Papers published in **PERCEPTION** and **i-PERCEPTION** that became the best-selling book **the invisible gorilla**

Simons D J, Chabris C F, 1999, "Gorillas in our midst: sustained inattentional blindness for dynamic events"  
*Perception* 28(9) 1059 – 1074

Chabris C F, Weinberger A, Fontaine M, Simons D J, 2011, "You do not talk about Fight Club if you do not notice Fight Club: Inattentional blindness for a simulated real-world assault"  
i-Perception 2(2)150 – 153
Asia-Pacific Conference on Vision

2012 Annual Meeting, July 13-15
Songdo Convensia, Inchon, Korea

Program and Abstracts

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Hosted by Department of Psychology, Department of Brain and Cognitive Sciences, Institute of Psychological Science, Seoul National University, and the Korean for Cognitive Science
Dear APCV2012 participants,

On behalf of the local committees, it is my great pleasure to welcome you all to APCV held in Incheon, Korea. Thank you so much for your participation in this growing community.

Following previous events, the APCV 2012 will provide a forum for scientists from all parts of the world to become informed about recent findings on various topics of vision, and to socialize with old friends and new colleagues.

This year, the scientific program will feature 3 invited speeches, 6 symposium sessions, 6 oral sessions, and 3 poster sessions, running full three days.

We sincerely hope that all APCV 2012 participants enjoy both scientific sessions and social events to make this event a continued success!

Choongkil Lee  
Chair of APCV 2012 Organizing Committee  
Department of Psychology, Seoul National University
Board, Review Committee & Staff

**APCV Council**

David Crewther (Swinburne University of Technology)  
Chien-Chung Chen (National Taiwan University)  
William Hayward (Hong Kong University)  
Choongkil Lee (Seoul National University)  
Satoshi Shioiri (Tohoku University)  
Hong Xu (Nanyang Technological University)  
Cong Yu (Peking University)

**APCV2012 Organizing Committee**

Choongkil Lee (Chair, Seoul National University)  
Yang Seok Cho (Korea University)  
Jeong Min Hwang (Seoul National University College of Medicine)  
Joo-Seok Hyun (Chung-Ang University)  
Woo Hyun Jung (Chungbuk National University)  
Ki Taek Kham (Kangwon National University)  
Chai-Youn Kim (Korea University)  
Min-Shik Kim (Yonsei University)  
Sang-Hun Lee (Seoul National University)  
Seong-Whan Lee (Korea University)  
Songjoo Oh (Seoul National University)  
Byoung-Tak Zhang (Seoul National University)

**Program Committee**

Chuan-Chin Chiao (National Tsing hua University)  
Hui-Ling Sarina Chien (China Medical University)  
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Chai-Youn Kim (Korea University)  
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Chun-Chia Kung (National Cheng Jung University)  
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Sheng Li (Peking University)  
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Ko Sakai (University of Tsukuba)  
Chia-Huei Tseng (The University of Hong Kong)  
Alan Wong (Chinese University of Hong Kong)  
Chun-Yi Yeh (National Taiwan University)  
Su-ling Yeh (National Taiwan University)

**Conference Secretariat**

Jihea Lim (windy@snu.ac.kr)
Transport Information

From the Airport

We strongly recommend taking KAL Limousine Bus among several choices (KAL Limousine Bus, Premium bus, Regular Taxi, etc). You can buy bus tickets at ticket booths (indoors Exit 4 and 9 & outdoors Exit 4, 6, 7, 8, 11, 13, and 9C) on the arrival floor (the 1st floor).

If you want to use public transportation conveniently, try using ‘T-money’ card which can be used to pay all kinds of transportation including Bus, Subway and even taxi. You can buy T-money cards in the airport or convenience stores. Once you buy it, you must charge your money in it. If there is money left in the T-money card, you can get your money back in the airport.

In the airport, you can buy ‘T-money’ at 7-Elevens, which is located around Hall A (Exit 3) and Hall B (Exit 5) on the arrival floor. You can refund when you leave Korea.

### Route

<table>
<thead>
<tr>
<th>Route</th>
<th>Operating Hours</th>
<th>Traveling Time</th>
<th>Fare (KRW)</th>
<th>Bus Stop</th>
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<tr>
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<td>05:02<del>22:10 (30</del>50 mins intervals)</td>
<td>30 mins</td>
<td>7,000</td>
<td>4B, 11A</td>
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<tr>
<td>Incheon Airport → Hyatt Incheon Hotel → Korea Coast Guard → Songdo Park Hotel → Songdo Bridge Hotel → Sheraton Incheon Hotel</td>
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### KAL Limousine Time Table (at Exit No. 4B)

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<th>06:53</th>
<th>07:33</th>
<th>08:13</th>
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### Route

<table>
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<tr>
<th>Route</th>
<th>Operating Hours</th>
<th>Traveling Time</th>
<th>Fare (KRW)</th>
<th>Bus Stop</th>
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<tbody>
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<td>Incheon Int’l Airport → Sipjeong-dong</td>
<td>06:50~23:00 (20 mins intervals)</td>
<td>50 mins</td>
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### Premium bus (No. 303): Regular & International Taxi

<table>
<thead>
<tr>
<th>Route</th>
<th>Operating Hours</th>
<th>Traveling Time</th>
<th>Fare (KRW)</th>
<th>Taxi Stands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incheon Int’l Airport → Songdo Convensia (or your Hotel)</td>
<td>Taxis are continuously available</td>
<td>20-30 mins</td>
<td>Regular: around 30,000 International: around 40,000 (to your destination)</td>
<td>Regular: 7C International: 4D</td>
</tr>
</tbody>
</table>

*You can go to Information Desk of International Taxi to use it (between Hall A and B).

From Incheon Airport to dormitory of Yonsei University (Songdo campus)

We recommend that you take KAL Limousine bus at the airport and transfer a Taxi at “Sheraton Incheon Hotel”
Area Map
General Information

Abstracts
Abstracts are available on the conference website, iPhone app and Android. Abstracts will be published in the open access journal I-Perception.

Assistance
If you have any questions please contact our APCV staffs (wearing the navy t-shirts with APCV 2012 logo) at the registration desk or in the oral/poster venues.

ATM
There is an Nonghyup Bank Global ATM located in the venue.
(access Mastercard, Maestro, cirrus, VISA, plus, JCB)

Food
Complimentary coffee, tea and light snacks will be provided each day during the coffee breaks at the second floor of the venue.
There are a number of cafes and restaurants nearby the venue for attendees to have lunch or dinner. (see Restaurant Guide)

Internet Access
APCV 2012 attendees can access free wifi in the venue. (no access code)

Lost and Found
Lost and found is located at the APCV 2012 registration desk on 1st floor in the venue.

Registration Desk
Open 8am-7pm, Fri-Sun

Contacts (for Emergency)
119 : Ambulance
112 : Police
Hotel Information

Sheraton Incheon Hotel ★★★★★

Next building of the Venue
Amenities : Fitness Facility, Travel Services, Luggage Storage,
Concier Service, Club Lounge, Business Center
#6-9, Songdo-Dong, Yeonsu-Gu, Incheon, Korea
Tel. +82-32-835-1001 / Fax. +82-32-835-1001
Website : www.sheratonincheon.com

The Sheraton Incheon Hotel is next to the APCV venue, and is only a 20 minutes drive from Incheon International Airport via the new Incheon Bridge. Also, the city’s green oasis, a 400,000 square meter Central Park, is adjacent to the hotel. Sheraton Incheon is the first international five-star deluxe hotel in Songdo, and the first fully non-smoking hotel in the Asia Pacific region. It was built with Eco-friendly methods and is a LEED (the Leadership in Energy an Environmental design) rated hotel in Korea. A 32 inch LCD Flat Screen TV, Wi-Fi and Broadband Access, Sheraton Coffee Maker and Mini bar is provided in each room. KAL limousine shuttle bus is operated from airport to the hotel (Every 30 minutes)

Songdo Park Hotel ★★★★☆

5 minutes to walk from the Venue
Direct access to the subway station
(Incheon Line, Univ. of Incheon station)
Amenities : Restaurant, coffee shop, banquet room, meeting room etc
#93-1, Songdo-Dong, Yeonsu-Gu, Incheon, Korea
Tel. +82-32-210-7000 / Fax. +82-32-210-7100
Website : www.songdoparkhotel.com

Located 10 minutes from the Songdo Convensia and Northeast Asia Trade Tower, Best Western Premier Songdo Park Hotel is a place where you can see Songdo Central Park. Songdo Park Hotel is linked to the Complex Transfer Center where 40 nationwide airport limousine lines and Red buses gather and the Univ. of Incheon subway station. Rooms are equipped with a 32 inch LCD Flat Screen TV with 38 satellite channels. Tea, coffee and electric kettle is provided in each room. Songdo Park Hotel serves a buffet breakfast each day in the La stella(19F).

Songdo Bridge Hotel ★★★★☆

15 minutes to walk from the Venue
Amenities : Restaurants, Lounge, Exercise Room, Coin Washing Room, Coffee Shop, Business Center, Conference Rooms
#10-2, Songdo-Dong, Yeonsu-Gu, Incheon, Korea
Tel. +82-32-210-3000 / Fax. +82-32-210-3300
Website : www.songdobridgehotel.com

Located in the center of a city called 'The Entrance to Korea', Incheon 'Songdo Free Economic Zone' in Songdo International City, the Premier Double is equipped with 241 luxurious rooms, including a business center and a variety of meeting rooms, where you can certainly mix business with pleasure. You'd be comforted to know that Songdo Bridge Hotel is the First Brand join of the BENIKEA (Best Night in Korea) Premier class supported by the Ministry of Culture, Sports & Tourism. Cozy and ample space designed rooms provide natural lighting and a beautiful downtown view. Equipped with a 32 inch LCD TV, refrigerator, safe and coffee pot.
Yonsei International Campus Dormitory

20 minutes to take a bus from the Venue
Amenities : Cafeteria(for breakfast), Convenience Store, Coffee shop, Coin Washing Room, Stationery Store, Docu Friends(for Copying)

Yonsei University 162-1 Songdo-dong, Yeonsu-gu, Incheon 406-840, Korea
This dormitory is available for participants of APCV 2012. To make a reservation, send the application form (Download) to the APCV'12 secretariat at windy@snu.ac.kr. Make a payment during the registration. Each participant should submit application form. Space is limited, on a first-come-first-served basis.
Restaurant Guide

Songdo PRUGIO

National Maritime Police Agency

Central Park

The # 1st World

Sheraton Incheon

Songdo ConvensiA
The #1st World I

### Restaurant

<table>
<thead>
<tr>
<th>Restaurant</th>
<th>Menu</th>
<th>Price</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>THE HOME (1F)</td>
<td>Pork Cutlet KRW 8,000</td>
<td></td>
<td>Tel.032-835-6330</td>
</tr>
<tr>
<td></td>
<td>Pasta KRW 9,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HAKOYA (1F)</td>
<td>Japanese Food</td>
<td></td>
<td>Tel.032-835-6700</td>
</tr>
<tr>
<td></td>
<td>Ramen KRW 6,000~8,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ChinChin China (2F)</td>
<td>Chinese Food</td>
<td>KRW 5,000~25,000</td>
<td>Tel.032-817-6666</td>
</tr>
<tr>
<td>Sancheck(산책) (2F)</td>
<td>Sushi Buffet / Lobster</td>
<td>KRW 15,900</td>
<td>Tel.032-835-5757</td>
</tr>
<tr>
<td>Mori (2F)</td>
<td>Japanese Food</td>
<td></td>
<td>Tel.032-835-5353</td>
</tr>
<tr>
<td></td>
<td>Ramen KRW 5,000~8,000</td>
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### Sandwich & Beverage

<table>
<thead>
<tr>
<th>Restaurant</th>
<th>Food</th>
<th>Price</th>
<th>Phone</th>
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<tbody>
<tr>
<td>Quiznos Sub</td>
<td>Sandwich</td>
<td>KRW 5,000~</td>
<td>Tel.032-835-5523</td>
</tr>
<tr>
<td>HANSOT DOSIRAK(한솥)</td>
<td>Lunch Box</td>
<td>KRW 2,500~</td>
<td>Tel.032-835-6954</td>
</tr>
<tr>
<td>O-Ga-Da(오가.다 五嘉茶)</td>
<td>Traditional Tea, Juice</td>
<td>KRW 3,300~</td>
<td>Tel.032-835-5553</td>
</tr>
<tr>
<td>Ravissant</td>
<td>Coffee</td>
<td>KRW 3,800~</td>
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<tr>
<td></td>
<td>Waffle</td>
<td>KRW 3,300~</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Tel.032-835-7002</td>
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### Food Court

<table>
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<th>Restaurant</th>
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<th>Price</th>
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<tbody>
<tr>
<td>JongGaJip(종가집)</td>
<td>Korean Food</td>
<td>KRW 5,000</td>
<td>Tel.032-858-6486</td>
</tr>
<tr>
<td></td>
<td>Bibimbap</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SongDo Sushi(송도횟집)</td>
<td>Sashimi, Sushi</td>
<td></td>
<td>Tel.032-835-5945</td>
</tr>
<tr>
<td>HwangGum Chueotang (황금추어탕)</td>
<td>Korean Food</td>
<td>KRW 6,000~</td>
<td>Tel.032-835-5392</td>
</tr>
<tr>
<td></td>
<td>Grilled Fish</td>
<td></td>
<td></td>
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<tr>
<td>MyungTaeMyungGa (명태명가)</td>
<td>Korean Food</td>
<td>KRW 6,000~</td>
<td>Tel.032-835-7574</td>
</tr>
<tr>
<td></td>
<td>Grilled Fish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HeungNamMyunOk (흥남면옥)</td>
<td>Korean Food</td>
<td>KRW 5,000~</td>
<td>Tel.032-835-6554</td>
</tr>
<tr>
<td>Han’s Deli (Korean Snack)</td>
<td>Pork Cutlet</td>
<td>KRW 4,900</td>
<td>Tel.032-835-7036</td>
</tr>
<tr>
<td></td>
<td>Pasta</td>
<td>KRW 4,300</td>
<td></td>
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</tbody>
</table>
The # 1st World ❄️

### Pub & Beverage

<table>
<thead>
<tr>
<th>Restaurant</th>
<th>Food &amp; Drink</th>
<th>Price</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMBLE Grill &amp; Pub</td>
<td>Teriyaki KRW 8,300~</td>
<td>Tel.032-832-8334</td>
<td></td>
</tr>
<tr>
<td>COZY ISLAND</td>
<td>Fresh Juice KRW 4,700~</td>
<td>Tel.032-835-5775</td>
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### Songdo PRUGIO (Commercial District)

#### Restaurant

<table>
<thead>
<tr>
<th>Restaurant</th>
<th>Food &amp; Drink</th>
<th>Price</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peter &amp; Paul</td>
<td>Pasta KRW 13,500 Lunch course KRW 18,000</td>
<td>Tel.032-858-0422</td>
<td></td>
</tr>
<tr>
<td>PhoMein</td>
<td>Vietnamese Noodle KRW 9,500~</td>
<td></td>
<td>Tel.032-859-0258</td>
</tr>
<tr>
<td>Gyodong Jeon Sunseng (교동전선생)</td>
<td>Korean Pancake KRW 10,000~19,000</td>
<td>Tel.032-835-5775</td>
<td></td>
</tr>
<tr>
<td>LA PIOGGIA</td>
<td>Pasta &amp; Pizza KRW 15,000~</td>
<td></td>
<td>Tel.032-831-0220</td>
</tr>
<tr>
<td>MASI</td>
<td>Sushi &amp; Donburi KRW 7,000~10,000</td>
<td></td>
<td>Tel.032-833-3108</td>
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<tr>
<td>Pyunghwa Dongtaetang (평화동태탕)</td>
<td>Korean Seafood KRW 6,000~</td>
<td>Tel.032-858-6655</td>
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#### Café & Pub

<table>
<thead>
<tr>
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<th>Price</th>
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<tbody>
<tr>
<td>Coffee Smith</td>
<td>Coffee KRW 4,500~ Cappuccino Waffle 12,000</td>
<td>Tel.032-831-3349</td>
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<tr>
<td>CAFÉ JIUMM</td>
<td>Coffee &amp; Bakery KRW 3,500~ Cake KRW 5,500~</td>
<td>Tel.032-831-1611</td>
<td></td>
</tr>
<tr>
<td>ZOO COFFEE</td>
<td>Coffee, Waffle, Sandwich KRW 3,500~5,300 Frappe KRW 5,500</td>
<td>Tel.032-851-9008</td>
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<tr>
<td>Hineken The Lounge</td>
<td>Beer &amp; Snack</td>
<td>Tel.032-832-1201</td>
<td></td>
</tr>
<tr>
<td>ASAKAN</td>
<td>Beer &amp; Snack</td>
<td></td>
<td>Tel.032-834-5542</td>
</tr>
<tr>
<td>Club JIUMM</td>
<td>Beer &amp; Snack</td>
<td></td>
<td>Tel.032-833-9897</td>
</tr>
</tbody>
</table>
Tour Guide

PT-1 Seoul City Tour

* Date: 16 July, 2012 (09:00~18:30)

* Price per person: KRW68,500

(Minimum 25 people are necessary for tour to take place)

* Price includes lunch, private bus, English speaking guide, admissions as per itinerary, parking fee

Itinerary

08:50 Gathering at Songdo Convensia
09:00-10:10 Drive to Seoul
10:10-11:30 Presidential House “Cheongwadae” Road – Gyeongbokgung Palace
11:30-12:30 Insadong Antique Alley
12:30-13:30 Lunch
13:30-15:00 N Seoul Tower
15:00-16:00 Namsangol Hanok Village
16:00-17:30 Namdaemun Market / Myeongdong
17:30-18:30 Back to Convensia

Description

Gyeongbokgung Palace – Built in 1394 as the main palace of the Joseon Dynasty (1392-1910) by its founder King Taejo, it is the most comprehensive and grandest of the five palaces of the Joseon Dynasty.

Insadong – located in the middle of the city, is an important place where old but precious and traditional goods are on display. There is one main road in Insa-dong with alleys on each side. Within these alleys are galleries, traditional restaurants, traditional teahouses, and cafes. The shops in Insa-dong are very popular among all age groups, because each store is unique.

N Seoul Tower

Opened to the public on October 15, 1980, Seoul Tower has been designated as a major tourist attraction where the beautiful panoramic view of Seoul can be seen. The 236.7 meter high Seoul Tower built on the 243m Mt. Namsan has been known as the best tower in Asia. After 30 years of devoted support from tourists, it was remodeled on December 9, 2005 with magnificent new look.
Namsangol Hanok Village – This beautiful village, covering a site of 7,934 square meters, is composed of three parts: a traditional Korean Garden, Time Capsule Plaza, and the village itself including five traditional Korean houses or hanok from the Joseon Dynasty. These houses were moved from their original locations scattered around Seoul and restored completely.

PT-2 Korean Folk Village & Suwon Hwaseong Fortress

- Date: 16 July, 2012 (09:00~17:30)
- Price per person: KRW 65,000
  (Minimum 25 people are necessary for tour to take place)
- Price includes lunch, private bus, English speaking guide, admissions as per itinerary and parking fee

Itinerary
08:50 Gathering at Songdo Convensia
09:00-10:50 Drive to Yongin
10:50-13:00 Korean Folk Village
13:00-14:00 Lunch
14:00-16:00 Suwon Hwaseong Fortress (UNESCO Heritage)
16:00-17:30 Back to Convensia

Description

Korean Folk Village – is a living museum that recreates the lifestyle of several centuries ago. There are potters, weavers, blacksmiths, and other artisans who practice their trades in traditional fashion. There are also 240 traditional houses and a small amphitheater for folk music and dance performance.

Suwon Hwaseong Fortress – Included on UNESCO’s list of World Cultural Heritage in 1997, Hwaseong Fortress embraces the downtown area of Suwon. It is a well-preserve architecture of the Joseon Dynasty built of stone and oven-baked bricks over two years from 1794 during the reign of King Jwongjo.
Social and Cultural Event

Date & Time: 7/14 (Sat.) 6:30 – 9 pm
Location: Grand ballroom, 3F Sheraton Incheon Hotel

The social and cultural event is scheduled in the evening of Saturday, July 14. The event includes a cultural program inviting you to the exquisite world of traditional Korean music and a banquet where you can meet with other conference attendees while enjoying westernized version of Korean food.

Cultural Program: Korean Traditional Music
Time: 6:30 – 7pm

Musical Performance:
Department of Korea Traditional Music, Hanyang University
**Sujecheon**

The most representative piece in the jeongak repertoire. It is performed by an ensemble composed primarily of wind instruments, including the piri and daegeum. The title Sujecheon may be translated as "Long Life, Immeasurable as the Heavens."

**Shinawi**

The shamanistic music of Korea. It is performed improvisationally by a musical ensemble. The traditional sinawi ensemble followed the principle of sam-hyeon-yuk-gak (三絃六角), with two flutes, a haegeum, a daegeum, a janggu (hourglass-drum), and a large buk (drum).

**Minyo**

Korean folk songs.

**Samul nori**

A genre of traditional percussion music originating in Korea. The word samul means "four objects" and nori means "play"; samul nori is performed with four traditional Korean musical instruments: kkwaenggwari (a small gong), jing (a larger gong), janggu (an hourglass-shaped drum), and buk (a barrel drum similar to the bass drum).

**Banquet**

Time: 7 – 9pm

**Dinner Menu**

- Selection of fresh baked rolls
- Cream soup of roasted butternut squash with maple syrup
- Assorted green salad and sesame leave dressed with soy dressing
- Ddukkal bi, Beef steak with roasted sweet pumpkin, chestnut, mash potato and black berry sauce
- Seasonal fresh fruit plate and rice cake
- Coffee or tea
### Schedule-at-a-Glance

<table>
<thead>
<tr>
<th>Friday, July 13</th>
<th>Saturday, July 14</th>
<th>Sunday, July 15</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>9:00</strong></td>
<td><strong>Symposium 1</strong></td>
<td><strong>Symposium 5</strong></td>
</tr>
<tr>
<td><strong>~</strong></td>
<td><strong>Oral Session 1</strong></td>
<td><strong>Oral Session 5</strong></td>
</tr>
<tr>
<td><strong>11:00</strong></td>
<td><strong>Seeing Biological Motion through Different Eyes</strong></td>
<td><strong>New Perspective on Ecological Optics</strong></td>
</tr>
<tr>
<td><strong>~</strong></td>
<td><strong>Eye and Brain</strong></td>
<td><strong>Object &amp; Face</strong></td>
</tr>
<tr>
<td><strong>11:00</strong></td>
<td><strong>Poster Session 1</strong></td>
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<td><strong>Jason Mattingley</strong></td>
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**Coffee Break**

**Lunch Break**

**Symposium 5**

**New Perspective on Ecological Optics**

**Object & Face**

**Symposium 3**

**Perceptual Grouping**

**Symposium 4**

**Mechanism of Motion Perception**

**Form & Depth**

**Symposium 6**

**Across the Surface of Conscious Visual**

**Motion**

**Keynote Lecture 1**

**John Maunsell**

**Keynote Lecture 2**

**Randolph Blake**

**Keynote Lecture 3**

**Jason Mattingley**

**Welcoming Reception**

**Banquet**

**Business Meeting**
Convensia Floorplan

**Lobby Level (1st Floor)**
- Symposium (Room 113-114) & Oral Presentation (Room 116-117)

**Ballroom Level (2nd Floor)**
- Keynote Lecture (Ballroom C) & Poster Presentation (Convensia Lounge)
Presentation Information

Oral Presentation

Location: Room No. 116/117, 1st floor

Each presentation in the oral sessions lasts for 15 minutes, followed by 5 minutes of discussion. Please make sure that your presentation fits the allotted time. All presenters in a given session are expected to appear in the presentation room at least 15 minutes before the beginning of the session.

The oral session room is equipped with laptop computers and LCD projectors. A laser pointer will be provided. If you have any other AV requirements, please contact the conference organizer (E-mail: opti36@snu.ac.kr) before July 12. Presenters are welcome to test their presentations during breaks at the registration desk.

Poster Presentation

Location: Lobby, 2nd floor

Poster boards are 109.5 cm wide × 167 cm tall. Pushpins will be provided. Poster boards will be numbered by APCV. These digits on poster boards indicate the numbers that will be assigned to individual abstracts in a program book. Poster presenters are expected to put their posters on the assigned boards BEFORE the MORNING poster session begins.
Keynote Lectures

K1 John Maunsell, Ph. D.

Alice and Rodman W. Moorhead III Professor of Neurobiology at Harvard Medical School / USA

Dr. John Maunsell has made many important contributions to our understanding of the function and organization of the visual cerebral cortex. His work as a graduate student at the California Institute of Technology with Dr. David Van Essen included anatomical studies with which he formulated the original version of the now well-known scheme showing a hierarchy of visual cortical areas. This hierarchy has been important framework for understanding the functional organization of visual cortex.

As a postdoctoral fellow with Dr. Peter Schiller at the Massachusetts Institute of Technology, Maunsell characterized the separate visual "ON" and "OFF" pathways, and the role of these and other parallel pathways in processing specific attributes of visual stimuli. He continued work on the general problem of the significance of parallel visual pathways when he set up his own lab at the University of Rochester, where he provided the first detailed description of the relationship between subcortical and cortical visual processing pathways. Maunsell's work provided basic underpinnings for much of our current understanding of both hierarchical and parallel organization in the visual system.

When Maunsell moved to the Baylor College of Medicine, he focused on the challenging question of the effects of behavioral state on the processing of visual information, a question he currently pursues at Harvard Medical School, where he is the Alice and Rodman W. Moorhead III Professor of Neurobiology. By recording the activity of individual neurons in monkey trained to perform carefully engineered visual tasks, Maunsell has shown that neural signals throughout much of visual cortex are profoundly affected by attention. His recent work has revealed that this modulation by attention is greatly influenced by normalization mechanisms that exist at all levels of sensory processing.

Maunsell's contributions have been recognized by many awards and honors, including election to the American Association for the Advancement of Science. His research has been funded by the National Institutes of Health, the Howard Hughes Medical Institute and the Office of Naval Research. Maunsell has served on many panels and editorial boards, and has been a handling editor for Vision Research and Visual Neuroscience. He currently serves as Section Head for Sensory Systems for the Faculty of 1000 and Editor-in-Chief for The Journal of Neuroscience.

Your Wandering Mind: Neuronal Correlates and Behavioral Consequences

Friday, July 13, 5:00-6:30 pm

No matter how hard we focus on a task, we cannot prevent our attention from wandering. By recording simultaneously from dozens of neurons in visual cerebral cortex, it is now possible to obtain a nearly-instantaneous measure of how visual attention is allocated. This approach is providing new insights into the mechanisms that control attention to locations and features, and how short-term drifts in attention affect behavioral performance.
Blake’s influential work artfully blends psychophysics, comparative psychology, neural modeling and brain imaging to study important aspects of perception including binocular vision, motion perception, visual grouping, multisensory integration and synesthesia. Besides advancing our understanding of perception and its neural bases, his work bears on clinical conditions including autism and schizophrenia.

Born December 22, 1945, Dallas Texas; BA University of Texas, Arlington, 1967; Ph.D. Vanderbilt University, 1972; NIH Postdoctoral Fellow, Baylor College of Medicine, 1972-74; Assistant to Full Professor, Northwestern University, 1974-1987; Professor of Psychology/Kennedy Center Fellow, Vanderbilt University, 1987–2001; Centennial Professor, Vanderbilt University, 2001 –present. Elected Fellow, American Association for the Advancement of Science, 1987; Elected Fellow, American Psychological Association, 1990; Fellow, Japan Society for Promotion of Science, 1992; William Evans Professorship, Otago University, 1995; Elected Fellow, Society of Experimental Psychologists, 2005; Elected Fellow, American Academy of Arts and Science, 2006; Earl Sutherland Award, 2000; American Psychological Association, Early Career Award, 1977; NIH Career Development Award, 1978-83; Distinguished Alumni Award, University of Texas, Arlington, 2002; Distinguished Faculty Award, Vanderbilt University, 2002; Ig Nobel Prize, AIR/Harvard, 2006; Jefferson Award, Vanderbilt University, 2008; Elected Fellow, Association for Research in Vision and Ophthalmology. 2010; Foreign Scholar, World Class University Initiative, South Korea, 2010-12; Elected Member, National Academy of Sciences, 2012.

