MAPPING A NOVEL VIEW OF THE HUMAN INFORMATION PROCESSING SYSTEM AND ITS APPLICATION IN DESCRIBING IDENTITY

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Abstract. This paper outlines the development of a scientifically oriented model that describes learning and memory in a broad context, based in studies of the energy and matter pathways through which an organism interacts with its environment. Concept maps are utilised to illustrate elements of the model's dynamic. The potential for utilisation of the information in a model of personal identity are explored, with identity considered in terms of the learning and memory inherent in an individual's interaction with the world.
Keywords: identity, learning and memory, information processing systems, connectivity, environmental interaction.

1 Introduction

Recent advances in biology are illuminating the pathways and patterning of thought, emotion and memory in ways that offer understanding of the lived experience of identity as correlated with complex views of the state of an organism in relationship with its environment. This does not ignore states correlated with social experience and seen as learning, memory, as well as imagination, as elements in this complex system of information exchange. This paper outlines the application of a biology-based model of learning and memory, developed through a process of concept mapping (e.g., Cañas et al., 2003), to the examination and development of a novel conceptualisation of human identity. This conceptualisation considers the information interactions between human organism and environment from a basis in modern science while, at the same time, remaining grounded in perspectives of identity within the social and behavioural sciences and humanities.

2 Background – Studies in learning, memory and connectivity

Based on comparisons of learning and memory in multi- and unicellular organisms, learning may be described in a broad sense as the process of change in connectivity, for example in number, strength and type of connections, within and between the structures or parts of an organism representing the pathway between an environmental signal and an organismal response (Woolcott, 2013) (Figure 1). On this basis, the number, strength and type of such connections may be described as memory. This connectivity may be as simple as a chain of chemical reactions that start with a chemical in the environment interacting with the exterior of the cell, but may include more complex chains and cascades of interactions with a variety of energetic and/or chemical components in a potentially large number of cells. Extremely complex organisms, such humans and other mammals, may operate in a similar way, with emergent effects as seen in complex systems (e.g., Thelen and Smith, 1994)

On the basis that any evaluation of a structure as living may not necessarily be considered as relevant, some researchers have explained learning in terms of an object, living or non-living, that processes information about its surroundings (e.g., Dennett, 1995). It can be argued, therefore, that the consideration of learning and memory as related to a physicochemical interaction with environment may apply across all organisms and non-organismal structures and that such fundamental interactivity can be viewed in terms of information processing.

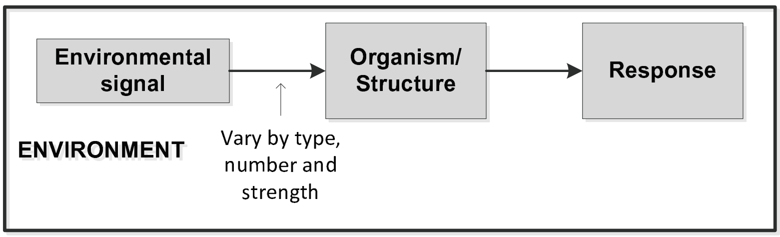

Figure 1: A map of the pathway from environmental signal to organismal/structural response. Learning and memory are related to the type, number and strength of environmental connections and information processing of the organism or structure.

The map in Figure 1 illustrates the broad sense of this system of connectivity. Even though this map appears to resemble the stimulus-organism-response information processing models of the 1970s (e.g., Skinner, 1938), it differs in a number of ways, embracing any environmental input instead of just stimulus, and includes non-organismal structures along with organisms. The response indicated here would also not be seen necessarily as behaviour. Additionally, based on the previous discussion, the organism or structure would have a memory described in terms of the quantity and quality of substances, or the matter and energy of which it consists (Woolcott, 2011).

3 Learning and memory in terms of a novel information processing system

A broad conceptualisation of learning and memory in terms of matter and energy pathways is used here as a basis for a model of information processing systems considered in a scientific context (Bates, 2005). In the novel conceptualisation used here, however, learning and memory can be thought of as associated with the interaction of the matter and energy of a structure, including an organism or an organismal structure (an organism or part of an organism), with matter and energy from the environment. In any interaction of a structure with its environment, the matter or energy communicated into or out of the structure can be seen as information and the connectivity or pathway between environmental information and the structure can be seen as spatiotemporal, since the information is first in one place and then later in another. Some of the information communicated in any such interaction may be integrated and result in changes to the structure, including changes in matter and energy content or connectivity (Figure 2).

