International Society for the Study of Time

Los Angeles 2019 Time In Variance

The 17th Triennial Conference of the ISST will take place June 23 to June 29 at Loyola Marymount University, Los Angeles, California, USA. The LMU campus overlooks Los Angeles and the Pacific Ocean, and it is just a few miles from Los Angeles International Airport.

--Panel by the Japanese Society for Time Studies--

Abstracts for the 2019 Conference on "Time in Variance", at

Los Angeles

June 23-29, 2019

Introduction: Makoto ICHIKAWA (Chairman/ Faculty of Humanities, Chiba University, Japan)

The Japanese Society for Time Studies (JSTS) was established to develop new areas of academic research concerning with Time in 2009. Time has been a topic of many academic research fields. JSTS' s goal is to promote research that breaks down the barriers in Time studies that exist between the humanities and natural sciences, as well as between basic and applied studies.

By connecting research across varied fields, JSTS is attempts to organize Time as it relates to both societal norms as well as to individual experiences. In this manner, JSTS is able to weave together a variety of research themes related to Time.

I organized this symposium to introduce some activities in JSTS to members of ISST. We have three speakers from different research fields. They are senior members in JSTS, and will talk about their recent achievements. I hope that this symposium will trigger successful communication between JSTS and ISST.

Paper 1: Peak interval procedures and Poisson distributions

Takayuki HASEGAWA (Executive board member/Ashikaga University)

The following are three famous mathematical models of timing behaviors:

1	SET (scalar expectancy theory)	J. Gibbon	a Gaussian function	1977-
2	BeT (behavioral theory of timing)	Killeen & Fetterman	a gamma density function (a Poisson function)	1988-
3	LeT (learning-to-time theory)	A. Machado	a linear sum of Poisson functions with positive coefficients	1997-

We often see, however, that they do not fit well with our empirical data. By peak-interval procedures, I obtained data of timing behaviors (lever pressing) in twelve rats for 70 days. The durations are as follows:

sessions	1-30	31-40	41-50	51-60	61-70
rat group A	30 sec	20 sec	30 sec	45 sec	30 sec
rat group B	30 sec	45 sec	30 sec	20 sec	30 sec

For the data, I made a new mathematical model [(*)]. The tool is a linear sum of gamma density functions with non-restricted coefficients for fits. Using a positive constant λ, for $t \geqq 0$, I defined a response function $R(t) = \sum_{n=0}^{3} c_n X_n(t)$, where $X_n(t) = \frac{\exp(-\lambda t)\cdot(\lambda t)^n}{n!}$ $(n = 0,1,2,3)$. As a result, c_0 nearly equals 0, $c_1 < 0$, $c_2 > 0$, and $c_3 < 0$. The fits obtained a better AIC (Akaike's Information Criterion) value even than Gibbon's theory, SET. In my model, the scalar properties are mathematically interpreted as almost a psychological transposition. Moreover, detailed quantity analyses showed the phenomenon of so-called carry-over effects in the data, which suggests a single set of neural 'watches' is used in this timing behaviors (peak-interval procedures from 20 to 45 seconds).

(*) T. Hasegawa & S. Sakata “A model of multisecond timing behaviour under peak-interval procedures” (2015) *Journal of Computational Neuroscience*, Vol. 38, No. 2; 301-313

Paper 2: Multifaceted Objective and Subjective Evaluation of "Time" from Bedtime to Sleep Onset; from the View Point of Time in Variance

Emi KOYAMA (Executive board member/Kyoto Institute of Technology), Yukina WADA (Kyoto Institute of Technology)

In modern Japanese society, sleep-wake schedules change after the World War II, and sleep time has become shorter and shorter as a sacrifice for the social life. However, even though sleep time reduction is expected to bring physiological sleep desire, there seems to be a problem that the sleep latency that is subjectively perceived in everyday life is not necessarily short. In order to evaluate ″time″ from bedtime to sleep onset from the view point of time in variance, using consecutive nights’ recordings for the same individuals, relationships between the objective sleep latency determined with polysomnography, the subjective sleep feelings of sleep initiation, and other objective sleep measures and subjective sleep scores were investigated. From five days before the start until the end of the experiment in the sleep laboratory, each participant was instructed to record the sleep log and to avoid taking a nap or excessive exercise. For over fifteen healthy male participants, seven-hour sleep measurement of ten nights each was carried out with the approval of the ethics committee. Polysomnogram, rectal and skin temperature, and body movements were recorded during sleep. Subjective evaluation of sleep at the time of awakening was scored using OSA sleep inventory, VAS, SSS, STAI, and St. Mary’s Hospital Sleep Questionnaire.
Subjective sleep latency was correlated with objective sleep latency, but on and after the third night adapted to the experimental environment, it was significantly longer than the latency of sleep Stage2. In addition, subjective sleep satisfaction showed a negative correlation with

subjective sleep latency and no correlation with objective sleep latency. From these results, it is suggested that how the individual feels "time" from bedtime to sleep onset shows variance caused by the complex influences from overnight physiological sleep state and subjective sleep feelings on awakening.

Paper 3: Study on time transfer for interplanetary space

Kenta Fujisawa (Executive board member/Director, Research Institute for Time Studies, Yamaguchi University)

Time system synchronized in a wide range is used for communication, e-commerce, long distance transportation system etc., and can be regarded as one of the infrastructures supporting modern civilization. The present human activity extends into the solar system. It will be necessary for human beings in the space-age to build time infrastructure by transporting precise time to a wide range of billions of kilometers. In addition, precise time transporting and time synchronization are also interesting from the point of view of science because they also serve as an experimental basis to study the interesting phenomena predicted by Einstein's general relativity.

Currently, the accuracy of time synchronization in the solar system is about 10 nanoseconds. In order to improve this accuracy by about one order of magnitude, we conducted a basic technology research on time transportation applying VLBI technology. In the room experiment with the prototype, an accuracy of 0.028 nanoseconds was achieved.

The second half of the talk will introduce the Yamaguchi University's Institute for Time Studies.