During his career spanning close to four decades, Randolph Blake has made lasting contributions, empirical and theoretical, to our understanding of visual perception. During his early career, Blake published a series of fascinating papers on vision in the cat, at that time the species of choice in neurophysiological studies of mammalian vision. His later work on motion perception established clear links between binocular stereopsis and 3D structure from motion, culminating in a highly original neural model of kinetic depth. Most notably, Blake has intensively studied human binocular vision, publishing landmark papers on binocular summation, stereopsis and binocular rivalry. His Psychological Review paper on rivalry, the most widely cited theoretical paper on that topic, stimulated an explosion of interest in rivalry within cognitive neuroscience and neurophysiology. Blake is the acknowledged expert on rivalry and perceptual bistability, as evidenced by his numerous invited chapters and edited volume. Blake has also devised clever, revealing “psychoanatomical” strategies for identifying neural sites of action within human vision, and he now supplements those strategies with innovative studies using brain imaging. Blake’s recent psychophysical and brain imaging work on perception of biological motion has sparked keen interest in that topic, and his innovative studies of synesthesia have confirmed the perceptual reality of this beguiling phenomenon. Blake has published over 250 articles in major psychology and neuroscience journals (h-index = 58), including 14 in the Nature journals, 9 in Science and 4 in PNAS; he has authored 25 chapters in edited volumes, and he was co-editor of Binocular Rivalry (MIT Press, 2005), the definitive source on this popular phenomenon. His research has been funded by grants from the National Institutes of Health and/or the National Science Foundation. During his career Blake has supervised 45 doctoral and postdoctoral students, many who have assumed successful research careers at universities and health science centers. He is active in many scientific organizations and in the public promotion of science education.

**Probing Visual Processing Outside of Conscious Awareness**

Saturday, July 14, 5:00-6:30 pm

Visual awareness seems to occupy center stage in our perceptual world, but is that just an illusion? To rephrase that question in a tractable form, what aspects of visual processing transpire outside of awareness? Binocular rivalry – fluctuations in perceptual dominance between conflicting visual stimuli -- affords one useful tool for answering that question, and this talk highlights some surprising discoveries that have been made using that tool.
Jason Mattingley, B.Sc. (Hons), M.Sc., PhD, MAPS, FASSA

Foundation Chair in Cognitive Neuroscience of the Queensland Brain Institute and the School of Psychology at the U of Queensland /Australia

Professor Jason Mattingley is Foundation Chair in Cognitive Neuroscience at The University of Queensland, where he holds a joint appointment between the Queensland Brain Institute and School of Psychology.

He received his PhD in neuropsychology from Monash University in 1994, and subsequently spent several years as a post-doctoral research fellow in Cambridge, England, where he was also elected a Fellow of King’s College. His research spans the broad field of cognitive neuroscience, with particular emphasis on mechanisms underlying visual perception, selective attention and motor control. His research team employs brain imaging and brain stimulation techniques to investigate various aspects of cognition in healthy individuals and in patients with neuropsychological impairments arising from brain injury.

He has published more than 150 articles in scholarly journals and books, including numerous papers in Nature, Science and Nature Neuroscience. His work has received more than 6,000 citations (h-index = 44). Professor Mattingley currently sits on the editorial boards of several international journals, including Brain & Cognition, Cognitive Neuroscience, Cortex, and Neuropsychologia. His research is funded by grants from both the Australian Research Council and the National Health and Medical Research Council. In 2012 he was awarded a prestigious Australian Research Council Laureate Fellowship. Professor Mattingley has received Early Career Awards from the Academy of Social Sciences in Australia and the Australian Psychological Society. In 2007 he was elected a Fellow of the Academy of Social Sciences in Australia. He currently sits on the Australian Academy of Science’s National Committee for Brain and Mind.

Professor Mattingley has supervised more than 40 graduate students and post-doctoral research fellows, many of whom now occupy senior faculty positions in Australia and Europe. He has made a sustained contribution to promoting science in the community, and is a founding member of The University of Queensland’s Science of Learning Centre.

Feature-based Attention in Health and Disease

Sunday, July 15, 5:00-6:30 pm

Mechanisms of attention are crucial for prioritizing sensory inputs that are currently relevant for guiding behavior. Much recent work has focused on how the human visual system selects subsets of stimuli based upon elementary features such as color. I will review recent work in which we have used novel behavioral tasks, combined with non-invasive imaging and stimulation techniques, to investigate feature-based selection processes in the healthy brain and in patients with central and peripheral visual dysfunction.
Symposia

Schedule Overview
Friday, July 13, 9:00 am – 11:00 am, Room 113-114
S1 Seeing biological motion through different eyes
Friday, July 13, 2:30 pm – 4:30 pm, Room 113-114
S2 The Brain in Action, Room 113-114
Saturday, July 14, 9:00 am – 11:00 am, Room 113-114
S3 Adaptation and aftereffects
Saturday, July 14, 2:30 pm – 4:30 pm, Room 113-114
S4 Mechanisms of motion perception
Sunday, July 15, 9:00 am – 11:00 am, Room 113-114
S5 New perspectives on ecological optics
Sunday, July 15, 2:30 pm – 4:30 pm, Room 113-114
S6 Across the surface of conscious visual awareness

S1

Seeing biological motion through different eyes
Friday, July 13, 9:00 am – 11:00 am, Room 113-114

Organizer: Songjoo Oh, PhD, Department of Psychology, Seoul National University
Presenters: Ian Thornton, PhD, Department of Psychology, Swansea University; Masahiro Hirai, PhD, Aichi Human Service Center, Jejoong Kim, PhD, Department of Psychology, Dukung Women’s University; Frank Pollick, PhD, Department of Psychology, University of Glasgow

Symposium Summary
Our ability to perceive the actions of others is crucial for survival. Surprisingly, recent evidence suggests that this ability can vary quite considerably from individual to individual. In this symposium we will explore the nature and development of biological motion processing ability in the normal population, in clinical settings and as a function of domain-specific expertise.

Presentations

S1-1

Individual differences in the perception of biological motion
Ian Thornton1(i.m.thornton@swansea.ac.uk); 1Swansea University, UK
Our ability to accurately perceive the actions of others based on reduced visual cues has been well documented. Previous work has suggested that this ability is probably made possible by separable mechanisms that can operate in either a passive, bottom-up fashion or an active, top-down fashion (Thornton, Rensink & Shiffrar, 2002 Perception 31 837-853). One line of evidence for exploring the contribution of top-down mechanisms is to consider the extent to which individual differences in more general cognitive abilities, such as attention and working memory, predict performance on biological motion tasks. In this talk, I will begin by reviewing previous work that has looked at biological motion processing in clinical settings and as a function of domain-specific expertise. I will then introduce a new task that we are using in my lab to explore individual variation in action matching as a function of independently assessed attentional control and working memory capacity.

S1-2 The temporal aspect of neural activities underlying the perception of biological motion in infants, children, adults and patients with developmental disorders
Masahiro Hirai1(hirai.masahiro@gmail.com); 1Aichi Human Service

Asia-Pacific Conference on Vision 2012 22
It has been demonstrated that our visual system can extract rich visual information from point-light motion. Despite the fact that we can perceive human actions from point-light motion with a brief exposure, the temporal aspect of the neural activities underlying the perception of biological motion has not been well explored. In this talk, I’ll introduce a series of behavioral, electroencephalography (EEG) and magnetoencephalography (MEG) studies on biological motion perception and propose a hierarchical model for its processing based on these findings. I’ll then show the developmental changes of the neural responses to biological motion in infants, children and how developmental disorders such as Williams Syndrome and pervasive development disorder (PDD) alter its neural responses.

S1-3 Perception of biological motion in schizophrenia and obsessive-compulsive disorder

Jejoong Kim¹(jejoong3@gmail.com); ¹Duksung Women's University, Korea

Major mental disorders including schizophrenia, autism and obsessive-compulsive disorder (OCD) are characterized by impaired social functioning regardless of wide range of clinical symptoms. Past studies also revealed that people with these mental illness exhibit perceptual problems with altered neural activation. For example, schizophrenia patients are deficient in processing rapid and dynamic visual stimuli. As well documented, people are very sensitive to motion signals generated by others (i.e. biological motion) even when those motions are portrayed by point-light display. Therefore, ability to perceive biological motion is important for both visual perception and social functioning, nevertheless, there have been no systematic attempts to investigate biological motion perception in people with mental illness associated with impaired social functioning until a decade ago. Recently, a series of studies newly revealed abnormal patterns of biological motion perception and associated neural activations in schizophrenia and OCD. These new achievements will be reviewed focusing perceptual and neural difference between patients with schizophrenia/OCD and healthy individuals, then implications and possible future research will be discussed in this talk.

S1-4 Experience dependent differences in brain mechanisms of action observation: From watching dance to CCTV surveillance

Frank Pollick¹(f.pollick@psy.gla.ac.uk); ¹University of Glasgow, UK

Our recent work has focused on using fMRI to investigate how experience in observing action is reflected in brain activity. In this talk I will concentrate on two studies that span a range of experience. The first study investigates brain activity of inexperienced observers when they view a complex 6-minute dance to which they have no familiarity. Comparison of brain activity to both a novel motion index and a measure of human event segmentation revealed a right hemisphere system including the inferior frontal gyrus and occipitotemporal cortex. This neural system can be interpreted as providing an ability to use motion and information about action hierarchies to parse unfamiliar streams of human activity. The second study contrasts the brain activity of naïve observers to experienced CCTV operators when they view selected video clips of real street activity while predicting whether physical violence ensues after completion of the video clip. Comparison of the brain activity between groups revealed a decrease of activity in the parahippocampal gyrus for the experienced CCTV operators. These results, consistent with our previous finding with experienced drummers (Petrini, et al, 2011), suggest improved neural efficiency for experienced observers in the representation of familiar actions.
The brain in action

Friday, July 13, 2:30 pm – 4:30 pm, Room 113-114

Organizer: Joris Vangeneugden, PhD, Italian Institute of Technology, Italy, BIDCM, Harvard

James C. Thompson, PhD, Department of Psychology, George Mason University; Ayse Pinar Saygin, PhD, Department of Cognitive Science, University of California, San Diego; Joris Vangeneugden, PhD, Italian Institute of Technology, Italy, BIDCM, Harvard; Anthony Atkinson, PhD, Department of Psychology, Durham University

Symposium Summary

The perception of acting conspecifics engages a number of brain regions. Typically pSTS counts as the protagonist, but also the premotor cortex and areas co-activated by static bodies (EBA) and faces (OFA/FFA) light up. Thompson will talk about a parsimonious conceptual dichotomy (form vs. motion) using fMRI in humans, supplemented with fMRI data both from humans and macaque monkeys by Orban. The other talks all employ TMS over pSTS and a stimulation focus on premotor (Saygin), EBA (Vangeneugden) or OFA (Atkinson), all aiming at a better understanding of the neural underpinnings of the action perception network.

Presentations

S2-1 The contribution of form and motion to the perception of human actions

James C. Thompson1(jthompsz@gmu.edu); 1George Mason University, USA

The visual pathway for the processing of human actions involves a stream of regions along the lateral occipitotemporal cortex (LOTC), including regions defined by their selectivity to human body shape/form (e.g., EBA) or motion (e.g., MT/MST). As the perception of actions, especially biological motion, involves the integration of form and motion cues, an important question has been the relative contribution of these cues to the neural response to biological motion in LOTC regions. Understanding the contribution of form and motion to the neural response of regions within the LOTC will provide us with clues to where these cues become integrated. In this presentation I will propose that the neural response to biological motion in LOTC regions comprises the linear combination of the response of independent neural populations tuned to either the form or the motion cues, rather than an integrated response. Part of the difficulty in testing this proposal is that it is not trivial to manipulate form or motion cues of a biological motion stimulus independently. However, recent evidence suggests that we might be able to take advantage of differences in the retinotopy and/or contrast sensitivity between form and motion selective neural populations. I will present functional magnetic resonance imaging (fMRI) and behavioural studies showing that form and motion cues in biological motion differ in their sensitivity to contrast and spatial position, and that we can use this to manipulate the contribution of each to the neural response and perception of actions.

S2-2 Body movements: From dots to bots

Ayse Pinar Saygin1(saygin@cogsci.ucsd.edu); 1Department of Cognitive Science, University of California, San Diego

The perception of others’ body movements and actions is critical for important functions such as hunting prey, avoiding predators, communication, and social interaction. In primates, the perception of body movements is supported by network of temporal, parietal and premotor brain areas. Our goal is to elucidate functional properties of this system. I will present work with two kinds of stimuli that allow us to focus on the role of visual form and visual motion in body movement perception. Neuroimaging, neuropsychological and transcranial magnetic stimulation (TMS) experiments with “dots” (point-light biological motion), allow us to focus on the role of motion in body movement processing (though it turns out it is difficult to abstract away from form even with these stimuli). To manipulate visual form and visual motion in fully illuminated stimuli, we also use a stimulus set of actions carried out by humans as well as “bots” (humanoid robots) in fMRI and EEG studies. Together, these studies establish the brain regions that support body movement perception in the human brain, and suggest steps towards identifying their functional and computational properties.

S2-3 Double dissociation between the extrastriate body area and the posterior superior temporal sulcus during biological motion perception: converging evidence from TMS and fMRI

Joris Vangeneugden1,2(joris.vangeneugden@gmail.com); 1Italian Institute of Technology, Italy, 2BIDCM, Harvard, USA

Our brains engage numerous regions when exposed to biological motion, with the posterior superior temporal sulcus (pSTS) being the primary locus. The exact roles of hMT+ and the extrastriate body area (EBA) remain unclear. Here, we set out to determine the specific roles of pSTS and EBA during biological motion perception, focusing on walker orientation and walking direction. To obtain converging evidence, we conducted separate TMS and fMRI experiments within the same subjects (N=12). Two separate tasks were used in the TMS study: walker orientation probing form processing and walking direction probing motion/sequence processing. Task performance was compared before and after applying repetitive offline TMS (1Hz) over EBA and pSTS (based on fMRI-guided stereotaxy). In the fMRI study, EBA and pSTS were mapped in separate scans using standard localizers. Subsequently, runs with point-light walkers were subjected to MVPA, determining the amount of static (orientation) and dynamic (direction) information present within EBA and pSTS. Both TMS and MVPA revealed a strong double dissociation between inferred
functions of EBA and pSTS. Disrupting EBA impaired performance on the walker orientation task, while leaving walking direction performance intact. In contrast, disruption of pSTS processing resulted in the opposite effect (p<.001). Similarly, EBA BOLD response revealed significant walker orientation information and no walking direction information, while (again) pSTS BOLD response displayed the opposite pattern (p<.005). We provide converging and causative evidence that dissociates EBA (static body processing) from pSTS (dynamic body sequence processing) during action perception.

**S2-4 On the (in)dependence of visual cues and cortical regions for judging trustworthiness and sex from faces: TMS, behavioural and human lesion evidence**

Anthony Atkinson1(a.p.atkinson@durham.ac.uk); 1Durham University, UK

Judging sex from faces relies on cues related to facial morphology and spatial relations between features, whereas judging trustworthiness relies on both structural and expressive cues that signal affective valence. I will present evidence of both asymmetric and symmetric dependence between the processing of a face’s sex and trustworthiness. In one study, we used event-related, fMRI-guided repetitive transcranial magnetic stimulation (rTMS) to test whether 2 face-selective regions — right occipital face area (rOFA) and posterior superior temporal sulcus (pSTS) — have functionally dissociable, critical roles in sex and trustworthiness judgments. Sex judgements were disrupted when rTMS was delivered over right OFA (relative to sham stimulation) but not when it was delivered over right or left pSTS, whereas trustworthiness judgements were disrupted when rTMS was delivered over right or left pSTS but not rOFA. Nonetheless, analysis of the reaction time distributions revealed a possible critical role also for rOFA in trustworthiness judgments, limited to faces with longer RTs, perhaps reflecting the later, ancillary use of structural cues related to the sex of the face. New evidence from an individual (DF) with lesions encompassing bilateral occipital cortex indicates that significantly above-chance discrimination of the sex and trustworthiness of faces is possible in the absence of OFA – but only for untrustworthy males and trustworthy females, consistent with the RT data of healthy participants in the TMS study. Further evidence of restricted dependence between perceptions of trustworthiness and sex is provided by a RT-interference experiment with neurologically healthy volunteers using the Garner paradigm.

**S3**

**Adaptation and aftereffects**

Saturday, July 14, 9:00 am – 11:00 am, Room 113-114

Organizers: Murakami, PhD, Tokyo University; Arni Kristjansson, PhD, University of Iceland

Presenters: David Whitney, PhD, UC Berkeley, Yoko Mizokami, PhD, Chiba University; Fang Fang, PhD, Peking University, China; Ikuya Murakami, PhD, Tokyo University, Japan; Arni Kristjansson, PhD, University of Iceland

**Symposium Summary**

There are many well-known aftereffects in vision thought to reflect how the visual system adapts to the input statistics in the environment. Such aftereffects may therefore be no mere curiosities but may instead reflect strategic gain modulations and changes of responding on behalf of the visual system. The symposium will bring together speakers who have investigated such adaptation, with the aim of uncovering its' functional benefits.

**Presentations**

**S3-1 The serial dependence of visual perception**

David Whitney1(dwhitney@berkeley.edu); 1UC Berkeley, USA

In our moment-to-moment perceptual experience, visual scenes can change, but objects rarely spontaneously come into or out of existence. The visual system may therefore delicately balance the need to optimize sensitivity to image changes (e.g., by adapting to changes in color, orientation, object identity, etc) with the desire to represent the temporal continuity of objects— the likelihood that objects perceived at this moment tend to exist in subsequent moments. One way that the visual system may promote such stability is through the introduction of serial dependence to visual perception: by biasing the current percept toward what was seen at previous moments, the brain could compensate for variability in visual input that might otherwise disrupt perceptual continuity. Here, in two sets of experiments, we tested for serial dependence in visual perception of orientation and facial expression. We found that on a given trial, a subject’s perception of the orientation of a grating reflected not only the currently viewed stimulus, but also a systematic attraction toward the orientations of the previously viewed stimuli. We found the same serial dependence in the perception of facial expression. This perceptual attraction extended over several trials and seconds, and displayed clear tuning to the difference (in orientation or facial expression) between the sequential stimuli. Furthermore, serial dependence in object perception was spatially specific and selective to the attended object within a scene. Several control experiments showed that the perceptual serial dependence we report cannot be explained by effects of priming, known hysteresis effects, visual short-term memory, or expectation. Our results reveal a systematic influence of recent visual experiences on perception at any given moment: visual percepts, even of unambiguous stimuli,
are attracted toward what was previously seen. We propose that such serial dependence helps to maintain continuity in the perception of object and scene properties in the face of a dynamic and noisy environment.

S3-2 Colorfulness perception adapting to natural scenes
Yoko Mizokami1(mizokami@faculty.chiba-u.jp); 1Chiba University, Japan

Our visual system has the ability to adapt to the color characteristics of environment and maintain stable color appearance. Many researches on chromatic adaptation and color constancy suggested that the different levels of visual processes involve the adaptation mechanism. In the case of colorfulness perception, it has been shown that the perception changes with adaptation to chromatic contrast modulation and to surrounding chromatic variance. However, it is still not clear how the perception changes in natural scenes and what levels of visual mechanisms contribute to the perception. Here, I will mainly present our recent work on colorfulness-adaptation in natural images. In the experiment, we examined whether the colorfulness perception of an image was influenced by the adaptation to natural images with different degrees of saturation. Natural and unnatural (shuffled or phase-scrambled) images are used for adapting and test images, and all combinations of adapting and test images were tested (e.g. the combination of natural adapting images and a shuffled test image). The results show that colorfulness perception was influenced by adaptation to the saturation of images. A test image appeared less colorful after adaptation to saturated images, and vice versa. The effect of colorfulness adaptation was the strongest for the combination of natural adapting and natural test images. The fact that the naturalness of the spatial structure in an image affects the strength of the adaptation effect implies that the recognition of natural scene would play an important role in the adaptation mechanism.

S3-3 Misbinding of color and motion in human V2 revealed by color-contingent motion adaptation
Fang Fang1(ffang@pku.edu.cn ); 1Peking University, China

Wu, Kanai and Shimojo (Nature, 429:262, 2004) described a compelling illusion demonstrating a steady-state misbinding of color and motion. Here, we took advantage of the illusion and performed psychophysical and fMRI adaptation experiments to explore the neural mechanism of color-motion misbinding. The stimulus subtended 20°×14° of visual angle and contained two sheets of random dots, one sheet moving up and the other moving down. On the upward-moving sheet, dots in the right-end area (4°×14°) were red and the rest dots were green. On the downward-moving sheet, dots in the right-end area were green and the rest dots were red. When subjects fixated at the center of the stimulus, they bound the color and motion of the dots in the right-end area erroneously – the red dots appeared to move downwards and the green dots appeared to move upwards. In the psychophysical experiment, we measured the color-contingent motion aftereffect in the right-end area after adaptation to the illusory stimulus. A significant aftereffect was observed as if subjects had adapted to the perceived binding of color and motion, rather than the physical binding. For example, after adaptation, stationary red dots appeared to move upwards and stationary green dots appeared to move downwards. In the fMRI experiment, we measured direction-selective motion adaptation effects in V1, V2, V3, V4, V3A/B and V5. Relative to other cortical areas, V2 showed a much stronger adaptation effect to the perceived motion direction (rather than the physical direction) for both the red and green dots. Significantly, the fMRI adaptation effect in V2 correlated with the color contingent motion aftereffect across twelve subjects. This study provides the first human evidence that color and motion could be misbound at a very early stage of visual processing.

S3-4 The tilt aftereffect and position-shift illusions
Ikuya Murakami1(ikuya@fechner.c.u-tokyo.ac.jp); 1Tokyo University, Japan

After prolonged viewing of tilted bars, subsequently viewed upright bars appear to be inclined oppositely. This tilt aftereffect is believed to involve population coding of orientation by various orientation-selective units interacting with each other, but it is unknown at what stage of shape processing pathway these neural interactions take place. We recently conducted psychophysical experiments to assess the relationship between this adaptable process and the underlying mechanisms of position-shift illusions including the flash-lag effect and the flash-drag effect. In these motion-related position phenomena, the perceived position of a briefly flashed stimulus is altered by the presence of a moving stimulus nearby, and as such, the subjective orientation seen in a specially designed stimulus can be tilted even though each stimulus component stays upright. We found that adaptation to this subjective tilt yielded no tilt aftereffect, demonstrating functional independence between the orientation and position mechanisms.

S3-5 Adaptive coding of the input: Functional benefits from adaptation to motion, tilt and brightness variation
Arni Kristjansson1(ak@hi.is); 1University of Iceland, Iceland

Many have argued that adaptation effects, some resulting from negative aftereffects from viewing of a stimulus tilted in a certain way or a stimulus moving in a particular direction reflect that the visual system adjusts its responses to the statistics of the input at any given time. I will review result from my laboratory on such effects, which show that discrimination around the level of an adapting stimulus (e.g. a particular motion direction, a certain tilt, or the midpoint of brightness variation) improves with prolonged adaptation to such a stimulus. So, for example, orientation discrimination thresholds around the adapted orientation decrease with increased viewing of a Gabor varying in phase over time. Similar improvements of discrimination of brightness changes are reported for a stimulus varying sinusoidally in luminance over time and for adaptation to motion. The results show how adaptation can lead to better discrimination around the level of the adapting stimulus itself, and that discrimination performance improves steadily with increased adaptation. The results show how the visual system
adjusts its response characteristics to the properties of the visual input at a given time.

S4

Mechanisms of motion perception
Saturday, July 14, 2:30 pm – 4:30 pm, Room 113-114

Organizer: Duje Tadin, PhD, University of Rochester

Presneters: Bart Krekelberg, PhD, Rutgers University; Sang-Hun Lee, PhD, Seoul National University; Shin’ya Nishida, PhD, NTT Communication Science Laboratories; Alan Stocker, University of Pennsylvania; Duje Tadin, PhD, University of Rochester

Symposium Summary

Motion perception is arguably the best understood visual submodality, largely because of longstanding research focus using a range of converging methodological approaches. This symposium will present recent advances in this active field of research. Talks will report results from psychophysics, neurophysiology, computational modeling and neuroimaging.

Presentations

S4-1 Motion detection based on recurrent network dynamics
Bart Krekelberg1(bart@rutgers.edu); 1Rutgers University, USA

The detection of a sequence of events requires memory. The detection of visual motion is a well-studied example; there the memory allows the comparison of current with earlier visual input; this comparison results in an estimate of direction and speed of motion. The dominant model of motion detection in primates - the motion energy model - assumes that this memory resides in subclasses of cells with slower temporal dynamics. It is not clear, however, how such slow dynamics could arise. We used extracellularly recorded responses of neurons in the macaque middle temporal area to train an artificial neural network with recurrent connectivity. The trained network successfully reproduced the population response, and had many properties also found in visual cortex (e.g. Gabor-like receptive fields, a hierarchy of simple and complex cells, motion opponency). When probed with reverse-correlation methods, the network’s response was very similar to that of a feed-forward motion energy model even though recurrent feedback is an essential part of its architecture. These findings show that a strongly recurrent network can masquerade as a feed-forward network. Moreover, they suggest a conceptually novel role for recurrent network connectivity; the creation of flexible temporal delays to implement short term memory and compute velocity.

S4-2 Hierarchy of direction-tuned motion adaptation in human visual cortex
Sang-Hun Lee1(visionsl@snu.ac.kr); 1Seoul National University, Korea

Prolonged exposure to a single direction of motion alters perception of subsequent static or dynamic stimuli and induces
substantial changes in behaviors of motion-sensitive neurons, but it remains unclear about an origin of neural adaptation and neural correlates of perceptual consequences of motion adaptation in human brain. Using functional magnetic resonance imaging (fMRI), we measured motion adaptation tuning curves in a fine scale by probing changes in cortical activity after adaptation for a range of directions relative to the adapted direction. We found a clear dichotomy in tuning curve shape: cortical responses in early-tier visual areas reduced at around both the adapted and opposite direction, resulting in a bidirectional tuning curve, whereas response reduction in high-tier areas occurred only at around the adapted direction, resulting in a uni-directional tuning curve. We also found that the psychophysically measured adaptation tuning curves were uni-directional and best matched the cortical adaptation tuning curves in MT and MST. Our findings are compatible with, but not limited to, an interpretation in which direct impacts of motion adaptation occur in both uni-directional and bi-directional units in early visual areas, but its perceptual consequences are manifested in the population activity in MT and MST, which may inherit those direct impacts of adaptation from the directionally selective units.

S4-3 Spatial processing of visual motion
Shin'ya Nishida1(shinyanishida@me.com); 1NTT Communication Science Laboratories, Japan

Local motion signals are extracted in parallel by a bank of motion detectors, and their spatiotemporal interactions are processed in subsequent stages. In this talk, I will review our recent studies on spatial interactions in visual motion processing. First, we found two types of spatial pooling of local motion signals. Directionally-ambiguous 1D local motion signals are pooled across orientation and space for solution of the aperture problem, while 2D local motion signals are pooled for estimation of global vector average (e.g., Amano et al., 2009, Journal of Vision, 9(3):4, 1–25). Second, when stimulus presentation is brief, coherent motion detection of dynamic random-dot kinematogram is not efficient. Nevertheless, it is significantly improved by transient and synchronous presentation of a stationary surround pattern. This suggests that centre-surround spatial interaction may help rapid perception of motion (Linares et al., submitted). Third, to know how the visual system encodes pairwise relationships between remote motion signals, we measured the temporal rate limit for perceiving the relationship of two motion directions presented at the same time at different spatial locations. Compared to similar tasks with luminance or orientation signals, motion comparison was more rapid and hence efficient. This high performance was affected little by inter-element separation even when it was increased up to 100 deg. These findings indicate the existence of specialized processes to encode long-range relationships between motion signals for quick appreciation of global dynamic scene structure (Maruya et al., in preparation).

