Cognitive Chrono-Ethnography (CCE): A Behavioral Study Methodology Underpinned by the Cognitive Architecture, MHP/RT

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Introduction: MHP/RT and CCE

At the 0-th order approximation, a person interacts with his or her environment by running an endless cycle of perceiving the external and internal environment through five senses via sensory neurons as parallel processing, and acting to the external environment through body parts via motor neurons as serial processing. As s/he perceives the results of movement of his/her body parts as well as the changes of the external environment as time goes by, the next cycle of Perceptual–Motor should occur. Interneurons in-between the sensory neurons and motor neurons convert the input patterns to the output patterns – these constitute a Perceptual-Cognitive-Motor process (PCM process). Starting from this basic cycle, we (M. Toyota and the author) constructed a comprehensive theory of action selection and memory, Model Human Processor with Realtime Constraints (MHP/RT), that should provide a basis for constructing any models for users interacting with ever-changing environments, and an accompanying behavioral study methodology, Cognitive Chrono-Ethnography (CCE) (Kitajima, 2016; Kitajima & Toyota, 2013) to be used to utilize, validate, and/or refine MHP/RT. MHP/RT and CCE are two wheels for conducting cognitive behavioral sciences, that complement each other from theoretical and experimental perspectives, respectively. Visit `http://oberon.nagaokaut.ac.jp/ktjm/organic-self-consistent-field-theory/index.html` for more information for the entire project.

Model Human Processor with Realtime Constraints (MHP/RT)

MHP/RT is an extension of Model Human Processor developed by Card, Moran, and Newell (1983). The purpose of MHP/RT is to implement at a higher level the facts that the fundamental processing mechanism of brain is Parallel Distributed Processing (PDP) (McClelland & Rumelhart, 1986), that human behavior emerges as the results of competition of the dual processes of System 2, slow *conscious* processes for deliberate reasoning with feedback control, and System 1, fast *unconscious* processes for intuitive reaction with feedforward control for connecting perception and motor movements, called Two Minds (Kahneman, 2003), and that human behavior is organized under happiness goals (Morris, 2006), on the assumption that the processing involved in action selection is truly dynamic interaction that evolves in the irreversible time dimension. The extension is done by considering that the endless PCM cycle continues from his or her birth to death in the ecological system that consists of the person and the environments, and it is a periodic circulation system.

MHP/RT consists of two parts. The first part is the cyclic PCM processes, in which PDP for those processes is implemented in hierarchically organized bands having their respective characteristic times for operations, i.e., biological, cognitive, rational, and social bands (Newell, 1990) by associating relative times (not absolute) to the PCM processes that carry out a series of events. The second part is memory, which supports the PCM processes. It is implemented as a distributed memory system and at the same time it serves as a mechanism to establish synchronization among multiple PCM processes.

Cognitive Chrono-Ethnography: CCE

Equipped with the cognitive architecture, MHP/RT, how can we study people's behaviors, characterized by Two Minds working dynamically along the time dimension? We came up with a solution in the form of a study methodology, called CCE. Cognitive Chrono-Ethnography combines three concepts. "Cognitive" declares that CCE deals with interactions between consciousness and unconsciousness in the PCM cycles. "Chrono(-logy)" is about time ranging from $\sim$100 msec to days, months, and years, and CCE focuses on such time ranges. "Ethnography" indicates that CCE takes ethnographical observations as the concrete study method because in daily life people's Two Minds tends to re-use experientially effective behavioral patterns, which is called "bias". Ethnographical field observations are essential for understanding each person's bias in his/her daily life.

