NeuroImage

www. . / a /
a 24 (2005) 928 935

Distinct neural substrates for the perception of real and virtual visual worlds

l' l' a ,a, ,* a ,a,1 . l' , a a l' , a Ca

[a]Department of Psychology, Peking University, Beijing, PR China
Learning and Cognition Laboratory, Capital Normal University, Beijing, PR China
Behavioral Brain Sciences, School of Psychology, University of Birmingham, Birmingham, UK
Key Laboratory of Cognitive Science, Institute of Biophysics, Chinese Academy of Sciences, Beijing, PR China

4 A 2004; 23 2004; a 29 2004
A a a 18 2004

Virtual environments have been frequently used for training and skill improvement. However, do real and virtual worlds engage the same brain states in human perceivers? . (q.4(e4iep.(0D (i 0- (and))D lhnma n (states)-a 4.acScif)- 2 2. (fond)- D .)funcScoields)-0- agnet 2s)-4 respectively. Relative to baselines using random static images, the medial prefrontal cortex (MPFC) and the cerebellum were activated only by movie clips of other humans. In contrast, cartoon clips of human and non-human agents activated the superior parietal lobes, while movie clips of animals also activated the superior parietal lobes. Our fMRI findings suggest that the perception of real-world humans is characterised by the involvement of MPFC and the cerebellum, most likely for on-line representation of the mental states of others, whereas the perception of virtual-world agents engages the parietal cortex in attention to actions.

Keywords: ; a a ; a w ; a a w

Introduction

V a a _ a _ a a w a x . xa , a l' a a a a l'a l' a a l' a , a a (a l' , 1999). A a a a l'a a a l'a a l' l' x , a a l'a _ l' l' a _ (B a a w , 2004). w , w l' l' a l' a a a w l' a a a _ a a w l'a , w l' w a w l' a a a , a , l' a l' a a x (C), l' w a a a w l' w' w a l' a a a a a _ (a a l' a ., 2002; a a a a , 2004), l'a a a a a w l' a a l' a a . l' _ a w' l' , w' w _ l' a a l' a w , a a a a w l' w' w a a w . a l' , w a a a a w' a a a , w' l' a a l' a a - a ( ) a l' l' a l' a a a w (a). a a (l' a l' a l' _ a) w' a a a (a a l' _ a l'a -). B a a _ w' wa l' l' wa a w l' a a a a l' a a a _ w a a a . a l' a w l' a a a , a a a l' a l'a x a a _ l'a . /W a _ l' a a a a l' l' a a l' a a w ( ) l' l' a l' a l'a a a a w (a).

