A en ion mod la es ne ronal correla es of in erhemispheric in egra ion and global mo ion percep ion

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In earl re ino opic areas of he h man is al s s em, informa ion from he lef and righ is al hemifields (VHFs) is processed con rala erall in o hemispheres. Despi e his segrega ion, e ha e he percep al e perience of a nified, coheren , and nin err p ed single is al field. Ho e ac l he is al s s em in egra es informa ion from he o VHFs and achie es his percep al e perience s ill remains largel nkno n. In his s d sing fMRI, e e plored candida e areas ha are in ol ed in in erhemispheric in egra ion and he percep al e perience of a nified, global mo ion across VHFs. S im li ere o-dimensional, comp er- genera ed objec s i h par s in bo h VHFs. The re inal image in he lef VHF al a s remained s a ionar , b in he e perimen al condi ion, i appeared o ha e local mo ion beca se of he percei ed global mo ion of he objec . This percep al effec co ld be eakened b direc ing he a en ion a a from he global mo ion hro gh a demanding fi a ion ask. Res l s sho ha la eral occipi al areas, incl ding he medial emporal comple , pla an impor an role in he process of percep al e perience of a nified global mo ion across VHFs. In earl areas, incl ding he la eral genic la e n cle s and V1, e obser ed correla es of his percep al e perience onl hen a en ion is no direc ed a a from he objec . These findings re eal effec s of a en ion on in erhemispheric in egra ion in mo ion percep ion and impl ha bo h he bila eral ac i i of higher- ier is al areas and feedback mechanisms leading o bila eral ac i i of earl areas

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pla roles in he percep al e perience of a nified is al field.

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(G , 2000; T , S ; S , & H , 1988).

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(L & R , 2000; & F , 1998). T ,

-

(C & M - , 1990).

D , -

. L , C , H (2009), MRI EEG , . T -

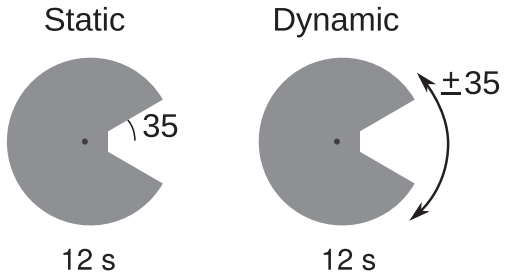
(1) (LOT) , MT+. I - , MT+ 1 . T - MT+ LOT , 1. . (2004) EEG MRI . T LOT , MT+, . B . H ,

HF ; . T , L . B . (2006) MRI . T , 1, 2, 3, . T . T ; 1, 2 , 3 , , . B . , . H , B . 1, 2 , 3 . A . A MRI (G , H , & B , 1999), MT+ (B , B , M , & , 2009; C ., 2011; S , B ; & B , 2002; H , K , & G , 2007; , A -E , P , & T , 2006). F , (L & R - , 2000). T , - , . ., . T HF , MRI . I , P - ” (F 1,). T P -

Methods

Participants

MR data acquisition



30° × 22° . T
1832 / 2
CIE $x = 0.357$, $y = 0.351$.

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ROI locali a ion

ROI (LGN), 1,
2, 3, 3A/B, 4, LO-1
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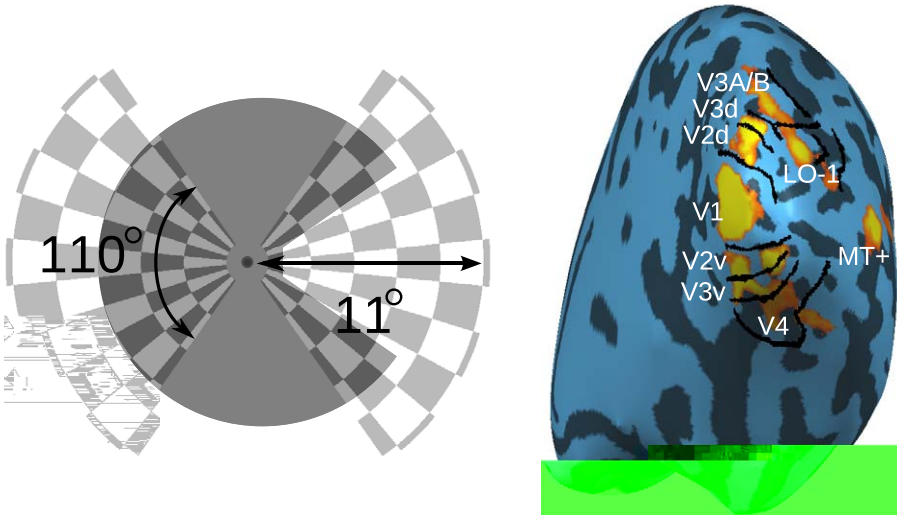

