Cognitive Chrono-Ethnography:
A Method for Studying Behavioral Selections in Daily Activities

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As human beings, we select our next behavior that should maximize our satisfaction by making use of the meme of our past experiences and by processing input from the environment and individual intrinsic state by appropriately allocating available cognitive resources. The underlying processes have been simulated by the Model Human Processor with Real-Time Constraints (MHP/RT) (Toyota and Kitajima, 2010). Based on MHP/RT, this paper proposes Cognitive Chrono-Ethnography (CCE), a new study method for understanding human behavior selections in daily life. When a study field is specified, CCE defines critical parameters by conducting qualitative MHP/RT simulations, and then designs ethnographical field observations and recordings of elite monitors' behavior in the space defined by the critical parameters. Structured interviews follow in order to obtain the participants' history of behavioral development. Analysis of the interview results aid in developing models of present behavior selections and chronological changes. A case study of CCE that deals with spectators' repetitive visits to a ballpark is presented in this paper.

INTRODUCTION

Our 24-hour day is roughly divided into three categories. The first is the hours for work in order to earn money necessary for daily life, the second is the hours for biological activities (e.g., eating and sleeping) that are necessary to live, and the third is the hours for leisure activities (e.g., playing sports, watching TV, driving a car, playing PC games, traveling, going to the movies, and surfing the Web). Traditionally, human factor studies have dealt with the first two categories.

Recently, with the development of ICT, many leisure-time opportunities have been provided by a number of service industries. Whether to use the service repeatedly or quit using it is solely up to the receptor, and the decision is not critical. However, since our ultimate purpose of living is to spend hours of satisfaction, provision of appropriate services to an individual receptor is of vital importance.

This paper proposes Cognitive Chrono-Ethnography (CCE), a new method for studying service receptors' behavioral selections. The following sections describe CCE and elaborate on its distinctive features, such as conducting a field study with a limited number of elite monitors and retrospective interviews that consider human cognitive-behavioral processing during the interview sessions. A case study follows to illustrate how a CCE study may be implemented.

COGNITIVE CHRONO-ETHNOGRAPHY

Outline of CCE

CCE consists of ethnographical field study that is designed by considering cognitive constraints in order to understand service receptors' behavioral selections in terms of their chronological development. In this section, we describe each of the three concepts of CCE: ethnography, chrono(-logy), and cognitive constraints.

Ethnographical field study. By definition, service is intangible, heterogeneous, simultaneous in production and consumption, and perishable. Therefore, the study must be conducted at the site where a service is implemented, not in a laboratory. In other words, the study method must be ethnographical.

Chronological understanding. What a person does at a specific time is determined by contents loaded in working memory, which originate from the environment and long-term memory. Sensory input from the environment is controlled by cognitive processes. Long-term memory cumulatively stores information as a person's living history and works as an autonomous system. Therefore, understanding the service receptors' behavior in the study field involves understanding active memories (i.e., the structure of the meme) (Toyota, Kitajima, and Shimada, 2009) when they receive the service at the time of the observation and the developmental process of the active memories in their service-receiving histories. Retrospective interviews are conducted to analyze the meme structure.

Cognitive constraints. Service receptors engage in cognitive-behavioral processing; therefore, ethnographical observables are constrained by service receptors' cognitive capabilities. This feature is described by the Model Human Processor with Real-Time Constraints (MHP/RT) (Toyota and Kitajima, 2010; Kitajima and Naitoh, in press) that extends the seminal "Model Human Processor" (Card, Moran, and Newell, 1983) for simulating people's information processing tasks in the domain of daily activities by incorporating such ideas as long-term memory as an autonomous system, sophisticated goal management for pursuing satisfactory living, and real-time constraints to organize behavior synchronously with the environment. Cognitive constraints include the following: the capacity of working memory is limited; the contents stored in working memory decays (e.g., at the rate of two of three items in 10 seconds); memory is bound to the context in which it

was formed (i.e., encoding specificity principle); contents in long-term memory are retrieved by placing cues in working memory; and behavioral selection is not rational (i.e., bounded rationality and satisficing principle) (Simon, 1996)).