S4-4 Optimal signal integration across spatiotemporal frequency channels in visual speed perception
Alan Stocker1(astocker@sas.upenn.edu); 1University of Pennsylvania

Humans can optimally integrate sensory cues across different perceptual modalities in order to form a coherent percept (Ernst/Banks 2002). It is unclear, however, to what degree optimal integration also occurs within a single perceptual modality. Here, we argue that humans integrate visual motion signals across independent spatiotemporal frequency bands and combine them with an general expectation for slow speeds (Stocker/Simoncelli 2006). We formalize this hypothesis with a Bayesian observer model containing multiple sensory channels, each sensing motion energy within a limited spatial frequency band. When triggered by a moving stimulus, the responses of individual channels undergo divisive normalization and are then integrated across all channels tuned to the same speed. We tested this model against data from a range of psychophysical experiments using broadband sinusoidal gratings with different frequency spectra. Fits of the observer model to individual subjects’ data well account for the full set of psychometric functions, thus can accurately predict perceptual biases as well as discrimination thresholds. Based on these results, we propose that optimal cue combination is a plausible mechanism for the integration of independent sensory signals into a coherent percept - even within a single perceptual modality such as visual motion.

S4-5 Perceptual and neural consequences of rapid motion adaptation
Duje Tadin1(duje@cvs.rochester.edu); 1University of Rochester, USA

Nervous systems adapt to the prevailing sensory environment, and the consequences of this adaptation can be observed both in the responses of single neurons and in perception. Given the variety of time-scales underlying events in the natural world, determining the temporal characteristics of adaptation is important to understanding how perception adjusts to its sensory environment. Previous work has shown that neural adaptation can occur on a timescale of milliseconds, but perceptual adaptation has typically been studied over relatively long timescales, typically on the order of seconds. This disparity raises important questions: Can perceptual adaptation be observed at brief, functionally relevant timescales? And if so, how do its properties relate to the rapid adaptation seen in cortical neurons? We address these questions in the context of visual motion processing, a perceptual modality characterized by rapid temporal dynamics. We demonstrate objectively that 25 ms of motion adaptation is sufficient to generate a motion-after-effect (MAE), an illusory sensation of movement experienced when a moving stimulus is replaced by a stationary pattern. This rapid adaptation occurs regardless of whether or not the adapting motion is perceived. In neurophysiological recordings from cortical area MT, we find that brief motion adaptation evokes direction-selective responses to subsequently presented stationary stimuli. A simple model shows that these neural responses can explain consequences of rapid perceptual adaptation. Overall we show that the MAE is not merely an intriguing perceptual illusion, but rather a reflection of rapid neural and perceptual processes that can occur essentially every time we experience motion.
New perspectives on ecological optics

Sunday, July 15, 9:00 am – 11:00 am, Room 113-114

Organizer: Nam-Gyoon Kim, PhD, Department of Psychology, Keimyung University
Presenters: Jeffrey Saunders, PhD, Hong Kong University; Zsolt Palatinus, PhD, University of Connecticut; Endre Kadar, PhD, University of Portsmouth, Namhun Kim, PhD, Ulsan National University of Science and Technology; Nam-Gyoon Kim, PhD, Keimyung University

Symposium Summary

This symposium will provide a forum in which participants explore both the successes and the future challenges posed by “ecological optics”. Participants will examine the contributions of Gibson's theory of ecological optics to current research efforts as they explore the ongoing challenges posed by such key Gibsonian concepts as "affordance" and "optical invariants," as well as the role of vision in controlling movement, Gibson's paradigmatic example.

Presentations

S5-1 Accuracy of walking direction with limited or no visual feedback

Jeffrey Saunders1 (saun@hku.hk); 1 Department of Psychology, Hong Kong University

Direction of self-motion during walking is indicated by multiple cues, including optic flow, non-visual sensory cues, and motor prediction. I measured the variability in walking direction with and without visual feedback, and tested whether visual and non-visual cues are weighted in an optimal manner. Open-loop walking in an immersive virtual environment was used to assess the accuracy of perceived walking direction. Observers walked toward a target 4m away either with no vision, or vision during the first 1m of walking. Three simulated environments were tested: target-only, target and textured ground, or target with textured ground and scattered posts. With no vision, variability in walking direction averaged 3°. Visual feedback during initial movement reduced variability to about 1.5°, and there was no effect of visual environment. Based on these measures, an optimal estimator would strongly weigh visual information. A second experiment measured the perceptual weighting of visual and non-visual cues. Optic flow specified a conflicting heading direction (±5°), and bias in walking direction was used to infer cue weights. The observed visual weights were smaller than predicted (33-43% vs. 71%), and varied depending on the visual environment. Non-visual information had more influence than expected given the relative reliability of cues. This is consistent with some studies of visually guided walking that have observed a limited role of optic flow in online control.

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750209H

S5-2 Shifting the perspective on biological movement perception

Zsolt Palatinus1 (zsolt.palatinus@gmail.com); 1University of Connecticut, USA

Most efforts for understanding biological movement perception seem to agree in assuming a key role of some version of 2D projective geometry being the basis of either computation or invariant detection somewhere between the stimulus and perception. Recent studies invite considering alternatives. Beintema and Lappe (2002 PNAS, 99 5661–5663) constructed sequential walker displays in which points were assigned along limb segments at random position at each frame and still reported correct responses. In our study, point light displays were prepared from motion-capture data of humans performing everyday activities. Animations were rendered either from a fixed camera position or from a curvilinear trajectory around the target. Same mean response time in the two conditions suggests that information for making correct judgments remained accessible despite the superposition of camera movement induced changes on the projection. An alternative approach is offered, based on Gibson's (1986, Lawrence Erlbaum Associates) conceptualization of the ambient optic array, a continuous energy field in which perception-action systems are immersed. The registration of these energy distributions manifests in fractal, scale-invariant fluctuations of exploratory movements, suggesting that there may be subtle contributions of previously unrecognized fluctuations. Fractal fluctuations may serve as a modality-general substrate for detection of information for perception and even cognition (Stephen and Hajnal, 2011 Attention, Perception, & Psychophysics 73 1302-1328, Dixon et al, 2012 Topics in Cognitive Science 4 51-62) In this work, we consider the possibility that subtle fluctuations in seated posture and head sway moderate the effects of optical energy arrays upon the perceptual system.

S5-3 Dynamic invariants in walking through an aperture while holding a tray with two hands

Endre Kadar1 (endre.kadar@port.ac.uk), Georgina Török1; 1University of Portsmouth, UK

Gibson’s (1979) ecological approach to visual perception is based on several key notions (i.e., affordance, optic flow and invariants). Early research focused on identifying invariants (π-numbers) to describe affordances using geometric body-scaled measures. Kadar and Koszeghy (2010) generalized π-numbers to invariant functions (π-functions) to allow dynamically scaled description of driving through gates of variable width. The present study further investigated the dynamic invariants of human locomotion in walking towards and passing through gates. Six participants were instructed to walk through gates of four different sizes with either comfortable or fast walking speed while holding a tray by two hands. Consistent with the results of Kadar and Koszeghy (2010) dynamically-scaled π-functions were identified. The speed control of the approach phase was further assessed in relation to the use of the optical τ parameter derived from optic flow specifying estimated time to
contact with the virtual plane defined by the frontal surfaces of the aperture. Aperture size and walking speed have influenced the control of speed at the approach phase: the derivative of $t$ in the neighborhood of the aperture increased with increasing width of the aperture. Analysis of the approach phase suggests a need for searching an even higher-level invariant structure of the dynamics of this passing through task. Gibson, 1979 The ecological approach to visual perception; Kadar & Koszeghy, 2010 International Journal of Sport Psychology 41(3) 80-81.

S5-4 Formal modeling of affordance in human-included systems

Namhun Kim1(nhkim@unist.ac.kr); 1Ulsan National Institute of Science and Technology, Korea

In spite of this necessary of consideration of humans into modeling, analysis and control of human-included systems, it has been considered a challenging problem because of the critical role of humans in complex systems, and of the human’s capability of executing unanticipated actions – both beneficial ones as well as detrimental ones. Thus, to provide systematic approaches to modeling human actions as a part of system behaviors, a formal modeling framework for human-involved systems in which humans play a controlling role based on their perceptual information is presented. The theory of affordance provides definitions of human actions and their associated properties, Finite State Automata (FSA) based modeling is capable of mapping the nondeterministic humans into computable components in the system representation. In this talk, we investigate the role of perception in human actions in the system operation and examine the representation of perceptual elements in affordance-based modeling formalism. The proposed framework is expected to capture the natural manners in which humans participate in the system as part of its operation. A human-machine cooperative manufacturing system control example and human agent simulation example will be introduced for the illustrative purposes at the end of the presentation.

S5-5 Dynamic occlusion deficiency in patients with Alzheimer’s disease

Nam-Gyoon Kim1(nk70@kmu.ac.kr); 1Keimyung University, Korea

At the core of Gibson’s ecological psychology is the notion of invariant, specifically an invariant pattern in the changing energy flux. Among the invariants identified to date are texture gradients, horizon ratio, optic flow, and tau. Gibson considered his discovery of the occluding edge the most radical because observers can perceive the layout of the environment (both unprojected and projected surfaces); and the accretion and deletion of optical texture, or dynamic occlusion, at the occluding edge resulting from observer movement produces an invariant pattern. Here I present the results of an experiment demonstrating diminished sensitivity to dynamic occlusion in Alzheimer’s disease (AD) that led to their reduced capacity to recover 3D shape from motion. Young controls, age-matched elderly controls and AD patients participated in the study. Participants watched computer simulations of an object, depicted as either transparent or opaque, rotating about the vertical axis against a background rendered in random dot texture. Young controls were most accurate, followed by elderly controls and AD patients. Both control groups identified opaque objects better than transparent objects, but AD patients identified both objects equally poorly. These results demonstrate the facilitating effect of the dynamic occlusion invariant to recover 3D shape from motion, the capacity of which is severely impaired in AD.
Across the surface of conscious visual awareness

Sunday, July 15, 2:30 pm – 4:30 pm, Room 113-114

Organizer: Chai-Youn Kim, PhD, Department of Psychology, Korea University

Presenters: Sheng He, PhD, University of Minnesota; Won Mok Shim, PhD, Dartmouth College; Joel Pearson, PhD, University of New South Wales; Chai-Youn Kim, PhD, Korea University; Naotsugu Tsuchiya, PhD, Monash University, Science and Technology Agency, Japan

Symposium Summary

We will present recent studies exploiting various paradigmatic phenomena for manipulating conscious visual awareness, which includes bistable perception, crowding, and continuous flash suppression. The symposium will further explore factors influencing our becoming consciously aware of visual stimuli; attention, imagery, emotion, and learning will be considered. The neural correlates of conscious visual awareness will also be discussed.

Presentations

S6-1 Attention and Interocular Competition

Sheng He1(sheng@umn.edu); 1University of Minnesota, USA

Visual attention functions to select relevant information for further processing among vast amounts of visual input, and attention is generally important for resolving competition between neural representations. I will first describe a set of EEG experiments investigating the role of attention in resolving interocular competition. Using an EEG frequency tagging method to track cortical representations of the conflicting images presented separately to the two eyes, we show that when attention was diverted away interocular competition remain unresolved. I will also describe a series of behavioral experiments showing that voluntary attention can be eye-specific, modulating visual processing within a specific monocular channel, despite that fact that observers normally do not have explicit access to the eye-of-origin information.

S6-2 Neural representation in the apparent motion path

Won Mok Shim1(won.mok.shim@dartmouth.edu); 1Dartmouth College, USA

When a static stimulus appears successively at two different locations, we perceive a transition of the stimulus across them – apparent motion. Previous studies have shown that some spatio-temporal representation is reconstructed in the apparent motion path and it leads to increased activation in the region of the primary visual cortex (V1) corresponding to the apparent motion path (Muckli et al., 2005 PLoS Biology 3 1501-1510). However, little is known about whether visual properties of an object engaged in apparent motion are maintained in this representation. In order to address this question, we used fMRI and pattern classification methods to examine the neural representation created on the apparent motion path when the object changes its orientation across the apparent motion path. Two intermediate orientations (0° and 90°) on the apparent motion path were induced by presenting gratings with different orientations at separate locations. The gratings were presented in a bistable quartet sequence and subjects were instructed to perceive either vertical or horizontal direction of motion during each trial. The results show that the regions of V1 contain information of the intermediate representations (0° vs. 90°) between the two gratings when they correspond to the path of perceived rotation but not when they are no longer on the motion path. This suggests that V1 generates neural representation of visual features that do not exist in the physical stimulus, but that correspond to our conscious perceptual experience of dynamic visual objects.

S6-3 Using visual consciousness to explore mental imagery and visual working memory

Joel Pearson1(jpearson@unsw.edu.au); 1University of New South Wales, Australia

Our ability to be conscious of the world around us is often discussed as one of the most amazing yet enigmatic processes under scientific investigation today. However, our ability to imagine the world around us in the absence of stimulation from that world is perhaps even more amazing. This talk will cover new methods for investigating mental imagery, its influence on visual perception and its role in visual working memory. Mental imagery can have a pronounced facilitatory influence on subsequent conscious perception. Likewise metacognitive reports of individual episodes of imagery can predict its influence on subsequent perception. These effects of imagery on conscious perception can also be used to predict an individual’s ability to hold visual spatial information in working memory.

S6-4 Visual awareness modulated by conditioned fear during bistable perception

Chai-Youn Kim1(chaikim@korea.ac.kr); 1Korea University, Korea

Bistable perception has been considered as a useful means to study visual awareness since it induces spontaneous fluctuation in awareness despite constant physical stimulation. Whether visual awareness during bistable perception is modulated by emotional valence associated with one of the two visual interpretations has been of great interest. This talk will present results from a couple of recent studies in my lab to investigate this issue. By comparing bistable perception prior to and followed by Pavlovian fear conditioning using disambiguated versions of the ambiguous figure, I and my colleagues found that negative emotional valence associated with one of two interpretations significantly influences conscious visual awareness during bistable perception. Specifically after fear conditioning, participants tended to be consciously aware of the...
interpretation associated with the aversive stimulation (CS+) longer at a time compared to the other (CS-). This influence of fear conditioning on bistable perception occurs only when the fear conditioning was effective indicated by the participant’s differential physiological response (heart rate) to CS+ and CS-. Changes in bistable perception after fear conditioning were also found to be correlated positively with the State-Anxiety score. I will also discuss results from the follow-up study showing that visual awareness during bistable perception is also modulated “unconsciously” conditioned fear.

S6-5 Visual consciousness tracked with direct intracranial recording from early and high-level visual cortices in humans and monkeys
Naotsugu Tsuchiya¹²(naotsu@gmail.com);¹Monash University, Australia, ²Japan Science and Technology Agency, Japan

Key insights about the neuronal correlates of consciousness have been gained by electrophysiological recording of single neurons from a particular area or by recording of indirect fMRI signals from whole brain. However, if rapid interaction among neuronal populations in distant cortical areas is essential for consciousness, other methods such as intracranial electrocorticogram (ECoG) that can attain both requirements are necessary. Here we report the results of ECoG experiments in three epilepsy patients and one monkey. We used Continuous Flash Suppression to investigate the neuronal activity when ‘invisible’ stimuli broke interocular suppression. We found that wide spread activity in the visual cortex preceded up to 1-2 seconds before subjective reports of detection and that alpha-band activity in the visual cortex induced by the initial flashes predicted how long the suppression was going to last. We will discuss implication of these findings for the neuronal dynamics associated with consciousness.
Friday Morning Talks

Eye and Brain

Friday, July 13, 9:00-11:00 am, Room 116-117

Oral session

Moderator: Chun-I Yeh

O1-1, 9:00 am
Decomposition of BOLD activity into tuned and untuned components reveals cohabitation of stimulus and choice information in V1
Kyoung Whan Choe1(kywch@snu.ac.kr), Randolph Blake1,2, Sang-Hun Lee1; 1Seoul National University, 2Vanderbilt University

Recent studies on V1 report top-down modulation of input-driven responses of sensory neurons, implying that exogenous sensory drives and endogenous top-down drives jointly determine V1 responses. By measuring fMRI responses in conjunction with a classification task on ambiguous ring stimuli, we sought to understand how V1 carries out its encoding operation on afferent currents while being adaptively modulated by top-down currents associated with perceptual tasks. Population activity of V1, as in its raw eccentricity profiles, failed to resolve the threshold differences between the ring stimuli due to large moment-to-moment fluctuations. The analysis of variance indicated that stimulus-evoked responses explain only one-fifth of the total variance and fMRI responses were highly correlated among eccentricity-bins, implying that a substantial fraction of V1 responses fluctuate as a whole. This led us to decompose the raw fMRI responses into untuned and tuned components: average response across eccentricity-bins and residual responses from the average, respectively, the former varying only in time and the latter varying both space and time. The tuned responses revealed the veridical encoding operation of V1 by readily distinguishing between the ring stimuli, which was impossible with the raw fMRI responses. In contrast, the untuned were correlated with two major aspects of choice behavior - inter-trial variability in response time and inter-subject variability in response bias. We propose that this cohabitation of stimulus and choice information in V1 indicates the presence of top-down exertion of gain modulation on the early processing stage by the high-tier stage that accumulates evidence for perceptual choices.

Acknowledgement: This work is supported by the WCU program through the National Research Foundation of Korea funded by the Ministry of Education, Science and Technology (R31-10089).

O1-2, 9:20 am
Suppression of spontaneous activity before visual response in the primate V1 neurons during a visually-guided saccade task
Choongkil Lee1(cklee@snu.ac.kr), Jungah Lee1, Kyesam Jung1; 1Seoul National University

Visually-guided saccadic responses are thought to involve multiple stages of processing in diverse brain structures including the primary visual cortex (V1). The variability of neural activity in each of these structures may present ambiguities for downstream stages in identifying sensory and motor signals among spontaneous discharges. Response time of saccadic eye movements made toward a visual target is correlated with the time of first spike of V1 evoked by the target (Lee et al, 2010 Journal of Neurophysiology 104 2556-2572). This suggests that downstream neurons receiving the output of V1 are faced with a challenging task of discriminating spikes of visual response against spontaneous discharge. Here we report a novel response property of the output activity of the V1 that immediately before neurons discharge a burst of activity to a visual target, spontaneous discharges were transiently suppressed. This suppression was ultra-fast and peaked around 20ms after target onset. The results of a simulation indicated that the suppression enhanced reliability of detecting activity onset. Thus, the initial transient suppression is hypothesized to enhance temporal contrast for identifying the onset of visual response by downstream neurons.

Acknowledgement: This research was supported by the Cognitive Neuroscience Research Program of the Korea Ministry of Education, Science and Technology.

O1-3, 9:40 am
Action word related to walk heard by the ears activates visual cortex and superior temporal gyrus: An fMRI study
Naoyuki Osaka1(nosaka@bun.kyoto-u.ac.jp), Mariko Osaka1; 1Osaka University

Cognitive neuroscience of language of action processing is one of the interesting issues on the cortical “seat” of word meaning and related action (Pulvermüller 1999 Behavioral Brain Sciences 22, 253-336). For example, generation of action verbs referring to various arm or leg actions (e.g. pick or kick) differentially activate areas along the motor strip that overlap with those areas activated by actual movement of the fingers or feet (Hauk et al, 2004 Neuron 41, 301-307). Meanwhile, mimic words like onomatopoeia have the other potential to selectively and strongly stimulate specific brain regions having a specified “seat” of action meaning. In fact, mimic words highly suggestive of laughter and gaze significantly activated the extrastriate visual/premotor cortices and the frontal eye field, respectively (Osaka et al, 2003 Neuroscience Letters 340 127-130; Osaka et al, 2009 Neuroscience Letters 461 65-68). However, the role of a mimic word related to walk on specific brain regions has not yet been investigated. Present study showed that a mimic word highly suggestive of human walking,
heard by the ears with eyes closed, significantly activated the
visual cortex located in extrastriate cortex and superior temporal
gyrus while hearing non-sense words that did not imply walk
under the same task did not activate these areas. These areas
would be a critical region for generating visual images of
walking and related action.

Acknowledgement: Supported by JSPS grant #22220003 to NO

O1-4, 10:00 am

The contributions of the ON and OFF gain difference to the
contextual effect in macaque monkey V1
Kuo-Sheng Lee1, Chun-I Yeh2(ciyeh@ntu.edu.tw); 1Department of
Psychology, National Taiwan University

In macaque monkey V1, the response amplitudes of ON and
OFF sub-regions of simple receptive fields are about equal for
cells in the input layer 4c, but the OFF responses tend to be
greater than the ON responses for layer-2/3 cells. This OFF-
over-ON bias is evident when receptive fields are mapped with
sparse noise (a series of dark or bright squares shown in
different space and time) but is weaker with Hartleys (gratings
shown briefly at different orientations and spatial frequencies).
One possible mechanism for the receptive-field mismatch in
layer 2/3 of V1 is the difference between ON and OFF response
gains caused by different degrees of sparseness between
Hartleys and sparse noise. Here we manipulated the relative
strength of ON and OFF sparse-noise responses until the
receptive field similarity (RFS, quantified as the pixel-by-pixel
correlation between two maps) between sparse-noise and
Hartley maps reached the maximum. On average, the relative
strength of ON/OFF responses in sparse-noise maps should be
increased to approximately two times of their origins in order to
match closely their Hartley compartments for layer-2/3 neurons
(1.93+-0.19; mean+S.E.M.). The sole change in response gain
largely increased the RFS between Hartley and sparse-noise
maps (on average the RFS increases from 0.35 to 0.58), and it
could account for approximately 81% of the overall differences
between the two maps. In summary, the difference in ON and
OFF gains under different visual stimulations is one critical
mechanism underlying the contextual effect in the superficial
layer of V1.

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Guthrie Patterson Trust and the Swartz Foundation. Thanks go to Drs.
Robert M. Shapley and Dajun Xing for their help with experiments.

O1-5, 10:20 am

The correlation between subjective and objective visual function
test in optic neuropathy patients
Ungsoo Kim1(ungsookim@kimeye.com), Se Rang Choi2; 1Kim's Eye
Hospital, Konanyang University

Purpose: To investigate the correlation between visual acuity and
quantitative measurements of visual evoked potentials (VEP), optical coherence tomography (OCT) and visual field
test (VF) in optic neuropathy patients. Methods: We evaluated
twenty-eight patients with optic neuropathy. Patients who had
pale disc, visual acuity less than 0.5 and abnormal visual field
defect were included. At the first visit, we performed visual
acuity and VF as subjective methods and OCT and VEP as
objective methods. In the spectral domain OCT, rim volume,
average and temporal quadrant retinal nerve fiber layer (RNFL)
thickness were measured. And, pattern VEP (N75, P100, N135
latency and P100 amplitude) and Humphrey 24-2 visual field
test (mean deviation and pattern standard deviation) were
obtained. Using Spearman's correlation coefficient, the
correlation between visual acuity and various techniques were
assessed. Results: Visual acuity was most correlated with the
mean deviation of Humphrey perimetry.
Friday Posters

Color and Lightness
Multisensory Perception
Form and Depth
Action and Virtual Environment

P1-1 The effect of convergence training on visual discomfort in 3D TV viewing
Hyun Min Jeon\textsuperscript{1}(hyunminjeon@kangwon.ac.kr), Keetaek Kham\textsuperscript{1};
\textsuperscript{1}Kangwon National University, Korea

The present study investigated whether convergence training has an effect on reducing visual discomfort in viewing a stereoscopic TV. Participants were assigned into either a training group or a control group. In the training group, one of the two different training procedures is provided: gradual change or random change in the disparities of bar stimulus which was used for convergence training. Training itself was very effective so that convergence fusional range was improved after 3 repeated trainings with intervals of two weeks. In order to evaluate the effect of convergence training on visual discomfort, the visual discomfort in 3D TV viewing was measured before and after training sessions. The results showed that a significant reduction in visual discomfort was found after training only in one training group. These results demonstrated a repeated convergence training might be helpful in reducing the visual discomfort. Further studies should be needed to set the most effective parameters of training of this pattern.

P1-2 Action makes it clear: Motor capability enhances visual sensitivity in distant space
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Distance is a critical factor determining the perceptual quality of visual objects. The closer they are, the better we see. Our visual experience, however, does not entirely depend on physical aspects of objects. In fact, the distinction between far and close distance is quite subjective. We often see distant objects with greater acuity as if they were near us. The present study investigated effects of motor capability on visual analysis in the space distant from the body (extrapersonal space). Since the vision has its critical role in guiding the action, we hypothesized that if a person is able to perform an action by using a tool, visual representations of the extrapersonal space might be altered. Using a keyboard, participants manipulated a ball on the screen at a distance they could not reach by hands. Each participant’s contrast threshold was measured before and after the manipulation task. As results, participants who were able to control the ball showed improved visual sensitivity relative to those who passively watched the ball moving (Experiment-1). Furthermore, when participants could move the ball in a certain area of the screen but not in the other, improved visual sensitivity was observed only in the area where motor capability was experienced (Experiment-2A). The effect of motor capability, however, was not significant in the peripersonal space (Experiment-2B). Overall, our results demonstrate that visual analysis of distant space can be improved by motor capability, which was temporarily induced by tool-use. It further suggests the tight link between action and vision.

P1-3 Individual differences in chromostereopsis under natural viewing conditions
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Chromostereopsis is a type of visual perception where a specific color is perceived closer to or farther from the observer than other colors in the plane pattern. The mechanism is considered to be binocular stereopsis by the chromatic aberration of the eyeball optical subsystem, but there are large individual differences in natural viewing conditions. For example, in the case of a red-blue pattern with black background, about 70% of observers perceive the red pattern to be closer while 20% perceive the blue pattern to be closer. In the present research, the binocular disparity of the chromostereopsis was estimated both experimentally and numerically and the reason for the individual differences studied. First, the disparity was measured using a constant method, in which a stereo pair of red-blue stimulus patterns (random dots) was presented on a black background. The distance between the red and blue patterns for the right eye image was varied to generate a binocular disparity. It was found that the range of the equivalent disparity was between -1.3 and 2.1 arc-min among 24 subjects. Numerical simulation based on ray-tracing using LeGrand's model eye showed good agreement with the experimental results. The simulation results indicate that when the outer or inner edge of the pupil is shielded, the binocular disparity of the chromostereopsis was drastically changed. We conclude that this situation might occur due to the eccentricity of the center of the pupil and be the main factor of the individual differences in the chromostereopsis in natural viewing conditions.

P1-4 Neural correlates of fading illusion revealed in responses of V1 neurons
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Visual stimuli without sharp edges fade gradually under visual fixation. This phenomenon is known as Troxler fading or fading illusion. Traditionally, this fading is explained by a hypothesis that physical stimulus is cancelled by a negative image generated in the visual pathway, because the negative image is
perceived momentarily when the physical stimulus is removed suddenly. One prediction that may be tested neurophysiologically is that, in the faded or adapted state, visual neurons actually respond to a blank screen, as if they actually ‘see’ the negative image. To examine this prediction in cat V1, we measured the contrast response function of single neurons by presenting flashed grating stimuli of various contrasts (7 contrasts in straddle +/- 25% range and pedestal, within 0-50% range; negative values for phase reversal) in a rapid succession. Data were analyzed using reverse correlation. The orientation and spatial frequency of gratings were fixed at the optimal value of each cell. We found that V1 neurons showed a shift of contrast response function during pedestal conditions to respond to a blank screen (i.e. 0% contrast stimulus). The amount of shift was consistent with the arithmetic mean of contrasts in each experimental condition. These results support the hypothesis that a negative image is generated during visual fading, and it behaves as if it were a real stimulus. Additionally, we examined phase retardation using periodic stimuli to investigate the temporal transition of contrast response functions. The time constant of phase retardation was comparable to that we observed perceptually.

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P1-5 Effect of luminance contrast on the color selective responses in the inferior temporal cortex neurons of the macaque monkey
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Although the relationship between color signal and luminance signal is an important problem in visual perception, relatively little is known about how the luminance contrast affects the responses of color selective neurons in the visual cortex. In this study, we examined this problem in the inferior temporal (IT) of the awake monkey performing a visual fixation task. Single neuron activities were recorded from the anterior and posterior color selective regions in IT cortex (AITC and PITC) identified in previous studies where color selective neurons are accumulated. Color stimuli consisted of 28 stimuli that evenly distribute across the gamut of the CRT display defined on the CIE-xy chromaticity diagram at two different luminance levels (5 cd/m2 or 20 cd/m2) and 2 stimuli at white points. The background was maintained at 10 cd/m2 gray. We found that the effect of luminance contrast on the color selectivity was markedly different between AITC and PITC. When we examined the correlation between the responses to the bright stimuli and those to the dark stimuli with the same chromaticity coordinates, most AITC neurons exhibited high correlation whereas many PITC neurons showed no correlation or only weak correlation. In PITC, the effect was specifically large for neutral colors (white, gray, black) and for colors with low saturation. These results indicate that the effect of luminance contrast on the color selective responses differs across different areas and suggest that the separation between color signal and luminance signal involves higher stage of the cortical color processing.

