Chinese Journal of
Applied Psychology
2017. Vol. 23. No. 2 99 – 109

2017 23 2 99 – 109

*

1** 2 3 4 5

1.

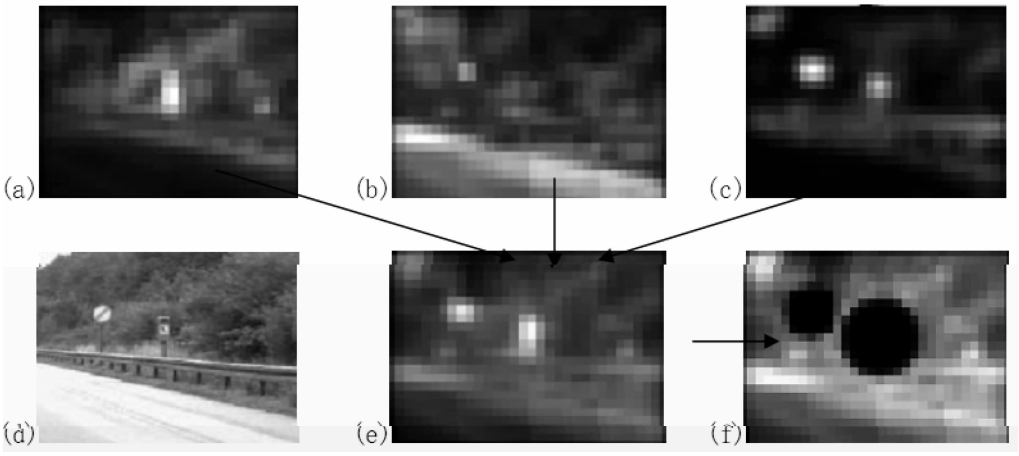
stimulus-driven mechanism, ˜ ˜
˜ ظم ˝ق شمخ يمم ,
ئح ن ˜ شمخ لحم
˝ bottom-up attention, и
˝ transient attention,
˝ exogenous attention, й تى ˜
ن
يحي й
شمخ شمخ
مم ˜ ظ ˝ frontal eye
field˜ FEF, и ل مى ˝ dorsomedial pre-
frontal cortex˜ DMPFC, и مى ˝ later
prefrontal cortex˜ LPFC, и ضر نح˝ ante-
rior cingulate cortex˜ ACC, и ضحي ˝ posterior
parietal cortex˜ PPC, и ضحي ˝ intraparietal
sulcus˜ IPS, ضحي – ضحي ˝ fronto-
parietal attentional network, ˝ de-
fault network, ˝ Baluch & Itti˜ 2011 ;Botvinick
et al.˜ 2001 ;Bush et al.˜ 2000 ;Kastner &
Ungereider˜ 2000 ;Noudoost et al.˜ 2010 ;Ser-
ences & Yantis˜ 2006 ;Swisher et al.˜ 2007 ;
Zhang et al.˜ 2016, й ˜ ي
˜
شمخ
˝ Jonides˜ 1981 ;Nakayama &
Mackeben˜ 1989, й William James كم
محج لحم и شمخ
ذ ˜ شجي لحم и
и и и и ضحى и
и ˜ شخ شي شمخ
й ˜ مم شمخ
شي й

