



簡介

神經經濟學是企圖結合神經科學、經濟學、和心理學等領域，了解人類決策的跨領域學門。自 1990 年代末期開始，經過十多年的發展，已在神經科學領域占有一席之地。發展過程中，我們看見了經濟學和心理學的理論、實驗及研究方法，對決策相關神經科學研究的重大影響。然而，以神經科學為基礎的決策研究，是否也會對經濟學產生根本的改變，依然是個大問號。

其中一個重要的關鍵在於跨領域交流的不足。台灣神經經濟學學術研究群的成立，便是想要在此挑戰中有所突破。成立之初，僅有三到四位成員，其中有神經科學家和經濟學家。自 2011 年起，我們開始籌辦神經經濟學系列演講。為強化跨領域交流，此系列演講的每一位講者，所進行之公開演講，有一場會在經濟學系或心理系舉行，另一場則在神經科學相關系所。舉辦至今，已邀請 11 位國際知名學者，舉辦超過 22 場公開神經經濟學系列演講 (http://homepage.ntu.edu.tw/~josephw/experimental_economics_group.htm)。逐漸，台灣已有一個逐漸成型的研究交流平台，針對神經經濟學，讓不同領域專長的研究者，進行跨領域的對話與合作。

今年，在科技部人文社會科學中心的經費支持下，我們舉辦神經科學與行為經濟學學術研討會，為期三天。研討會邀請國內外神經科學、行為或實驗經濟學等領域之專家，分享當下神經科學與經濟學跨領域整合之成果與未來發展趨勢。

探討議題包含：

1. 經濟理論與大腦：經濟理論的組成元素（如獎賞大小、機率、風險等）在神經生理上的證據
2. 違背理性選擇的大腦：情境式價值評估（context-dependent valuation）和誘餌效應（decoy effect）的神經計算機制
3. 價值評估（valuation）的神經系統：不同種類下之經濟選擇的運算機制
4. 決策成形（decision formation）的動態歷程：序列假設檢驗（sequential hypothesis testing）的神經計算機制
5. 決策與老化（decision making and aging）：決策在老年族群的個別差異
6. 金錢買得到的正義：人們願意犧牲多少金錢來換取窮人「立足點」的平等（例如：教育機會）？重新解讀羅斯「正義論」的「差異原則（difference principle; maximin rule）」
7. 跨期選擇（intertemporal choice）下的當下偏誤（present bias）：獎賞來源如何影響跨期選擇之動態不一致性（dynamic inconsistency）

在此誠摯邀請您一同參與這場跨領域的交流！

神經經濟學學術研究群敬邀



Symposium Schedule

July 2

Chair: Chen-Ying Huang

	Speaker	Title
09:30-09:40	Shih-Wei Wu	Opening Remark
09:40-10:20	Philippe Tobler	Neural Representation of Economic Value
		Constituents
10:20-10:30		Q&A
10:30-11:00		Coffee Break
11:00-11:40	Shih-Wei Wu	Gambling on your Perceptual Abilities: The Tradeoff between Sensory Uncertainty and Subjective Value of Rewards in Economic Choice
11:40-11:50		Q&A
11:50-13:30		Lunch Break
13:30-14:10	Joseph Tao-Yi Wang	Justice: What Money Can Buy
14:10-14:20		Q&A
14:30-15:00		Round Table Discussion 1: What and how can behavioral economics contribute to neuroscience



Symposium Schedule

July 3

Chair: Joseph Tao-Yi Wang

	Speaker	Title
09:30-09:40	Joseph Tao-Yi Wang	Opening Remark
09:40-10:20	Tian-Ming Yang	Sequential Hypothesis Testing in the Brain
10:20-10:30		Q&A
10:30-11:00		Coffee Break
11:00-11:40	Chen-Ying Huang	Why Do Irrelevant Alternatives Matter? An fMRI-TMS Study of Context-Dependent Choice
11:40-11:50		Q&A
11:50-13:30		Lunch Break
13:30-14:10	Charles Sprenger	Working Over Time: Dynamic Inconsistency in Real Effort Tasks
14:10-14:20		Q&A
14:30-15:00		Round Table Discussion 2: What and how can neuroscience contribute to behavioral economics



Symposium Schedule

July 4

Chair: Shih-Wei Wu

	Speaker	Title
09:30-09:40	Chen-Ying Huang	Opening Remark
09:40-10:20	Joshua O. Goh	Individual Differences in Older Adult Fronto-Striatal Decision Processing
10:20-10:30		Q&A
10:30-11:00		Coffee Break
11:00-11:50		Round Table Discussion 3: The future of Neuroeconomics
11:50-12:00		Closing Remark



Organizing Committee

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Neural Representation of Economic Value Constituents

Philippe Tobler

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University of Zurich, Switzerland

Economic and finance models have identified constituents of value, such as magnitude (of reward or punishment), probability and risk. A wealth of studies shows that these constituents are represented in the brain. Common representations occur e.g. in dopamine neurons, the striatum and the medial prefrontal cortex. These findings provide converging support for traditional formal models of economic value and their descriptively better fitting behavioral versions.



