


Eye Movement and Reading Laboratory
Department of Psychology, National Chengchi University

眼動研究的認知基礎與應用

國立政治大學心理學系

蔡介立 (Jie-Li Tsai)



眼動與閱讀實驗室
EYE MOVEMENT AND READING LABORATORY
DEPARTMENT OF PSYCHOLOGY, NATIONAL CHENGCHI UNIVERSITY

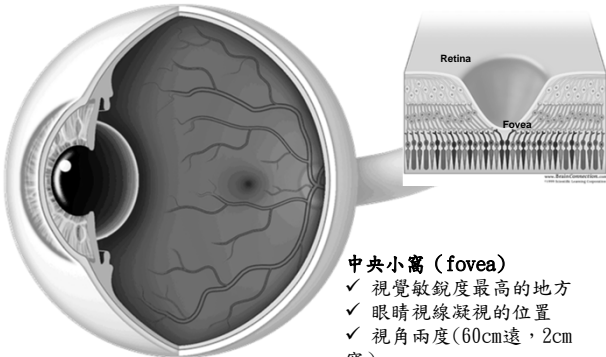
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Overview

- Eye movements and Cognition
 - Why do the eyes move?
 - Tracking eye movements
 - Factors affecting eye movements
 - Analyzing eye movements
- Some research fields applying the eye-tracking technique
 - Language processing
 - Eye-hand coordination

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Why the eyes move ?




中央小窩 (fovea)

- ✓ 視覺敏銳度最高的地方
- ✓ 眼睛視線凝視的位置
- ✓ 視角兩度(60cm遠, 2cm寬)

www.BrainConnection.com

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Change blindness



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動動眼，看的更清楚



- ✓ Visual acuity
- ✓ Attentional resource
- ✓ Spatial memory

(科學人・2007.09)

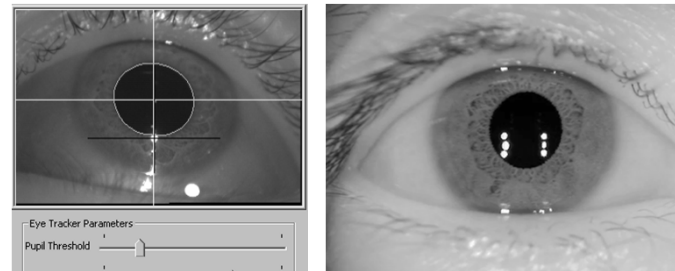
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The eye tracking systems



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Detecting pupil and corneal reflection