Material and methods

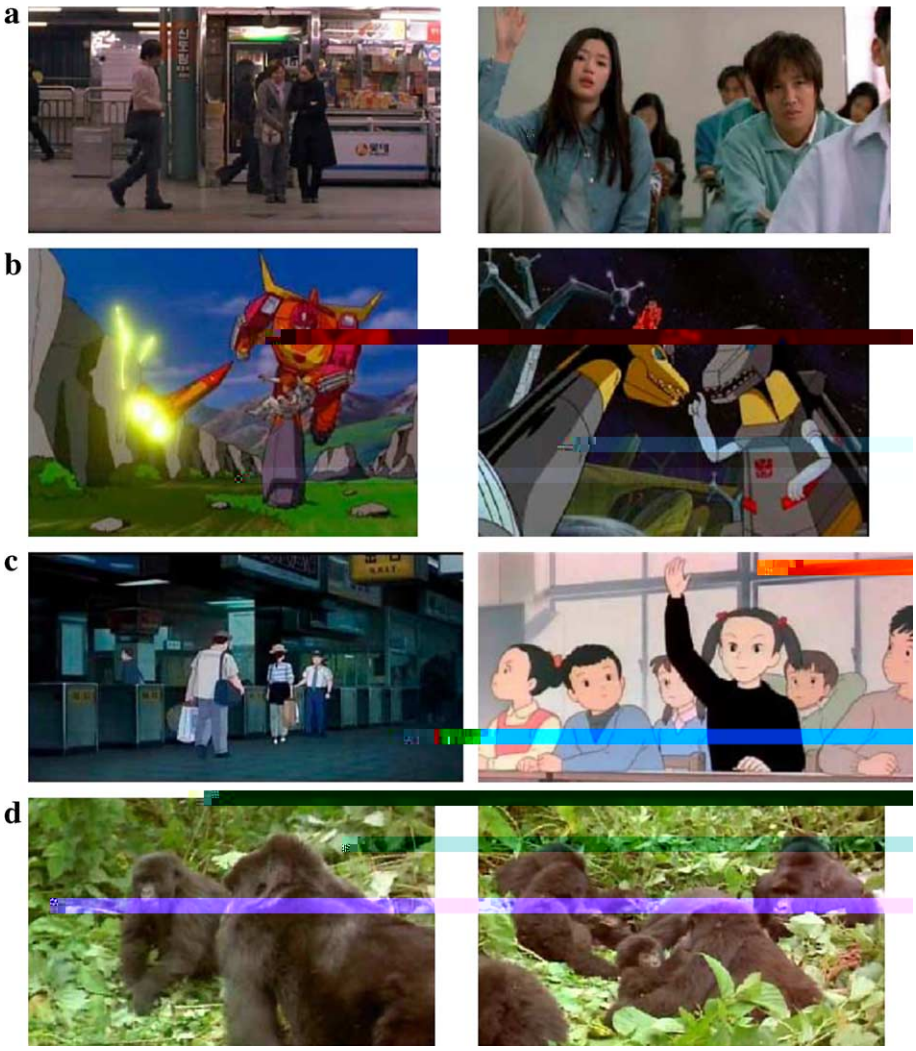
Subjects

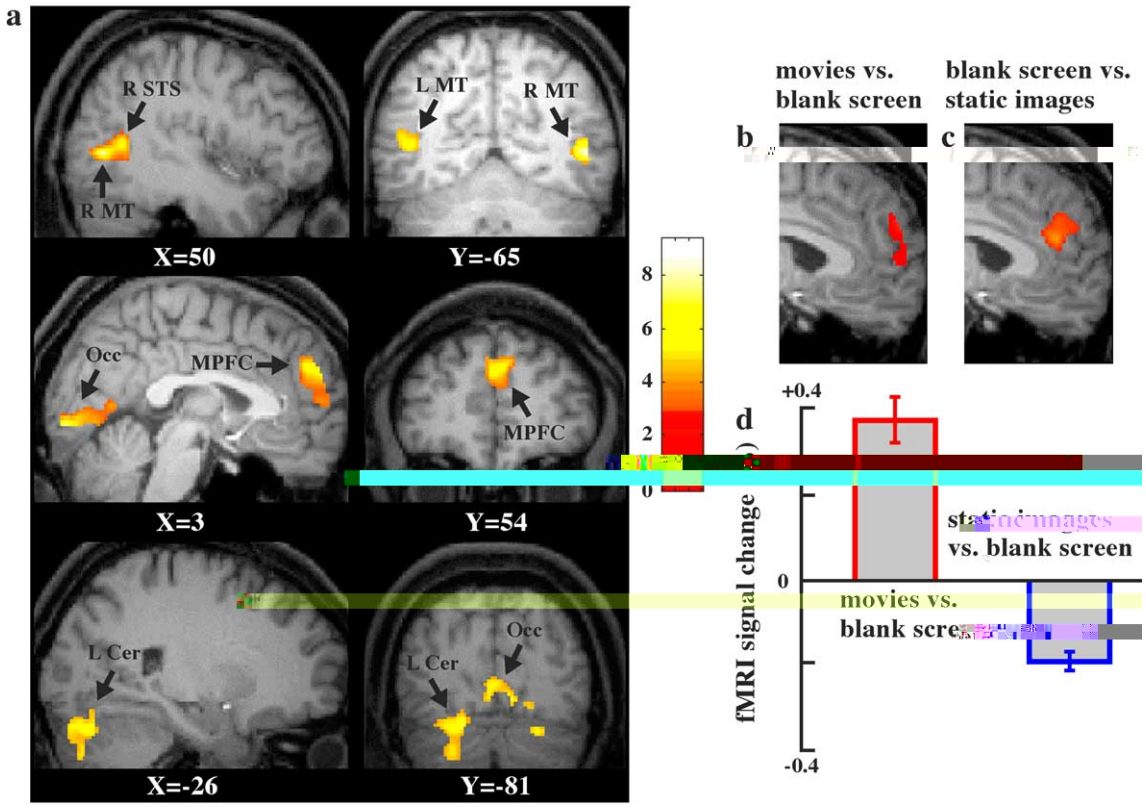
w a (6 a ; 21 41 _ a a , a 25.5) w l' a _ l'a l' _ a a l' _ . A