Ethnographical field observations must be designed by considering the cognitive constraints that affect the service receptors' behavior. In addition, retrospective interviews for chronological understanding of the service receptors themselves are also regarded as cognitive-behavioral activities; thus, it is necessary to design the interview sessions by considering cognitive constraints. A separate section will further elaborate on this feature.

CCE's Procedure

CCE is carried out in the following six steps.

Step 1. Define the study field. It is important to specify the study field sufficiently to undertake successful CCE studies. Manifestations of cognitive constraints under the characteristic atmosphere of the study field, which must be understood in terms of the effects of cognitive constraints, will be observed in the study field. Examples of CCE studies can be found in Someya, Kitajima, Tahira, and Kajikawa (2009) for spectators' behavior at professional baseball games, Kitajima, Tahira, and Takahashi (2010) for visitors' behavior to a hot-spa resort, Kitajima, Akamatsu, Maruyama, Kuroda, Katou, Kitazaki, Minowa, Inagaki, and Kajikawa (2009) for the behavior of human navigators who are trying to provide useful information to drivers, and Kitajima, Kumada, Akamatsu, Ogi, and Yamazaki (2005) for passengers who are trying to use signs to find their way at unfamiliar train stations.

Step 2. Define critical parameters. Critical parameters are initial hypotheses about the cognitive constraints that should work when service receptors' activities are organized in the study field. To do this, it is necessary to examine the structure and dynamics of the study field in order to ensure the existence of chronological changes of the service receptors, to construct hypotheses about the critical parameters, and to carry out a preliminary test. Steps 1 and 2 are conducted interchangeably to define the parameter space to be explored.

Step 3. Select elite monitors. In order to conduct CCE, we select study participants (elite monitors), using the parameter space. Each point in the parameter space has values, continuous or discrete. We want to know what such-and-such service receptors would do in such-and-such way in such-and-such circumstance (not an average behavior). Therefore, we select service receptors in which we are interested (such-and-such persons) by consulting the parameter space. In this process, it is necessary for the points in the parameter space that correspond to the elite monitors to be appropriate for analyzing the structure and dynamics of the study field. Monitor selection is conducted by purposive sampling rather than by random sampling. This step is unique to CCE, and the next section will provide more details.

Step 4. Record the monitors' behavior. The elite monitors should behave as they normally do at the study field. We record their behavior in such a way that the collected data is rich enough for us to consider the results in the parameter space, as unintrusively as circumstances allow.

Step 5. Conduct retrospective interviews. We then use the collected data to clarify the structure of the meme of the elite monitors by conducting a series of structured interviews. The next section will elaborate on this feature of CCE. The results of the interviews are analyzed for the purpose of defining the basis of the representations of the collected data. The analysis involves finding common terms used in the interviews and common activities that are defined by combinations of the common terms, as well as statistical analysis of the activities (e.g., factor analysis and cluster analysis).

Step 6. Construct models of service receptors. The last step of CCE is to construct models of service receptors that address what such-and-such service receptors do in such-and-such a way in such-and-such circumstances.

KEY FEATURES OF CCE

Elite Monitors

CCE requires selecting high-quality participants called elite monitors who behave in specified patterns defined by critical parameters. Elite monitors are selected through a screening test, a questionnaire on a Web survey, and sometimes an interview. CCE differs from other methodologies that employ random sampling and qualitative study.

Sampling method. In general, researchers in the fields of cognitive psychology and ergonomics are interested in typical human behavior. Their research requires random selection of a large sample. In contrast, CCE does not require a large sample; it requires three monitors at most for each group. Nor does it need to offset deviations with random sampling because the elite monitors share common features defined by critical parameters.

Validation of using small samples. Whether proper results can be obtained using so few samples is a topic of controversy. Sample size, however, is not considered a problem here. The size of the sample is determined by the optimum number necessary to enable valid inferences to be made about the subjects (Marshall, 1996). Increasing the number of samples is not necessary to improve the accuracy of the results. Nielsen and Landauer (1993) insisted that the use of three subjects is sufficient to obtain new findings in a usability test. Therefore, we expect that the sample size of elite monitors in the CCE is sufficient to obtain effective results.