Figure 3. ROIs were identified using wedges texture-mapped with counter-phase contrast reversing checkerboard patterns in early visual areas (the Pac-man figure in the background is shown here for visualization purposes; it was not present in the actual experiment). For MT+, moving random dots were used as a localizer. Boundaries between early visual areas were drawn using the results of a separate retinotopic mapping session for each participant. The image on the right shows ROIs and visual area boundaries on an inflated brain of one participant.

, MT (H ., 2002; M ., 2000). H , . T , MT+.

Re ino opic mapping s im li

A . R . T - - . T 30° 30° 10 ; 360° 12 . T . T 2° 1° 14°. E 10 . T 10 . F , 3A/B, LO-1, LO-2 ; L H (2006) (T ., 1997). T 3-D . B MR (E , G , & , 1997; S ., 1995).

MR da a processing and anal sis

F B - Q (B I , M , T N). P , 3-D , , - (0.015 H) (A. M. S ., 1999). N MRI . A , - , . F ROI - B Q . $(p < 10^{-4}$,) . F - ; , J . T . A , - (F 5), - (12) . A ,

P - : ( ) D
(F 6). *not*
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Beha ioral e perimen

(P -)
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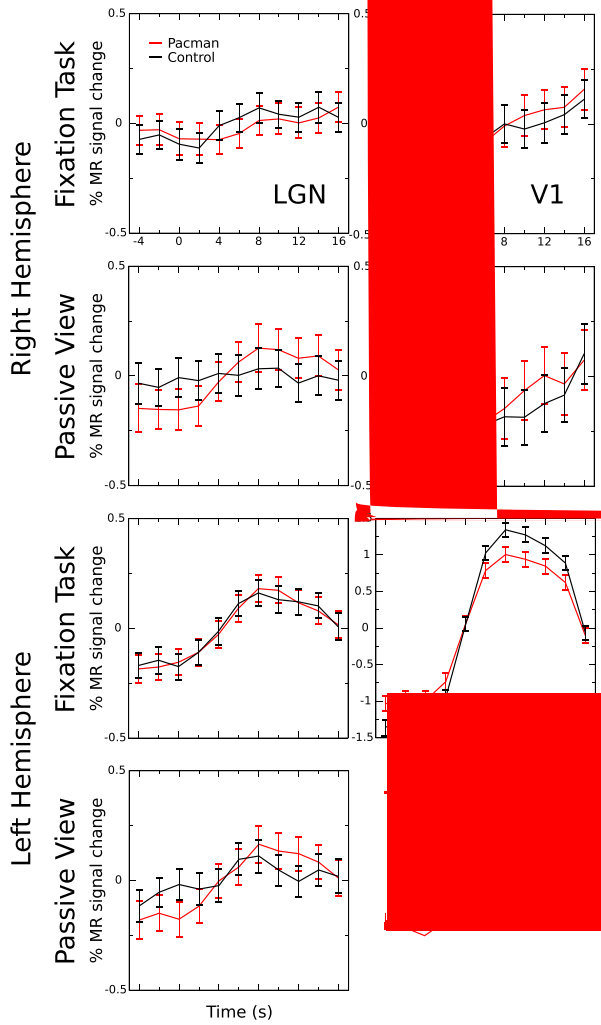
64 . T ’ - . T . E (250 ;) , . T : S - , : (P - ,), (MANO A) (ANO A).

Res l s

? I P - ; HF , HF . T ; (RF) HF . , . O , RF HF, . C - , : . A , HF ; P - . I ; HF . F 4 F 5 P - ; . T ; . T - , (: 85% P - , 76% $\alpha = 0.05$ ’ RT = 653 665 , $\alpha = 0.05$). T N MR (A. T. S ., 2004; T ., 1998). I (12) P - . I ; ROI, MRI P - . R F 6. F , - ; - ; 3A/B, LO-1, MT+, P - . I , , - , T - , LGN. T - . I , P - (F 5), 1, P - LO-1 3A/B ($\alpha = 0.05$). T , - - ; .