P1-6 The correlation in appearance between gold and metallic gloss
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Gold, silver or bronze is perceived in metallic, glossy surfaces with certain chromaticity ranges. However it is not known yet how gold depends on the metallic perception? The present study compared the perceptual degree of goldenness and perception of metallic gloss to investigate underlying perceptual mechanisms for gold and metallic gloss. We simulated metallic and non-metallic objects (sphere and Stanford Bunny and 26-faceted polyhedron) by 3DCG to be used as stimuli in the experiments. These metallic and non-metallic images were morphed in luminance to make stimuli with different metallic levels. The luminance of each morphed image was multiplied to make different luminance levels. The same chromaticity, which was estimated as high degree of goldenness in our previous experiments, was used for all stimuli. The observer carried out the magnitude estimation of goldenness and the surface metallicity, which criterion was whether the stimuli appear as metallic surface, for the stimuli with 6 different metallic levels and 5 different luminance levels. Although it was confirmed that the degree of goldenness almost correlated with the degree of metallic it was found that the degree of goldenness increased with luminance level of stimuli whereas the degree of metallicity did not increase. This result suggests that the perception of goldenness does not totally depend on the metallic perception. Furthermore, this result indicates that goldenness might change depending on illumination level because the luminance level of the stimuli could be regarded as the illumination intensity.

P1-7 Modern Display Technology in Vision Science: Assessment of OLED and LCD Monitors for Visual Experiments
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For many decades, cathode ray tube (CRT) monitors have been the dominant display technology in vision science. However, in recent years, most manufacturers stopped their CRT production lines, which enforces the application of alternative display technology in the field of vision science. Here, we analyze liquid crystal displays (LCDs) and organic light-emitting diode (OLED) monitors for their applicability in vision science experiments. Based on extensive measurements of their photometric output, we compare these technologies and contrast them with classical CRT monitors. Vision scientists aim to accurately present both static and dynamic stimuli on their display devices. As for the presentation of static stimuli, we demonstrate an increased accuracy for LCD and OLED devices compared to CRT monitors, because the former exhibit a higher degree of independence of neighboring pixels. As for dynamic presentations, both CRTs and OLEDs outperform LCD devices in terms of accuracy, because dynamic presentations on LCDs
require a reorientation of the liquid crystal molecules, so that successive frames in time depend on each other. Together with widely unknown and uncontrolled technical artifacts, these properties of LCDs may impair visual experiments that require high temporal precision. Therefore, OLED monitors are more suitable for vision science experiments with respect to both their static and their temporal characteristics. However, for certain applications in visual neuroscience, the low duty cycle of some OLED devices may introduce frequencies to the photometric output which fall within the window of visibility of neurons in the visual cortex and therefore interfere with single unit recordings.

P1-8 The effect of spatial frequency, color and width of interval on chromatic induction
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Chromatic induction refers to changes of color that appear when color is observed in the existence of other colored. Chromatic contrast and chromatic assimilation are included in chromatic induction. Two experiments were conducted to investigate the impact of spatial frequency, color and width of interval on chromatic induction. S-cone pattern and L-cone pattern were used as stimuli. In experiment 1, the impact of spatial frequency was tested. In experiments 2, the effect of interval in the stimulus was tested. The result of experiment 1 and 2 showed that chromatic induction by assimilation was appeared all conditions. This result was suggested that color of stimuli was not affected to chromatic induction. The results showed that chromatic induction was perceived stronger when spatial frequency was higher, but chromatic induction was weaker when width of interval was extended. These results were suggested even if spatial frequency of induction areas were higher chromatic induction was decreased when intervals were widen. And results were suggested chromatic assimilation was appeared by different mechanism with color spreading mechanism.

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P1-9 Relationship between color shifts in Land’s two-color method and higher- and lower-level visual information
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Land’s two-color method gives rise to apparent full-color perception, even though only two colors (e.g., red and gray) are used. Previous studies indicate that chromatic adaptation, color memory, and inductive effects contribute to the shifts of color perception from real to illusory colors (e.g., Kuriki, 2006 Vision Research 46 3055-3066). This paper investigates the relationship between the color shifts induced by Land images and the skewness of the luminance histogram. In Experiment 1, several Land images are created based on a yellow ball and the magnitude of the color shifts of the images are measured. The results of Experiment 1 show a significant correlation between the magnitude of the color shifts and skewness, suggesting that skewness is critical for the color shifts. In Experiment 2, we test the hypothesis that color shifts depend on just skewness; the color shifts should be invariant even if the Land images are scrambled. However, the results of Experiment 2 demonstrate that scrambled Land images exhibit less intense color shifts, suggesting that color shifts are determined by the object’s overall shape or surface gloss, not just skewness. Taken together, we conclude that both low-level visual processes, such as those associated with luminance histogram skew, and high-level cognitive functions, such as object interpretation or understanding of surface gloss, are involved in the color shift of Land images.

P1-10 The Association between Colors and Emotions
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Wexner (Wexner, 1954 Journal of Applied Psychology 38 432–435) demonstrated colors were associated with specific emotions. Colors have many meanings, such as red can lead to induce positive or negative emotions (Kaya & Epps, 2011 College Student Journal 38 396-406). This study extends previous findings and aims to investigate two questions, (1) whether colors are associated with the emotions of pictures in IAPS (International Affective Picture System) and (2) whether perceiving IAPS consciously and unconsciously has different emotion associations. We replaced facial expressions with pictures of IAPS as stimuli. Five colors (black, red, yellow, blue and white) and 3 categories of IAPS (fear, awe and amusement) were manipulated in this study. Pictures were displayed in different durations to manipulate conscious (250ms) and unconscious (33ms) visual stimuli (Manuel & Pedro, 2009 Behavior Research Method 41 184-191) in two experiments. Participants were required to select the most suitable color at their first glance when the pictures of IAPS were presented, and vice versa. Results showed that overall association between colors and pictures of IAPS was weak but the association pattern was meaningful. It concluded (1) black and red colors are associated with the fearful emotion, and blue color is associated with the happy emotion; (2)white color do not associate with fear emotion, which is incongruent with the previous study (Osvaldo and Paul, 2007 Colour: Design & Creativity 1 1-20); (3)participants did not perform differently between conscious and unconscious stimulus conditions.

P1-11 Visual function and neurotoxic symptoms related to exposure to organic solvents
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Aim: Exposure to Perchloroethylene (PERC), a solvent used in
dry-cleaning, is associated with neurotoxicity and changes in colour vision (CV) and contrast sensitivity (CS). However PERC’s impact on other aspects of visual function (VF) such as chromatic contrast sensitivity (CCS), glass pattern detection (GPP), visual search (VS) and global motion sensitivity (GMS) remains unclear. This study compared VF and neurotoxicity in two populations at risk, dry-cleaners (cases) from Colombia and Australia. Control groups of people with community levels of exposure to PERC were also assessed. Methods: A case-control study of VF in people who are working in the dry-cleaning industry for at least 1 year (n=40 Colombia - n=34 Australia) with controls (n=35 each site). VF measures assessed were CSF, CCS, the FM Hue 100 test, VS, GPP and GMS. Neurotoxic symptoms were assessed using the Q16 modified version questionnaire. Results: Cases had poorer CCS, hue discrimination, GPP, GMS and higher Q16 scores than controls (p<0.05). There was no effect of country. CS function was poorer than controls (p<0.05) for spatial frequencies≥0.50cpd for Australian cases but for ≥1.0cpd for Colombian cases. There were no significant differences between cases and controls for serial and parallel VS. Conclusion: Our CSF and CV findings indicate that the CS deficit extends to lower spatial frequencies. Furthermore we report a reduction in the detection of form, motion and CCS. These deficits were associated with neurotoxic symptoms. Because VS was unaffected, it suggests that PERC affects lower order visual functions more severely than higher level cognition.

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P1-12 Different double-pulse distinguishability among the luminance opponency, the red-green opponency, and the blue-yellow opponency
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The inter-stimuli-interval (ISI) thresholds of double pulses discrimination were measured to investigate the temporal distinguishability of double pulses of the luminance opponency, the red-green opponency, and the blue-yellow opponency. Double pulses were presented randomly in one of four quadrants, defined by a central fixation cross on a CRT display controlled by the real time sequencer (RTS) of the VSG system in 42 bit color mode calibrated with less than 3% display error rate of the 1931 CIE luminance and chromatic coordinate. Each pulse was of duration 6.7 msec and included a Gaussian patch with gradation of tristimulus values from the peak to the background in equal-energy-white (the luminance opponency) or isoluminance (the red-green and the blue-yellow opponency) configuration. Eleven observers were asked to report the number of pulses (one or two) observed while ISI was adjusted by a psi method. Psychometric functions were estimated using the cumulative distribution function of the extreme value distribution. The threshold was the ISI value corresponding with the rate of 63.21% correct answer. Significant differences were found among ISI thresholds of the luminance, blue-yellow, and red-green opponency. Results supported that the temporal distinguishability of double pulses of the luminance opponency, the red-green opponency, and the blue-yellow opponency were significantly different. The difference can be explained by the impulse response functions (IRF) with various first peak time among the luminance opponency, the red-green opponency, and the blue-yellow opponency.

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P1-13 Color induction from surround color under interocular suppression
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The effect of surround colors on color appearance is known to subserve color constancy in humans, but it is controversial how are multiple mechanisms in the visual system involved in this effect. We used an interocular-suppression technique to examine how the effect occurs at the level higher than the interaction of binocular information. A test color chip (1.7° x 1.7° in visual angle) was presented in a static surround either with continuous-flash suppression in the dominant eye (CFS condition) to make the surround perceptible, or without the suppression (no-CFS condition). The surround stimulus was either a Mondrian or a uniform field of the same mean chromaticity. Stimuli were simulated OSA color chips under red, white (D65) or green illuminant and were presented on a CRT display. Unique yellows were measured by asking the subjects to judge whether the test stimulus appeared reddish or greenish. Two sizes of the surround stimuli (widths of 1° and 4°) were used. Results showed significant shifts in unique yellow even under the CFS conditions, except for the 1°-uniform-surround condition. Under the no-CFS condition, the shifts showed remarkable difference between subjects, except for 4°-Mondrian-surround condition. Interestingly, trends of the shifts showed high consistency within each subject, across conditions. These results indicate that mechanisms at both higher and lower level than the neuronal site of interocular suppression are involved, and that the color shifts follow each subject’s strategy in the higher-order mechanisms when only insufficient clues are available in the surround to estimate illuminant color.

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P1-14 Relationship between colorfulness adaptation and spatial frequency components in natural image
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We previously found the effect of colorfulness-adaptation in natural images. It was observed stronger in natural images than unnatural images, suggesting the influence of naturalness on the adaptation. However, it was not examined enough what characteristics of images and what levels of visual system involved. This research investigates whether the effect of colorfulness-adaptation is associated with spatial frequency components in natural images. If adaptation was a mechanism in
early cortical level, the effect would be strong for adaptation and test images sharing similar spatial frequency components. In the experiment, we examined how the colorfulness impression of a test image changed following to adaptation images with different levels of saturation. We selected several types of natural images from standard image database for test and adaptation images. We also processed them to make shuffled images with spatial frequency component differed from the originals and phase-scrambled images with the component similar to the originals, for both adaptation and test image. Observers evaluated whether a test image was colorful or faded. Results show that the colorfulness perception of the test images was influenced by the saturation of the adaptation images. The effect was the strongest for the combination of natural (original) adaptation and natural test images regardless of image types. The effect for the combination of phase-scrambled images was weaker than those of original images and stronger than those of shuffled images. They suggest that not only the spatial frequency components of an image but also the recognition of images would contribute to colorfulness-adaptation.

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P1-15 Categorical color perception of LED illuminant color for deuteranomal

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Color information has a great value in our everyday lives, but it is not thoughtful of people with color vision deficiency (CVD). We can choose several color names to categorize a lot of colors around us. Eleven color names (white, black, red, green, yellow, blue, brown, orange, pink and gray) are known as basic color categories, but CVD can’t necessarily describe colors as people with color vision normal (CVN) do. Previous studies showed that it was hard for CVD to discriminate illuminant color than object color and their color perception largely changed depending on experimental conditions. In this study, we investigated categorical color perception of illuminant color for deuteranomal, using a mixture of light consists of a red, a green and a blue LED as a test stimulus. We tested those stimuli with three luminance levels (180 cd/m², 18 cd/m², 1.8 cd/m²) and two visual angles (10°, 0.5°). Subjects were three deuteranomals and three CVN. Our result showed that the categorical color of mild deuteranomal was similar to that of CVN, but that of severe deuteranomal was not. Severe deuteranomal judged low chromatic colors as achromatic colors than CVN did. The smaller visual angle or lower luminance level the test stimulus had, the more deuteranomals confused color. They suggest that the effect of the Bezold-Brucke phenomenon is greater to deuteranomals than CVN. Furthermore, deuteranomals use not only chromatic information but also luminance information when they describe color.

P1-16 The effect of visual stimuli of LED lighting by color temperature and illuminance control on attention and meditation level of mind

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Recently LED (Light Emitting Diode) lighting sources are applied not only for display like LED BLU(back light unit) TV but also for general lighting like LED lamps for home and office. The color temperature or chromaticity, and brightness of LED lighting can be easily controlled. Preferred combinations between illuminance and color temperatureof lighting depend on daily living activities (Oi et al, 2007 Symposium on Design of Artificial Environments 214-215). Changes in intensity can be more easily detected than color changes (Almeida et. Al, 2009 Perception 38 1109-1117). We investigated whether the illumination stimuli of LED lighting can enhance attention and relaxation level by controlling color temperature and illuminance according to activities. EEG signals are used to estimate attention and relaxation level of human subjects under different lighting conditions. Nine participants with normal eye sight and color vision participated in the experiments with four different activities under different illumination conditions. LED lighting with color temperature 3600K in 240 lux is used for relaxation activities, and LED lighting with 6600K in 794 lux is used for the task which requires attention. These lighting conditions are compared with conventional lighting condition with 4600K in 530lux. Preliminary experiment results show that low color temperature with low illumination intensity of LED lighting enhances relaxation level and high color temperature with high illuminance improves attention level compared with conventional lighting environment without illuminance and color temperature changes.

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P1-17 Pseudo-Haptics using motion in depth stimulus and second order motion stimulus

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Modification of motion of the computer cursor during the manipulation by the observer evokes illusory haptic sensation (Lecuyer et al, 2004 ACM SIGCHI’04 239-246). This study investigates the pseudo haptics using motion-in-depth and second-order motion. A stereoscopic display and a PHANTOM were used in the first experiment. Subject was asked to move a visual target at a constant speed in horizontal, vertical, or front-back direction. During the manipulation, the speed was reduced to 50% for 500 msec. The haptic sensation was measured using the magnitude estimation method. The result indicates that perceived haptic sensation from motion-in-depth was about 30% of that from horizontal or vertical motion. A 2D display and the PHANTOM were used in the second experiment. The motion cue was second order - in each frame, dots in a square patch reverses in contrast (i.e., all black dots become white and all white dots become black). The patch was moved in horizontal
direction. The result indicates that perceived haptic sensation from second-order motion was about 90% of that from first-order motion.

**P1-18 The Effect of Background Music on Working Memory**

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Many studies do the visual working memory research under sunny sound condition (Alley and Greene, 2008 Current Psychology 27 277-289; Iwanaga and Ito, 2002 Perceptual Motor Skills 94 1251–1258, Pring and Walker, 1994 Current Psychology 13 165-171). In order to understand more about background music, we modified previous studies to examine how the performance of working memory is affected by four different music conditions. Participants were randomly assigned into two groups to listen to two different pop songs to see if they have the similar effect on the performance of working memory. They were required to do six trials of digit span task under each music condition (silence, classical music, non-vocal music, vocal music). After showing ten digits, each for 800ms, participants were asked to recall and write down the digits in correct order within 20 seconds. The results showed that there was no significant difference between two pop songs. Therefore, data was pooled for further analysis and indicated that there are significant differences and correlations in working memory among four music conditions. The finding that the effect of non-vocal music affects working memory is greater in this study than that of westerns (Alley and Greene, 2008; Pring and Walker, 1994), which is consistent with the previous study in Japan (Iwanaga and Ito, 2002). The application of this study will be discussed in detail.

**P1-19 Horizontal vertical illusion by touch**

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Revesz (Revesz, 1934 Zeitschrift fur Psychologie, Bd. 1, Kap 20) and Bean (Bean, 1938 Journal of Experimental Psychology 22 283-289.) reported almost all the geometrical optical illusions existed in a tactual mode. Such a study can examine theories of visual illusions with modality-free theories. A number of articles have been devoted that repeated judgments decline magnitude of visual illusion. In the current study, we examine whether repeated judgments decline magnitude of geometrical haptic illusion. Fick illusion, i.e., horizontal vertical illusion, was investigated. A graphics Braille display with 32×48 dots was used to present inverted-T haptically without vision. The horizontal line was consistently 49.2 mm long and the vertical line was varied in each trial. Three subject with normal sight participated. They judged which line is longer than the other. The point of subjective equality at which the subject perceives the two lines to be the same was measured using the method of constant stimuli. On the first session, the mean PSE was about 13%; to compensate for the illusion the vertical line must be set physically shorter than the horizontal line. We found that repeated judgments produced a reduction in illusion magnitude and dissolved the illusion entirely.

**P1-20 The relation of eye and hand movement during multimodal recall memory**

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Eye and hand movement tracking has been proven to be a successful tool and is widely used to figure out characteristics of human cognition in language or visual processing (Just and Carpenter, 1976 Cognitive Psychology, 8, 441-480). Eye movement has proven to be a successful measure to figure out characteristics of human language and visual processing (Rayner, 1998 Psychological Bulletin, 124(3), 372-422). Recently, mouse tracking was used for social cognition like categorization of sex-typical faces and studying spoken-language processes (Magnuson, 2005 PNAS, 102(28), 9995-9996; Spivey et al, 2005 PNAS, 102, 10393-10398). Here, we present a framework that uses both eye gaze and hand movement simultaneously for analyzing the relation of them during memory retrieval. We tracked eye and mouse movements when the subject was watching a drama and playing a multimodal memory game (MMG), a cognitive task designed to investigate the recall memory mechanisms in watching video dramas (Zhang, 2009 AAAI 2009 Spring Symposium: Agents that Learn from Human Teachers, pp. 144-149). Experimental results that eye tracking and mouse tracking provide complementary information about underlying cognitive processes. Also, we found some interesting patterns in eye-hand movement during multimodal memory recall.

**P1-21 A study on stereonomalies: comparison of upper and lower visual field**

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Stereonomalies suggest that some people lack disparity detectors or have disorder of subsystem associated with stereopsis and consequently fail to perceive correct depth. Crossed and uncrossed disparity detectors are well-established mechanism. The current study searches other stereonomalies. In the experiment, a fixation and a test target were presented for 500 msec in a darkroom. The fixation was right in front of the subject and the test was on the median plane. The test appeared at upper or lower visual field with crossed or uncrossed disparity. The eccentricity of the position of the test target was 2, 4, or 6 deg. The given disparity was between the average threshold of depth percept and the average fusion limit, so observers with normal vision must perceive them correctly. The task of subject was to report the apparent depth of the test target: far, near, or zero. 14 subjects participated. Nine of these subjects gave no anomalous signs. One indicated detection of uncrossed disparity detection. Three indicated detection of uncrossed disparity detection only at lower visual field. One indicated detection of uncrossed disparity detection at lower visual field and that of crossed disparity detection at upper visual field. These results
indicate that some people have stereoanomalies that depend on visual fields.

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P1-22 Upper-lower asymmetry in slant perception and natural scene statistics

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This study investigates the upper-lower asymmetry of slant perception by measuring our daily environment and conducting a psychophysical experiment. We hypothesize that the performance of slant perception varies according to the viewing direction because the visual system adapts to the probability distribution of environmental slants. In the environmental measurement, we sampled 17 locations (2 indoor and 15 outdoor ones) from our daily environment. At each location, a 3D laser scanner was used to measure the spatial layout by collecting radial distances to the surrounding surfaces. On the basis of the measurements, we calculated the probability distribution of the magnitude of surface slant, which was analyzed for each upper and lower area with respect to the eye level. Consequently, the distribution for the lower area, compared to that for the upper area, showed a remarkably high peak at the horizontal (i.e., ground-like) slant. In the psychophysical experiment, participants observed a surface with a random-dot texture, which was presented in the upper and lower viewing directions. For each direction, the participants performed two tasks: adjusted the surface’s slant to be vertical (i.e., wall-like) and horizontal (i.e., ceiling- or ground-like). The results show that the response is most accurate for the horizontal task in the lower direction. This finding, coupled with the distribution of environmental slants, suggests that the visual system is sensitive to the ground-like slant that often exists in our daily environment. This asymmetrical property of slant perception is consistent with our hypothesis.

P1-23 The difference between the perceived depth of shapes with and without head movement

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It is well known that depth can be perceived from motion parallax. To produce motion parallax, observers (with head movement) or objects (without head movement) need to move. In previous studies, the magnitude of perceived depth with head movement was compared with that without head movement using several corrugated surfaces. It was found that perceived depth with head movement was larger than that without head movement. The purpose of the present research was to investigate the influence of discontinuities on the perceived surface. We used stair-like (square-wave) stimuli, and investigated the magnitude of perceived depth with or without head movement. We found that: (1) The magnitude of perceived depth increased as the number of square-waves increased. (2) There was a tendency to perceive larger depth with head movement than without head movement, but the difference between magnitudes of depth with and without head movements decreased as the number of square-waves increased. (3) Observers tended to perceive 4- and 6-step square-wave stimuli as continuous. (4) For the 2-step square-wave stimulus, observers tended to grossly underestimate the magnitude of depth or could not perceive depth at all. These findings suggest the possibility that perception of increased depth is caused by the perception of surfaces as continuous.

P1-24 Neural representation of gloss in the macaque inferior temporal cortex

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The variation of the appearance such as gloss provides one of the most important information for object recognition. However, little is known about the neural mechanisms related to the perception of gloss. We examined whether the neurons in the inferior temporal (IT) cortex of the monkeys are coding gloss of objects. We made visual stimuli which have various surface reflectance properties, and tested responses of IT neurons to these stimuli while a monkey was performing a visual fixation task. We found that there exist neurons in the lower bank of the superior temporal sulcus that selectively responded to specific stimuli. The selectivity was largely maintained when the object shape or illumination condition was changed. In contrast, neural selectivity was lost when the pixels of objects were randomly rearranged. In the former manipulation of the stimuli, gloss perceptions were maintained, whereas in the latter manipulation, gloss perception was dramatically changed. These results indicate that these IT neurons selectively responded to gloss, not to the irrelevant local image features or average luminance or color. Next, to understand how the responses of gloss selective neurons are related to perceived gloss, responses of gloss selective neurons were mapped in perceptual gloss space in which glossiness changes uniformly. I found that responses of most gloss selective neurons can be explained by linear combinations of two parameters that are shown to be important for gloss perception. This result suggests that the responses of gloss selective neurons of IT cortex are closely related to gloss perception.

P1-25 Filling-in the blind spot with the average direction

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Previous studies have shown that the visual system integrates local motions and perceive the average direction (Watanabu and Duchon, 1992 Vision Research 32 931–941). We investigated whether the surface of the blind spot is filled in with the average direction of the surrounding local motions. To test this, we varied the direction of a random-dot kinematogram (RDK) both in adaptation and test. Motion aftereffects (MAE) were defined as the difference of motion coherence thresholds between with and without adaptation. The participants were initially adapted to an annular RDK surrounding the blind spot for 30 seconds in their dominant eyes. The direction of each dot in this RDK was selected equally and randomly from either a
normal distribution with the mean of 15° clockwise from vertical, 15° counterclockwise from vertical, or from the mixture of them. Immediately after the adaptation, a disk-shaped test RDK was presented for 1 second to the corresponding blind-spot location in the opposite eye. This RDK moved either 15° clockwise, 15° counterclockwise, or vertically (the average of the two directions). The participants’ task was to discriminate the direction of the test RDK across different coherence levels. We found significant MAE when the test RDK had the same directions as the adaptor. More importantly, equally strong MAE was observed even when the direction of the test RDK was vertical, which was not physically present during adaptation. The result demonstrates that the visual system uses the average direction of the local surrounding motions to fill-in the blind spot.

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P1-26 Influence of depth from luminance contrast on vergence eye movements

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A vergence eye movement is the simultaneous movement of both eyes in opposite directions to obtain or maintain single binocular vision. It has been shown that a vergence movement is not only induced by binocular depth, but also by the changing size of the stimuli, which produces perception of motion in depth. That is, a monocular depth cue influences the direction of the eye movement even when the eye movement contradicts depth from the disparity cue. Despite that there a number of monocular depth cues are known, the influence on the vergence movement is known only with changing size. In this study, we focused on luminance contrast as a monocular depth cue and examined whether it influences the vergence movement. The stimuli were a gabor patch with contrast changing sinusoidally in time at a given temporal frequency. When the observer looks at the stimuli, apparent depth changes with the contrast change. Eye movement measurements showed vergence movements synchronizing with luminance changes. Change in perceived depth caused by change of the luminance contrast influences vergence movement.

P1-28 Supranormal orientation selectivity of visual neurons in orientation-restricted animals

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Altered sensory experience in early life often leads to remarkable adaptations in humans and animals. Consistent with this, previous studies have reported that restricting visual inputs in young animals can make drastic long-lasting changes in the early sensory areas of their brains. Typically, the majority of sensory neurons are allocated to stimulus features to which the animals were exposed. However, if that is the only change, it will make the sensory encoding highly redundant with many neurons signaling the same features. Are there additional changes, heretofore unnoticed, to functional properties of single neurons in such adaptation processes? Here we show that stimulus selectivities like the sharpness of tuning of single neurons in the primary visual cortex are modified to match a particular environment that has a restricted range of orientations. Specifically, we found in orientation-restricted animals that neurons tuned to an experienced orientation show sharper orientation tuning than neurons in normal animals, whereas the opposite was true for neurons tuned to non-experienced orientations. The sharpened tuning appears to be due to elongated receptive fields. Additionally, quality of signals such as the signal-to-noise ratio can be improved by averaging the activities of a population of neurons unless the same noise source is shared. Correlation of noise shared across neurons in the orientation-restricted animals was comparable to that in normal animals, confirming the potential for such improvements.
Our results demonstrate that restricted sensory experiences can sculpt the supranormal functions of neurons tailored for a particular environment.

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P1-29 Banding detection exceeds spatial frequency limit of the visual system by single frequency grating and jitter

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The halftone screen with fine vertical gratings is often used to modulate image in the printing technology. When the halftone screen is disturbed by the jitter in horizontal direction we observe the lattice fringe (called banding) in the horizontal direction. Surprisingly, any frequency component does not exist in the spatial frequency domain of the banding. Also, the banding is detected even when the spatial frequency of the halftone screen exceeds the frequency limit of the visual sensitivity, where the gratings (carrier) are the longitudinal wave of the horizontal direction, also the jitter (side band) are transversal wave of the vertical directions. A doubly periodic function takes place above as etiology, and then, higher harmonics occur. This complicates an argument. We validated the banding appearance by the carrier grating of the single frequency (69 cpd) and jitter (5.2 cpd) as the side band that removed higher harmonics, to find a response curve by 2AFC in experiment. The correlation between the response curve and the cross term of the jitter spectrum and grating spectrum is absolutely high. So the presence of the nonlinear response is indicated in the early stage. We applied a nonlinear function to the above stimulation to evaluate non-linearity. As a result, we think the banding spectrum is generated by the configuration of nonlinearity and the spatial frequency characteristic in the early stage.