Eye Tracker Parameters

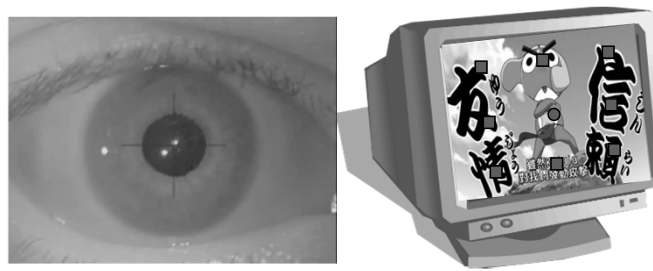
Pupil Threshold

CR Threshold

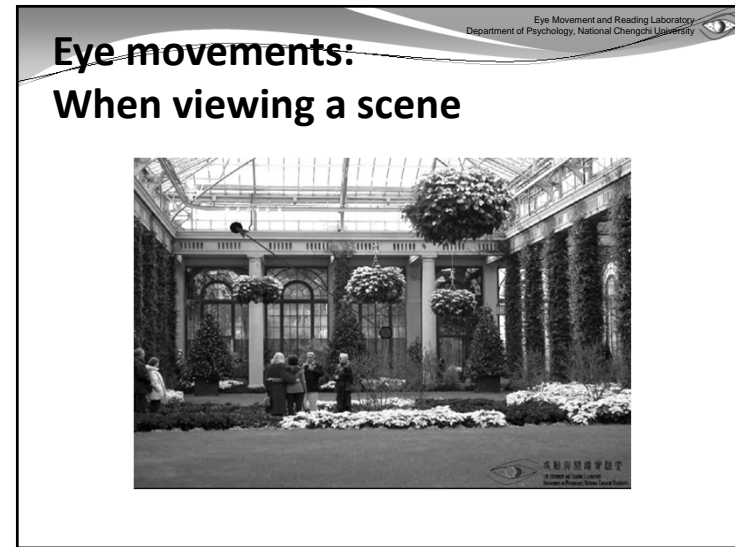
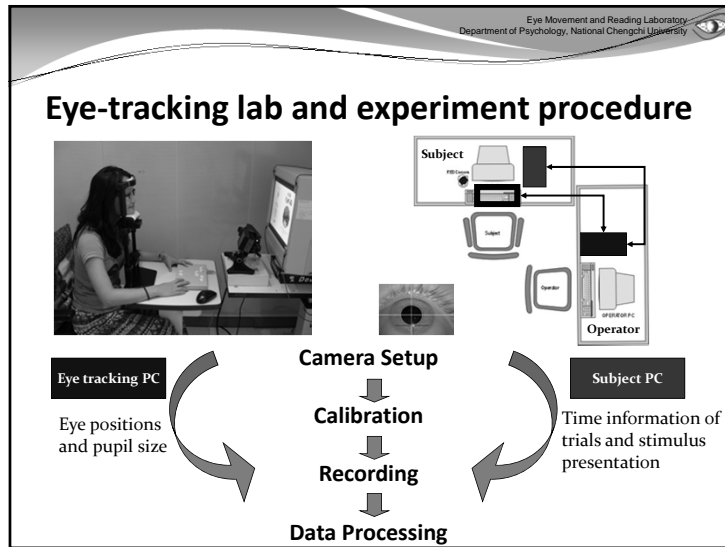
Display AOI Dynamic Thresholding Advanced

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Calibration



Mapping eye movements to eye fixation locations



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Cognitive operation and eye movements

- Eye movements are driven by
 - The demands of a task in the spatial and temporal dimensions

- Eye movements are affected by
 - Stimulus features
 - Goal
 - Task/Context
 - Strategies

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Reading the mind in the eyes

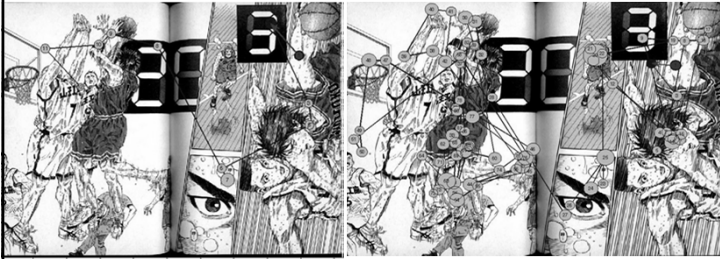
1. Free examination
2. Estimate the material circumstances
3. Give the ages of the people
4. Surmise what the family had been doing before the visitor arrivals
5. Remember the clothes worn by the people
6. Remember the position of the people and objects in the room.
7. Estimate how long the visitor had been way from the family

(Yarbus, 1967)

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Preference and motivation

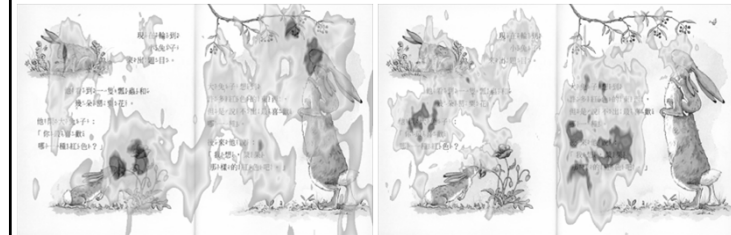
Female Male



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Preference and reading skill

Kindergartener First grade

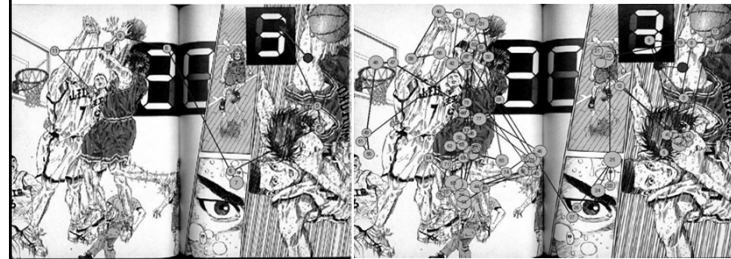


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Analyzing Eye Movements

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Analysis without AOI



- Mean fixation duration, Total viewing Time
- Mean saccade length

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Fixational map

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Analysis with AOIs

re-reading
fixation
skipping
regress out

下雨的時候，外公會拿著拐杖慢慢走到學校接我回家。

拿著拐杖慢慢

拿著拐杖慢慢

- FFD(first fixation duration): ①
- GD(gaze duration): ① + ②
- TVD(total viewing duration): ① + ② + ④
- SFD(single fixation duration): ③