Beha ioral e perimen

T , 12- P - ( ) not ? ( ) , (/). P - - ” (. ., N , not ”); .” P - , ,” ,” .” A



= 0.947, $F(2, 964) = 27.18$, $p < 0.0001$. N

$\alpha = 0.01$. T

ANO A

, $F(1, 965) = 22.41$, $p < 0.0001$,

, $F(1, 965) = 28.36$, $p < 0.001$, . N

$\alpha = 0.01$. T

$-0.46°$

(0°) ($SE = 0.03$)

$-0.66°$ ($SE = 0.032$)

E e- racking e perimen

. T

$0.77°$ ($SE = 0.042$) (0°

( )) $0.45°$

( ), ($SE = 0.044$) .

Passive View

Average % MR signal difference

Disc ssion

3A/B, LO-1, MT+ P -

, LGN, P - . I ; . T , HF . T (T ., 1997). M , L ; MT+, , . L (A. T. S ., 2004; T ., 1998) . L . (2009) 1 LOT ; MT+, LOT 1 (., 2004). T ; , MRI, . MT+ (B & B , 2005; C & M , 1990) 1 (B & B , 2005; L & R , 2000). T MT+ M ; , LGN (L & R , 2000; S , P , , & H , 2004). G 1 (B & B , 2005), MT+ (., 2004) ; 1.

S , LGN . T . T

LGN MT+ K (B & B , 2005; S ., 2004), . I , LGN (SC), SC MT (B , 2004). M , , - , SC MT (B , 2004; C , 2004). I MT+ SC , , LGN . T 1, 2, 3 MT . C - (G , 2000; N & C ; 1996). I ; G ç, B , S , K (2011), MRI DTI, - MT 1 . T MT . S - MT (C & M , 1990; G ç ., 2011) 3 3A/B (C & M , 1990) 1, 2, 3 (C & M - , 1990). T HF . MT 1, 2 3 (B & B , 2005; B , 2004). H , 1, 2, 3, - MT . T ; MT+ .

E , MT+ (B & B , 2005; C ., 2011; C , H , D , & , 2001; O'C , R , K , T , & S , 1997; S ., 2002). M , - (G ., 1999) LGN (O'C , F , P , & K , 2002). ,

. T ,

HF

. T

(L & R , 2000; & F , 1998).

P RF MT

70°

(B , 2013; B , M , & , 1998; M , B , & , 1995). M , MT RF

, RF

(B ., 2009; C ., 2011; ., 2006; H ., 2007). M , (O'C , D , & K , 1999; R , L , & S , 1998),

(M M & S ; 2004, 2005) ((S ., 2002; T & T , 1999)

HF MT.

O B . (2006),

2 3

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R ,

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MRI

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MRI

P

P ,

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RF ; 1/2,

B . (2006) . N

P (85%

, 76%) : T

P

(P

LOT 3A/B, MT+, LO1). H , LOT

Concl sions

T ,

. O

3A/B, LO-1, MT+ ( ),

Keywords: global motion perception, interhemispheric integration, fMRI, visual brain, perceptual experience of unified visual field

Ackno ledgmen s

S S T R C T "1001" (108K398), E C M C I R " (PIRG-GA-2008-239467), T A S "D I " . A M , C M R R NIH N B I C C G (P30 NS057091). HB KD F C , S D .

C . C : H B . E : @ . . . A : D P & N M R R C , B , A , T .

References

B , H., , H., F , M., N , A., , M., T , C., & E , . (2006). T : I - : *The Journal of Neuroscience, 26*(34), 8804 8809.

B , R. T., & B , D. C. (2005). S MT. *Annual Review of Neuroscience, 28,* 157 189.

B , K. H. (2004). T : M . I L. M. C , J. S. , & C. J. B (E -), *The visual neurosciences*, . 2 (. 1203 1216).

B , D. C. (2013). M : H : I J. & L. C (E -), *The new visual neurosciences* (. 763 775). C , MA: MIT P -.

B , D. C., B , S., M , M. C., & , P. (2009). P : *Vision Research, 49*(10), 1065 1072.

B , D. C., M , M. C., & , L. M. (1998). L : *Vision Research, 38*(12), 1731 1743.

C , C. (2004). T . I L. M. C , J. S. , & C. J. B (E -), *The visual neurosciences*, . 1 (. 592 608). C , MA: MIT P -.