P1-30 Axis orientation effects on interaction between color-selective symmetry detectors

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We used a noise masking paradigm to examine the interaction between color-selective symmetry detection mechanisms in the visual system. We used a 2AFC paradigm in which a random dot noise mask was presented in both intervals. One interval contained a target while the other, a random dot control. The target consisted of a red and a green symmetric pattern with the same (both were 45° or -45°) or orthogonal (one 45° and the other -45°) orientation. The observers were to determine which interval contained the symmetric target. We measured the target density threshold at various noise densities. For all conditions, the target density threshold increased with noise density with a slope 0.96 on log-log coordinates. The threshold for the same-orientation condition was lower than that for the orthogonal condition at all noise densities. We fit our data with a divisive inhibition model for symmetry pattern detection (Chen & Tyler, 2010 PLOS One), in which the response of a symmetry detector is the excitation of a linear symmetry operator raised to a power and then divided by the divisive inhibition from all relevant symmetry operators. The best fit showed that the mutual inhibition between symmetry detectors in the same-orientation condition was only 13% of that in the orthogonal condition. Hence, instead of a strong same-orientation inhibition commonly observed in experiments using Gabor patches, it is actually easier for the visual system to integrate symmetric patterns of the same symmetric axis.

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P1-31 Mahjong tile illusion: Illusory shape perception induced by object surface texture

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When we observe a three-dimensional (3D) object such as a table, its contour along the gaze line is dramatically shortened on the retinal image. This phenomenon is called perspective foreshortening. The visual system compensates for the foreshortening, at least partly, in order to achieve valid object shape perception in 3D space. This compensation seems automatic and sometimes causes visual illusion. In the Shepard illusion, for example, the two parallelograms identical in shape are seen as two different shapes because of the compensation. Here I report a novel illusion of this kind. The outline of a trapezium, without internal details, does not induce apparent depth perception. When two spindle shapes are drawn inside, the figure is seen as a foreshortened rectangle with surface texture. The spindles are seen as two foreshortened disks, which indicates that they provide an apparent context for perspective foreshortening. The length of the side line of the trapezium with spindles is perceived to be longer in comparison to the length of the side line of an identical trapezium without spindles. Surface texture affects shape perception. The former figure is similar to a two-circle mahjong tile. Two experiments that included a magnitude estimation procedure and a method of adjustment were conducted to confirm the illusion. The contrast between the two figures confirmed the illusion. The illusion was found either in realistic perspective line-drawings or in schematized figures. The illusory effect was not fully accounted for by the Oppel-Kundt illusion or the illusory perception of Helmholtz's square.

P1-32 Response of human visual system to paranormal stimuli appearing in three-dimensional display

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Three-dimensional (3D) display became one of indispensable features of commercial TVs in recent years. However, the 3D content displayed by 3D display may contain the abrupt change of depth when the scene changes, which might be considered as a paranormal stimulus. Because the human visual system is not accustomed to such paranormal stimuli in natural condition, they can cause unexpected responses which usually induce discomfort. Following the change of depth expressed by 3D display, the eyeballs rotate to match the convergence to the new 3D image position. The amount of rotation varies according to the initial longitudinal location and depth displacement of 3D image. Because the change of depth is abrupt, there is delay in
human visual system following the change and such delay can be a source of discomfort. To guarantee the safety in watching 3D TV, the acceptable level of displacement in the longitudinal direction should be revealed quantitatively. Additionally, the artificially generated scenes also can provide paranormal stimuli such as periodic depth variations. In the presentation, we investigate the response of human visual system to such paranormal stimuli given by 3D display system. Using the result of investigation, we can give guideline to creating the 3D content to minimize the discomfort coming from the paranormal stimuli.

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O2-1, 2:30 pm
Decoupling orientation specificity from perceptual learning in amblyopic vision

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Perceptual learning (PL) improves visual functions in amblyopes, but this learning is often specific to the trained orientation, possibly implying neural plasticity in the amblyopic early visual cortex. However, orientation specificity in normal vision can be decoupled from PL with a training-plus-exposure (TPE) technique (Zhang et al., 2010 Journal of Neuroscience 30 12323-12328), suggesting PL occurs in higher brain areas. Here we used the TPE in adults with amblyopia to investigate whether PL reflects V1 plasticity or improved high-level decision making in the amblyopic brain. Our results demonstrate that: (1) PL of contrast discrimination in the fovea of amblyopic eyes (AEs) did not transfer to an orthogonal orientation. However, AEs were then exposed to the orthogonal orientation through irrelevant orientation discrimination training, which enabled contrast learning to transfer to the orthogonal orientation. (2) We found similar transfer in the AEs after the non-amblyopic eyes (NAEs) were exposed. (3) Orientation specificity in Vernier and orientation learning was also eliminated by exposure of the transfer orientation in AEs or NAEs through irrelevant orientation or contrast training. (4) Surprisingly, orientation specificity in NAE Vernier learning was eliminated after AEs were exposed to the orthogonal transfer orientation, indicating the AE can teach the NAE. TPE enabled learning transfer across orientations suggests that PL in amblyopic vision may not reflect plasticity in the amblyopic early visual cortex. Rather it may result from improved readout of noisy stimulus inputs at the decision stage, which compensates for the functional deficits in the amblyopic visual system.

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O2-2, 2:50 pm
Examining Vision and Attention in Sports Performance Using a Gaze-Contingent Paradigm

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In time-constrained activities, such as competitive sports, the rapid acquisition and comprehension of visual information is vital for successful performance. Currently our understanding of how and what visual information is acquired and how this changes with skill development is quite rudimentary. Interpretation of eye movement behaviour is limited by uncertainties surrounding the relationship between attention, line-of-gaze data, and the mechanism of information pick-up from different sectors of the visual field. We used gaze-contingent display methodology to provide selective information presentation to the central and peripheral parts of the visual field while performing a decision-making task. Eleven skilled and 11 less skilled players watched videos of basketball scenarios under three different vision conditions (tunnel, masked, and full vision) and in a forced-choice paradigm responded whether it was more appropriate for the ball carrier to pass or drive. In the tunnel and mask conditions vision was selectively restricted to, or occluded from, 5° around the line of gaze respectively. The skilled players showed significantly higher response accuracy and faster response times compared to their lesser skilled counterparts irrespective of the vision condition, demonstrating the skilled players superiority in information extraction irrespective of the segment of visual field they rely on. Findings suggest that the capability to interpret visual information appears to be the key limiting factor to expert performance rather than the sector of the visual field in which the information is detected.

O2-3, 3:10 pm
Temporal order of attentional disengagement and reengagement: estimation with steady-state visual evoked potential

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An attention shift has been assumed to comprise three stages of neural processes: disengagement from the initially attended location, shift to a new destination, and reengagement on the new location. We developed a novel experimental paradigm to estimate the timings of attentional “disengagement” and “reengagement”. We recorded steady-state visual evoked potentials (SSVEPs) for two flickering stimuli at different frequencies, which were presented on the left and right of the center of the display. Participants were, after attending to the either stimulus, instructed to stay their attention on the same
location, or to shift attention toward the other stimulus. We estimated the time course of attentional disengagement and that of attentional reengagement from the difference between the SSVEPs under different attention shift conditions. We conducted two experiments using exogenous (Experiment 1) and endogenous cues (Experiment 2) for controlling visual attention and succeeded to measure the time courses of SSVEP modulations accompanied by disengagement and reengagement of attention. Interestingly, temporal orders of the attentional processes differed between these experiments. In Experiment 1, attention was reengaged to a new object earlier than it was disengaged from the initially attended object. In Experiment 2, on the other hand, attentional reengagement occurred no significantly earlier than disengagement. These results suggest that attention shift processes were not executed in a fixed order; rather, the timings seem to change depending on the types of attention involved in the shift.

02-4, 3:30 pm
Selective attention modulates the nonlinear interaction between stimuli

YeeJoon Kim, Preeti Verghese; Smith-Kettlewell Eye Research Institute, United States

Prior studies suggest that visual attention selects objects of interest by biasing the competition in favor of attended items. However, our current understanding of this competitive process is based on indirect inference. To fill this critical gap in our understanding of selective attention, we directly measured the interaction between two stimuli by using high-density EEG combined with cortical source localization. This technique offers a powerful approach to directly measure responses to individual stimuli (self-terms) as well as to their interaction (intermodulation term). Observers were tested with a pair of adjacent wedge-shaped gratings flickering at two different frequencies (7.14 and 5.56 Hz, respectively), and two static wedge-shaped gratings located diametrically opposite the flickering wedges. By directing attention to one or both stimuli, we determined how attention modulated the response to each stimulus as well as to the interaction between the two stimuli. These responses were compared to a condition when observers attended away from the flickering gratings. Our data show that selective attention differentially modulates self-terms as well as intermodulation terms. Consistent with data from previous single-cell studies, the self-terms have the greatest amplitude when attention is directed to one of the two stimuli. In contrast, the intermodulation term has the greatest amplitude when observers attend to both stimuli, is smaller when they attend to one grating, and insignificant when attention is directed away. Our results suggest that this interaction term is a valuable tool to advance our understanding of the non-linear processes involved in selective attention.

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02-5, 3:50 pm
Tracking location and features of objects within visual working memory

Michael Patterson, Shanshan Yang; Nanyang Technological University, Singapore

Four studies examined how color or shape features can be retrieved from memory using SSVEP. In each trial, 6 colored dots or 6 black shapes were displayed in randomly selected locations for 1.5 seconds. An auditory cue for either the shape or the color to-be-remembered was presented either simultaneously, immediately, or 2 seconds later. Non-informative cues appeared in some trials to serve as a control condition. After a four-second delay, 5/6 objects were re-presented, and participants indicated the location of the missing object either by moving the mouse (Exp 1 and 3), or by typing coordinates using a grid (Exp 2 and 4). Compared to the control condition, cues presented simultaneously or immediately after stimuli improved location accuracy in all experiments. However, cues presented after 2 seconds only improved accuracy in Experiment 1. These results suggest that location information may not be addressable within visual working memory using shape features. In Experiment 1, but not Experiments 2-4, cues significantly improved accuracy when they indicated the missing object could be any of the three identical objects. In Experiments 2-4, location accuracy was highly impaired when the missing object came from a group of identical rather than uniquely identifiable objects. This indicates that when items with similar features are presented, location accuracy may be reduced. In summary, both feature type and response mode can influence the accuracy and accessibility of visual working memory for object location.

02-6, 4:10 pm
Predicting Performance in Natural Scene Searches

Matthew Asher, Iain D Gilchrist, David J Tolhurst; University of Bristol, England, University of Cambridge, England

Completely natural scene search is a paradigm that cannot be directly compared to the typical types of search task studied, where objects are distinct and definable. Here we have look at the possibility of predicting the performance of humans for completely natural scene tasks, using a direct comparison of human performance against new and existing computer models of viewing natural images. For the human task, participants were asked to perform a target present/target absent search task on 120 natural Scenes, the target being a subsection of the Scene and the false-target matched to the scene. The identical task was given to a selection of reproductions of existing computer processing techniques, including Feature congestion (Rosenholtz et al, 2005 SIGCHI 761–770), Saliency (Itti and Koch 2001 Journal of Electronic Imaging, 10, 161–169), Target Acquisition Model (Zelinsky, 2008 Psychological Review, 115, 787–835) and a new variation on the Visual Difference Predictor (To et al, 2008 Proceedings of the Royal Society B-Biological Sciences, 275, 2299–2308). We show that the models are very bad at generating parameters that predict performance, but that A'
of Human performance is predicted pretty well by the simple clutter in the image and these results lead us to conclude that in natural search tasks, the nature of both the Scene and the Target are important, and that the global influence of local feature groups can have an influence of the task difficulty.

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Large-scale contextual effects in early human visual cortex

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A commonly held view about neurons in early visual cortex is that they serve as localized feature detectors. Here, however, we demonstrate that the responses of neurons in early visual cortex are sensitive to global visual patterns. Using multiple methodologies – psychophysics, fMRI, and EEG – we measured neural responses to an oriented Gabor (“target”) embedded in various orientation patterns. Specifically, we varied whether a central target deviated from its context by changing distant orientations while leaving the immediately neighboring flankers unchanged. The results of psychophysical contrast adaptation and fMRI experiments show that a target that deviates from its context results in more neural activity compared to a target that is grouped into an alternating pattern. For example, the neural response to a vertically oriented target was greater when it deviated from the orientation of flanking (HHVHH) compared to when it was grouped into an alternating pattern (VHVHV). We then found that this pattern-sensitive response manifests in the earliest sensory component of the event-related potential to phase fashion in time. Participants needed to tell which blob was flickering asynchronously in time. Three temporal frequencies (1, 2, and 3 Hz) and two element separations (1.25 and 5 degrees) were compared. We found that the amblyopic group exhibited a deficit only for the 1.25 degrees element separation in amblyopic eye but was normal for the other configurations compared to controlled participants. It suggests amblyopes have deficits in temporal processing but only for foveal vision. We also found the sensitivity for the non-strabismic anisometropia group is reduced for all three temporal frequencies whereas for the strabismic anisometropia group it was reduced at 3Hz only, suggesting the impairment in temporal synchrony might be different for different types of amblyopia.

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Asynchrony detection in amblyopes

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Amblyopia is a developmental abnormality of visual cortex. Although amblyopes experience perceptual deficits in spatial vision tasks, they have less temporal sensitivity loss. We investigated whether their temporal synchrony sensitivity is impaired. In experiment 1, four Gaussian blobs, located at the top, bottom, left, and right of a presentation screen, were flickering in 3 Hz and one of them was flickering in out-of-phase fashion in time. Participants needed to tell which blob was different from the other three and contrast threshold of the blobs was measured to determine the synchrony detection threshold. We found the thresholds were not correlated with the contrast thresholds for detecting the flickering blobs; suggesting synchrony detection and temporal detection threshold are processed by different mechanisms. In experiment 2, synchrony thresholds were measured as participants’ ability to tell if one of the four high contrast Gaussian blobs was flickering asynchronously in time. Three temporal frequencies (1, 2, and 3 Hz) and two element separations (1.25 and 5 degrees) were compared. We found that the amblyopic group exhibited a deficit only for the 1.25 degrees element separation in amblyopic eye but was normal for the other configurations compared to controlled participants. It suggests amblyopes have deficits in temporal processing but only for foveal vision. We also found the sensitivity for the non-strabismic anisometropia group is reduced for all three temporal frequencies whereas for the strabismic anisometropia group it was reduced at 3Hz only, suggesting the impairment in temporal synchrony might be different for different types of amblyopia.
pairs. SC was higher than NC, and its functional and temporal structures were quite similar to those of NC. Furthermore, the partial correlation analysis revealed that NC between a given pair of UVs was best predicted by their SC than by any other factors examined in the current study.

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O3-4, 10:00 am

Two types of crowding effects revealed by word inversion experiments

Chien-Chung Chen1(c3chen@ntu.edu.tw), Chien-Hui Tancy Kao2, Hsin-Hung Li2, 1National Taiwan University, Taiwan, 2RIKEN, Japan

Crowding refers to the phenomenon that the visual performance to a visual target deteriorates with the presence of nearby flankers. To investigate the mechanisms underlying crowding in object perception, we used Chinese characters as stimuli such that we can estimated the role of grouping and familiarity. The target was presented at 6 degree from the fixation. The flankers were placed to both sides of the target with a 1.5 degree center-to-center distance. The target and the flankers were either upright or inverted characters. When the target and the flankers were iso-orientation, in half of the trials, they might be combined into a compound character. The task of the observer was to decide whether the target is upright or inverted. Compared with the no flanker condition, the presence of the flankers reduced the percentage of correct response (accuracy) regardless the character type or orientation. The accuracy for the iso-orientation conditions was always higher than that for the aniso-orientation conditions. The result is the same regardless whether the target and the flankers can be grouped into a compound word, hence cannot be explained by the word superior effect. Our result suggests two types of flanker effects: The first is a general crowding effect that reduces the visibility of the target whenever a flanker is presented and may result from an early visual mechanism. The second is specific to character orientation and thus should be mediated by a mechanism that tuned to visual word forms.

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O3-5, 10:20 am

The effects of segmentation and spatial geometry on the tilt illusion

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In the tilt illusion, when the orientation of the center and surround gratings differ by a small angle, the center grating appears to tilt away from the surround orientation (repulsion); however, for a large difference in angle, the center appears to tilt towards the surround orientation (attraction). Orientation perception therefore depends strongly on the context. Changes in two-dimensional configuration or three-dimensional scene geometry may alter the segmentation features between the center and surround, and cause variations in central orientation perception. We first measured the effect of two sources of segmentation information, contrast and stereo disparity differences, on the strength of the tilt illusion in human observers. We observed: when the center contrast was high, both low-contrast surround and stereo depth segmentation cues reduced the amplitude of both the repulsion and attraction effect, relative to a high-contrast, 2D surround; a higher surround contrast (70%) relative to the center (10%) decreased the repulsion effect but increased both the range and magnitude of the attraction effect. Next, we examined the effect of perceptual grouping behind a 3D occluder ring between the center and surround on perceived central orientation. We observed significantly stronger tilt repulsion effects across occlusion than the condition with a ring at the same plane as the center and surround. We also found that the tilt repulsion is selective for the peripheral location of the surround. These results suggest that scene organization plays a role in central orientation perception.

Acknowledgement: NIH RO1 EY015621

O3-6, 10:40 am

Contextual influence on perceptual judgment is independent of the eye of origin of the contextual inputs: implications for extra-striate mechanisms

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Human observers judge whether there is a faint, foveal, horizontal target bar in a briefly presented stimulus. In some trials, there are task-irrelevant horizontal flanker bars extending horizontally, bilaterally, and collinearly from the target location. Zhaoping and Jingling (2008, PLoS Computational Biology 4:e14) found that low and high contrast flankers bias the perception, such that observers were more likely to see the target as present and absent respectively. This finding was understood from the framework of Bayesian inference, since the flanker contrast influences our brain’s internal likelihood function for the luminance contrast at the target location. In particular, a target is presumed more likely to produce (via noisy image formation) low or even zero image contrast when the flankers have low rather than high contrast, and therefore low contrast flankers tend to make perception fill-in the target even when it is absent. We extend the previous study using dichoptic presentation. Each stimulus bar is presented to one eye only; the eye of origins of the left set of the flankers, the right set of the flankers, and the target are randomly and independently chosen for each trial. Preliminary results show that the contextual influence on the perceptual bias is largely independent of the dichoptic condition, as long as the binocular alignment (assessed in a separate experiment) of the dichoptic stimuli is sufficiently adequate. Since there are few monocular neurons beyond the primary visual cortex, our finding implies that extra-striate cortices are largely responsible for the visual inference in our task.

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Saturday Posters

Object, Face and Body

Attention and Learning

P2-1 Visual short-term memory lacks sensitivity to stereoscopic depth changes but is much sensitive to monocular depth changes

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Depth from both binocular disparity and monocular depth cues presumably is one of most salient features that would characterize a variety of visual objects in our daily life. Therefore it is plausible to expect that human vision should be good at perceiving objects’ depth change arising from binocular disparities and monocular pictorial cues. However, what if the estimated depth needs to be remembered in visual short-term memory (VSTM) rather than just perceived? In a series of experiments, we asked participants to remember depth of items in an array at the beginning of each trial. A set of test items followed after the memory array, and the participants were asked to report if one of the items in the test array have changed its depth from the remembered items or not. The items would differ from each other in three different depth conditions: 1) stereoscopic depth under binocular disparity manipulations, 2) monocular depth under pictorial cue manipulations and 3) both stereoscopic and monocular depth. The accuracy of detecting depth change was substantially higher in the monocular condition than in the binocular condition, and the accuracy in the both-depth condition was moderately improved compared to the monocular condition. These results indicate that VSTM benefits more from monocular depth than stereoscopic depth, and further suggests that storage of depth information into VSTM would require both binocular and monocular information for its optimal memory performance.

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P2-2 Effects of color preview history on inter-trial inhibition of selective attention

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The distractor previewing effect (DPE) refers to the phenomenon that search times for target colors that were previewed (target preview or TP) in a preceding target-absent display (TAD) are slower than for distractor colors that were previewed (distractor preview, DP) in the TAD. The DPE is explained as attentional inhibition for the features associated with TADs. We investigated history effects of this inter-trial inhibition by manipulating color preview history and examined the DPE using RT and the N2pc (an electrophysiological index of attention allocation). The TAD, ranging from 0 to 2, was followed by a target-present display in which participants responded to the shape of a color-oddball. For the 2TADs, a single color (red or green) was repeated twice or the two colors were alternated, resulting in TTP, DDP, TDP, and DTP conditions depending on which color (target or distractor) in the search display was previewed. The 1TADs resulted in the TP and the DP, and the 0TADs comprised immediate search trials. RTs showed: (a) the TP was slower than the DP; (b) the TTP and DDP were slowest and fastest, respectively, and between these the DTP was slower than the TDP; (c) the TTP-DDP difference doubled the TP-DP difference due to the RT increase in the TTP. The conditions with slower RTs corresponded with late onsets and smaller amplitudes in the N2pc. These results suggest that effects of color preview history are cumulative with weight on more recent events and support the idea of inter-trial inhibition of target selection.

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P2-3 Visibility modulates the effect of spatial attention

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Recently, there is a growing interest in the relationship between spatial attention and consciousness. Since William James (1980 Principle of psychology, New York: Holt) emphasized the interconnection between attention and consciousness, they have been considered inseparable (Posner, 1994 PNAS). However, Koch and Tsuchiya (2007 Trends in Cognitive Sciences 11 16-22) suggested attention can be dissociated from consciousness, producing a state such as attention without consciousness. Previous studies supported this claim by showing attention can modulate the amount of adaptation from invisible stimuli (Bahrami et al., 2008 Perception 37 1520-1528; Shin et al, 2009 Attention, Perception & Psychophysics 71 1507-1513). However, these studies did not examine the interaction between attention and visibility. To investigate this, we measured the effect of attention on both visible and invisible stimuli that were attended simultaneously. Participants were adapted on two motion gratings which were presented to the dominant eye and thereby always visible, and on two tilted gratings presented invisibly to the corresponding locations of the opposite eye. Participants paid attention to one of the two locations by performing a contrast decrement detection task on one of the motion adapters during adaptation. We separately measured motion aftereffects (MAE) and tilt aftereffects (TAE) for both attended and unattended locations. Spatial attention increased the amount of MAE, but not that of TAE. These results suggest the effect of
spatial attention can vary depending on the visibility of stimuli, indicating the interaction between the two.

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P2-4 What is special about action video games for training visual cognition?
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Previous training studies (e.g., Green and Bavelier, 2003 Nature 423 534–7) link action video games (AVG) to improvements in visual cognition. However, specific components of AVG that result in these improvements remain undetermined. One possibility is that only near-transfer occurs because game-play demands closely resemble the cognitive behaviors tested. Alternatively, far-transfer may occur to cognitive behaviors not specifically trained. To test between these possibilities, 4 groups of participants played 4 different AVG for 20 hours. Games differed in speed, number of simultaneous items to-be-tracked, and attentional switching demands. Group 1’s AVG was similar to games in previous training studies with high speed and attentional demands, and multiple concurrent enemies (Modern Combat). Group 2’s AVG had lower object-tracking demands due to sequential instead of concurrent enemies (Metal Gear Solid Touch). Group 3’s AVG had slower speed by delaying counterattacks of enemies (Arcade Super Sniper). A fourth group played a hunting AVG that included target searching with no counterattacking enemies, and thus no speed, switching, or multiple object-tracking demands (Deer Hunter). Three tests of visual cognition - attentional blink, change detection and visual search, were administered before and after training. Attentional blink was reduced only in groups 1 and 2 whose training contained high-speed and attentional switch demands. Only Group 1, with training of attending to multiple simultaneous attackers improved change detection in multiple objects. All games contained visual search and thus all groups improved in visual search after training. Results support the near-transfer proposal for visual cognition improvement.

P2-5 Retrospective perceptual distortion of position representation does not lead to delayed localization
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Previous studies have reported retrospective influences of visual events occurring after a target event. In the attentional attraction effect, a task-irrelevant position cue presented after a target stimulus has been found to distort the perceived position of the target. The present study explored the temporal relationship between the stimulus presentation and speed of response in this effect, by measuring the reaction time in conditions with (or without) the cue presented before, at the same time, or after the target presentation. If the processing speed for the stimuli were equal, the time separation between the presentation of target and cue should lead to a delay in response time when compared with the condition where both stimuli are simultaneously presented. The results indicated no significant difference in reaction time for such comparison. As an interpretation of the results, the processing of the rapid dynamic attentional shift induced by the cue might be faster than that for the target localization, and completed before the establishment of conscious percept without affecting the overall response time.

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P2-6 Redundancy effects on Stroop interference
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Detecting flashes of light is faster when two light stimuli appear, one in each visual fields, than when just one stimulus appears in a visual field. This ‘redundancy gain’ phenomenon shows the cooperation of redundant signals for common task goal. Then, what if they are in the context of competition? Two perceptually identical objects might compete with each other as much as two different objects of a category. Alternatively, they might cooperate to form a stable, veridical representation. These conflicting possibilities were tested with three behavioral experiments. Experiment 1 and 2 used a name-picture Stroop task. In each trial, participants categorized a famous target name into that of an actor or a sports player while ignoring a flanking famous face distractor, which could be either congruent (e.g., an actor's name and face) or incongruent (e.g., an actor's name and a player's face). In redundancy condition, same face was added in the opposite side of the face distractor. As results, relative to a single distractor, Stroop interference was enhanced by two perceptually identical distractors. Importantly, this redundancy effect disappeared when two faces were the same at the response level, but different at the perceptual level. This effect was replicated with nonface objects in Experiment 3, which further showed that redundancy effect was not affected by time differential display of identical distractors. Overall, current study found a phenomenon of ‘redundancy loss’ and suggests that redundant presentation of a stimulus overcome attentional constraints by facilitating perceptual processing.

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P2-7 Encoding of graded changes in validity of spatial priors in human visual cortex
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If the spatial validity of prior information is varied systematically does human behavioral performance improve in a graded fashion, and if so, does visual cortex represent the probability directly? Cortical activity was measured with fMRI while subjects performed a contrast-discrimination task in which the spatial validity of a prior cue for target location was
systematically varied. Subjects viewed four sinusoidal gratings (randomized contrasts of 12.5%, 25% and 50%) shown in discrete visual quadrants presented twice. The contrast in one location (target) was incremented in one of the two presentations. Subjects reported with a button press which presentation contained the greater contrast. The target grating was signaled in advance by a cue which varied in spatial validity; at trial onset, small lines pointed to four, two, or one of the possible target locations, thus indicating the target with 25%, 50%, or 100% probability. Behavioral performance was 2.1 and 3.3 times better in the 100% probability condition than the 50% and 25%, respectively (p<0.001, ANOVA). Unlike behavioral performance, cortical activity in early visual areas showed the same increase in response amplitude for cued versus uncued stimuli for both 100% and 50% probability (V1-V4, V3A all p>0.18, Student's t-test, 25% had no uncued condition). How could behavioral performance improve in a graded fashion if cortical activity showed the same effect for different probabilities? A model of efficient selection in which V1 responses were pooled according to their magnitude rather than as a simple average explained the observations (AIC difference -15).

P2-8 Applications of the Magnocellular Advantage Model: Developmental Aspects of Dorsal Stream Processing
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Differential timing of the development of the dorsal and ventral visual streams is well accepted, with the latency of the M pathway to V1 not reaching adult levels 10 years of age (Crewther et al.1999. Electroencephalography and Clinical Neurophysiology, Supp, 49, 123-128). This could have major consequences for how children perceive and attend to the environment. Thus, how the later development of the dorsal visual stream impacts the transient visual processing abilities in children was investigated within a framework of the Magnocellular Advantage model of the mature visual system. Typically developing participants (N = 110) grouped as Younger Children (4-7 yrs), Older Children (10-13 yrs) and Adults (18-30 yrs), completed a series of customised computer motion and form coherence tasks designed to provide a functional measure of dorsal/ventral pathway performance. Dorsal involvement in a traditionally ventrally-dominated object-recognition task was achieved by biasing onset/offset conditions to preferentially stimulate the temporal characteristics of both pathways. Adults performed better than children on all tasks except motion coherence thresholds. A significant improvement in performance was seen between younger children and older groups on dorsal tasks (Motion Coherence and Navon Global Accuracy) but not on all ventral tasks (Form Coherence and Navon Local Exposure Time). Results support earlier psychophysical and electrophysiological investigations indicating that the dorsal stream matures later than the ventral stream. Therefore, in young children the underdeveloped dorsal visual pathway may rely more on slower ventral stream visual processing, which has important implications for the perception and attentional processing of transient events.