The information within a structure (as matter and energy), including any internal structural or positional relationships, patterns or configurations, actual or potential, is the memory of that structure, regardless of the learning mechanism. The communication of such information both into and out of any structure can be described in terms of learning if there is a resultant change in memory. Any change in information or informational connectivity within a structure is referred to here as information processing. The state, or activity, of a structure, given such input or output of information, relies on observation of change of the total information within the structure and, hence, incorporates any change observed temporally, such as growth or motor activity, as a type of memory expression. Memory within this model can be described, therefore, in terms of the overarching range of possibilities or potentialities of any matter and energy within such information processing systems, and learning can be described as any change to memory that results from input or output of information.

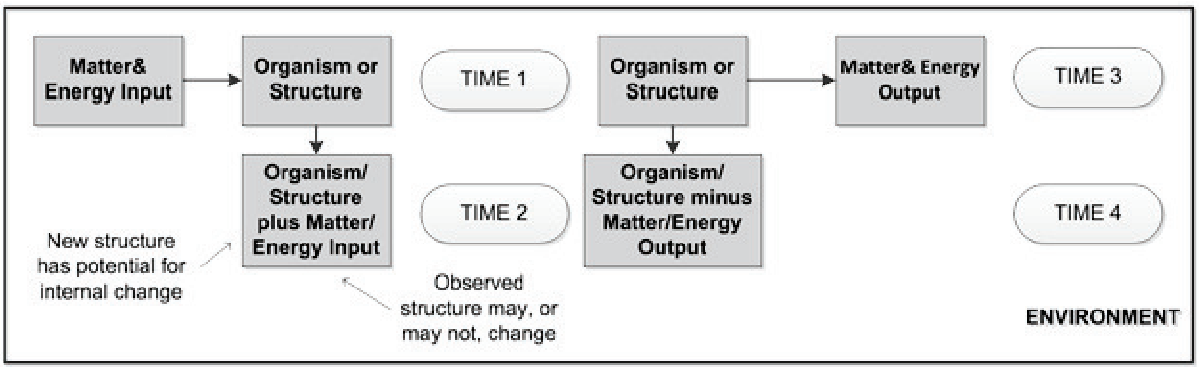

Figure 2: A model for information processing based in matter and energy pathways between a structure and its environment. This map uses only one connection pathway and does not indicate the type or strength of that connection.

4 The human information processing system

The advantage of this novel conceptualisation is that the broad concepts of learning and memory considered in terms of matter and energy pathways can be integrated within a single model through a formal description of an information processing system that is based in scientific assumptions. The model described here, in theory at least, may be used in a broad sense to describe any discrete matter and energy component of the universe (*sensu* Gribbin, 1994) as an information processing system and, hence, to enable the comparison of such components. Within this broad model, a human is an information processing system, a discrete entity of matter and energy whose connectivity with environment can be described in terms of informational interactions within a definable matter and energy universe. The human system consists of connected component systems, such as the nervous and circulatory systems, which connect with each other as well as with the external environment. Within the model outlined here, human learning and memory, therefore, involves the connectivity with environment of the entire human system (see Figure 3) and not just the information processing within, or information transmission into and out of, its component systems, such as seen in treating the central nervous system as a stand-alone learning system. A similar holistic connectivity has been proposed in recent interdisciplinary studies that consider learning and memory to involve the entire human organism and its interaction with environment (e.g., Squire & Kandel, 2008).

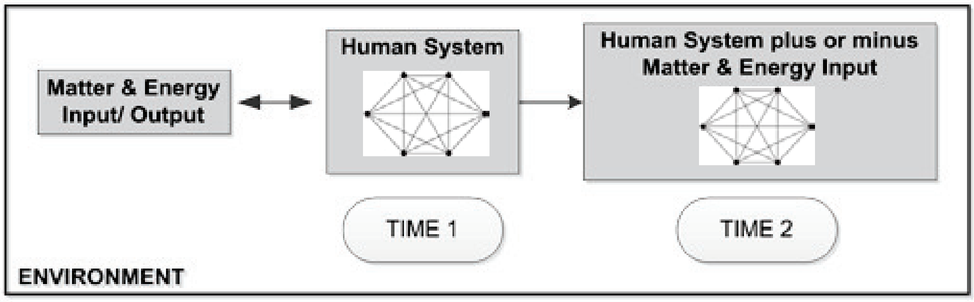

Figure 3: The human information processing system as a set of interacting internal systems whose memory is determined by both input and output of matter and energy spatiotemporally.