CCE Procedure

Figure 1 shows the seven steps to conduct a CCE study:
1) Ethnographical Field Observation: Use the basic ethnographical investigation method to clarify the outline of the structure of social ecology that underlies the subject to study.
2) Mapping the Observed Phenomena on Cognitive Architecture: With reference to the behavioral characteristics of people which have been made clear so far and MHP/RT, consider what kind of characteristic elements of human behavior are involved in the investigation result in (1).
3) Identifying Study Parameters through Model-Based Simulation: Based on the consideration of (1) and (2), construct an initial simple model with the constituent elements of activated memories, i.e., meme, and the characteristic PCM processing to represent the nature of the ecology of the study space.
4) Design a CCE Study: Based on the simple ecological

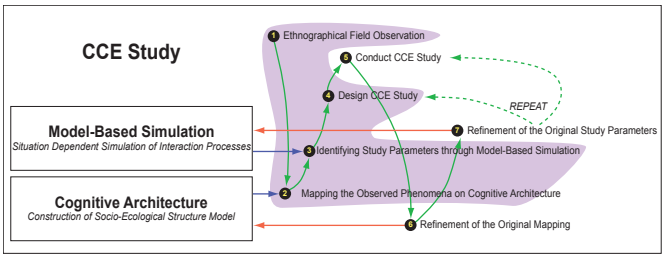

Figure 1: The CCE procedure (Kitajima, 2016, Figure 5.1).

model, identify a set of typical behavioral characteristics from a variety of people making up the group to be studied. Then formulate screening criteria of elite monitors who represent a certain combination of the behavioral characteristics, and define ecological survey methods for them.

5) Conduct CCE Study: Select elite monitors and conduct an ethnographical field observation.

6) Refinement of the Original Mapping: Check the results of (5) against the results of (2) for appropriateness of the mapping. If inappropriate, back to (2) and redo from there.

7) Refinement of the Original Study Parameters: If the result of (5) is unsatisfactory, go back to (4) and re-design and conduct a revised CCE study, otherwise go back to (3) to redo the model-based simulation with a set of refined parameters.

Completed CCE Studies: A Few Examples

Navigation in a train station by following signs: With the focus of action selection processes involved in slow navigation, Kitajima and Toyota (2012) reported a CCE study to investigate how elderly people use guide signs at train stations when they have to transfer lines, in addition to use some facilities such as restrooms, lockers, and so on. The results showed: 1) persons with inferior planning function with normal attention function did not use guide signs when they had mental models, whereas they did not gather task-relevant information but irrelevant one when they had no mental model, and 2) persons with inferior planning function and inferior attention consistently had problems in gathering task-relevant information by using guide signs because of vague description of behavioral goals. The interactions between planning and attention functions and the existence of mental models are consistent with MHP/RT's simulation results.

Sightseeing in a hot spring resort: Hot spring resorts are popular tourist attractions in Japan. However, little is known about why they are popular destinations. To answer this question, Kitajima, Tahira, Takahashi, and Midorikawa (2012) conducted a CCE study. Forty-three groups participated in the study as elite monitors. Each group arrived at Kinosaki-Onsen and were asked to tour the place. They were instructed to carry a GPS and a digital camera for recording their activities. By analyzing the results of the interviews, we identified six types of tourist activities including: bathing, staying, eating, exploring, touring, and shopping, each of which corresponds to a different set of happiness goals.

On-Going CCE Studies

Designing Memorable Events: People live in the environment filled with artifacts, part of which is real and the rest is virtual. Kitajima, Shimizu, and Nakahira (2017) conducted initial steps of CCE to understand how the PCM processes along with the memory process result in memorable experiences. Preliminary experiments were conducted to see how omnidirectional movies in virtual reality augmented with audio-guide made the experience memorable by timely provision of multi-modal information as designed by MHP/RT.

Designing Immersive Events: Immersive virtual environments are distinct from other types of multimedia learning environments. Dinet and Kitajima (2018) reported initial steps of CCE that focused on the conditions necessary to produce "immersive experience" for the user. The CCE study will continue in the context of developing a multimodal interface to help young pedestrians acquire necessary skills for safe navigation in dangerous traffic environments.

Six Publications Relevant to this Abstract

Dinet, J., & Kitajima, M. (2018). Immersive interfaces for engagement and learning: Cognitive implications. In *Proceedings of the 2015 virtual reality international conference* (pp. 18/04:1–18/04:8). New York, NY, USA: ACM.

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