

Restoration of Selective Connectivity in Adult Mammalian Retina

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Specificity of synapses between neurons of different types is essential for the proper function of the central nervous system. While we have learned much about formation of these synapses during development, the degree to which adult CNS can reestablish specific connections following injury or disease remains largely unknown. I will show that specific synaptic connections within the adult mammalian retina can be reestablished after neural injury. We used selective laser photocoagulation to ablate small patches of photoreceptors in-vivo in adult rabbits, ground squirrels, and mice. Functional and structural changes in the retina at different time points after the ablation were probed via electrophysiology and immunostaining accompanied by confocal imaging. We found that deafferented rod bipolar cells located within the region where photoreceptors were ablated restructure their dendrites. New dendritic processes extend towards surrounding healthy photoreceptors and establish new functional synapses with them. To test if specific connectivity can be reestablished, we observed restructuring of deafferented S-cone bipolar cells that synapse exclusively with S-cone photoreceptors in the healthy retina. We discovered that deafferented S cone bipolar cells extend their dendrites in random directions within the outer plexiform layer. If the extended dendrite encounters a healthy S-cone, it forms a synapse with it. At the same time, it passes M-cone photoreceptors without making synapses. Finally, we used transgenic mice to investigate molecular mechanisms behind the observed restructuring. Our results indicate that the adult mammalian retina retains the ability to make new specific synapses leading to reestablishment of correct neural connectivity.

Symposium 2-1 (July 30, 2019)

On the Border of Implicit and Explicit Processing

Organizer: Shao-Min (Sean) Hung

California Institute of Technology

Implicit processing plays an important role in maintaining visual functions. After all, at a given moment, our phenomenal experience is inherently limited by various factors, including attention, working memory, etc. In the current proposal, we will tackle major questions in the field and challenge intuitions on implicit/unconscious processing. These questions include the fundamental relation between attention and consciousness, using the level of visual processing as a delineation of explicit and implicit processing, and how implicit decision making perturbs the explicit sense of agency.

Naotsugu Tsuchiya will show recent findings on how attention tracks suppressed stimulus under binocular rivalry. Shao-Min Hung will provide evidence from unconscious language processing, substantiating high-level implicit processing. Daw-An Wu further discusses how TMS alters our attribution of motor decision making.

These topics will be integrated by Shinsuke Shimojo, providing an overall view of the current challenges and advances in the field, including “postdiction.” Some of these challenges can be better dealt with once we are equipped with more suitable views on implicit processing, such as a

dynamic interaction among visual items across time, utilizing both predictive and postdictive factors.

Implicit Processes are Dynamic and Interactive

Shinsuke Shimojo

California Institute of Technology

Can the implicit level of mind execute only simple sensory/cognitive functions? And is the bottleneck to consciousness single, or multi-gated? These questions are elusive, especially considering examples such as implicit semantic priming, and implicit stroop effect (Hung talk in this symposium). I will aim for taxonomy and integration of related findings including my own, to have a clearer overview. First, there are multiple definitions of implicit processing on top of “subliminal”, as exemplified in causal misattribution in action (Wu talk), and attention vs. consciousness (Tsuchiya talk). Second, the implicit/ explicit distinction will NOT map onto the lower-/higher-levels of cognitive function (Hung talk). Rather, there are multiple gates to consciousness as indicated in the binocular rivalry debate (80s, up to now), and also quick interplays between implicit and explicit processes. Third, the implicit process may be dynamic spreading over time, operating predictively and postdictively. Auditory-visual “rabbit” effect would be a great example where implicit postdictive process leads to a conscious percept (Shimojo talk). The implicit process is also based on separate dynamic sampling frequencies. Some evidence comes from interpersonal bodily and neural synchrony (Shimojo talk), and dependence of perceptual changes upon allocation of attention relying on different temporal frequencies (Tsuchiya talk). Thus all together, we may need to abandon several simplistic ideas of implicit processes, and rather take a more dynamic and interactive view.

Attention Periodically Samples Competing Stimuli during Binocular Rivalry

Naotsugu Tsuchiya

Monash University

The attentional sampling hypothesis suggests that attention rhythmically enhances sensory processing when attending to a single (~ 8 Hz), or multiple (~ 4 Hz) objects. Here, we investigated whether attention samples sensory representations that are not part of the conscious percept during binocular rivalry. When crossmodally cued toward a conscious image, subsequent changes in consciousness occurred at ~ 8 Hz, consistent with the rates of undivided attentional sampling. However, when attention was cued toward the suppressed image, changes in consciousness slowed to ~ 3.5 Hz, indicating the division of attention away from the conscious visual image. In the electroencephalogram, we found that at attentional sampling frequencies, the strength of inter-trial phase-coherence over fronto-temporal and parieto-occipital regions correlated with changes in perception. When cues were not task-relevant, these effects disappeared, confirming that perceptual changes were dependent upon the allocation of attention, and that attention can flexibly sample away from a conscious image in a task-dependent manner.

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The 15th Asia-Pacific Conference on Vision was held in Osaka, JAPAN, from 29th of July to 1st of August, 2019. The conference aimed to facilitate discussion on vision research in Asian-Pacific region, attended by 458 participants from all over the world. The program consisted of four keynote lectures, 13 symposia including 57 speakers, and 50 oral and 220 poster presentations. The organizing committee are grateful to all the contributions.

The Abstracts are provided below. Keynote talks are presented first, symposia second, and then the contributed talks and posters are listed by session.

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