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Analysis with AOIs

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Analysis with AOIs

AI Chongchi University
& Reading Laboratory
眼動與閱讀實驗室

people Research Publications

我的研究，是在原鄉的土地上，向有著歷史的痕，而對遠東的人，我忽然會渴望也能夠遠出原鄉的繁榮，然而，它總伴隨著「不從以確的，是從從華研空去社社，雖然生活在中國南方，我與也這見

Jie-Li, Tsai, (蔡介立) Ph.D.
jtsai@nccu.edu.tw

Sequence	Entry time	Exit time	Hit ratio	Reversions	Average fixation	First fixation	Fixation count
AOI 003	497 ms	1118 ms (22%)	1/1 (100%)	1/1	212 ms	106 ms	0
AOI 004	11	890 ms	154 ms (2%)	1/1 (100%)	154 ms	154 ms	1
AOI 005	10	795 ms	68 ms (1%)	1/1 (100%)	68 ms	68 ms	1
AOI 007	4	2039 ms	478 ms (23%)	1/1 (100%)	143 ms	138 ms	3

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AOIs change along the timeline

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Eye movements: when reading a passage

演一個很重要的角色；婦女出門會在手絹上噴一點
，男士刮完鬍子也會抹一些，小孩被蚊蟲咬傷，大
人會在他紅腫的地方擦幾滴明星花露水，保證立刻
消腫。如今國外名牌化妝品大肆入境，綠色瓶裝的

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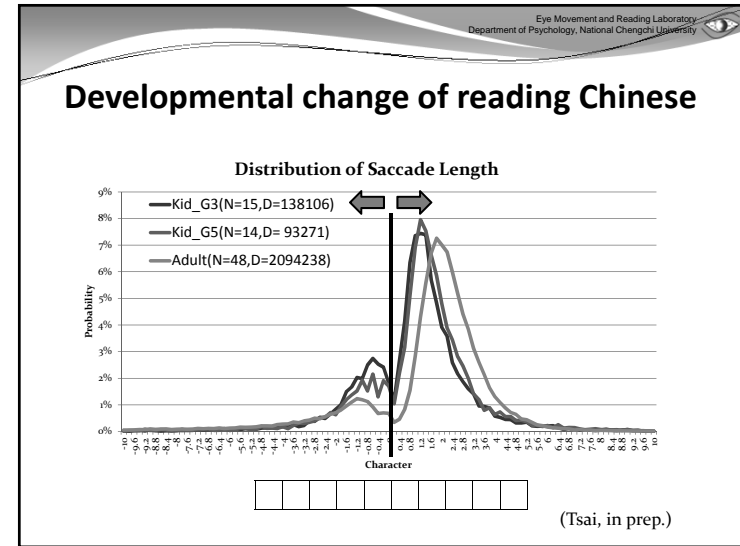
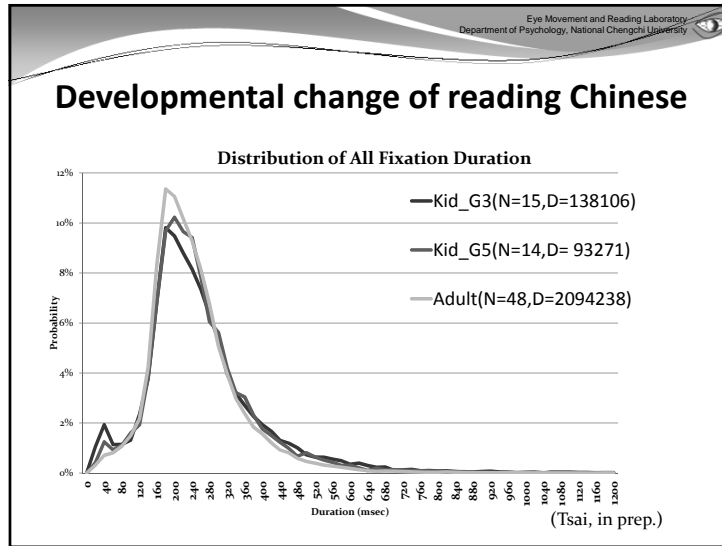
Eye movement control and reading

地球暖化問題日趨嚴重，節約能源成為全人類的重要課題

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Basic characteristics in reading

- Sequence of fixations and saccades, not moving smoothly.
- Each fixation lasts about 250 msec, with intra- and inter-reader variability.
- Each saccade lasts about 20-40 msec and the saccade length is 2-3 Chinese characters (7-9 English letters) in average.
- Processing all words but not fixating every word, some are skipped
- About 10 to 15% of regressive saccades to reprocess earlier words



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Perceptual span and parafovea preview

地球暖化問題日趨嚴重，節約能源成為全人類的重要課題

- Perceptual span
 - A limit number of characters can be perceived and processed in a fixation
 - Chinese: 1L3R (characters); English 3-4L 14-15R (letters)
 - Asymmetric to the right side
- Parafoveal preview
 - A word which was parafoveally previewed on F_{n-1} could be foveally processed again in F_n .
 - Integration of currently fixated word with its preview is necessary.