* C a l' . a _ l' _ , _ , 5 l' _ a a , B 100871, Cl' a. a x: +86 10 6276 1081.
E-mail address: l'a @ . . (. a).
1 a : a _ l' _ , _ a, 75 a a , a , 55455.
Available online on ScienceDirect (www.sciencedirect.com).

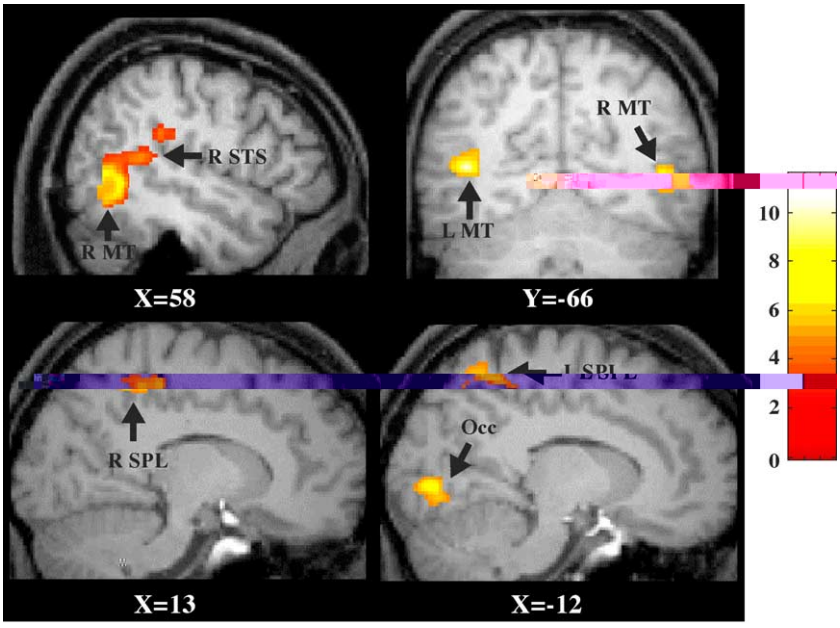
1053-8119/$ - a
:10.1016/ . a .2004.09.046

