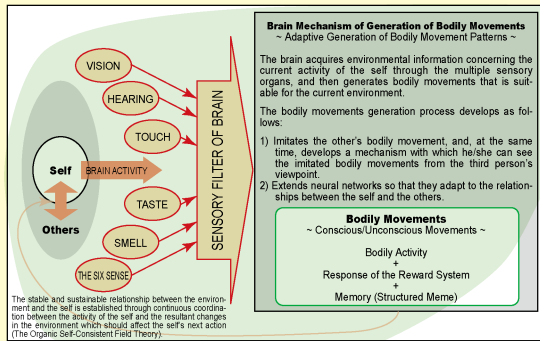


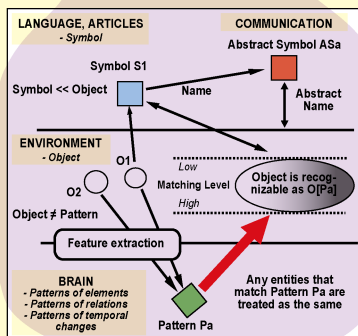
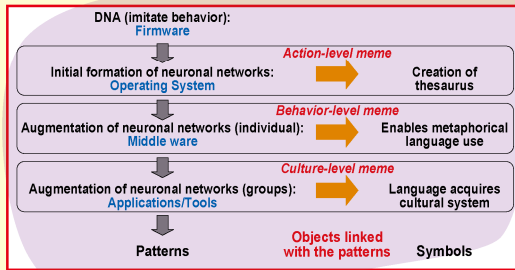
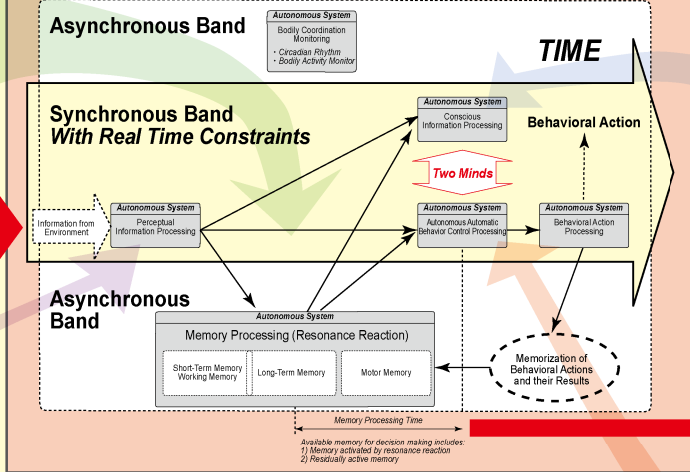
MultiDimensional (MD) Frame: The Basic Elements of Memory Structure

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Abstract Object cognition occurs as follows: collecting information from the environment via perceptual sensors; integrating and segmenting the collected information, centering on visually collected objects; and continuing these processes until the necessary objects to live in the environment are obtained. These objects are then used independently in Systems 1 and 2 of Two Minds, and memorized after integrating related entities associated with each system. Due to the limitation of the brain's processing capability, the range of integration is limited; therefore, System 1 memory and System 2 memory may differ. However, they may share objects originating from perceptual sensors. Thus, when objects that are the result of the just-finished integration and segmentation process are processed in the next cycle, representation of the objects may serve as the common elements to combine System 1 memory and System 2 memory to form an inter-system memory. We call this memory the MultiDimensional (MD) Frame.

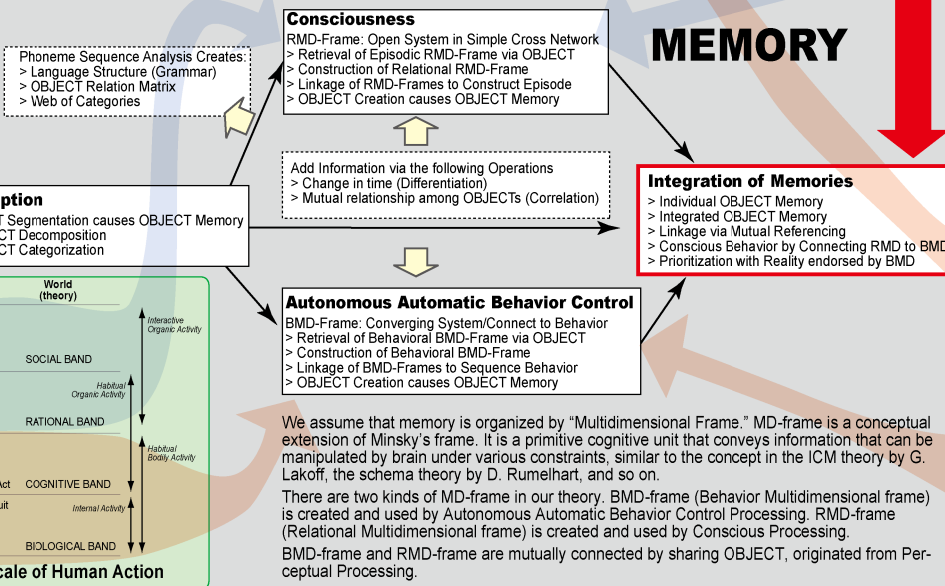


Model Human Processor with Real-Time Constraints



Newell's Time Scale of Human Action

Scale (sec)	Time Units	System	World (theory)	Activity Type
10 ⁷	Months			Interactive Organic Activity
10 ⁶	Weeks			
10 ⁵	Days		SOCIAL BAND	Habitual Organic Activity
10 ⁴	Hours	Task		
10 ³	10th	Task	RATIONAL BAND	Habitual Body Activity
10 ²	Minutes	Task		
10 ¹	10th	Unit Task		
10 ⁰	1st	Operations	COGNITIVE BAND	Internal Activity
10 ⁻¹	100th	Deliberate Act		
10 ⁻²	10th	Neural Circuit		
10 ⁻³	1st	Neuron		
10 ⁻⁴	1μs	Organelle	BIOLOGICAL BAND	



We assume that memory is organized by "Multidimensional Frame." MD-frame is a conceptual extension of Minsky's frame. It is a primitive cognitive unit that conveys information that can be manipulated by brain under various constraints, similar to the concept in the ICM theory by G. Lakoff, the schema theory by D. Rumelhart, and so on. There are two kinds of MD-frame in our theory. BMD-frame (Behavior Multidimensional frame) is created and used by Autonomous Automatic Behavior Control Processing. RMD-frame (Relational Multidimensional frame) is created and used by Conscious Processing. BMD-frame and RMD-frame are mutually connected by sharing OBJECT, originated from Perceptual Processing.