C , S., & M , J. (1990). O : O ; - , - : *Journal of Comparative Neurology, 298*(2), 188 214.

C , S., B , L., 'A , G., B , D. C., T , M., & M , M. C. (2011). S BOLD . *PLoS ONE, 6*(7), 21661.

C , J., H , S., D , S., & , F. A. (2001). : ? *Acta Psychologica, 107*(1), 69 94.

E , S., G , G., & , B. (1997). R - MRI. *Cerebral Cortex, 7*(2), 181 192.

G , S. P., H , D. J., & B , G. M. (1999). S . *Proceedings of the National Academy of Sciences, USA, 96*(6), 3314 3319.

G , M. S. (2000). C : D ? *Brain, 123*(7), 1293 1326.

G ç, E., B , J., S , ., & K , A. (2011). I . *Current Biology, 21*(17), 1494 1499.

H , K., K , K., & G , J. (2007). T - 4. *The Journal of Neuroscience, 27*(44), 11896 11911.

H , A., D , R., & H , D. (2002). R -MT MST. *The Journal of Neuroscience, 22*(16), 7195 7205.

L , . A., & R , P. R. (2000). T . *Trends in Neurosciences, 23*(11), 571 579.

L , J., & H , D. J. (2006). T . *The Journal of Neuroscience, 26*(51), 13128 13142.

L , M., & , . (2004). T . *Nature Reviews Neuroscience, 5*(9), 729 735.

L , ., , N., C , ., & H , B. (2009). M EEG MRI. *NeuroImage, 46*(4), 989 997.

M M , S. A., & S , D. C. (2004). M . *Neuron, 42*(4), 677 686.

M M , S. A., & S , D. C. (2005). P . *The Journal of Neuroscience, 25*(41), 9444 9448.

M , M., B , D., & , L. (1995). T . *Nature, 376*(6540), 507 509.

M , M., T , M., M , D., F , A., C , G., & B , D. (2000). A MRI. *Nature Neuroscience, 3*(12), 1322 1328.

N , N., & C , M. C. (1996). P . *Neuropsychologia, 34*(4), 297 309.

O'C , D. H., F , M. M., P , M. A., & K , S. (2002). A : *Nature Neuroscience, 5*(11), 1203 1209.

O'C , K. M., D , P. E., & K , N. (1999). MRI . *Nature, 401*(6753), 584 587.

O'C , K. M., R , B. R., K , K. K., T , A., & S , R. L. (1997). MRI MT MST. *Neuron, 18*(4), 591 598.

R , P. R., L , . A., & S , H. (1998). O - . *Nature, 395*(6700), 376 381.

S , M., B , G. T., & B , G. M. (2002). G - . *Nature Neuroscience, 5*(7), 631 632.

S , M., D , A., R , J., K , K., B , J., B , T., ... T , R. (1995). B . *Science, 268*(5212), 889 893.

S , L. C., P , K. F., , M. J., & H , J. C. (2004). B 1: A MT. *Nature Neuroscience, 7*(10), 1123 1128.

S , A. M., L , B. K., R , . E., , F. Q., S , T. M., , ., ... F , J. A. (1999). I MRI . *Neuroimage, 9*(5), 526 533.

S , A. T., , A. L., & S , K. D. (2004). N : E . *Human Brain Mapping, 21*(4), 213 220.

T , R. B., M , J. D., H , N. K., L , P. J., L , A. K., R , J. B., ... D A. M. (1997). F 3 . *The Journal of Neuroscience, 17*(18), 7060 7078.

T , R. B., M , J. D., H , N. K., L , A. K., & D , A. M. (1998). T . *Proceedings of the National Academy of Sciences, USA, 95*(3), 818 824.

T , R. B., S , E., S , M. S., & H , S. L. (1988). F . II. R - . *The Journal of Neuroscience, 8*(5), 1531 1568.

T , S., & T , J. C. M. (1999). F - . *Nature, 399*(6736), 575 579.

, S., D , M., , J., D -M , C., S , C., & B , J. (2004). T . *Neuroimage, 21*(3), 818 828.

, T., A -E , K., P , F., & T , S. (2006). D MT . *Nature Neuroscience, 9*(9), 1156 1160.

, S., & F , D. (1998). T R : I . *Brain, 121*(1), 25 45.