2

2.1

تم ظم تمخ ˜ تم
ظم ˝ salient, ˜ تم ظم
لحم й ˝ sali-

ency, شمخ ظم شخ ئؤ شد
شمخ ئي يخ й شمخ ظم
˜ شمخ أه
˝ Niebur & Koch˜ 1998 ;Olshausen et al.˜
1993 ;Tsotsos et al.˜ 1995, й Koch Ullman
˝ 1985, كم˜
شمخ لحم
ئؤ شخ ˜وسلم
شمخ كم Treisman كا ˝ شمخ شمخ
فمح master map˜ Treisman˜ 1988, й
˜ تم ج حي شمخ
شمخ أه ىى تج
شمخ طمم حى ˜
شمخ й
كم 1998, ˝ ضحى Itti ˜ مم حى
شمخ شمخ شمخ
˝ 1, й
شمخ وسلم صح 9 سمم شجي
˜ и и كم ئي
˜صمم شمخ وسلم صمم
سمم شجي شمخ وسلم صح وسلم
˝ centre-sur- يخ – صمم˜
round differencing, سمم شجي ئي شمخ
شمخ ظم ˜وسلم
شمخ وسلم صح c يخ – й
˝ и وسلم كاا , نم سمم
وسلم صح c – 1˜ وسلم صح c – 1
سمم شجي صمم й سمم شجي محج
ظم ˜ 6 صمم وسلم ˜ 12
سمم شجي Gabor كا كا
24 طح й 42
أه تج
˜ شمخ طح winner-take-all ч
يحي شمخ ˜ تج حى بخ
˝ inhibition of re-
turn, ˝ Klein˜ 2000, ˜ ظم يحي تمخ
˜ شمخ
شمخ ن نه بخ شمخ



1

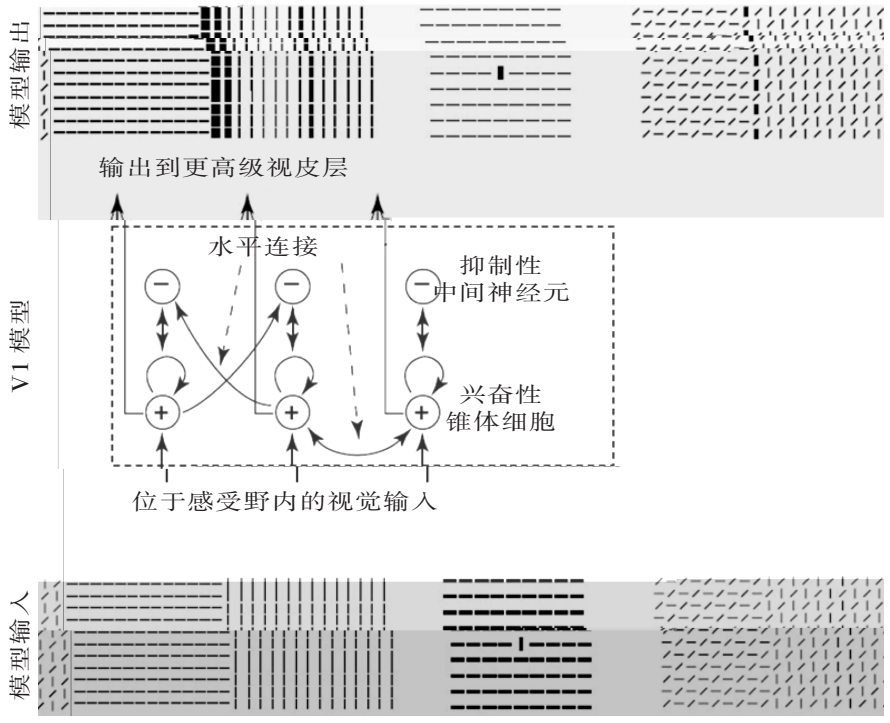
1 a, b, c, d, e, f

Itti et al., 1998

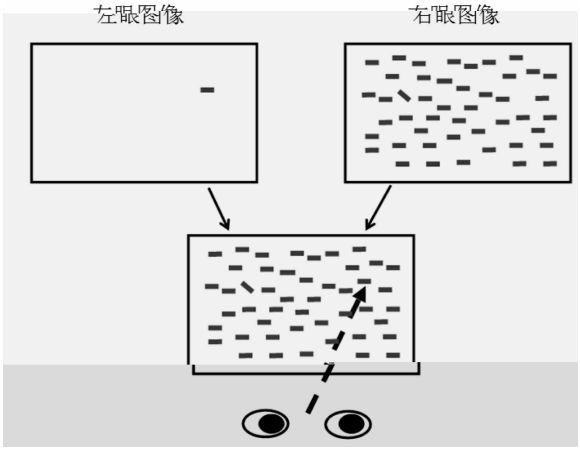
Itti, 1998, Itti & Koch, 2001; Koch & Ullman, 1985; Wolfe, 1994, V1, superior colliculus; Fecteau & Munoz, 2006; Kustov & Robinson, 1996, pulvinar; Shipp, 2004, parietal cortex; Bisley & Goldberg, 2010; Bogler et al., 2011; Geng & Mangun, 2009; Gottlieb et al., 1998; Serences et al., 2005, V4; Mazer & Gallant, 2003, FEF; Serences & Yantis, 2007; Thompson & Bichot, 2005, PFC; Katsuki & Constantinidis, 2012,