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Eye movement research in reading

- Factors affecting eye movements
 - Perceptual
 - Lexical
 - Contextual
- Multiple eye movement indices reflecting processing difficulty in details
 - Global measures
 - Local measures
 - Regressive behaviors
 - Temporal sequence

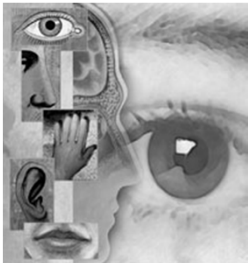
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Some language issues

- Chinese syntactic processing
 - The Role of Semantics in Syntactic Processing: Eye-tracking Experiments of Reading Chinese Relative Clauses (呂翠屏, 政大語言所碩士論文, 2010)
- Chinese semantic ambiguity resolution
 - The Influence of Contextual Predictability on Processing Chinese Polysemy (高佩如, 政大語言所碩士論文, 2011)
 - Revisiting the Subordinate Bias Effect of Lexical Ambiguity Resolution (盧怡璇, 政大語言所碩士論文, 準備中)
- Shared picture-book reading (K & G1)
 - 成人共讀策略對兒童繪本閱讀理解之影響 (張雅嵐, 政大幼教所碩士論文, 2011)
- Sight translation
 - Tracking Eye Movements in Sight Translation: the Comprehension Process in Interpreting (黃致潔, 師大翻譯所碩士論文, 2011)
- Spoken word recognition

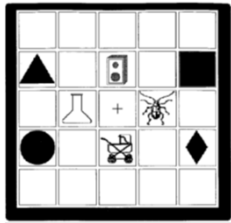
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Seeing, Listening, and Speaking

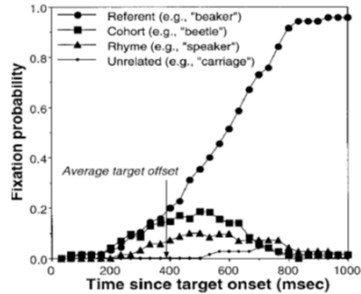


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Visual World Paradigm



(Allopenna, et al., 1998)

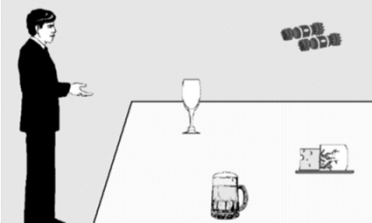


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Language-mediated anticipatory eye movements

(Altmann & Kamide, 2007)

- The man will drink the beer.
- The man has drunk the wine.

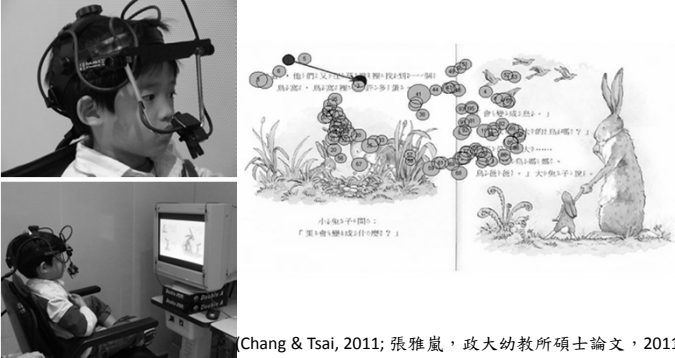


Object:	Beer		Wine glass	
	will drink	has drunk	will drink	has drunk
At onset of 'will/has'	.16	.13	.10	.11
At onset of 'the wine/beer'	.32	.26	.16	.25

Proportions are shown at two positions within the sentence: at the onset of the auxiliary verb and at the onset of the sentence-final referring expression.