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P2-9 Spatial characteristics of visual attention estimated by SSVEP
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Visual attention is a function that selectively picks up some particular information to process among enormous visual information projected on the retina. We studied the spatial extent of visual attention by using a component of visual evoked potential called SSVEP (Steady-State Visual Evoked Potential). SSVEP is a sinusoidal modulations in the evoked potential induced by continuously flickering stimulus, which has the same temporal frequency as that of the stimulus. It has been reported that attending to one of the flickering stimuli modulates amplitude of the SSVEP of corresponding temporal frequency. We measured changes in the SSVEP amplitude at various distances from the focus of attention. We used eight stimuli that arranged equidistantly along a circle (diameter = 10.0 deg), centered at the fixation point. The stimuli flickered at different temporal frequencies, and changes in the amplitude of the SSVEP were measured. Subjects conducted a detection task at one of the eight stimulus locations while directing attention to a direction designated by a cue. We found clear peaks of SSVEPs corresponding to the temporal frequency of each stimulus. We also found modulations of SSVEP amplitudes by attention. The SSVEP amplitude declined gradually with the distance from the attention focus. These SSVEP measurements succeed to measure the spatial extent of visual attention across the visual field with an objective measure.

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P2-10 Salient local targets receive higher interference from collinear global distractors
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Salient items usually attract our attention in visual search. A target overlapping with a salient distractor should thus have benefit than that was non-overlapping. Nevertheless, we (Jingling & Tseng, in press) reported a special case that overlapping targets were more difficult to discriminate if the distractor formed a collinear global shape. One of the possibilities is that the target was not salient enough, making it subjective to interference from the global distractor. In this study we manipulated target salience by different levels of
luminance contrast and test whether a more salient target received less interference. The search display consisted of 576 gray elemental bars arranged in 21 rows x 27 columns against a dark background. One of the columns was filled by orthogonal bars, making it a salient distractor. The bars in the distractor could be vertical or horizontal, making it collinear or not, respectively. The subjects discriminated whether a target bar was brighter or darker. There were 4 luminance levels of the target bars. The target bar overlapped with the distractor at chance. We found that, discriminating overlapping targets took longer than non-overlapping targets for trials with vertical distractor, but shorter for that with horizontal distractor. Contradictory to our prediction, the interference was found especially when target contrast was higher. Our result argued against the possibility that collinear global distractor interfered with search because of non-salient target. This result highlights the importance of perceptual grouping in visual search, and perhaps grouping play a more important role than perceptual salience.

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P2-11 Attentional control setting did not alter the interference from global collinear distractor in visual search

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A salient item usually captures our attention in visual search. When a distractor is salient, it should help observers to find a target that was overlapping on it. However, in Jingling and Tseng (in press, Journal of Experimental Psychology: Human Perception and Performance, doi: 10.1037/a0027325), a target overlapping with a salient distractor took longer to discriminate than that was non-overlapped, if the salient distractor was grouped by collinearity. One of the reasons on prolonged responses for overlapping targets is that the collinear distractor did not contingent on the attentional control setting of task requirements. More specifically, the target was a broken bar, which might induce an attentional control setting on searching for discontinuity. Meanwhile, the distractor was grouped continuously, which was against the attentional control setting and generated interference to overlapping target. In this study, we modified the definition of the target and tested whether the interference preserved when the attentional control setting was not on discontinuity. The target was either a diamond or a square, and was either overlapping or not with the collinear salient distractor. Participants discriminate the shape of the target. The results replicated our previous study in that overlapping targets were harder to find. Our result argued against the possibility that the interference were induced by conflicts between the collinear distractor and the attentional control setting, implying that the interference might generated from earlier perceptual processing.

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P2-13 Location word cues' effect on location discrimination task: cross-modal study

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As well known, participants are slower and make more errors in responding the display color of an incongruent color word than a congruent. This traditional Stroop effect is often accounted for with relatively automatic and dominant word processing. Against that the word dominance account has been widely supported, it is not clear in what extent of perceptual tasks it is valid. Here we aimed to examine whether the word dominance effect is observed in location stroop task and in audio-visual situation. The participants were required to press a key according to the location of visual (Exp 1) and audio (Exp 2) targets, left or right, as soon as possible. A cue of written (Exp 1a and 2a) or spoken (Exp 1b and 2b) location word, “left” or “right”, was presented on left or right side to the fixation with cue lead times (CLT) of 200 and 1,200 ms. Reaction time from target presentation to key press was recorded as a dependent variable. As results, the location validity effect was marked in within-modality but less in cross-modality trials. The word validity effect was strong in within but not in cross-modality trials. The CLT leaded some effect of inhibition of return. So the word dominance could be less effective in location task and in cross-modal situation. The spatial correspondence seems to overcome the word effect.

P2-14 Noise Effect to Cross-Modality Stop Signal Task in Patients with Attention-Deficit / Hyperactivity Disorder

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Background: Response inhibition has been proposed as a core element of attention-deficit / hyperactivity disorder (ADHD). ADHD has two subtypes, the hyperactivity and combined subtype (ADHDcom) was considered to have more inhibition deficit while inattentive subtype (ADHDin) was not (Barkley, 1997). Stochastic resonant model proposed that noise exert a positive effect on cognitive performance for ADHD (Söderlund, et al., 2007). Current study addressed the issue of the facilitation/ interference effect of noise on patients with AD/HD by adopting a cross-modality stop-signal task. Method: The cross-modality stop signal task contained a visual discrimination task and auditory stop signal. Participants were asked to respond to the visual stimuli, and they were asked to withhold their response when the stop signal was presented (25% trials). The stop signal was a pure tone embedded background noise with various sound levels (no noise, 35dB, 55dB). Stop signal reaction time (SSRT) was estimated following Logan, et al., (1984) as an index for inhibition function. Result: The result revealed that the SSRT’s for ADHDcom were significantly longer than that of ADHDin. The noise did not improve inhibition performance; rather, an interference effect was evident for both subtypes of ADHD. Our result failed to support...
the finding of Söderlund et al. (2007).

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P2-15 EEG Analysis on Story Change in TV Drama
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Human brain naturally recognizes a change of environment or atmosphere without big effort and this is essential for interactive communication in a social life and specific reaction in an emergency situation. Most studies have investigated change detection of the brain with conditional experimental paradigms rather than the performance of everyday tasks. However, naturally-occurring sensory stimuli are multimodal and dynamic. In an effort to study the relationship between users’ induced physiological responses and changes of environment and atmosphere under more naturalistic and ecological conditions, we performed a basic experiment using audio-visual movies and electroencephalogram (EEG) measurement. Eight healthy subjects were asked to watch a television sitcom without any responses and their EEG signals were recorded simultaneously with 126 electrodes mounted in an elastic electrode cap. Time-frequency analysis of EEG revealed distinctive neural oscillations at the point of story change in the movie. This result could be used for applications in brain-computer interface, and provides a reference to cognitive impairment studies such as Attention Deficit Disorder (ADD) or Attention-Deficit/Hyperactivity Disorder (ADHD).

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P2-16 Dual-bound model and the role of time bound in perceptual decision making
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The diffusion model (DM) encapsulates the dynamics of perceptual decision within a ‘diffusion field’ that is defined by a basis with sensory-evidence (SE) and time vectors. At the core of the DM, it assumes that a decision is not made until an evidence particle drifts in the diffusion field and eventually hits one of the two pre-fixed bounds defined in the SE axis. This assumption dictates when and which choice is made by referring to when and which bound will be hit by the evidence particle. What if urgency pressures the decision system to make a choice even when the evidence particle has not yet hit the SE bound? Previous modeling attempts at coping with time pressure, despite differences in detail, all manipulated the coordinate of SE bounds. Here, we offer a novel solution by adopting another bound on the time axis. This ‘dual-bound’ model (DBM) posits that decisions can also be made when the evidence particle hits a time bound, which is determined on a trial-by-trial basis by a ‘perceived time interval’ – how long the system can stay in the ‘diffusion’ field. The classic single-bound model (SBM) exhibited systematic errors in predicting both the reaction time distributions and the time-varying bias in choice. Those errors were not corrected by previously proposed variants of the SBM until the time bound was introduced. The validity of the DBM was further supported by the strong across-individual correlation between observed precision of interval timing and the predicted trial-by-trial variability of the time bound.

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P2-17 Individual Differences in Dynamic Criterion Shifts during Perceptual Decision Making
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Perceptual decision-making involves placing an optimal criterion on the axis of encoded sensory evidence to maximize outcomes for choices. Optimal criterion setting becomes critical particularly when neural representations of sensory inputs are noisy and feedbacks for perceptual choices vary over time in an unpredictable manner. Here we monitored time courses of decision criteria that are adopted by human subjects while abruptly shifting the criterion of stochastic feedback to perceptual choices with certain amounts in an unpredictable direction and at an unpredictable point of time. Subjects viewed a brief (0.3 s), thin (.07 deg) annulus around the fixation and were forced to judge whether the annulus was smaller or larger than an unknown boundary. We estimated moment-to-moment criteria by fitting a cumulative Gaussian function to the data within a sliding window of trials that are locked to a shift in feedback criterion. Unpredictable shifts in feedback criterion successfully induced shifts in actual decision criterion towards an optimal criterion for many of subjects, but with time delay and amount of shifts varying across individual subjects. There were disproportionately more numbers of overshooters - reaching and then surpassing the optimal criterion required - than undershooters - subpar reach, with a significant anti-correlation with sensory sensitivity. To find a mechanism that generates these individual differences, we developed a dynamic criterion learning model by modifying a reinforcement learning model, which assumes that a criterion is adjusted every trial by a weighted discrepancy between actual and expected rewards.

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P2-18 Temporal and featural separation of memory items play little role for VSTM-based change detection
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Classic studies of visual short-term memory (VSTM) found that presenting memory items either sequentially or simultaneously does not affect recognition accuracy of the remembered items. Other studies also suggest that capacity of VSTM benefits from formation of bound object-based representations leading to no
cost of remembering multi-feature items. According to these ideas, we aimed to examine the role of temporal and featural separation of memory items in VSTM change detection, 1) if sample items are separated across different temporal moments and 2) if across different feature dimensions. In a series of change detection experiments, we asked participants to report a change between a sample and a test display with a brief delay in between. In experiment 1, the sample items were split into two sets with a different onset time. In experiment 2, the sample items were split across two different feature dimensions (e.g., half color and half orientation). The change detection accuracy in Experiment 1 showed no substantial drop when the memory items were separated into two onset groups compared to simultaneous onset. The accuracy did not drop either when the features of sample items were split across two different feature groups compared to when were not split. The results indicate that temporal and featural separation of VWM items does not play a significant role for VSTM-based change detection.

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P2-19 The effect of item repetition on item-context association depends on the prior exposure of items
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Previous studies have reported conflicting findings on whether item repetition has beneficial or detrimental effects on source memory. To reconcile such contradictions, we investigated whether the degree of pre-exposure of items can be a potential modulating factor. The experimental procedures spanned two consecutive days. On Day 1, participants were exposed to a set of unfamiliar faces. On Day 2, the same faces presented on the previous day were used again in half of the participants, whereas novel faces were used for the other half. Day 2 procedures consisted of three successive phases: item repetition, source association, and source memory test. In the item repetition phase, half of the face stimuli were repeatedly presented while participants were making male/female judgments. During the source association phase, both the repeated and the unrepeated faces appeared in one of the four locations on the screen. Finally, participants were tested on the location in which a given face was presented during the previous phase and reported the confidence of their memory. Source memory accuracy was measured as the percentage of correct non-guess trials. As results, we found a significant interaction between prior exposure and repetition. Repetition impaired source memory when the items had been pre-exposed on Day 1, while it led to greater accuracy in novel ones. These results show that pre-experimental exposure can modulate the effects of repetition on associative binding between an item and its contextual information, suggesting that pre-existing representation and novelty signal interact to form new episodic memory.

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P2-21 Searching for Multiple Targets using the iPad
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Search for multiple targets is constrained by both retrospective (i.e. where you’ve been) and prospective (i.e. where you’re planning to go) components of performance. Previous studies using the Multi-Item Localisation (MILO) task have demonstrated that participants accurately remember and discount locations they have already visited and that they plan future actions up to 2 or 3 items ahead (Thornton & Horowitz, 2004 Perception & Psychophysics 66 38-50). A prominent feature of the MILO serial-reaction time (SRT) function is a highly elevated, that is slowed, response, to T1 compared to T2 and all the other items. This “prospective gap” is typically between 600-1000 ms. Here we present three experiments that use the MILO iPad app to explore this “prospective gap”. In Experiment 1, we “shuffled” the position of future targets each time a response was made. This blocks planning and thus slows all responses to the level of first target, effectively eliminating the gap. In Experiment 2, participants responded to eight identical targets, removing the need to plan a specific sequence of actions. In this situation, absolute response time is greatly reduced and the T1-T2 gap shrinks to around 350 ms. In Experiment 3, participants repeated their search through the same array 10 times. Under these circumstances, the gap systematically reduced from 1300 ms on trial 1 to 300 ms on trial 10. Together, these results suggest that the previously observed prospective gap is a combination of set-up time for registering a new visual layout, response preparation, and sequence planning.

P2-22 Aging effects on the visual scanning of emotional faces
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This study investigated the effect of aging on the: accuracy of response, reaction time and visual scanning strategy, while emotional faces were viewed. Forty-three neurologically-healthy participants were assigned to either a young, middle, or older-aged group. Overall, older adults were significantly less accurate in recognising facial expressions, especially those demonstrating negative emotions. Further, the young and middle-aged adults took significantly less time to recognise an emotional face than the older adults. When assessing eye movements, it was noted that the older group generated a significantly greater number of fixations to the faces and spent more time overall in looking at the various facial features. Regardless of the emotional expression and participant age, all participants looked more frequently and for longer at the eye region, this was then followed by the nose and then mouth. The findings from this work support the existence of an age-related decline in emotion recognition. However, this study is the first to document...
reaction time differences in identifying facial affect across three different age groups. The eyes are the most important facial feature when identifying an emotional face and this holds true across the age ranges investigated in this work. In essence, when looking at emotional faces, middle and older-aged adults demonstrate a similar scanning pattern compared to their younger counterparts – they just take longer to do so. Therefore, the normal age-related decline in recognising facial affect appears not due to impairment in the way the eyes move to look at faces.

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P2-23 Deficits on preference but not attention in patients with depression: Evidence from gaze cue

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Gaze is an important social cue and can easily capture attention. Our preference judgment is biased by other’s gaze, that is, we prefer objects gazed by happy or neutral faces and dislike objects gazed by disgust faces. Since patients with depression have a negative bias in emotional perception, we hypothesized that they may have different preference judgment on the gazed objects than healthy controls. Twenty-one patients with major depressive disorder and 21 healthy age-matched controls completed an object categorization task and then rating their preference on those objects. In the categorization task, a schematic face either gazed toward or away from the to-be-categorized object. The results showed that both groups categorized faster for gazed objects than non-gazed objects, suggesting that patients did not have deficits on their attention to gaze cues. Nevertheless, healthy controls preferred gazed objects more than non-gazed objects, while patients did not have significant preference. Our result indicated that patients with depression have deficits on their social cognition rather than basic attentional mechanism.

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P2-24 Emotional contents of faces are not only determined by visual characteristics of facial features alone but also by what the features do stand for

Joo-Seok Hyun1(jshyun@cau.ac.kr), Hyung-Bum Park1, Youngseon Shin1; 1 Department of Psychology, Chung-Ang University, Korea

Emotional contents of faces would pose ambiguity when each facial feature varies in a subtle manner. Here we propose that such ambiguity may not solely arise from visual similarity in facial expressions but also from the way the expressions are interpreted in our daily life. In the present experiments, we asked participants to search for a target face with no facial expression (i.e., neutral) either 1) among a set of faces with smiles (i.e., pleasant) or 2) among faces with an angry frown (i.e., unpleasant). The face stimuli were either photographs taken from real faces or simple line drawings. The participants were asked to report target presence or absence as fast as possible. In the target-present trials, mean search response time was faster if distractors were all pleasant faces, whereas was rather delayed if the distractors were all unpleasant faces. Further, the overall response times in the target-absent trials were slower than the target-present trials, and the pattern of the delay was more evident if the distractors were all unpleasant faces than all pleasant faces. The results indicate that the neutral target face among unpleasant faces is difficult to be searched after whereas relatively easy among pleasant faces. The results also suggest that what determines emotional contents of faces is not only the visual similarity across facial expressions but also what the expressions do stand for in our daily life.

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P2-25 Love priming and perception bias

Hong Im Shin 1(shin7038@naver.com); 1Yonsei University

On the basis of previous research (Gasper and Clore, 2002 Psychological Science 14 34-40) showing that positive emotion like love facilitates global perception, two experiments were carried out to answer, whether the love priming always has a positive impact on global processing, and whether global versus local perception varies with the self-regulatory focus associated with love styles. In Experiment 1, participants were primed by either imagining a walk with a person they were in love with (love priming condition) or a walk alone (control condition). Then, they were shown large letters made of small letters and decided if either of two specific letters appeared on the screen. Compared to this, in Experiment 2, the participants had to do the letter task as in the previous experiment. In addition, they had to fill out the love style scales after the love priming trials. The results implicates that various love styles could be differentiated regarding to different goals which might have an impact on the self-regulatory focus in perception.

P2-26 Comparison between normal people and schizophrenic patients on face recognition

Yi-Woo Lee1(moabill@gmail.com), Woo Hyun Jung1; 1Chungbuk National University, Korea

This research was tested to compare face recognition of normal people and schizophrenic patients. Frontal male faces were used as stimuli, which were Northeast Asian and Southeast Asian. Normal people and patients with positive/negative symptom of schizophrenia participated in this research, and all participants were Korean. Participants were instructed to memorize a stimulus (target) presented briefly, and recognize it later among another stimuli (fillers). In recognition task, five faces were
presented with a target or without as fillers. The results showed that while schizophrenic patients had difficulty recognizing targets, all participants performed best in the condition of other ethnic target-own ethnic fillers. These results suggest that own ethnicity effect could not be observed, and imply that face processing of schizophrenic patients might be disrupted by perception level rather than memory level.

Acknowledgement: This work was supported by the National Research Foundation of Korea Grant funded by the Korean Government (NRF-2010-330-B00312).

P2-27 Electrophysiological correlates of conscious and unconscious processing of emotional faces in individuals with high and low autistic traits

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LeDoux (1996, The Emotional Brain) has suggested that subconscious presentation of fearful emotional information is relayed to the amygdala along rapid subcortical route. Rapid emotion processing is important because it alerts other parts of brain to emotionally salient information. It also produces immediate reflexive responses to threatening stimuli in comparison to slower conscious appraisal, what is of important adaptive survival values. Current theoretical models of autism spectrum disorders (ASD) have linked impairments in the processing of emotional information to amygdala dysfunction. It can be suggested that impairment in face processing found in autism may be the result of impaired rapid subconscious processing of emotional information which does not make faces socially salient. Previous studies examined subconscious processing of emotional stimuli with backward masking paradigms by using very brief presentation of emotional face stimuli proceeded by a mask. We used event-related potential (ERP) study within a backward masking paradigm with subjects with low and high autistic tendencies as measured by the Autism Spectrum Quotient (AQ) questionnaire. The time course of processing of fearful and happy facial expressions and an emotionally neutral face was investigated during subliminal (16 ms) and supraliminal (166ms) stimuli presentation. The task consisted of an explicit categorization of emotional and neutral faces. We looked at ERP components N2, P3a and also N170 for differences between subjects with low (<12) and high (>19) AQ.

P2-28 An amplification of feedback from facial muscles strengthened sympathetic activations to emotional facial cues

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The facial feedback hypothesis suggests that feedback from cutaneous and muscular afferents influences our emotions during the control of facial expressions. Enhanced facial expressiveness is correlated with an increase in autonomic arousal, and self-reported emotional experience, while limited facial expression attenuates these responses. The present study was aimed at investigating the difference in emotional response in imitated versus observed facial expressions. For this, we measured the facial electromyogram of the corrugator muscle as well as the skin conductance response (SCR) while participants were either imitating or simply observing emotional facial expressions. We found that participants produced significantly greater facial electromyogram activation during imitations compared to observations of angry faces. Similarly, they exhibited significantly greater SCR during imitations to angry faces compared to observations. An amplification of feedback from face muscles during imitation strengthened sympathetic activation to negative emotional cues. These findings suggest that manipulations of muscular feedback could modulate the bodily expression of emotion and perhaps also the emotional response itself.

P2-29 Comparing the other-race-effect and congenital Prosopagnosia using a three-experiment test battery

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Congenital prosopagnosia, an innate impairment in recognizing faces, as well as the other-race-effect, the disadvantage in recognizing faces of foreign races, both influence face recognition abilities. Here we compared both phenomena by testing three groups: German congenital prosopagnosics (cPs), unimpaired German and unimpaired South Korean participants (n=23 per group), on three tests with Caucasian faces. First we ran the Cambridge Face Memory Test (Duchaine & Nakayama, 2006 Neuropsychologia 44 576-585). Participants had to recognize Caucasian target faces in a 3AFC task. German controls performed better than Koreans (p=0.009) who performed better than prosopagnosics (p=0.0001). Variation of the individual performances was larger for cPs than for Koreans (p = 0.028). In the second experiment, participants rated the similarity of Caucasian faces (in-house 3D face-database) which differed parametrically in features or second order relations (configuration). We found differences between sensitivities to change type (featural or configural, p=0) and between groups (p=0.005) and an interaction between both factors (p = 0.019). During the third experiment, participants had to learn exemplars of artificial objects (greebles), natural objects (shells), and faces and recognize them among distractors. The results showed an interaction (p = 0.005) between stimulus type and participant group: cPs where better for non-face stimuli and worse for face stimuli than the other groups. Our results suggest that congenital prosopagnosia and the other-race-effect affect face perception in different ways. The broad range in performance for the cPs directs the focus of our future research towards looking for different forms of congenital prosopagnosia.

P2-30 Discrimination of facial expressions in patients with Parkinson's disease

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Besides movement disorder, patients with Parkinson disease (PD) are revealed to have non-motor deficits. To fast detect or discriminate emotion stimuli is the basic ability of a human, and this ability implies adaptive value. There were two purposes in this study. The first goal was to investigate the discrimination of facial expressions in PD. The second goal was to investigate whether the fast discrimination of facial expressions in PD related to the level of their motor severities. 28 PDs and 28 age-matched healthy controls were recruited in this study, and they were asked to discriminate between positive (happiness) and negative (sadness, fear, anger) faces. The results revealed that PD discriminated all faces longer than healthy controls did, and PD also had less accuracy in the condition of happy and sad faces compared with healthy controls. We had further analysis to separate PDs into two subgroups by the cut-off score “35” of UPDRS motor examination (part3). PDs with lower motor severity performed worse in the condition of sad faces than healthy controls did. Beside the deficits in perceiving negative emotions, the PDs with higher motor severity had dysfunctions in processing happy faces. We concluded that PDs had selective deficits in discriminating facial expressions, and this discriminating ability would be getting worse along with the progress of motor severity.

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P2-31 In-group advantage in negative facial expressions

Li-Chuan Hsu1(lchsu@mail.cmu.edu.tw), Chia-Yao Lin1, Yi-Min Tien2; ¹China Medical University, Taiwan, ²Chung Shan Medical University, Taiwan

To perceive facial expressions is suggested to be universal. However, studies have shown the in-group advantage (IGA) in recognition of facial expressions (e.g. Matsumoto, 1989; 1992) which is that people understand emotions more accurately when these emotions are expressed by members of their own culture group. A balanced design was used to investigate whether this IGA was showed in Western people and as well as in Asia people (Taiwanese). An emotional identification task was adopted to ask participants to identify positive (happy) and negative (sad, fear, and anger) faces among Eastern and Western faces. We used Eastern faces from Taiwanese Facial Expression Image Database (Chen, 2007) and Western faces from Ekman and Frisen (1979). Both reaction times and accuracies of performance were measured. Results showed that even all participants can identify positive and negative faces accurately; Asia participants responded significantly faster to negative Eastern faces than to negative Western faces. The similar IGA effect was also shown in Western participants. However, no such culture difference was found to positive faces. The results revealed the in-group advantage of the perception of facial expressions was specific to negative emotions and question the universality of perceiving facial expressions.

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P2-32 Influence of spatial frequency information on face gender with different expressions

Kuei-An Li1(n60213@hotmail.com), Li-Chuan Hsu1, Yi-Min Tien2; Pi-Chun Huang3; ¹China Medical University, Taiwan, ²Chung Shan Medical University, ³Department of Psychology, National Cheng Kung University, Taiwan

Visual image contains broadband information and is processed by different neural channels that are tuned to different spatial frequencies. Here we investigated whether or not our ability in gender identification on emotional faces was influenced by this early visual processing. Four types of emotional (happy, anger, sad and fear) faces were used and all of the stimuli were processed by spatial frequency analysis. Spatial frequency content in the original faces was filtered by using a high-pass filter (cut-off frequency was 24 cycles/image) for the HSF stimuli, and a low-pass filter (cut-off frequency was 6 cycles/image) for the LSF stimuli. Participants needed to identify the gender of the faces. The results showed that the participants responded faster and had higher accuracy to LSF faces than to HSF ones. They also responded faster and had higher accuracy to male faces than to female faces. Further analysis revealed that, the identification on anger man and happy woman had advantage among combinations of genders and emotions in LSF condition. However, this advantage was not manifested in HSF condition. We concluded that the identification of gender with different emotions may rely on the processing of low spatial frequency channel.

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P2-33 Influence of emotional context on memory: Déjà vu made me hesitate

Guei Gen Tsai1(p7362519@gmail.com), Li-Chuan Hsu1, Yi-Min Tien2; ¹China Medical University, Taiwan, ²Chung-Shan Medical University, Taiwan

People store emotionally charged information better than they do neutral one. This is called that emotional context enhanced memory. Here, we investigated the influence of emotional facial expression on memory. An emotional identification task (EIT) was adopted to ask participants to identify positive (happy) and negative (sad, fear, and anger) faces. Two versions (version A and version B) of faces randomly selected from Taiwanese Facial Expression Image Database (Chen and Yen, 2007 Taiwanese Facial Expression Image Database. [Online]. http://bml.ym.edu.tw/~download/html). Participants were also divided into two groups which are asked to receive pre-EIT with different versions respectively. After 8 weeks later, all participants received post-EIT with two versions of faces together which were presented under the order control of counter balance. The results showed there was no difference between two versions of faces in the pre-EIT. However, participants responded presented faces slower in post-EIT than they did in pre-EIT. After further analysis, we found the slower
Facial expressions are one of the most important means of nonverbal communication transporting both emotional and conversational content. For investigating this large space of expressions we recently developed a large database containing dynamic emotional and conversational expressions in Germany (MPI facial expression database). As facial expressions crucially depend on the cultural context, however, a similar resource is needed for studies outside of Germany. Here, we introduce and validate a new, extensive Korean facial expression database containing dynamic emotional and conversational information. 10 individuals performed 62 expressions following a method-acting protocol, in which each person was asked to imagine themselves in one of 62 corresponding everyday scenarios and to react accordingly. To validate this database, we conducted two experiments: 20 participants were asked to name the appropriate expression for each of the 62 everyday scenarios shown as text. 10 additional participants were asked to name each of the 62 expression videos from 10 actors in addition to rating its naturalness. All naming answers were then rated as valid or invalid. Scenario validation yielded 89% valid answers showing that the scenarios are effective in eliciting appropriate expressions. Video sequences were judged as natural with an average of 66% valid answers. This is an excellent result considering that videos were seen without any conversational context and that 62 expressions were to be recognized. These results validate our Korean database and, as they also parallel the German validation results, will enable detailed cross-cultural comparisons of the complex space of emotional and conversational expressions.

Acknowledgement: This research was supported by the World Class University (WCU) program through the National Research Foundation of Korea funded by the Ministry of Education, Science, and Technology (R31-1008-000-10008-0) and NRF grant (2010-0011569).