Purposive sampling. Sampling in CCE is similar to purposive sampling conducted in qualitative studies, with regard to using a specified subject and situation (e.g., Patton, 1990). However, CCE differs from qualitative study, especially theoretical sampling (Strauss and Corbin, 1988). In qualitative study design, the principal strategy is that samples are usually theory-driven to a great extent. Theoretical sampling requires building interpretative theories from the emerging data and selecting a new sample to examine and build a theory. With qualitative study, definitive hypothesis or subjects are not necessarily required.

Use of Contextual Cues for Memory Digging

The goal of CCE is to obtain rich and accurate information about elite monitors' behavior in retrospective interviews. The monitors are shown various cues to prompt their memory during the interview. The cues are recorded during the observations using various kinds of recording devices (e.g., photos and VTRs recorded from the individual view). Sometimes the monitor's heart rate and body acceleration are also measured.

Contextual-dependent memory. Contextual cues prompt human memory. In the field of cognitive science, this is known as context-dependent memory (e.g., Smith and Vela, 2001).

Mental reinforcement of contextual cues. Many researchers have found that both physical reinforcement (e.g., environmental and material contexts) and mental reinforcement improve our recall accuracy (e.g., Godden and Baddeley, 1975; Smith, 1979). Mental reinforcement includes mental information and state (e.g., images to be remembered and feelings at the time of memorizing) (e.g., Eich, 1995; Smith, 1979). Mental reinforcement improves the reliability of an eyewitness (Geiselman, 1988). Some researchers have confidence in the effect of mental reinforcement because it has been found to have stability. Based on findings of mental reinforcement studies, showing elite monitors some recorded contextual cues during observations prompts their memory.

Cognitive interview. Contextual cues are used during cognitive interviews to help eyewitnesses reconstruct events reliably and accurately (Geiselman, Fisher, MacKinnon, and Holland, 1986). To help interview participants remember, they are given instructions based on four principles: (a) mentally reinstate the context of the event or think about physical surroundings and psychological state, (b) report every detail, even trivial and irrelevant things, (c) report in different temporal order, and (d) describe the event from a different point of view. This methodology helps reduce interview participants' mistakes in recall and increase the number of items recalled (e.g., Geiselman et al., 1986).

A CASE STUDY OF CCE:
WHY DO FANS REPEAT VISITS TO THE BALLPARK?

This section describes a case study of CCE. The field of study was the ballpark of a Japanese professional baseball team, the Hokkaido Nippon-Ham Fighters. This study focused on the repeat visiting behavior of loyal fans of the Fighters. The specific study questions were: "Why do loyal fans repetitively visit Sapporo Dome to watch professional baseball games?" and "How have they evolved to their current status of loyal fans?"

Outline of the Study

About the Hokkaido Nippon-Ham Fighters. The Hokkaido Nippon-Ham Fighters are a professional baseball team in Japan's Pacific League. The team takes its name from the major shareholding company, Nippon Ham, which is the corporate name of Nippon Meat Packers, Inc. In 2004 the Fighters moved from Tokyo to Sapporo, the largest city on the island of Hokkaido. The team uses Sapporo Dome, a stadium located in Toyohira-ku, Sapporo, Hokkaido, Japan, that is primarily used for football and baseball. It is the home field of the football club Consadole Sapporo and the baseball team Hokkaido Nippon-Ham Fighters. Sapporo Dome opened in 2001 and currently has 42,126 seats. This stadium hosted three games during the 2002 FIFA World Cup.

Structures of fans. Loyal fans (repeaters) of a professional baseball team have their own individual histories in arriving at their current fan stage. They started in a pre-fan stage, passed through the fan stage, and ultimately reached their current loyal-fan stage. In the pre-fan stage, fans know little about the team, or at most they pay a certain amount of attention to the team and/or have some interest in the team. However, their attitude toward the team is passive, and they exert no aggressive action. Starting from this pre-fan stage, they advance to the fan stage, when they aggressively desire to have a relationship with the team. For example, fan-stage individuals display emotion towards the results of the games, and start to become interested in watching live games at the stadium. However, they do not have much interest in information about the team. A fan-stage person advances to a loyal fan by breaking through these passive characteristics. Loyal-stage fans aggressively collect information about the team, go to the stadium to watch live games when time allows, or even arrange their activities so as to give top priority to watching live games at the stadium.