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Education

- 2004 Ph.D. in Anatomy, University of Cambridge
- 1998 Masters (first class) in Experimental Psychology; minors Constitutional Law and General Ecology, University of Bern
- 1998-2001 Graduate program in Cognitive Psychology, funded by Swiss National Science Foundation by Universities of Bern, Geneva and Zurich

Positions

- 2010-present Swiss NSF Professor, Department of Economics, University of Zurich
- 2010-2013 Associate Professor, Finance Department, University of Tilburg, Netherlands
- 2009-2013 Scientific consultant, Unilever, Vlaardingen, Netherlands
- 2009-2010 Royal Society University Research Fellow, Department of Experimental Psychology, University of Oxford
- 2006-present Visiting scientist, Tohoku University, Sendai, Japan
- 2004-2009 Postdoctoral research fellow, Department of Physiology, Development and Neuroscience, University of Cambridge

Selected Publications

- Kahnt, T., Park, S. Q., Haynes, J.-D. & **Tobler, P. N.** (2014). Disentangling neural representations of value and salience in the human brain. *Proceedings of the National Academy of Sciences, USA*, 111, 5000-5005.
- Preller, K. H., Herdener, M., Schilbach, L., Stämpfli, P., Hulka, L. M., Vonmoos, M., Ingold, N., Vogeley, K., **Tobler, P. N.**, Seifritz, E. & Quednow, B. B. (2014). Social interaction in cocaine users: blunted response to social gaze and underlying functional changes of the reward system. *Proceedings of the National Academy of Sciences, USA*, 111, 2842-2847.
- Crockett, M. J., Braams, B. R., Clark, L., **Tobler, P. N.**, Robbins, T. W. & Kalenscher, T. (2013). Restricting temptations: Neural mechanisms of precommitment. *Neuron*, 79, 391-401.



Gambling on your Perceptual Abilities: the Tradeoff between Sensory Uncertainty and Subjective Value of Rewards in Economic Choice

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In perceptual decision making, choices are made based on judgment of noisy sensory stimuli. In economic choice, people choose according to preference ranking based on subjective value. The neural mechanisms underlying perceptual decisions and economic choice have been well-characterized separately. It is not known whether common neural and computational mechanisms exist in the formation of these distinct types of choices. To investigate these questions, we designed a perceptual task that is formally equivalent to economic choice under risk, making them mathematically comparable. At the behavioral level, we found that subjects in the perceptual lottery task tended to be risk averse, consistent with previous studies on economic decision making under risk. This highlights that attitudes toward risk, a key signature in economic choice, also play an important role in perceptual judgment or estimation. Neurally, we found that fronto-parietal systems involved in economic choice participate in valuation just as much as fronto-parietal systems for the evaluation of noisy sensory stimuli. Activity in these systems represents the integration of reward value and the probability of reward associated with the perceptual lotteries under consideration. These systems then interact with motor cortices for performing value comparison that guides action selection.



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Positions

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Sept. 2008 – May 2010, Postdoctoral fellow, Division of Humanities and Social Sciences, California Institute of Technology, Pasadena, USA

Selected Publications

Wu, S-W., Delgado, M. R., & Maloney, L. T. (2011). The neural correlates of the subjective utility of monetary outcome and probability weight in economic and in motor decision under risk. *Journal of Neuroscience*. 31(24), 8822-8831.

Wu, S-W., Dal Martello, M. F., & Maloney, L. T. (2009b). Suboptimal allocation of time in sequential movements. *PLoS ONE* 4(12): e8228. doi:10.1371/journal.pone.0008228.

Wu, S-W., Delgado, M. R., & Maloney, L. T. (2009a). Economic decision-making compared with an equivalent motor task. *Proceedings of the National Academy of Sciences USA*, 106, 6088-6093.