P2-36 Spatial frequency characteristics of Chinese character recognition in different complexity categories

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Objective: Human visual system is able to recognize objects in large complexity variation. Despite such capability, little is known about the effects of complexity on object recognition. Here we studied the spatial frequency (SF) characteristics in identifying Chinese characters (CCs) of different complexity levels. Method: Stimuli were 150 frequently-used CCs categorized into 3 complexity groups. Each character was digitally band-passed by 11 cosine log filters (bandwidth = 2 octaves, center frequency = 1.27 to 12.8 cycles/character in 0.1 log step). We measured contrast sensitivity for recognizing CCs of sizes 0.5°, 1°, and 2°. Peak SF (cycles/deg) and bandwidth (octaves) were plotted against character size in nominal character frequency (cycles/deg). A CSF ideal observer model (Chung et al, 2002 Vision Research 42 2137-2152) was formulated to examine whether early CSF filtering followed by template matching could explain human performance. Results: Log-log slopes of peak SF vs. size functions were 0.60±0.04 (M±SD), 0.67±0.02, and 0.72±0.05 for the low, medium and high complexity groups. Bandwidth of the tuning functions was...
P2-37 Processing affordance information from invisible tool images
Shinho Cho1(choxx305@umn.edu), Sheng He1; 1University of Minnesota, United States
A recent study showed that viewing manipulable objects such as images of tools induces the neural activation of posterior parietal areas. This neural activation is observed even when visual awareness of the image is visually suppressed. (Fang and He, 2005 Nature Neuroscience 10 1380-1385; Almeida et al, 2010 Psychological Science 21 772-778). However, the specific visuomotor information in tool images that drives the activation of dorsal areas is still unclear. We measured priming effect of invisible tool prime (left or right handed orientation). Observers distinguished the orientation of target tools (appropriate for left vs right handed grip) briefly presented following visually suppressed primes (Experiment1). Also we measured the suppression time of tool images whose handle direction was presented in a left- or right-handed orientation. A dynamic noise pattern was presented to one of the observer’s eyes at full contrast, while images of tools (left- or right handed) were simultaneously presented to the left or right visual field of the other eye. The subjects were asked to respond to the appearance of any partial or full part of the test image (Experiment2). Results showed that 1) observers responded faster in the congruent condition (the same orientation between prime and target) and 2) tool images shown in the right visual field took less time to gain dominance against the dynamic noise. These results suggest that even without overt recognition of presented tools, an object’s affordance can be registered and processed in the brain.
Acknowledgement: This research was supported by NSF grant BCS-0818588.

P2-38 What gives a face its race?
Wonmo Jung1(croquies@korea.ac.kr), Regine GM Armann1, Isabelle Bülthoff2; 1Korea University, Korea, 2Max Planck Institute for Biological Cybernetics, Germany
By biological criteria, human “races” do not exist (e.g., Cosmides et al., 2003). Nevertheless, everyday life and research from various fields show that we robustly and reliably perceive humans as belonging to different race groups. Here, we investigate the bases for our quick and easy judgments, by measuring the influence of manipulated facial features on race classification. Asian and Caucasian faces of our 3-dimensional face database (http://faces.kyb.tuebingen.mpg.de) were paired according to sex, age and overall appearance. With these Asian-Caucasian face pairs we created a variety of mixed-race faces, by exchanging facial features between both faces of a pair: eyes, nose, mouth, “outer” features, shape or texture. Original and modified faces were shown in a simple race classification task. We tested 24 Westerners (Germany) and 24 Easterners (South Korea). In both groups, eyes and texture were major determinants for race classification, followed by face shape, and then outer features, mouth, nose, which only had a weak influence on perceived face. Eastern participants classified Caucasian original faces better than Asian original faces, while Western participants were similarly good at classifying both races. Western participants - but not their Eastern counterparts - were less susceptible to eye, shape and texture manipulations in other-race faces than in their own-race faces. A closer look at the data suggests that this effect mainly originates from differences in processing male and female faces in Western participants only. Our results provide more evidence of differences between observers from different cultural and ethnic backgrounds in face perception and processing.
Acknowledgement: This study was supported by the Max Planck Society and the World Class University Program at Korea University
Form and Depth

July 14, 2:30 – 4:30 pm, Room 116-117

Oral session

Moderator: Christopher Taylor

04-1, 2:30 pm
The Visibility of Temporal Artifacts in Stereo 3D Displays
Joohwan Kim¹(imjoohwankim@gmail.com), Paul V. Johnson¹, Martin S. Banks¹; ¹UC Berkeley, US

The temporal protocols used in stereoscopic 3D (S3D) displays have many parameters that affect the visibility of temporal artifacts. Flicker is visible at low presentation rates. Motion artifacts—judder, edge banding, and edge blur—are salient at low capture rates. Different stereoscopic techniques can introduce distortions in apparent depth. For example, temporal interlacing (i.e., alternating presentation to the two eyes) can cause depth distortions for objects moving horizontally across the screen. Spatial interlacing (i.e., presenting information to the two eyes simultaneously, but with alternate pixel rows going to different eyes) avoids depth distortions, but causes a reduction in effect spatial resolution. We performed a psychophysical experiment to measure perceptual thresholds for three temporal artifacts in S3D displays: flicker, motion artifacts, and depth distortions. We used a stereoscope consisting of two CRTs running at 200Hz. A high-precision synchronizer drove the two CRTs thereby allowing us to simulate a wide variety of S3D display protocols accurately. We measured the visibility of the three artifacts while varying presentation rate, capture rate, object contrast, and object velocity. We tested both temporal- and spatial-interlacing protocols. From the results, we developed a perceptual model of artifact visibility in S3D displays.

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04-2, 2:50 pm
Centre-surround interactions in the aging system: effects of centre-surround contrast and stimulus duration
Allison McKendrick¹(allisonm@unimelb.edu.au), Renee Karas²; ²The University of Melbourne, Australia

The perceived contrast of a sinusoidal grating patch depends on its surrounding contrast. Normal aging alters these types of contrast related contextual effects, with older adults showing increased surround suppression relative to younger adults (Karas and McKendrick, 2009 Journal of Vision, 9.5.11). This study aimed to determine whether age related increases in surround suppression manifest for particular contrast conditions, or specific contrast ratios between centre and surround. We also varied stimulus duration to determine whether group differences could arise due to between-group differences in surround adaptation. Fifteen younger (20-30 years) and 15 older adults (65-79 years) participated. Center-surround contrast discrimination (the Chubb contrast illusion) was measured for a 0.67deg diameter circular patch of 4 c/deg grating, surrounded by a 4deg diameter annulus of grating of the same orientation, phase and spatial frequency. Nine contrast conditions were tested (all combinations of centre/surround for stimuli of 20%, 40% and 80% contrast) with a stimulus duration of 500ms. The 40% centre, 80% contrast surround was also tested with a stimulus duration of 100ms. Surround suppression was increased in the older group (F(1,28) = 6.88, p=0.01), particularly for low centre contrasts (interaction between group and centre contrast, p=0.01). Increased surround suppression was present for both 500ms and 100ms presentations (main effect of group F(1,26) = 10.78, p=0.01).

Acknowledgement: Australian Research Council FT0990930 (AMM)

04-3, 3:10 pm
Perceived blur is integrated locally in natural images
Christopher Taylor¹( christopher.taylor@schepens.harvard.edu), Peter J Bex¹; ¹Harvard Medical School, USA

Blur has been studied with isolated contours, but natural scenes are composed of occlusions at a range of depths giving rise to retinal images with broad distributions of blur. We have reported that observers are efficient at integrating wide distributions of blur with limited bias toward sharp or highly blurred elements in naturalistic, but highly controllable dead leaves patterns (Taylor and Bex, 2011 Journal of Vision 11(15),13). To extend these findings to natural scenes, we asked observers to match the local perceived blur in a natural image to the perceived blur in a dead leaves stimulus. The dead leaves patches had blurred five different levels of Gaussian blur (σ=2,4,8,16,64 cy/image) and the observers' traced regions in the natural image whose blur matched that of the dead leaves patch on each trial. We developed a measure of local blur to relate perceived blur in natural images to the Gaussian blur in dead leaves stimuli. We found that our measure in regions traced by observers correlated well with the image blur in the dead leaves patch, indicating that the measure of perceived blur captures how blur is perceived in natural scenes. Further analyses revealed that the skew and kurtosis of blur distributions in traced regions was not significantly different from a Gaussian distribution, indicating that observers do not rely on overly sharp/blurred regions to judge perceived blur. Thus, the distribution of local image blur, rather than the global image blur or the blur of single items, determines perceived optical and image quality.
Representation of shape is a fundamental problem in vision science. Neurophysiological studies of macaque have reported that neurons in the primary visual cortex (V1) respond to Medial Axis (MA) of 2D surface, and that those in higher cortex (IT) respond to surfaces of 3D shape. However, how the cortex translates a pair of 2D retinal images into 3D shape has not been clarified. In the present study, we investigated the problem of 3D shape representation in the cortices with the specific focus on the translation of 2D to 3D shape representation. Based on the neurophysiological evidence, we propose that a pair of 2D-MA that encodes 2D surfaces in V1 is fused to generate a 3D-MA that represents 3D shape in higher cortex. In order to investigate this hypothesis, we developed a computational model and analyzed its behavior. The model computes 2D-MAs from a pair of stereo images, detects the disparities of the 2D-MAs using an energy model that mimics V1 complex cells, and computes 3D-MA from the disparities between the 2D-MAs. Our model reconstructed successfully 3D shape from a number of objects including natural objects and those with complex structures. The results support our hypothesis that a pair of 2D-MA is computed independently in V1, and then 3D-MA that represent 3D shape is computed from the fusion of the 2D-MAs.

How does binocular disparity affect the impressions in viewing stereograms?

Makoto Ichikawa1(ichikawa@l.chiba-u.ac.jp), Daisuke Toya1; 1Yamaguchi University, Japan

We examined how the size of binocular disparity affects the impressions in different dimensions, as well as apparent depth, in viewing line-contoured stereograms, random dot stereogram, and stereoscopic pictures of naturalistic scene. We used semantic differential method with the scales that are related to the different dimensions of impression; evaluation, activity, and potency. The stereograms of naturalistic scene were selected to give observers strong or weak impressions in different impression dimensions. We prepared the two-depth-layer condition and six-depth-layer condition for those stereograms. The size of binocular disparity between the nearest and farthest layers ranged from 0 to about 70 min of arc. Apparent depth magnitude increased with the increment of disparity size for those stereograms while the increment for the six depth-layer condition was larger than that for the two depth-layer conditions. Regardless of the type of stereograms, for the six depth-layer condition, the rating for the evaluation increased with the size of disparity although, for the two-depth-layer condition, it did not increase at the large disparity size. In addition, the rating for the activity increased with disparity size for both the two depth-layer condition and six depth-layer conditions if the stereogram induces some active impression by itself. These results indicate that the effects of binocular disparity size on apparent depth magnitude and impressions in viewing stereoscopic pictures depend upon the depth structure that is specified by binocular disparity, rather than what the stereogram representationally depicts.
Object and Face

July 15, 9:00 – 11:00 am, Room 116-117

Oral session
Moderator: Takao Sato

05-1, 9:00 am
Cognitive functions influence lightness perception
Suncica Zdravkovic(szdravko@f.bg.ac.rs); 1University of Belgrade

Lightness research offers ample evidence that visual scene contains all the cues necessary to perform lightness calculations. In real life, contrary to laboratory findings, familiarity of the objects seems to be more important than the temporarily viewing conditions. In our experiment observers were led to believe that they see the same object moving from one illumination to the other. The estimated shade in the second illumination varied as a function of the shade in the first illumination. In the second experiment, object identity was stressed by the introduction of targets with distinct geometrical shape. Subjects were familiarized with these targets and under impression that those targets only targets used, even after illumination and background changed. Consequently, their matches corresponded to memorized and not viewed shade. In the third experiment observers were familiarized with two sets of targets. Only one set was used in the experiment, but twice, with different instructions. The targets were estimated based on the instruction mentioning the set from which the target presumably was taken. Nevertheless, imagery did not aid the process. When the observers were asked to keep imagining the gray shade they were previously observing, the lightness estimation depended exclusively on the factors presented in the visual scene. However, memory overpowers viewing condition. In the last experiment, observers were shown the same object in two illuminations simultaneously but were asked to estimate lightness when the object was removed from view. The value of this match-from-memory was in between the values for the two illumination levels.

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05-2, 9:20 am
Mona Lisa effect of eyes and face
Takao Sato¹(lsato@mail.ecc.u-tokyo.ac.jp), Kenchi Hosokawa¹;
¹University of Tokyo, Japan

A person depicted in portrait paintings does not appear slanted even when observers move around. The gaze is also fixed to the observer. This constancy in angle of face/body orientation or gaze direction is called Mona Lisa effect. Do observers realize the portrait was physically slanted when the effect occurs? What is the relationship between the effect for face/body and gaze? To answer these questions, we separately measured the perceived angle of face/body orientation or gaze direction while varying the physical slant of portrait itself. The stimulus was a computer generated face (19x12 deg) presented on a 3D LCD display. It was surrounded by 24x24 deg black-contour frame filled with a noise texture. There were also no-frame and/or no-texture conditions. The slant was varied between -30 deg. The observer was asked to judge the direction of gaze and the orientation of face or background in separate sessions. It was found that the perceived gaze almost always directed toward the observer regardless of slant angle or existence of frame or background. In contrast, the face orientation was judged facing to the observer for only in 40-50% trials and it was facing in correct angle in 50-60% trials. The background was perceived correctly in most trials. These results demonstrate special characteristics of eyes. The gaze is always directed to you even when the portrait was slanted and the background was perceived slanted. The face has intermediate characteristics, it is sometimes directed to you, but in sometimes it appears slanted. Acknowledgement: This study was supported grants-in-aid for scientific research from the Ministry of Education, Science, Sports and Culture for TS
Dissociating Face Identity and Facial Expression processing via Visual Adaptation

Hong Xu1(xuhong@ntu.edu.sg), Pan Liu1; 1Nanyang Technological University, Singapore

Face identity and facial expression are processed in two distinct neural pathways. However, most of the existing face adaptation literature studies them separately, despite the fact that they are two aspects from the same face. The current study conducted a systematic comparison between these two aspects by face adaptation, investigating how top- and bottom-half face parts contribute to the processing of face identity and facial expression. A real face (sad “Adam”) and its two size-equivalent face parts (top- and bottom-half) were used as the adaptor in separate conditions. For face identity adaptation, the test stimuli were generated by morphing Adam’s sad face with another person’s sad face (“Sam”). For facial expression adaptation, the test stimuli were created by morphing Adam’s sad face with his happy face. In each trial, after exposure to the adaptor, observers indicated the perceived face identity or facial expression of the following test face via a key press. They were also tested in a baseline condition without adaptation. Results show that top- and bottom-half face each generated a significant face identity aftereffect. However, the aftereffect by top-half face adaptation is much larger than bottom-half face. On the contrary, only bottom-half face generated a significant facial expression aftereffect. This dissociation of top- and bottom-half face adaptation suggests that face parts play different roles in face identity and facial expression. It thus provides further evidence for the distributed systems of face perception.

Acknowledgement: MOE AcRF Tier 1 (HX)

Do kids see what adults see despite a transient disadvantage?

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Adult models of visual processing, including our “Magnocellular Advantage Model”, assume the presence of feed-forward-feedback connections between V1 and V5. But if the magnocellular pathway and dorsal visual stream do not reach adult levels till about 10, how do young children see the world? Our electrophysiological and psychophysical evidence indicates a different developmental trajectory between the dorsal and ventral visual streams. Thus it is not clear what impact maturation of the dorsal visual stream has on object recognition, given its suggested role in activating bottom-up attention mechanisms, prior to ventral-stream processing. Young-children (aged 4-9), older-children (aged 10-13) and adults (aged 18-30) were compared on a number of measures traditionally associated with the dorsal-stream driven attention mechanisms, and several examples of traditionally ventrally-dominated object-recognition contrast-sensitivity tasks. Object presentation was modulated by abrupt (dorsal plus ventral) or ramped (ventral only) onset/offset conditions. A measure of the ‘transient advantage’ was determined as the difference between ramped and abrupt threshold scores. Results indicated a positive ‘transient-advantage’ (superior abrupt versus ramped performance) for older-children compared to a negative ‘transient-advantage’ in young-children. Interestingly, whilst adults outperformed both child groups in object-recognition performance, the transient-advantage was less than for older-children. These findings suggest that in young children an immature dorsal visual pathway may heighten reliance on ventral visual processing, and implies a reduced ability in directing attention to transient events and indicate the need for a new model of visual processing in young children.

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When the world changes in your hands: similarity ratings of objects morphing during active exploration

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View-based theories of object recognition posit that coherent object representations are formed by linking together successive views of an actively explored object. This linking process relies on the assumption that the object does not change during exploration. Here, we test how object representations might be influenced when the shape of the object changes slowly during exploration. In our experiment, participants rated the similarity of two novel, 3D objects, whose shape was parametrically defined. Seventeen participants explored each object for 10sec on an iPad which afforded natural and efficient interaction. The experiment contained a baseline condition, in which two objects of varying parameter-differences were presented, and a morphing condition, in which the first of the two objects slowly morphed during active exploration, making the objects more similar. Interestingly, no participant was aware of this morphing manipulation. Comparing baseline and morph trials, however, we found significantly higher similarity ratings during morphing (F(1,16)=84.79, p<0.001). Furthermore, correlations between similarity ratings and differences in object parameters were high for the baseline condition (r=.64), with smaller parameter differences being perceived as more similar. Interestingly, in the morphing condition correlations were lower for parameter differences after the morph (r=.22), but remained high for differences before (r=.47) and during morphing (r=.50). In conclusion, similarity ratings in the baseline condition captured the complex parameter space well. Although participants did not notice the changing shape, morphing did systematically bias the ratings. Interestingly, similarity judgments correlated better in the initial exploration phase, suggesting a capacity limit for view integration of complex shapes.

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Mapping the other-race-effect in face recognition using a three-experiment test battery

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The fact that people are better at recognizing faces of their own race than others is called the other-race-effect (ORE). Most studies use only a single test to map and determine the characteristics of the ORE, however. Here, we investigated how two groups of fifteen age-matched Korean and German participants recognize Asian and Caucasian faces with three experiments as part of testing a new battery for characterizing face-processing performance. Participants first underwent the standard Cambridge face memory test in which they had to learn Caucasian target faces at varying noise levels which then were to be recognized in a forced-choice task. In this task, German participants performed significantly better than Koreans (83% versus 72%). The second experiment used a standard old-new recognition task with 20 Caucasian and 20 Asian faces (courtesy of the tarrlab@CMU). Here, Koreans were better with Asian faces (d’-difference=1.23) whereas Germans only showed a tendency towards an ORE (d’-difference=0.44). In the third experiment, participants had to rate the similarity of Caucasian face pairs which varied parametrically along featural and configural dimensions using the morphable faces from the MPI face-database. Here, we found that Korean participants were significantly less sensitive to featural changes than German participants. In conclusion, we were able to demonstrate an ORE for most of our experimental conditions. Interestingly, data from the third experiment suggests that the ORE may be due more to lessened sensitivity to featural than to configural processing for other-race faces. Future studies will extend this new test battery to prosopagnosics.

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Eye and Brain
Grouping
Perception of Art
Object & Biological Motion

P3-1 Ophthalmologic factors influencing asthenopia with watching 3D displays
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Purpose: To identify ophthalmologic factors influencing asthenopia with watching 3D displays. Methods: 30 adult subjects without ophthalmologic abnormality watched the same 3D displays for 30 minutes. Each subject’s far and near visual acuity, near point of accommodation and convergence, amplitude of fusional convergence and divergence, stereopsis, angle of phoric deviation, tear breakup time and temperature of ocular surface before and after watching 3D displays were measured. And survey for subjective symptom right after watching 3D displays was done. The above-mentioned experiments were performed equally with 2D displays for detection of innate influence of 3D displays. Results: Near point of accommodation and convergence were significantly changed after watching 3D displays(p<0.05) compared to 2D displays. And all 10 subjective symptoms were significantly increased after watching 3D displays. (p<0.05) Conclusion: The accommodation and binocular vergence are predominant ophthalmologic factors that might influence asthenopia significantly with watching 3D displays. Subjective visual discomfort significantly increases with watching 3D displays, and more specific evaluation should be added for detecting the practically related factors with asthenopia. Acknowledgement: This research is supported by Ministry of Culture, Sports and Tourism (MCST) and Korea Creative Content Agency (KOCCA) in the Culture Technology (CT) Research & Development Program 2011.

P3-2 Brain activity correlated with visual discomfort during stereoscopic depth perception
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Stereoscopic depth perception is based on slight differences between two retinal images, which are mimicked by 3D displays. Within the range of binocular fusion, the magnitude of perceived depth increases with disparities. However, experiencing depth using 3D displays is often accompanied by visual discomfort. Despite of our understanding of the neural basis of stereosis, the relationship between binocular disparities and visual discomfort has seldom been explored. Here we report results from an fMRI study with implication for neural mechanisms underlying such relationship. We presented random dot stereograms (12 X 12°in visual angle) with 4 levels of interplane disparity (0°, 0.75°, 3°, and 5.25°in visual angle) dichoptically to the observer in the MR scanner. Following 4 secs of each stimulus presentation, the observer rated the magnitude of perceived depth and degree of visual discomfort. Behavioral results showed that the magnitude of perceived depth was the greatest at the interplane disparity of 0.75° followed by sharp decline, whereas the degree of visual discomfort continued to increase. fMRI results showed parametric modulation within the areas including middle occipital gyrus, IPL, precentral gyrus, and ACC as a function of interplane disparity. Among these areas, IPL, an area known to be related to visuomotor integration, was specifically associated with perceived depth, whereas ACC and inferior frontal gyrus were correlated more with visual discomfort. Our results suggest disparities exceeding the range of binocular fusion as a potential source for visual discomfort, which are reflected in the increased frontal activation.
Acknowledgement: This research is supported by Ministry of Culture, Sports and Tourism (MCST) and Korea Creative Content Agency (KOCCA) in the Culture Technology (CT) Research & Development Program 2011.

P3-3 Differences in EEG signals between the 3D and 2.5D Motion Pictures
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We measured and compared brain waves of the viewers watching the 2D, 2.5D, and 3D motion pictures. The relative α-band power of the 2.5D-viewers was lower than that of the 2D-viewers, while that of the 3D-viewers remained unchanged. This result implies visual neural processing of the 2.5D-viewers is different from that of the 3D-viewers.

P3-4 Binocular Visual Acuity in Exotropia
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Purpose: To investigate binocular interaction of visual acuity in patients with intermittent exotropia and its relationship with accommodative responses during binocular vision. Methods: Sixty-seven patients with intermittent exotropia of 8 years or older were included. Binocular visual acuity (BVA) and monocular visual acuity (MVA) were measured in sequence. Accommodative responses of both eyes were measured using the WAM-5500 autorefractor/keratometer (GrandSeiko, Fukuyma, Japan) during binocular and monocular viewing conditions at 6 meters. Accommodative responses during binocular vision were calculated using the difference between the refractive errors of binocular and monocular vision. Main Outcome Measures: Binocular interactions of visual acuity were
categorized as binocular summation, equivalency, or inhibition. The prevalence of the 3 patterns of binocular interaction was investigated. Accommodative responses were correlated with differences between BVA and better MVA. Results: Most patients (41 patients, 61.2%) showed binocular equivalency. Binocular inhibition and summation were noted in 6 (9.0%) and 20 (29.9%) patients, respectively. Linear regression analysis revealed a significant correlation between binocular interaction and accommodative responses during binocular vision (p < 0.001). Accommodative responses significantly correlated with the angle of exodeviation at distance (p = 0.002). Conclusions: In patients with intermittent exotropia, binocular inhibition is associated with increased accommodation and a larger angle of exodeviation, suggesting that accommodative convergence is a mechanism that maintains ocular alignment. Thus, BVA inhibition may be attributed to diminishing fusional control in patients with intermittent exotropia.

P3-5 Temporal interactions between binocular inputs in visual evoked-potentials
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The interaction between neural activity driven by inputs through the two eyes were examined using visual evoked-potentials (VEP) in normal human subjects. VEP recordings were obtained at the occipital electrodes using binocularly asynchronous pattern-reversal checkerboard stimuli: The pattern-reversal times for the two eyes differed by 0, +/-50, +/-150, or +/- 350 ms, with the positive stimulus-onset asynchrony (SOA) meaning that the right-eye reversal occurred first. For comparison, monocular VEP’s were also obtained using trial conditions where the checkerboard pattern-reversals were shown to only one eye, while a blank field to the other. The VEP’s of the various trial conditions were analyzed using both temporal and frequency analysis methods. Three observations were made: First, the N75 amplitude was significantly reduced in the +/- 50-ms SOA conditions. Second, on +/- 150-ms and 350-ms SOA conditions, a negative potential was observed over the period when the stimuli were binocularly incongruent. Third, the alpha-band power was reduced and the beta-band power increased on asynchronous conditions, compared to the synchronous pattern-reversal. These findings show that activities of binocular neurons in the visual cortices get modulated by binocular incongruity in the asynchronous pattern-reversal stimuli. Our stimuli may prove valuable in elucidating neural mechanisms of integration of binocular visual inputs, especially when combined with brain source-localization techniques and compared between normal subjects and patients with dysfunction in binocular vision.

P3-6 A method to estimate the pupil center from eye image
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Videooculography is an eye tracking method widely used in vision researches. The essence of videooculography is to estimate pupil center accurately, irrespective of drooping eyelids, eyelashes, corneal reflection, and non-uniform lighting. Commonly, eye image is binarized and the contour of pupil is extracted. Ellipse detection finds the center with a high degree of accuracy when the pupil outline is well obtained. In many practical applications, however, pupil is extracted with deflection and adjacent noise. The current study draws focus to devise a method of pupil center estimation for pupil outline image with deflection and noise. The method consists of three steps. It firstly takes noise out using Hough transform and then defect part by analyzing outliner of curvature of the contour. Hough transform is employed to find the center lastly. We compared the accuracy on finding the pupil center by least squares methods, Hough transform, and our method. 45 eye images were tested. The result indicates that mean error of least squares methods, Hough transform, and our method were 8.4, 6.5, 2.4 pixel.

P3-7 On prototyping a visual prosthesis system with artificial retina and optic nerve based on arrayed microfibers
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The traditional visual prosthesis system combines both a camera and a microelectrode array implanted on the visual neural network including retina, optic nerve, and visual cortex. Here, we introduce a new visual prosthesis system in which an artificial retina and optic nerve are demonstrated. The prototype of optic nerve for image transmission is comprised of arrayed PMMA microfibers with both ends connected with two planes, one functioned as retina for light reception and another attached to visual cortex. The microfibers are drawn from the thin film prepared by PMMA/chlorobenzene solution. Each micro fiber serves as an optical waveguide for the delivery of a single image pixel. It is demonstrated that with proper imaging optics, arrayed micro fibers could be lit as discrete light spots in accordance with the input image. Each micro fiber is expected to function as a stimulation unit for optical neural modulation in a visual prosthesis system.
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P3-8 Eye position distribution depending on head orientation in natural scene viewing
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We usually move our body and head as well as eyes in order to obtain information from visual environments. Although several studies reported the coordination between eye and head movements, most of them used simple stimuli and/or conditions. In this study, we investigated relationships between eye movements and head orientations while viewing natural scene images in a large size of screen. We measured participants’ eye positions and head orientations simultaneously during a natural
scene image viewing (each image subtended about 53° × 41°), in which the participant on a chair moved their head and eyes naturally for 5 seconds. We analyzed the eye- and head-movement data to obtain frequency distribution of eye position as a function of head orientation. The results showed a clear correlation between horizontal eye position and horizontal head orientation. When the head pointed to the left or right, the peak frequency of eye position shifted also to the left or right (relative to the head), respectively, and when the head was centered, the peak of the frequency distribution for the eye position was also centered in the head. These results are consistent with our previous study in which a visual search task was performed (visual search for "T" among "L"s). In contrast, no correlation was found between vertical direction between the eye positions and head orientations. These findings suggest that the mechanism of head-eye coordination may function only horizontally at least under the present condition.