Study questions. During the five years since the Fighters moved to Sapporo, its number of fans has increased dramatically. There were 38,776 fans registered with the official fan club in 2004, 41,817 in 2005, 41,193 in 2006, 60,216 in 2007, and 74,974 in 2008 (as of September 30 of each year). It is easy to enumerate plausible reasons behind the continuous increase in the number of fans. First is the so-called Shinjo effect. Outfielder Tsuyoshi Shinjo joined the Fighters in 2004, after his three-year career with Major League Baseball teams the New York Mets and the San Francisco Giants. The phenomenon known as the Shingo effect was created with his outstanding talent in making professional baseball an entertaining show. Second, the Fighters won the Pacific League championship in the 2006 and 2007 regular seasons. Third is the contribution of manager Hilman. Finally, we can list the efforts of the players and the front-office staff who visited various places, including local schools, in an effort to establish intimate relationships with local communities.

However, nobody knows exactly why the Fighters have achieved such great success. This long-standing lack of knowledge in the service industry hinders its productivity. Therefore, the Japanese government and the Ministry of Economy, Trade, and Industry (METI) have decided to fund research and development projects to help service providers implement services more efficiently by understanding successful practices based on scientific and technological underpinnings. For the Fighters, scientific underpinnings include understanding why fans repeatedly come to Sapporo Dome to watch the Fighters' games and how they enjoy them, and correlating such understanding with the events that the Fighters provided.

Project B*B: A CCE Study for Understanding Why Spectators Repeat Professional Baseball Games

Project B*B was started at the beginning of the 2008 regular season for the purpose of establishing a set of hypotheses concerning the processes of developing repeaters who attend games hosted by the Hokkaido Nippon-Ham Fighters at Sapporo Dome. B*B (pronounced be-be) is the nickname of the Fighters' mascot.

We took the following approach to develop a set of hypotheses concerning the developmental processes of repeaters.

Selection of monitors (CCE's step 3). We conducted a Web survey and recruited nine highly loyal fans (elite monitors) from the Fighters' fan club members who had different attitudes towards professional baseball, cheering, and merchandising, and had visited Sapporo Dome several times since the Fighters moved to Sapporo. The nine selected fans were supposed to represent different "fan styles" and had different histories in reaching their current fan status.

Field observation (CCE's step 4). We had the elite monitors visit Sapporo Dome three times to watch designated Fighters-hosted games. We recorded their viewing behavior using a DVD camera recorder located three rows in front of the monitors' seats to capture their game-viewing behavior, installing a small ear-mounted CCD camera to record the scene they were viewing, recording their vocalizations with a pin microphone, and using an electrocardiograph and an accelerometer to capture their physiological responses to the events of the game (Figure 1). The designated games were a three-game series with the Softbank Hawks in July, a three-game series with the Orix Buffalos in August, and a three-game series with the Rakuten Golden Eagles in September. Each elite monitor was asked to attend all three series.

| (a) | (b) | (c) | (d) |

Figure 1. Illustration of field observation. (a) an electrocardiograph and an accelerometer, (b) ear-mounted CCD camera, (c) the view of the ear-mount camera, and (d) three elite monitors in their seats watching a game.

Retrospective interviews (CCE's step 5). We conducted structured interviews after each visit to Sapporo Dome, replaying the behavior records, the viewing-scene records, and the broadcasted TV video of the game for the characteristic events, including scoring scenes, field events between innings, and events for which the participants exhibited remarkable changes in physiological data. Each participant was interviewed three times. The purpose of the first interview was to understand how the participants enjoy the game. The purpose of the second interview was to understand how participants developed their loyalty from the pre-fan stage several years ago, to the fan stage a few years ago, and then to the current repeating stage. The purpose of the third interview was to un-

derstand what triggered the state changes and what factors helped them retain each fan stage.