Justice: What Money Can Buy

Joseph Tao-Yi Wang

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The “difference principle” of Rawlsian theory of justice (Rawls, 1971/1999), aka maximin criterion, is often tested by asking experimental subjects to allocate monetary payments. Since the difference principle was originally proposed to allocate “primary social goods,” such as education, it is not surprising past experiments have found little support for it. Instead, we test Rawlsian law with experiments where subjects allocate primary social goods (tools to facilitate a real effort task in the next stage), instead of money. The results show that a majority of subjects behave as if they had maximin preferences when there is a high threshold to obtain tools for the real effort task, even though they exhibit a wide variety of other regarding preferences when the threshold is low.



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Education

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June, 1998 B.S. in Mathematics with minor in Economics and minor in Foreign Languages
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Positions

August, 2010 – present Associate Professor of Economics, National Taiwan University

August, 2007 – July, 2010 Assistant Professor of Economics, National Taiwan University

December, 2004 – July, 2007 Postdoctoral Scholar in Economics, Division of Humanities and
Social Sciences, California Institute of Technology

Selected Publications

Elaine M. Liu, Juanjuan Meng and **Joseph Tao-yi Wang** (2014), "Confucianism and Preferences: Evidence from Lab Experiments in Taiwan and China," *Journal of Economic Behavior and Organization*, 104, 106-122.

Ostling, Robert, **Joseph Tao-yi Wang**, Eileen Y. Chou, and Colin F. Camerer (2011), "Testing Game Theory in the Field: Swedish LUPI Lottery Games," *American Economic Journals: Microeconomics*, 3(3), 1–33.

Wang, Joseph Tao-yi, Michael Spezio and Colin F. Camerer (2010), "Pinocchio's Pupil: Using Eyetracking and Pupil Dilation to Understand Truth Telling and Deception in Sender-Receiver Games," *American Economic Review*, 100(3), 984-1007.

Kang, Min Jeong, Ming Hsu, Ian Krajbich, George Loewenstein, Samuel McClure, **Joseph Tao-yi Wang**, and Colin F. Camerer* (2009), "The Wick in the Candle of Learning: Epistemic Curiosity Activates Reward Circuitry and Enhances Memory," *Psychological Science*, 20(8), 963-973.



Sequential Hypothesis Testing in the Brain

Tian-Ming Yang

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We often make decisions by collecting and evaluating multiple pieces of evidence of different reliability until we feel we have enough evidence. Such a strategy is formally known as the sequential hypothesis testing. In the sequential hypothesis testing, one makes decisions between two alternative hypotheses by accumulating evidence until the total amount of evidence reaches a threshold. Here we present an experiment to show that macaque monkeys use the sequential hypothesis testing to solve a probabilistic reasoning task and neuronal activity in the parietal cortex reflects their decision process. We trained two monkeys to choose between a pair of eye movement targets based on a series of shapes presented sequentially. Each shape served as a piece of supporting evidence of different reliability. The monkeys exhibited choice behavior that was consistent with a sequential sampling strategy. They assigned greater weights to more reliable cues and made their final choice when the accumulated information from the sequence of cues reached to a threshold. Moreover, the activity of neurons in the lateral intraparietal cortex mimicked the sequential sampling process during the decision. Their firing rates reflected accumulated probability quantities and reached a stereotyped threshold before the monkeys committed to a decision. The monkeys' choices and reaction times including their variability were explained by the accumulation of noisy evidence to bound. Our results furnish direct evidence that the brain may employ a sequential sampling strategy for decisions with uncertain information.



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Education

1997-2003 PhD in Neuroscience, Baylor College of Medicine, Houston, TX

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Positions

2013- Investigator, Institute of Neuroscience, Shanghai, Laboratory of Neural Mechanisms of Decision Making

2008-2013 Staff Scientist at National Institute of Mental Health, Study of the cortical circuitry of reward, learning and memory.

2003-2008 Postdoctoral fellow, HHMI laboratory at University of Washington, Study of the sensory and motor integration in the visual system of behaving monkeys.

