, 1988) p 17). Little dykes to keep drives from flooding off in certain directions and ditches to direct energy in other directions. So the idea that Attachment Theory may borrow from REC is that structure is the residue of experience that filters and biases future behaviour.

One of Bowlby's contributions in his revision of the psychoanalytic framework was to introduce the idea of information, rather than structure, as the means of recording past experience. IMWs that act as memories and that provide simulations of the future only really works with such an information processing formulation. In the view proposed here, that is in accord with the basic minds approach of REC and also draws upon old psychoanalytic ideas in a new context, the attachment control system grows in a way that records what it experiences during its development. The elements (building blocks) for an attachment control system, as a result of experience, thus become coordinated into a system to give a particular structural form. Taking on this idea does not mean that Attachment Theory would regress back to a psychoanalytic framework. An encounter between enactivism and Attachment Theory asks: should Attachment Theory incorporate the idea that experience can be recorded in terms of how information processing structures are built in addition to representing key attachment experiences in memory? A REC approach to the human mind suggests that a large proportion of information processing is non-contentful. So, in the attachment domain, a REC view might accept that relationship talk involves representational content, but this kind of representation is not part of adaptive control in behaviour patterns like exploration from a secure base

or return to a safe haven provided by the mother. Following REC, when a rat pup or a gosling returns to its mother we might consider it is not producing plans and goals with representational content. However, in humans, from an early age adaptive control guiding organisms towards their goals occurs alongside relationship talk about those goals. Mechanisms of adaptive control can then be mediated - inhibited or activated or otherwise directed - by mechanisms that involve representational content. This may occur repeatedly over ontogenetic development leaving long-lasting biases - so adaptive control ends up being finely shaped by linguistically presented ideas. Is it then correct to call these mechanisms of adaptive control non-contentful? Of course, the nature of how adaptive control in the attachment system is shaped by activities like relationship talk is an empirical question. But as we saw in section 5.1 the predictive processing framework (Clark, 2014) provides a strong alternative to sensorimotor enactivism, and it is also an alternative to the adaptive control of basic minds presented in this section that would support close interaction between lower level control mechanisms and higher level linguistic mediation. So future work can more closely examine whether Attachment Theory is best revised within a 'representation friendly' framework (Pouw & de Jong, 2015) or the more radical approach of basic REC minds (Hutto & Myin, 2013).

6.   Conclusion

In breaking from psychoanalysis Bowlby was a revolutionary, but at heart he was also a conservative, because he wanted to save the core and most valuable findings of Freud's psychoanalytic framework. These were insights about the highly active and interactive nature of social and emotional development in infancy. Since Bowlby was an eager 'borrower' of scientific concepts from the ideas which were popular at the time he formulated Attachment Theory, he might today look to incorporate the diverse insights of 4e cognition in a revised framework for the attachment control system. In section 2 we asked whether IWMs in adults are linked both to processes of shared meaning making and interpretation, and to processes of adaptive control, that is, whether they should not only be conceived in linguistic or symbolic form, but also conceived as analogue or embodied information processing structures. In section 4 we showed how embedded and extended cognition provide possible explanations for how infants derive support from their caregivers. The approach of embedded cognition is closer to the stance taken by Attachment Theory as it is now understood. The hypothesis of extended cognition may prove fruitful in stimulating new empirical directions but will perhaps be too radical for the intuitions of attachment researchers, partly because of the way it presents infant and carer interaction so unequally. Then in section 5 we considered how an enactivist approach can help explain subjective experiences in attachment interactions, and how internal control structures can direct future actions without a link to 'truthful' representations of past events.

Considering issues of embodiment, embedding, extension, and enactivism together has a major benefit because these four approaches pull in different directions. So together they provide a balanced reformulation for Attachment Theory. Considering IWMs as analogue in addition to symbolic keeps the IWM construct tied to an individual. The embedded and extended cognition approaches reminds us of the dialogic nature of attachment and the enactive approach forces us to question our representational assumptions and consider a place for subjective experience in our explanations. Taken together these perspectives complement each other. Future work might focus on how the 4e perspective provides empirical payoffs in attachment research on sensitivity to signals, cooperation

with ongoing behaviour, acceptance of baby's needs (babyness), and physical/emotional availability. Research might also explore how the 4e components influences the measurement of secure base phenomenon, such as exploring away from mother with her in mind and retreating to her for comfort or being comforted by expectation of her availability and responsiveness. We can never really know how Bowlby would have responded to the questions posed by 4e cognition but we can act to make revisions to Attachment Theory that conserve his key theoretical insights.

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