P3-9 Roles of subthreshold LFP induced by receptive field surround for response modulation in monkey V1

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A focal stimulus outside the receptive field robustly induces LFP change, while the same stimulus evokes no spike activity. We determined how this subthreshold LFP change interacted with spike response to the RF stimulus. Specifically, we sequentially presented two identical Gabor stimuli with a variable stimulus onset asynchrony (SOA); the first one (S1) was presented outside RF inducing a subthreshold LFP change, and the second one (S2) was subsequently presented within RF generating a spiking response. This enabled us to manipulate the temporal relation between subthreshold LFP and evoked spike activity and to determine whether subthreshold LFP contributed to modulation of spike activity in a SOA-dependent manner. We found that the subthreshold LFP propagated a considerably long distance, estimated to be more than 10mm of cortical distance. The cross-correlation between the time course of subthreshold LFP and the pattern of SOA-dependency of spike activity was significant. These results indicate that signal integration is farther beyond the RF than previously estimated based on spike-triggered average, and suggest that subthreshold LFP modulate spike activity in a SOA-dependent manner.

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P3-10 Crossmodal perceptual grouping modulates subjective causality between action and outcome

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Agents have to determine which external events their action has causally produced. A sensation of causal relation between action and outcome is called subjective causality. Subjective causality has been linked to the comparator model. This model assumes that the brain compares an internal prediction for action outcome with an actual sensory outcome, distinguishing between self and externally produced outcomes depending on spatiotemporal congruency. However, recent studies have expressed some doubt about the idea that subjective causality arises depending solely on the spatiotemporal congruency, suggesting instead that other perceptual/cognitive factors play a critical role in determining subjective causality. We hypothesized that crossmodal grouping between action and outcome contributed to subjective causality. Crossmodal temporal grouping is an essential factor for crossmodal simultaneity judgments with ungrouped crossmodal signals likely to be judged as non-simultaneous. We predicted that subjective causality would decrease when an agent’s action was not temporally grouped with action outcome. In the experiment, observers were asked to press a key in order to trigger a display change with some temporal delay. To disrupt temporal grouping between action and outcome, a task-irrelevant visual flash or tone was sometimes presented synchronously with the button press and/or the display change. Subjective causality was decreased when the flash or the tone was coincided with the button press. This demonstrates that perceptual grouping has a key role in determination of subjective causality, a result that is not accounted for by the standard comparator model.

P3-11 Individual differences in the perception of biological motion and fragmented figures are not correlated.

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We live in a cluttered, dynamic visual environment that poses a problem: to perceive objects, the visual system must integrate information over space and time. Does a single, omnibus mechanism carry out this grouping operation, or does grouping depend on separate mechanisms each specialized for different feature aspects of the object? To address this question, we used a Quest procedure to measure thresholds for detecting static fragmented figures in noise and dynamic point-light biological motion figures in noise, in a large group of young adults. As expected, there were substantial individual differences in performance on both tasks, but correlation between the measures was not significant. These results imply that these two tasks rely on different integrative mechanisms, and it is tempting to think about those mechanisms in terms of the dorsal and ventral stream pathways.

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P3-13 Dynamics of unconscious contextual effects in orientation processing

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Contextual effects abound in the real world. A classic example of this is the tilt illusion that results in a target’s orientation appearing repelled from that of a surround. However the
opposite effect can also occur (the indirect tilt illusion) and the target’s orientation appears shifted towards that of the surround. These orientation biases are believed to result from different mechanisms with the indirect TI requiring input from higher cortical areas. We designed a novel reverse correlation technique to investigate this. The stimulus consisted of a concentric annular surround (outer diameter 7.8°) containing a 2cpd grating that could have one of 12 possible orientations abutting a circular patch (diameter 1.8°) where a vertical 2cpd grating was presented every 2 seconds. The surround was refreshed on each frame (11.7ms) and each orientation had an equal probability of being selected. The observers’ (n=5) task was to report after each target presentation whether it had appeared tilted clockwise or counterclockwise of a subjective vertical. All observers displayed a strong direct tilt illusion with this novel technique. In the majority of the observers (n=4) we also obtain an indirect tilt illusion. Both illusions occur reliably and over a similar time course (roughly ± 60ms around the time of target presentation) despite the lack of conscious access to the surround orientation. These results support the role of a single mechanism underlying orientation biases and refute the need for higher-level conscious processing of the context.

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P3-14 The cross-modal double flash illusion cannot be explained by interactions between primary sensory representations

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The cross-modal double flash illusion (DFI) refers to an interaction of multisensory signals wherein the presentation of a single visual flash accompanied by two cross-modal inducers, auditory or tactile pulses, results in observers reporting the presentation of two flashes. This phenomenon has become an exemplary case of the strong modulatory effect possible between cross-modal signals. However, it remains unclear precisely what about the different signals is interacting. The prevailing interpretation typically invokes interactions between different singular sensory representations - an explanation consistent with what would be expected in detection tasks. Here we investigated whether such a simple interaction could in fact account for the DFI. Using a paradigm similar to the original, we manipulated the apparent similarity of the cross-modal inducers such that they differed in attribute (1000 Hz pure tone or Gaussian noise) or modality (audio or tactile). When the inducer pair was the same, a DFI was found. However, if the inducer pair differed, the DFI was strongly mitigated, if not abolished. These results demonstrate that the DFI depends critically on the apparent similarity of the cross-modal inducers, something that wouldn’t matter if the illusion were based on direct interactions of discrete sensory representations. We propose that the DFI is the result of interactions between multi-event temporal structures, rather than discrete sensory events. These structures are determined through within-mode grouping and compared and combined supra-modally to generate event representations. This type of interaction likely underlies other multisensory timing phenomena such as temporal ventriloquism.

P3-15 Perceived 3D shape from motion for small and large perspective changes

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Studies of structure-from-motion have generally found that perceived depth from motion is not veridical and depends on speed. However, some recent studies have found that metric shape perception can be yielded by large perspective changes (Bingham and Lind, 2008 Perception & Psychophysics 70 524-540; Lee et al, 2008 Journal of Vision 8(6) 759a). We investigated the accuracy of metric shape judgments for varied amounts of perspective change, and whether amount of perspective change modulates the speed dependence of structure-from-motion. SFM stimuli were views of rotating elliptical cylinders with varied depth-to-width ratios (0.5-1.5) and with different slants in depth (top face: 60°, 70° or 80°). Objects were rotated around the normal axis by ±5°, 10°, 20° or 45°. The rotation was sinusoidal with peak speed of 15 °/s, 20°/s or 25°/s. We also tested a static-views control condition in which the same range of views was presented without continuous motion. We found that accuracy in the SFM conditions systemically increased with amount of change in perspective. With small perspective change, judgments showed overall underestimation of depth. Larger perspective change reduced these biases, and performance approached veridical. Judgments from static-views were much less accurate, indicating that the benefit from large perspective change is not due solely to the most extreme views. We found no effect of rotation speed even with small perspective change, contrary to expectations. Our results demonstrate that increasing perspective change can improve the accuracy of perceived 3D shape from motion, and that observers are capable of near-veridical metric judgments.

P3-16 Neural substrates of interval timing in the human brain

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A vast volume of psychophysical studies on interval timing (IT) point to its omnibus involvement in an extensive repertoire of sensory, executive and motor behaviors. This ubiquitous association of IT with other cognitive events makes it difficult to elucidate neural underpinnings of IT because neural responses pertaining to IT and those non-IT events are intimately intermingled. Recently, we developed an implicit interval timing (IT) task, in which subjects watched an object move at a constant speed and become invisible unpredictably, and guessed the arrival time of the invisible motion at a specified position. Capitalizing on the invisibility of the object that carries time intervals, we adapted this task to fMRI experiments to explore cortical mechanisms that substantiate IT in humans. We found that area MT and superior parietal region (SPR), which has been proposed as a human homologue of the macaque LIP, were
activated during the visible-motion period, consistent with their well-known responses to motion stimuli. Unlike MT, SPR remained active during the following invisible-motion period, along with other motor regions including putamen and cerebellum. The SPR’s sustained activity overarching the visible-motion, invisible-motion and motor periods may be construed as (i) the cortical activity of accessing the spatiotemporal information available in sensory or motor areas, (ii) the neural accumulation of elapsed time at timescale of seconds as suggested by the pacemaker-accumulator model, or, alternatively, (iii) a neural correlate of the hazard rate of ecologically relevant events, in line with previous findings in the primate brain.

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P3-17 Why is it difficult to see moving objects in the dusk? Visual motion priming reveals two motion mechanisms functioning under mesopic vision
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We know empirically that perception of moving objects deteriorates in the dusk. The purpose of this study is to reveal the reason of such sensitivity degradation under mesopic vision, when both cones and rods operate. For the purpose, we utilized a phenomenon called visual motion priming, in which the perceived direction of a directionally ambiguous test stimulus is influenced by the moving direction of a preceding priming stimulus. Participants judged the perceived direction of 180-deg phase-shifted, thus directionally ambiguous, sine-wave grating (test stimulus) followed by a smoothly drifting priming stimulus under three different retinal illumination levels; photopic, mesopic and scotopic levels, respectively. The spatial distance between priming and test stimuli was varied from 0 to 10 deg in visual angle. When the stimuli were high-contrast, the test stimulus was perceived to move in the same direction as the primer (positive priming) under photopic level, while the test stimulus was perceived to move in the opposite direction of the primer (negative priming) under scotopic level. Neither positive nor negative priming was observed under mesopic level. When the stimuli were low-contrast and spatially separated, however, only negative priming was observed regardless of the retinal illumination level. These results suggest that a higher-order motion system such as a feature-tracking mechanism is functioning to induce visual motion perception under photopic level, while a first-order center-surround motion system is functioning under scotopic level. We speculate that the concurrent activation of different motion mechanisms induces a degradation of motion sensitivity under mesopic vision.

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P3-19 Failure to extract velocity information from contours induces the footsteps illusion.
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When a black or white rectangle drifts horizontally across a background of black and white vertical stripes, the rectangle appears to stop and start as it crosses each stripe (the footsteps illusion; Anstis, 2001 Perception 30 785-794). Although previous studies indicate that confusion between contrast and velocity signals in the motion detectors or the spatial pattern of the background contribute to the footsteps illusion (e.g., Sunaga et al, 2008 Perception 37 902-914), it remains unclear which factor is critical. We hypothesize that the contour of the rectangle is significant to the footsteps illusion. A subjective experiment is conducted using modified rectangles, the contour of which were emphasized by adding contour lines, filling random dots inside, or putting illusory contour inducers on the four corners. Two kinds of rectangles were presented above and below central fixation simultaneously and the background strips were scrolled from right to left, or vice versa. Participants were asked which rectangle was perceived to drift more smoothly. The results demonstrate that the footsteps illusion is reduced when the rectangle’s contour is emphasized. Placing random dots inside the rectangle yielded a weaker illusion than the rectangle that was surrounded by lines. These results suggest
that humans perceive the velocity of moving objects (or background) based on the extracted contours which are constructed by integrating low spatial frequency information.

P3-20 Two and four stroke apparent motions can induce self-motion perception
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Visual stimulus which occupies large area of observer’s visual field and moves uniformly can induce illusory motion perception of the observer’s self-body in the direction opposite to its motion (vection). Psychophysical experiment with 11 observers was executed in order to examine whether two and four stroke apparent motions can induce vection or not. It has been known that two frames of visual pattern which are slightly shifted with each other can create impression of continuous motion toward designated direction, using luminance reversal pattern (Four stroke motion) or introducing brief blank inter-stimulus interval (Two stroke motion). Vection strengths measured by magnitude estimation were compared between conditions of the two and the four stroke motion, conventional apparent motion and original motion sequence with 60 Hz refresh rate (real motion). Experiment revealed that both the two and the four stroke motions can induce self-motion perception with considerable strength. The four stroke motion and the conventional apparent motion can induce self-motion perception as strong as the one induced by the real motion. The two stroke motion induced weaker vection than the four stroke motion or real motion, with least smoothness of motion among the conditions. The results suggested that observer’s perception of smoothness of the visual motion would affect strength of self-motion perception.

P3-21 Detection of focal points of hierarchical motion using point-light display
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Recent studies about mirror neurons suggest that many cognitive processes are based on information about body control extracted while viewing the motion of others. Although biological motion has been well studied in the field of vision science, the focus to date has not been on the extraction of information directly related to body control. In this study, we examined how efficiently people detect “focal points” of hierarchical motion, which seems closely related to body control. Focal points are the loci of the cause of shape change. For example, when we see an arm bending at the elbow, the focal point is the elbow although other parts, e.g., the wrist and fingers, actually move. Focal points directly indicate which joint or muscles you should control when you mimic the movement. In our experiment, each stimulus was composed of five points of light representing a four folded arm. We set two conditions of motion: reaching and bending. Participants were asked to detect the focal point of the motion. Angle noise was introduced to each joint movement. Results showed that the focal points were detected more correctly when they were closer to the root of the arm (the highest level of the hierarchical structure) for both conditions. Further, focal point detection was more vulnerable to angle noise during bending than during reaching. Variation in the degree of local motion is one of the possibilities to explain the observed differences between the two conditions.

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P3-22 Perception of emotion on object movement
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Previous studies showed that perceived animacy from object movement using simple figures (i.e., Heider & Simmel, 1944 American Journal of Psychology 57 243-259). Other studies using a single figure suggested that the complexity and animacy on the object movement operating change timing, change frequency and acceleration increased the preference to the object (Matsuda et al., 2010 8th Congress of the Japanese Society for Cognitive Psychology), showed that observers could estimate the common emotion from the simple object movement (Tomikawa & Oda, 2009 The Institute of Image Information and Television Engineers 33 1-4). The perception of emotion to the object movement might influence the increase of preference with perceiving animacy in Matsuda et al. (2010). This study examined the perception of the six basic emotions (Ekman & Freisen, 1975 Unmasking the face) on object movement using the paradigm in Matsuda et al. (2010). As a result, evaluation scores for “happiness” and “surprise” increased in high frequency condition and scores for “sad” increased in low frequency condition. This result seemed to affect the increase of preference to the object with complex movement in Matsuda et al.(2010). Evaluation scores for the emotion need to be subject feel it, such “anger”, “disgust” and “fear”, were low each conditions. Also, in comparison with other emotions, evaluation scores for “surprise” were similar to the scores for animacy in Matsuda et al. (2010). This result seems that the perception of “surprise” contributed the perception of animacy on a single object movement.

P3-23 Center/surround motion interactions measured using a nulling procedure
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Many direction-selective neurons have receptive field structure that promotes suppressive interactions between center and surround regions. These interactions sculpt the overall pattern of activity among those neurons and, therefore, presumably impact perceived direction of motion. To test this conjecture, we have assessed the effect of motion signals produced by a moving stimulus on perceived motion within a neighboring region. On
each trial a vertical bar (inducer) appeared at 8 eccentricity in the upper visual field, moving either leftward or rightward, and a circular shaped random dot kinematogram (test) appeared at 4 eccentricity. The test dots moved randomly except when the inducer passed nearby the test, at which time a pulse of coherent motion occurred in one of the two directions within the test. Coherence strength was adjusted by QUEST to maintain equal likelihood (point of subjective equality: PSE) of leftward and rightward reports of perceived direction during this motion pulse. The inducer caused a substantial shift in PSE: it was necessary for the test to contain 50% coherent motion in the same direction as that of the inducer to nullify the illusory motion within the test caused by the inducer. The effect of the inducer could also be offset by simultaneously presenting a second inducer moving in the opposite direction. This pattern of results implies substantial suppressive interactions between neighboring moving stimuli, interactions whose strength and direction can be assessed psychophysically using nulling procedures.

Acknowledgement: This work is supported by the WCU program through the National Research Foundation of Korea funded by the Ministry of Education, Science and Technology (R31-10089).

P3-24 Pre-Existing Brain States Predict Aesthetic Judgments
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Intuition and an assumption of basic rationality would suggest that people evaluate a stimulus on the basis of its properties and their underlying utility. However, various findings suggest that evaluations often depend not only on the thing evaluated, but also on a variety of contextual factors. Here we demonstrate a further departure from normative decision making: Aesthetic evaluations of abstract fractal art by human subjects were predicted with up to 75% accuracy by their brain states before the stimuli were presented. These predictions were based on cross-validation tests of pre-stimulus patterns of BOLD fMRI signals across a distributed network of regions in the frontal lobes. This predictive power did not simply reflect motor biases in favor of pressing a particular button. Our findings suggest that endogenous neural signals that exist before trial onset can bias people’s decisions when evaluating visual stimuli.

P3-25 Creativity in Drawing: The Role of Visual Perception in Postural Changes
Miho Nishizaki1(mnishiza@sd.tmu.ac.jp); 1Tokyo Metropolitan University

Drawing is a complex and uniquely human activity that involves motoric, perceptual, and conceptual processes. Realistic drawing usually requires several hours for depicting structure, texture, and shadow. This study, based on Gibson’s ecological approach, treated vision as perceptual systems (Gibson, 1966 The senses considered as perceptual systems) for purpose of understanding the process by which a realistic depiction is drawn on a surface. Two experiments examined the role of visual perception in drawing. Each task was performed under two typical conditions. In Experiment 1 (“vertical”), the participant, a skilled individual who had more than 7 years of experience with art, performed the drawing with an easel. In Experiment 2, (“horizontal”) this participant performed the drawing without an easel. The coordination of the actions that comprised the drawing process were examined according to the points at which shifts in behavior occurred. Observations revealed that perceptual–motor coordination can be classified into four basic patterns: (A) head and torso movements, (B) looking at objects, (C) depicting by hand, and (D) looking at the picture. The drawing process is characterized by transitions in the frequency and duration of combinations of these patterns. In particular, combinations including (A) influenced the results of both Experiment 1 and Experiment 2. Moreover, the combination of (A) and (D) was more frequent under the vertical than the horizontal condition. These findings suggest that the control of the looking-and-depicting seemed to be supported by flexibility in postural changes and in the direction of the drawing surface.

P3-26 The “perceptual novelty” and the education effect; a neuroaesthetic study
Eunae Lee1(hotta0420@gmail.com), Momo Kim1, Hyunju Lee1, Seungbok Lee1, Jungwoo Son1; 1Chungbuk National University, Korea

Recently, neuroaesthetic studies have focused on surrealism and abstract arts using techniques that reflect ‘perceptual novelty’ or ‘depayment’. These researches, however, did not control several factors that could elicit the ‘perceptual novelty’. This study was conducted to examine the changes of the brain activities when the participants appreciate the indoor pictures with only an object was magnified. Meanwhile, under the assumption that a brief education about the modern art could have an educational effect on the participants’ brain activities enjoying the perceptual novelty, the differences in their brain activities between the education group and the control group were compared. The stimuli were made by superimposing a photo of an object onto image of indoor background (24 images). Each stimulus was one of two conditions: ‘big-size object condition’, ‘normal-size object condition’. Participants were randomly divided into two groups and we briefed the education group on contemporary arts including the depayment. Using fMRI, all the 21 participants’ brain activities were measured while performing the following tasks: thinking about feelings elicited by the pictures of the two conditions, judging the pragmatic aspect about the pictures of the two conditions. Data on the brain images were acquired with ISOL 3.0T MR scanner, using an EPI sequence and analyzed using SPM8. The parametric analysis demonstrated the following areas were activated when education group thought about the feelings elicited by the ‘big-size object’ pictures: right parahippocampal area, which was related to memory, the right precentral gyrus, involved in self-agency or selfhood and basal ganglia, related to reward.

Acknowledgement: national research foundation of Korea
P3-27 Eye-movement of observers viewing implied motion in abstract paintings

Ji-Eun Kim1(blessedpond@gmail.com), Eun-Hye Shin1, Chai-Youn Kim1; 1Korea University, South Korea

Artists such as Duchamp and Balla tried to portray moving objects on static canvases by superimposing snapshots of moving objects. Previously, our group showed the influence of prior experience on brain responses within a motion-sensitive area MT+ to abstract paintings with or without implied motion (Kim and Blake, 2007 Spatial Vision 20 545-560). In the present study, we went further to investigate whether the differential MT+ activation between observers is originated from differential eye movement patterns. This hypothesis is not far-fetched since previous studies have shown that the way artistic experts view abstract paintings is different from that of naïve observers (Vogt and Magnussen, 2007 Perception 36 91-100).

Methods: 2 groups of observers (expert in art vs. naïve) were tested. 2 abstract paintings with implied motion (‘Nude descending a staircase No. 2’ & ‘Girl running on a balcony’), 2 abstract paintings without implied motion (‘Park bei Lu’ & ‘Composition No. II’), and 2 chronophotographs were presented for 5s. After each stimulus presentation while their eye movement was recorded, observers performed 1-back task.

Results: Experts, when viewing paintings with implied motion, tended to focus more on the parts of paintings portraying motion – e.g., head and feet of moving creatures – than did naïve observers. In addition, experts, unlike naïve observers, moved their eyes in the direction corresponding to the direction of moving objects in those paintings. Results imply that experts and naïve observers are different in terms of “where” and “how” they view abstract paintings with implied motion.

Acknowledgement: This work was supported by the National Research Foundation of Korea Grant funded by the Korean Government (NRF-2011-327-B00981)
Sunday Afternoon Talks

Motion

July 15, 2:30 – 4:30 pm, Room 116-117

Oral session
Moderator: Sang Wook Hong

O6-1, 2:30 pm  
**Perceived timing of different features at surface formation**

Daniel Linares¹(danilinares@gmail.com), Alex O Holcombe², Isamu Motoyoshi³, Shin’ya Nishida⁴; ¹NTT, Japan, ²University of Sydney, Australia

Different features of a stimulus, such as color, motion or orientation, are to some extent processed independently in the brain. It is not clear, however, whether a change within a feature is perceived with different delays for different features because different methods—temporal order, synchrony and pairing judgments—show conflicting results. Previous methods provide estimates of perceived timing that often are quite variable across trials and observers suggesting the involvement of high-level strategies. Here, we report a new method to measure the perceived timing of feature changes that shows low variability. When four pac-men are presented properly aligned above a background defined by some feature, the illusory surface that pac-men produce appears to be filled-in with the feature. We asked observers to report the feature value inside a briefly presented illusory surface when the feature in the background changed over time (Motoyoshi, 2007). We found that observers’ estimates are very precise for both continuous and discrete feature changes. For example, when a background changes motion repetitively between two discrete values (60 ms leftwards and 60 ms rightwards), observers can precisely report the motion direction filling-in an illusory surface presented for 60 ms. We propose that our method measures the perceived timing for different features at the level of surface formation.

O6-2, 2:50 pm  
**Relationship between orientation- and direction-selective responses in the human visual cortex**

Sang Wook Hong¹(shong6@ad.fau.edu), Frank Tong²; ¹Vanderbilt University, USA

Human visual system effectively processes the direction of motion, irrespective of the form that defines the motion. We investigated the neural basis of this form-invariant motion processing, by comparing cortical responses to moving gratings and random dot patterns using functional magnetic resonance imaging (fMRI) in conjunction with multivariate pattern classification. In the gratings experiment, observers viewed sinusoidal gratings moving in one of four possible directions, in which the spatial orientations of the gratings were perpendicular to the direction of motion. In separate fMRI runs, observers viewed random-dot patterns moving in the same for possible directions at 100% coherence, except here the spatial orientations, induced by motion streaks, were parallel to the direction of motion. We found that activity patterns throughout early visual areas V1 to MT+ could reliably discriminate the direction of motion defined by moving gratings and by random dot patterns, indicating that direction-selective neural responses are prevalent in all early visual areas. However, generalization analysis between two types of moving stimuli revealed that classification of BOLD activity patterns was more strongly influenced by the spatial orientation of stimuli than motion direction for early visual areas V1 and V2, and that motion-based classification was more prominent in relatively higher visual areas. These findings indicate that both orientation and direction information is preserved in all visual areas, and second, that patterns of BOLD activity are dominated by orientation-selective responses at early stages of visual processing and direction-selective responses become dominant at the later stages of visual processing.

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O6-3, 3:10 pm  
**Hic-et-nunc (here-and-now) encoding of a moving target for its saccadic foveation**

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The neural representation of a moving target undergoes a spatiotemporal “diffusion” while the associated retinal activity propagates toward the motor centers and recruits the appropriate muscles for its interception in the external world. Indeed, the divergent projections within the visual system and the transmissions of signals through multiple relays, with diverse conduction velocities and integration times, lead to activities that are spatially and temporally distributed across several brain regions. In spite of this neural “blurring”, accurate saccadic eye movements can be made to bring the image of a moving target onto the fovea. Such a performance indicates that the brain is able to rapidly estimate the current spatiotemporal coordinates of the target, at least at the time of saccade landing. We tested in the monkey the robustness of this estimate when a change in eye position and a delay are experimentally added before the animal launches a saccade toward a moving target and in the absence of visual feedback. These spatiotemporal perturbations were induced by a brief microstimulation in the deep superior colliculus. The results show that the interceptive saccades can remain accurate and relatively independent of the time taken to react and to foveate the target. We propose that the brain builds an estimate of the expected and current spatiotemporal (hic-et-
nunc) coordinates of the target and that this signal feeds the same local feedback loop as the mechanism proposed for guiding saccades toward a stationary target (Fleuriet and Goffart, 2012 Journal of Neuroscience 32 452-461).

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O6-4, 3:30 pm

Visual perception of object motion during self-motion does not depend on heading perception

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Recent studies have suggested that the visual system subtracts the optic flow pattern experienced during self-motion from the projected retinal motion of the environment to recover object motion, a phenomenon called “flow parsing”. In this experiment we tested whether the flow parsing process depends on heading perception, or only on the motion signals in optic flow. Two displays (83°x83°, 500ms) simulated an observer approaching a frontal plane that was composed of randomly placed dots or randomly placed dot pairs that formed a radial Glass pattern. The center of this radial Glass pattern was 10° away from the focus of expansion of the flow pattern. The radial Glass pattern allowed us to manipulate the perceived heading without affecting the motion input. For both displays, a probe dot moved upward on the frontal plane at 5° away from fixation. A horizontal component (along the world X-axis) under control of an adaptive staircase was added to the probe dot’s vertical motion on the plane to determine when the probe motion was perceived as vertical. Heading perception was measured with a separate display containing the Glass pattern but no probe dot. We found that while the presence of the Glass pattern significantly biased the heading perception of eight participants, it did not affect the probe dot’s perceived movement direction. We conclude that flow parsing is independent from heading perception and operates directly on the global motion information.

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O6-5, 3:50 pm

The relationship between pursuit eye movements and perception during binocular rivalry

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It has recently been shown that action-percept congruency plays a role in binocular rivalry, a form of bistable perception that occurs when incompatible images are presented to the two eyes. Here, we investigated the degree to which smooth-pursuit eye movements can bias perceptual competition. In the first experiment, observers pursued a horizontally oscillating dot that was superimposed on rivalrous, leftward and rightward drifting gratings. Perceptual dominance was consistently biased in the direction of smooth-pursuit and tended to switch when pursuit direction switched. The strength of this relationship increased with speed, especially when the pursuit speed matched the grating speed. In a second experiment, we investigated the interaction between pursuit and intentional control on rivalry dynamics. Relative to non-volitional viewing, percept-pursuit coupling was weakened when observers were instructed to selectively maintain one percept or to mismatch their percept with pursuit. However, instructions to match percept with pursuit did not further increase the strength of coupling. Our results contribute to converging evidence that self-generated actions can influence perception. We have provided insight into how this affects binocular rivalry, by showing that percept-pursuit coupling can be suppressed at the observer’s will.

O6-6, 4:10 pm

Curved apparent motion initiated by a causal launch

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When objects collide, observers perceive not only the motion but also causal relations, such as which objects caused which others to move. The present study investigated whether such causal interpretations can influence the perceived path of apparent motion. We presented a display of two alternately flashing motion tokens on the ends of a semicircular occluder, and two additional “context objects” placed immediately above the tokens moved upward at each token onset. In such a display the motion token was seen as moving along the curved path behind the occluder, deviating from the default shortest straight path. This finding suggested that observers spontaneously attributed the vertical displacement of the context object to collision by the motion token, which affected the percept of the path of the colliding token. To rule out a potential alternative explanation based on motion priming, a subsequent experiment tested new displays in which the spatial or temporal pattern of context events was altered in ways that preserved or strengthened motion priming, but weakened the causal interpretation. We found that curved apparent motion was observed far more often when it was consistent with a causal launch than when it was not, regardless of priming, suggesting that curved motion is indeed induced by the causal interpretation placed on the collision. In sum, our results suggest that perceived causality is not merely a summary interpretation imposed upon motions already determined by perceptual processes, but rather may make a fundamental contribution to the disambiguation of the underlying sensory signal itself.

Acknowledgement: This work was supported in part by NIH (NEI) EY021494.
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