Since, on the basis of this model, any component structure within the human system can be described as a discrete information processing system that interacts with other component systems, differing aspects of human cognition can be considered separately, but with a view to the dynamics of the system as a whole. Describing the system in this way, therefore, allows a formalisation of the partitioning of cognitive structures as discrete entities and this may facilitate the examination of dynamic interactions of such component systems that are known to operate, not only during spatiotemporal sequencing of memories (Squire & Kandel, 2008) but also in the linkage of emotions and chemical reward with learning and memory (Panksepp, 1998). This treatment may formalise also the study of interactions of component systems that act dynamically, through emergence, to adapt each human to a range of environmental inputs (Thelen & Smith, 1996).

5 Describing human identity in terms of an information processing system

In considering the human individual as the type of information processing system outlined above, human identity can be conceptualised as resulting from system-wide interactions of internal component systems, some of which are linked to the external environment. This is a very broad view of identity and contrasts markedly with what is termed 'identity theory' in studies of philosophy or the social and behavioural sciences. In the social sciences, for example, identity theories may be based in views referred to in terms of the embedded self, where interpersonal relations are seen as the essential factor in determining identity self and role internalisation. In philosophy, theorists (e.g., Smart, 2012) sometimes discuss identity theory in terms of conflicts related to materialism and links between beliefs and desires related to brain/mind.

The model proposed here is not an identity theory, but may be useful in describing personal interactions, provided that they are considered in terms of inputs as matter (e.g., sound transmission) or energy (e.g., light transmission), and this may have some resonance with the materialism discussed in Smart (2012). In the model described here, however, cognition and behaviour are categorised as part of the information processing of the identity described, with such responses considered as observed memory expression, over specified time periods, of the entire system's interactions. The model here would also suggest that inputs such as oxygen, water or glucose, be considered as part of the model, since these are part of the environment that affects the human system in some way (e.g., Riby, Meikle & Glover, 2004), in the same way that electricity input affects a computer.

Support for this system-wide approach can be seen in studies that have related cognition and behaviour to characteristics of the whole organism rather than particular subsystems, such as the brain (Squire & Kandel, 2008), as well as in studies that relate cognition to activity of a muscular system that acts in tandem with the nervous system (Llinás, 2001). Component systems within a human individual may process information in different ways and over different time frames, but may act together to contribute to cognition and behaviour. Such interaction is dependent, of course, on the connectivity between such component systems. The model supports the view that this cognitive and behavioural system incorporates the information processing components that are involved in motivation and emotion (e.g., Panksepp, 1998).

6 Conclusion

The broad model suggested here may provide, among other things, an overall perspective from which to view a system-wide human interaction with environment. The examination of such information pathways in a model of human identity may generate a more detailed account of information being transferred into and out of the human system, where this information affects the formation or description of each human as an identity, through a better understanding of the links that occur in environmental information and the actual networks or pathways that are used to store that information. Identity conceptualised as generated from system-wide dynamics, in multilevel and parallel reciprocal interactions as suggested in this paper, reflects a scaled systems perspective from unicellular organisms through to complex multicellular organisms. The model as conceptualised here holds the paradox of stable patterning and dynamic variation within an identity system described in terms of matter and energy interactions. The development of such a model needs to include such elements as evolutionary processes, self-systems and culture, and to account for adaptation within a general coherence. Within the broader project, the next generation of conceptualisation and research into identity as system wide phenomena will necessarily cross disciplinary boundaries to include areas of subsystem specialty including such research areas as psychology, social science, physiology, ecology, education, development, genetics, medicine and culture. Possible application of an identity model that incorporates system-wide dynamics at any one moment and over time, includes educational contexts and the model may shed light on approaches to identifying conditions for maximising potential and minimising the effects of vulnerability in such contexts.

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