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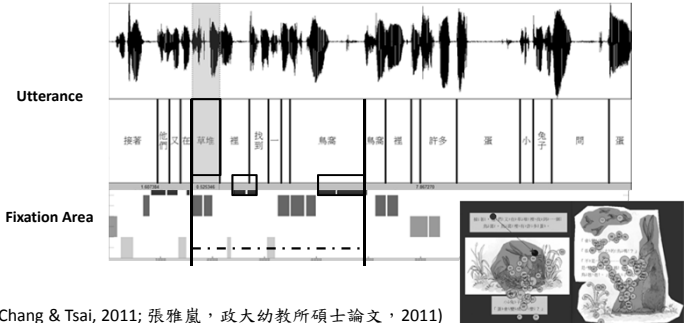
互動策略對學前兒童繪本理解的影響 兒童閱讀繪本的凝視軌跡



Chang & Tsai, 2011; 張雅嵐, 政大幼教所碩士論文, 2011

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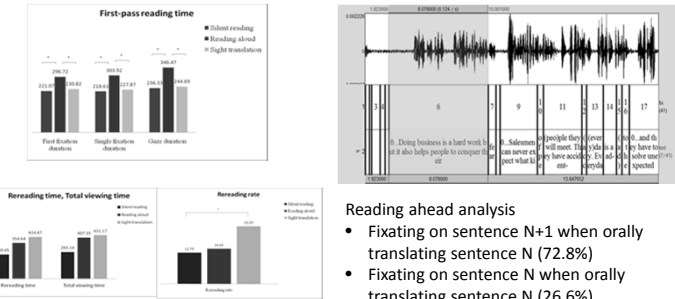
Seeing cooperates with listening



(Chang & Tsai, 2011; 張雅嵐, 政大幼教所碩士論文, 2011)

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Translation and Interpretation: The locus of reformulation in sight translation



First-pass reading time

Condition	First Fixation	Single Fixation	Clear Fixation
Silent reading	238.72	239.82	238.72
Reading aloud	238.72	239.82	238.72
Sight translation	238.72	239.82	238.72

Reading ahead analysis

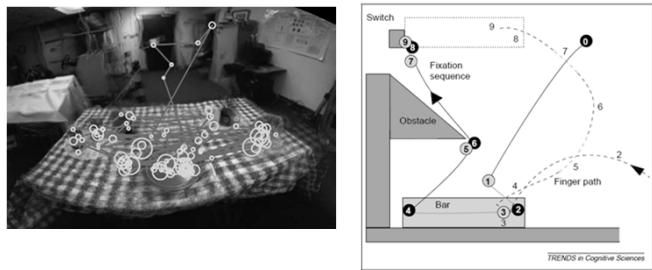
- Fixating on sentence N+1 when orally translating sentence N (72.8%)
- Fixating on sentence N when orally translating sentence N (26.6%)
- no oral production (0.6%)

(Huang, Tsai, & Chen, 2011; 黃致潔, 師大翻譯所碩士論文)

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Eye-hand coordination

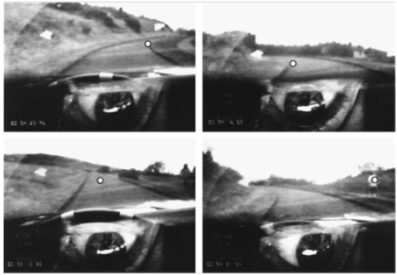
- Fixations are tightly linked *in time* to the evolution of the task
- Eye-hand coordination: just-in-time strategy



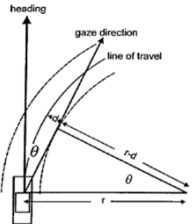
(Hayhoe & Ballard, 2005)

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Driving: Steering on winding roads



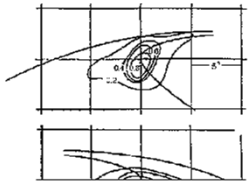
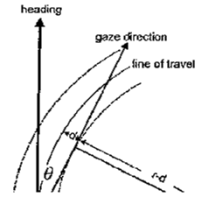
Gazed: the tangent points
(the up-coming band)



(Land, 1998)

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Driving: Steering on winding roads

- gaze direction and steering wheel angle are very similar
- gaze direction precedes steering wheel angle by about 0.8s

(Land & Lee, 1994; Land, 1998)

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The linking Assumptions

- Seeing is tightly linked to cognition
 - Computation
 - Constraint
- Cognition coordinates seeing in time with
 - Listening
 - Speaking
 - Action (hands, head, body)
- Seeing is ahead of action
 - Anchoring
 - Anticipation

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Thank you !



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<http://emrlab.nccu.edu.tw>