2.2 V1

V1 Allman et al., 1985; Gilbert & Wiesel, 1983; Rockland & Lund, 1983, Li, 1999, 2002, V1, Shipp, 2004, V1 pop-out, 2,


模型输出
输出到更高级视皮层
水平连接
抑制性
中间神经元
V1 模型
兴奋性
锥体细胞
位于感受野内的视觉输入
模型输入

2



3

Zhaoping 2008

2.3

V1

V1

V1

Itti et al. 1998

Li 1999 2002

Bisley et al.

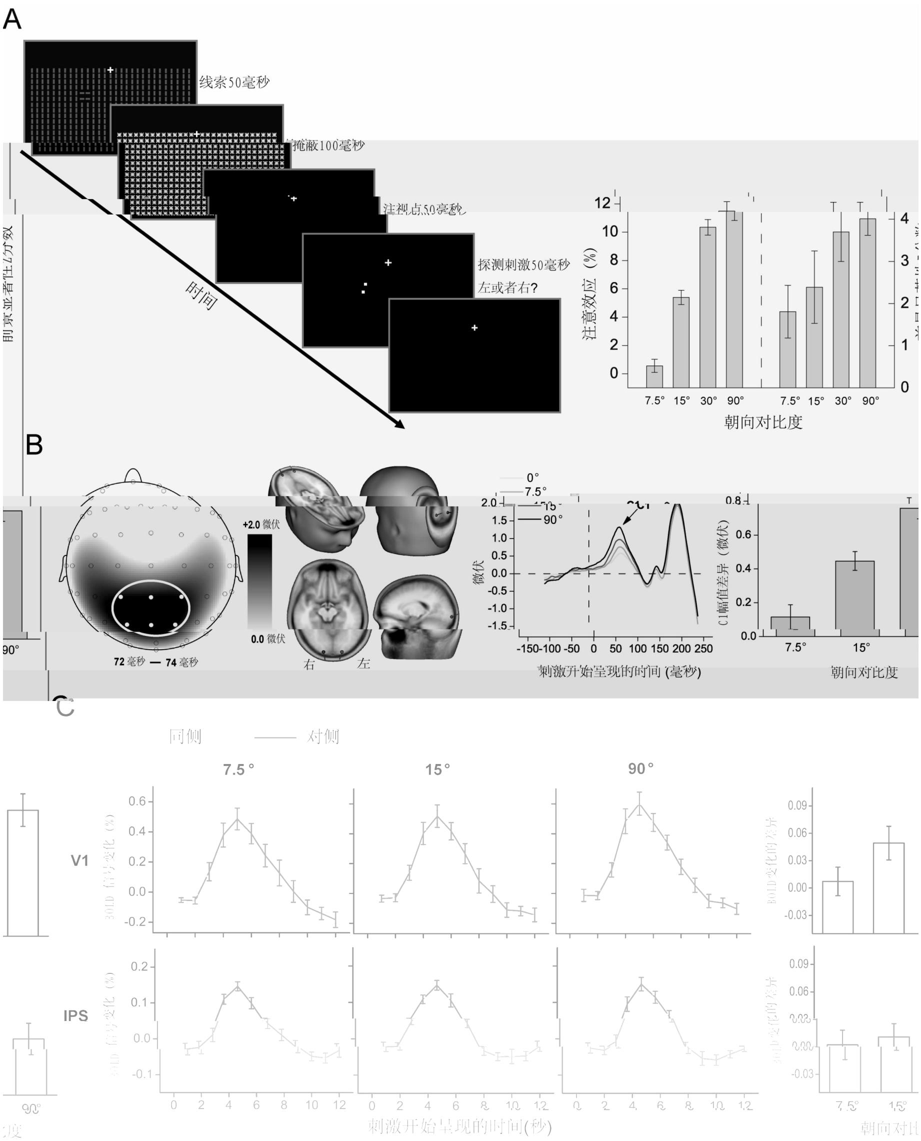
2010

Schiller & Lee 1991 V4

Burrows & Moore

V4

شمخ شمخ˝ 4B˛ Й كم C1 V1 شمخ طح Й
V1 حي شمخ ئو ˝ Clark et حى˘ شمخ
al.˘ 1995 b˛Martinez et al.˘ 1999˛ ˘ حى ضم V1 لحم نج˘ جم
طح جم V1 Й حى Li شمخ V1 ˝ 1999˘ 2002˛ ˘
˘ Chen ضحى ˝ 2012˘ 2016˛ في ضحي ئه تجي يخ مم
شمخ تم ˝ تم ظ شخ Й
شمخ ˘ شج شمخ كا ˛



4 V1

˝ يخ ئۇ Й Zhang et al.˘ 2012˛

3

vernier task V1

bisection task

5 A pop-out

Asplund 2010

inferior frontal junction IFJ

FEF IPS IFJ TPJ VFC

Li Gilbert 2002 Li 2008 McManus 2011

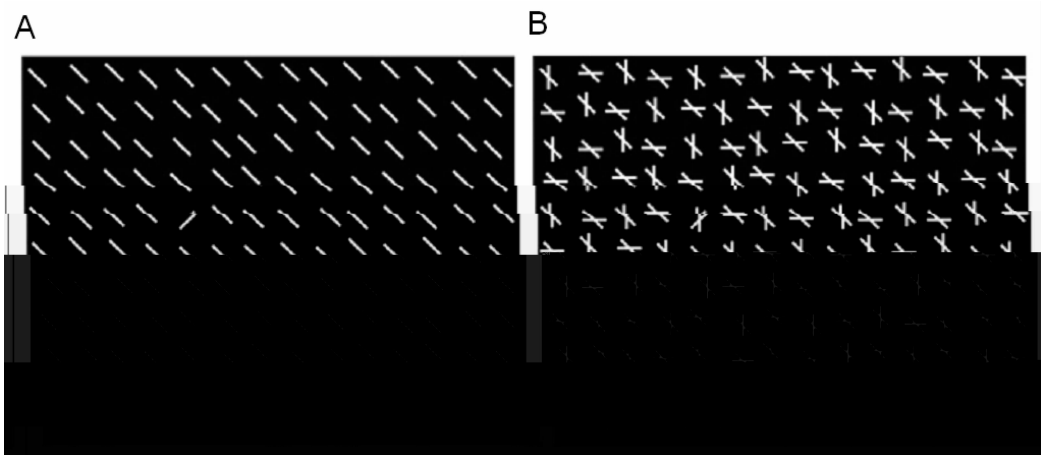
Freeman V1 2003

Li 2004 V1

Krauzlis et al. 2013 Michael & Buron 2005 Saalmann & Kastner 2011 Fecteau et al. 2006 Kustov et al. 1996 Shipp 2004 Snow et al. 2009 Zénon Krauzlis 2012

Zhao ping Guyader 2007

Chen et al. 2016 Li 1999 2002 Zhang et al. 2012 VFC Corbetta et al. 2002 TPJ IPS FEF



5

Zhaoping & Guyader 2007,

Allman J. Miezin F. & McGuinness E. 1985, . Stimulus specific responses from beyond the classical receptive field Neurophysiological mechanisms for local-global comparisons in visual neurons. *Annual Review of Neuroscience 8* 407 – 430.

Asplund C. L. Todd J. J. Snyder A. P. & Marois R. 2010, . A central role for the lateral prefrontal cortex in goal-directed and stimulus-driven attention. *Nature Neuroscience 13* 4, 507 – 512.

Baluch F. & Itti L. 2011, . Mechanisms of top-down attention. *Trends in Neurosciences 34* 4, 210 – 224.