Construct fan loyalty evolution model (CCE's step 6). We compiled the results of interviews in the form of a fan-loyalty evolution diagram (FLE diagram) that represented in detail how individual participants had evolved their loyalty by specifying triggers for stage changes, circumstances that made them stay at a particular stage, and activities in both the regular season and in the off-season. Nine FLE diagrams were created. We then collapsed them to derive models of developmental processes of repeaters, which will be described in the next section.

Results: Developmental Processes of Repeaters

The following section describes results of analysis of the evidence collected during the interview sessions that focused on triggers that caused monitors to step up a stage (i.e., from pre-fan stage to fan stage, and from fan stage to loyal-fan stage), and the conditions that made or make them stay in a particular stage (Someya et al., 2009). These triggers and conditions define a rough qualitative model of the developmental process of fan loyalty.

Progressing from the pre-fan stage to the fan stage. Three cases were found in the study.

1) "Retirement of a star player" and "expectation of league championship." In the 2006 regular season, two events triggered three participants who had little knowledge about professional baseball and another three participants who had knowledge about professional baseball but did not have enough interest in it to progress to the fan stage. One event was an announcement by the then-star player, outfielder Tsuyoshi Shinjo, that he was retiring, relatively early in the regular season. This news was reported frequently in various media. The other event was that the Fighters were in the first championship race of the league and Japan's professional baseball leagues. 2) "Watch the fans cheering." Two participants who had little knowledge about professional baseball and one participant who had little interest in professional baseball advanced to the fan stage after watching live cheering in the stadium. 3) "Know the players and the team" and "unexpected talent of players outside baseball." Regardless of their knowledge level of professional baseball, knowing players and the team triggered participants to progress to the fan stage. Three participants who knew professional baseball reacted to the players' behavior outside baseball, causing them to advance to the fan stage.

Advancing from the fan stage to the loyal-fan stage. Ten cases were found in the study:

1) "Watching live games at the stadium." 2) "Knowing the rules of baseball and the team." 3) "Watching games by oneself," "one's wife became a fan by following his lead," "communication with his/her friends at the stadium," or "meeting persons who visited the stadium." The common feature of these triggers is the establishment of an environment where fans could comfortably watch the games at the stadium with someone who contributed to building a relationship with them (e.g., spouse or friends). 4) "Presence of players who always come to mind." Participants who had little knowledge

about baseball or professional baseball, those who were fans of other professional baseball teams, and those who became fans at the end of the regular seasons tended to find opportunities that should provide information about players, teams, and the Fighters in particular. These participants were eager to attend off-season events such as talk shows and advanced to loyal fans in the next regular season. 5) "Collecting the Fighters' goods." 6) "Recording events of live games and/or collecting the recordings as proof of watching the games." 7) "Expectation of the climax series and the Nippon series," and eagerness to watch those series. 8) "Communication with the other fans when watching live games." 9) "Network community" that they accessed during live games to exchange information and post opinions. 10) "Seeing the players closely (e.g., visiting camp in Okinawa," and those who had special interest (or who followed pro-baseball) said that their greatest interest was in seeing live action on a professional field.

CONCLUSION

This paper proposed a new study method, CCE, to understand people's heterogeneous daily activities. Simon (1996) stated, "An ant [a man], viewed as a behaving system, is quite simple. The apparent complexity of its behavior over time is largely a reflection of the complexity of the environment in which it finds itself." The apparent complexity, or heterogeneity, of man's leisure activities will be resolved once we appropriately frame the study field by considering cognitive constraints. We believe CCE is an effective way of dealing with people's daily activities, stemming from the simple mechanism of daily behavioral selections, MHP/RT.

The case study revealed histories of nine elite monitors, which demonstrated how they moved through the fan stages, from the pre-fan stage to the fan stage and ultimately to the loyal-fan stage. We identified three features that motivated participants to advance from the fan stage, and ten features that motivated them to advance from the fan stage to the loyal-fan stage. These features should suggest possible paths that potential loyal fans follow and should provide valuable hints for designing efficient fan services that help potential fans comfortably progress to the loyal-fan stage. These fan services would be regarded as CCE-based service designs that provide people more satisfactory leisure times.

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