Selected Publications

Yang T, Bavley R, Fomalont K, Blomstrom K, Mitz A, Turchi J, Rudebeck P, and Murray E (2014) Contributions of the hippocampus and entorhinal cortex to rapid visuomotor learning in rhesus monkeys, Hippocampus (in press)

Rudebeck PH, Putnam P, Daniels T, **Yang T**, Mitz A, Rhodes S, and Murray EA (2014) A role for primate subgenual cingulate cortex in sustaining autonomic arousal. P.N.A.S. 111(14): 5391-5396

Yang T and Shadlen MN (2007) Probabilistic Reasoning by Neurons. Nature. 447: 1075-80



Why Do Irrelevant Alternatives Matter? An fMRI-TMS Study of Context-Dependent Choice

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Independence of Irrelevant Alternatives is a fundamental axiom of rational choice. The decoy effect, a form of context dependence, implies a violation of the axiom. We investigated the neural underpinning of the decoy effect using functional magnetic resonance imaging. When the chosen alternative dominated the (irrelevant) decoy alternative, the left ventral striatum was more active, suggesting an increased decision utility. This is consistent with the hypothesis that decision utility is context dependent. We constructed a trial-by-trial measure of the strength of the decoy effect. The left inferior parietal lobule (IPL) negatively correlated with this measure, consistent with the interpretation that the decoy effect is weaker when there is stronger attentional control. Looking into how control was recruited, the right inferior frontal gyrus (IFG), often implicated in overriding irrelevant responses, correlated with the activity of IPL when control was critical to making a good decision. The left ventral striatum, in turn, correlated with the activity of IFG when the role of control would be to increase, as opposed to decrease, the decision utility of the chosen alternative. To further study the role of the IFG, we used transcranial magnetic stimulation to temporarily disrupt IFG in a group of participants. Compared with the control group of participants whose site of stimulation is the vertex, the IFG group exhibited more preference reversals, and had larger percentage increase of response times when the chosen alternative did not dominate the decoy, possibly pointing to the role of IFG in reducing decoy-induced bias.



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Positions

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1999 – 2003 Assistant Professor of Economics, National Taiwan University,

Selected Publications

Hui-Wen Koo, **Chen-Ying Huang** and Kamhon Kan, “Interlinked Contracts: An Empirical Study,”
Economica 79, 350-377 (2012)
Chen-Ying Huang and Tomas Sjostrom, “The Recursive Core for on-Superadditive Games,”
Games 1, 66-88 (2010)
Wen-Jui Kuo, Tomas Sjostrom, Yu-Ping Chen, Yen-Hsiang Wang and **Chen-Ying Huang**, “Intuition and Deliberation: Two Systems for Strategizing in the Brain,” *Science* 324, 519-522 (2009)



Working Over Time: Dynamic Inconsistency in Real Effort Tasks

Charles Sprenger

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Experimental tests of dynamically inconsistent time preferences have largely relied on choices over time-dated monetary rewards. Several recent studies have failed to find the standard patterns of present bias. However, such monetary studies contain often-discussed confounds. In this paper, we sidestep these confounds and investigate choices over consumption (real effort) in a longitudinal experiment. We pair this effort study with a companion monetary discounting study. We confirm very limited time inconsistency in monetary choices. However, subjects show considerably more present bias in effort. Furthermore, present bias in the allocation of work has predictive power for demand of a meaningfully binding commitment device. Therefore our findings validate a key implication of models of dynamic inconsistency, with corresponding policy implications.



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1999-2002 B.A., Economics, Stanford University, Stanford, CA

Positions

July 2011-present Assistant Professor, Economics, Stanford University, Stanford, CA

Selected Publications

"Temporal Stability of Time Preferences" (with Stephan Meier), Forthcoming, Review of Economics and Statistics.

"Violence and Risk Preferences: Experimental Evidence from Afghanistan" (with Michael Callen, Mohammad Isaqzadeh, and James Long), American Economic Review, 2014, 102(1), 123-148.

"Estimating Time Preferences from Convex Budgets" (with James Andreoni), American Economic Review, 2012, 102(7), 3333-3356.

"Risk Preferences Are Not Time Preferences" (with James Andreoni), American Economic Review, 2012, 102(7), 3357-3376.



Individual Differences in Older Adult Fronto-Striatal Decision

Processing

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With an increasingly aging world population, there is an important and urgent need to evaluate how age affects decision-making processing in older adults. Studies have demonstrated age-related neurobiological changes in structural integrity and functional responses in fronto-striatal regions involved in decision processing. Such brain changes compromise older adults' ability to make optimal risky decisions and to process feedback accordingly. Older adults, however, are not all affected similarly by neurobiological aging, with some being more resistant to age-related neurocognitive declines. In this talk, I will present recent findings from our laboratory on individual differences in older adult risk preferences and neural sensitivity to expected value and feedback responses. Whereas previous tendencies might be to regard older adults as being more risk-seeking or risk-averse relative to young adults as a group, our data shows that a more individualised approach is critical to understanding older adult value-based decision-making.