Bisley J. W. & Goldberg M. E. 2010, . Attention intention and priority in the paT

t

goal-directed and stimulus-driven attention in the brain. *Nature Review Neuroscience*, *3*, 201 – 215.

Enns, J. T., & Di Lollo, V. (2000). What's new in visual masking? *Trends in Cognitive Sciences*, *4*(9), 345 – 352.

Fecteau, J. H., & Munoz, D. P. (2006). Salience, relevance, and firing: A priority map for target selection. *Trends in Cognitive Sciences*, *10*, 382 – 390.

Freeman, E., Driver, J., Sagi, D., & Zhaoping, L. (2003). Top-down modulation of lateral interactions in early vision: Does attention affect integration of the whole or just perception of the parts? *Current Biology*, *13*, 985 – 989.

Geng, J. J., & Mangun, G. R. (2009). Anterior intraparietal sulcus is sensitive to bottom-up attention driven by stimulus salience. *Journal of Cognitive Neuroscience*, *21*, 1584 – 1601.

Gilbert, C. D., & Li, W. (2013). Top-down influences on visual processing. *Nature Review Neuroscience*, *14*, 350 – 363.

Gilbert, C. D., & Wiesel, T. N. (1983). Clustered intrinsic connections in cat visual cortex. *Journal of Neuroscience*, *3*, 1116 – 33.

Gottlieb, J. P., Kusunoki, M., & Goldberg, M. E. (1998). The representation of visual salience in monkey parietal cortex. *Nature*, *391*, 481 – 484.

Hegdé, J., & Felleman, D. J. (2003). How selective are V1 cells for pop-out stimuli? *Journal of Neuroscience*, *23*, 9968 – 9980.

Itti, L., & Koch, C. (2001). Computational modelling of visual attention. *Nature Review Neuroscience*, *2*, 194 – 203.

Itti, L., Koch, C., & Niebur, E. (1998). A model of saliency-based visual attention for rapid scene analysis. *IEEE Transactions on pattern analysis and machine intelligence*, *20*(11), 1254 – 1259.

James, W. (1890). *The principles of psychology*. *2*. London: MacMillan. 403 – 404.

Jonides, J. (1981). Voluntary vs. automatic control over the mind's eye's movement. In: M. I. Posner and O. Marin (Eds.), *Attention and performance*, *Vol XI*. Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers. pp. 187 – 205.

Kastner, S., & Ungerleider, L. G. (2000). Mechanisms of visual attention in the human cortex. *Annual Review of Neuroscience*, *23*, 315 – 341.

Katsuki, F., & Constantinidis, C. (2012). Early involvement of prefrontal cortex in visual bottom-up attention. *Nature Neuroscience*, *15*(8), 1160 – 1166.

Klein, R. M. (2000). Inhibition of return. *Trends in Cognitive Sciences*, *4*(4), 138 – 147.

Koch, C., & Ullman, S. (1985). Shifts in selective visual attention: Towards the underlying neural circuitry. *Human Neurobiology*, *4*, 219 – 227.

Koene, A. R., & Zhaoping, L. (2007). Feature-specific interactions in salience from combined feature contrasts: Evidence for a bottom-up saliency map in V1. *Journal of Vision*, *7*, 1 – 14.

Krauzlis, R. J., Lovejoy, L. P., & Zénon, A. (2013). Superior Colliculus and Visual Spatial Attention. *Annual Review of Neuroscience*, *36*, 165 – 182.

Kustov, A. A., & Robinson, D. L. (1996). Shared neural control of attentional shifts and eye movements. *Nature*, *384*, 74 – 77.

Li, W., & Gilbert, C. D. (2002). Global contour saliency and local colinear interactions. *Journal of Neurophysiology*, *88*(5), 2846 – 2856.

Li, W., Piëch, V., & Gilbert, C. D. (2004). Perceptual learning and top-down influences in primary visual cortex. *Nature Neuroscience*, *7*(6), 651 – 657.

Li, W., Piëch, V., & Gilbert, C. D. (2008). Learning to link visual contours. *Neuron*, *57*(3), 442 – 451.

Li, Z. (1999). Contextual influences in V1 as a basis for pop out and asymmetry in visual search. *Proceedings of the National Academy of Sciences*, *96*, 10530 – 10535.

Li, Z. (2002). A saliency map in primary visual cortex. *Trends in Cognitive Sciences*, *6*, 9 – 16.

Lynch, J. C. (1987). Frontal eye field lesions in

monkeys disrupt visual pursuit. *Experimental Brain Research*, *68*, 437 – 441.

Martinez, A., Anllo-Vento, L., Sereno, M. I., Frank, L. R., Buxton, R. B., Dubowitz, D. J., Wong, E. C., Hinrichs, H., Heinze, H. J., & Hillyard, S. A. (1999). Involvement of striate and extrastriate visual cortical areas in spatial attention. *Nature Neuroscience*, *2*, 364

Prog. Brain Research, *147*, 251 – 262.

Treisman, A. (1988). Features and objects: The fourteenth Bartlett memorial lecture. *Quarterly Journal of Experimental Psychology*, *40*(2), 201 – 237.

Treisman, A. M., & Gelade, G. (1980). A feature-integration theory of attention. *Cognitive Psychology*, *12*(1), 97 – 136.

Tsotsos, J. K., Culhane, S. M., Kei Wai, W. Y., Lai, Y., Davis, N., & Nuflo, F. (1995). Modeling visual attention via selective tuning. *Artificial Intelligence*, *78*(1), 507 – 545.

Wolfe, J. M. (1994). Visual search in continuous, naturalistic stimuli. *Vision Research*, *34*, 1187 – 1195.

Wolfe, J. M., & Franzel, S. L. (1988). Binocularity and visual search. *Attention, Perception, & Psychophysics*, *44*, 81 – 93.

Zénon, A., & Krauzlis, R. J. (2012). Attention deficits without cortical neuronal deficits. *Nature*, *489*(7416), 434 – 437.

Zhang, X., Japee, S., Safiullah, Z., Mlynaryk, N., & Ungerleider, L. G. (2016). A Normalization Framework for Emotional Attention. *PLoS Biology*, *14*(11), e1002578.

Zhang, X., Zhaoping, L., Zhou, T., & Fang, F. (2012). Neural activities in V1 create a bottom-up saliency map. *Neuron*, *73*, 183 – 192.

Zhaoping, L. (2008). Attention capture by eye of origin singletons even without awareness: A hallmark of a bottom-up saliency map in the primary visual cortex. *Journal of Vision*, *8*, 1 – 18.

Zhaoping, L., & Guyader, N. (2007). Interference with bottom-up feature detection by higher-level object recognition. *Current Biology*, *17*(1), 26 – 31.

Zhaoping, L., & May, K. A. (2007). Psychophysical tests of the hypothesis of a bottom-up saliency map in primary visual cortex. *PLoS Computational Biology*, *3*, e62.

Neural Mechanisms of Bottom-up Attention

ZHANG Xi-lin[1] **FANG Fang**[2,3,4,5]

(1. National Institutes of Health/National Institute of Mental Health, Maryland, 20892, USA;
2. School of Psychological and Cognitive Sciences and Beijing Key Laboratory of Behavior and Mental Health, Peking University, Beijing 100871, China;
3. Key Laboratory of Machine Perception (Ministry of Education), Peking University, Beijing 100871, China;
4. PKU-IDG/McGovern Institute for Brain Research, Peking University, Beijing 100871, China;
5. Peking-Tsinghua Center for Life Sciences, Peking University, Beijing 100871, China)

Abstract

The stimulus-driven contribution to the allocation of attention is bottom-up attention. Investigating its neural mechanisms leads to a better understanding of how the brain creates consciousness. Although bottom-up selection is typically quick and potent, there are controversies concerning the brain regions involved. Two models with their respective evidence about bottom-up attention over the past decades were reviewed: the saliency-based attention and primary visual cortex (V1), saliency map models. Issues for future studies were further discussed.

Key words: attention, bottom-up attention, saliency map, brain imaging, primary visual cortex (V1)