Stimuli and procedure

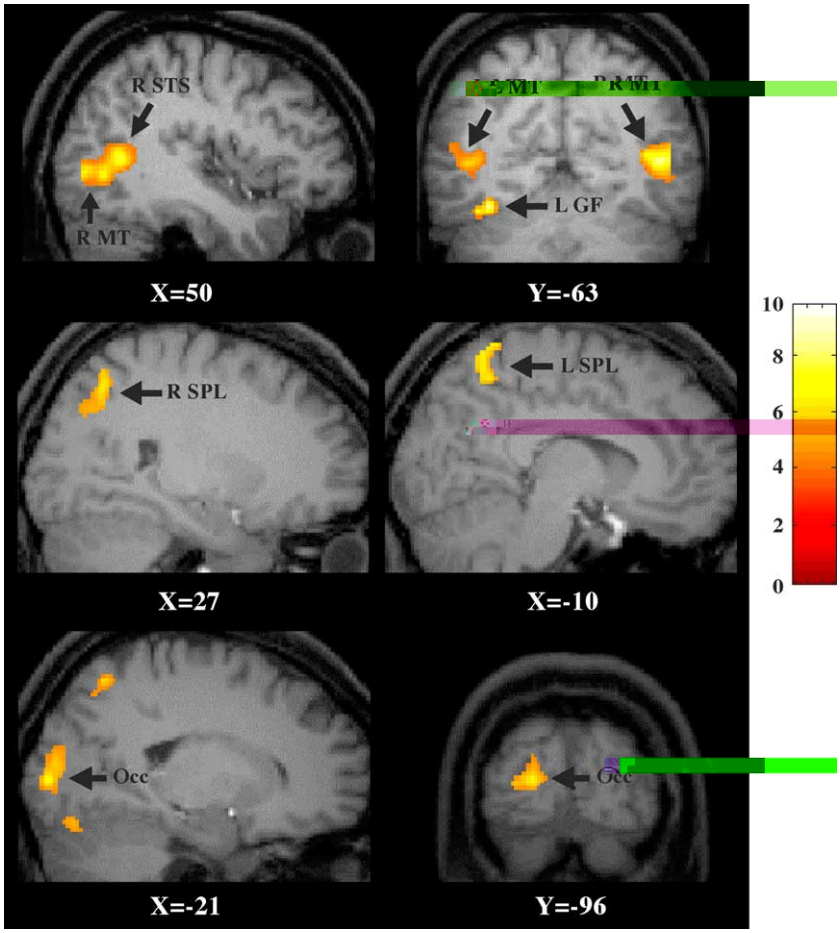




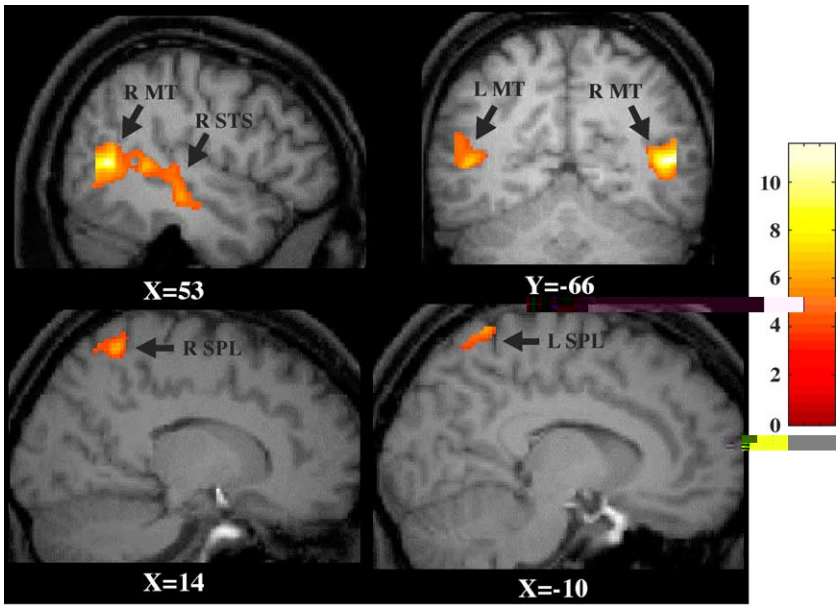
. 3. B a a a a a a w l' w l' l' a a a a . (a) l' a w l' a a a a a . l' a a a 12 w a a a . C a a w l' l' a a a l' . l' a a l' a z a . A a w a a a l' , l' a a x ( ), l' C, a l' (C). ( ) l' C a a l' a w l' a l' a (a 6, 60, 23, *Z* = 3.35, *P* < 0.001,). ( ) l' C a a l' a w l' a a a a a l' (a 8, 40, 13, *Z* = 5.04, *P* < 0.001,). ( ) a a l' a w l' a a l' C . l' a w a a a x l' a l' C . 2a l' wa l' , a a , a a . a wa l' a , wa l' a a w' a wa l' a a a a l' C .



. 4. a a a a l' a w a l' a a a a a a . A a w a a a l' , l' a a x ( ), a l' a l' a a ( ).



. 5. B a a a a a w l' w l' a . A a w a a a l' , l' a x ( ), l' - ( ), a l' a l' a a ( ).

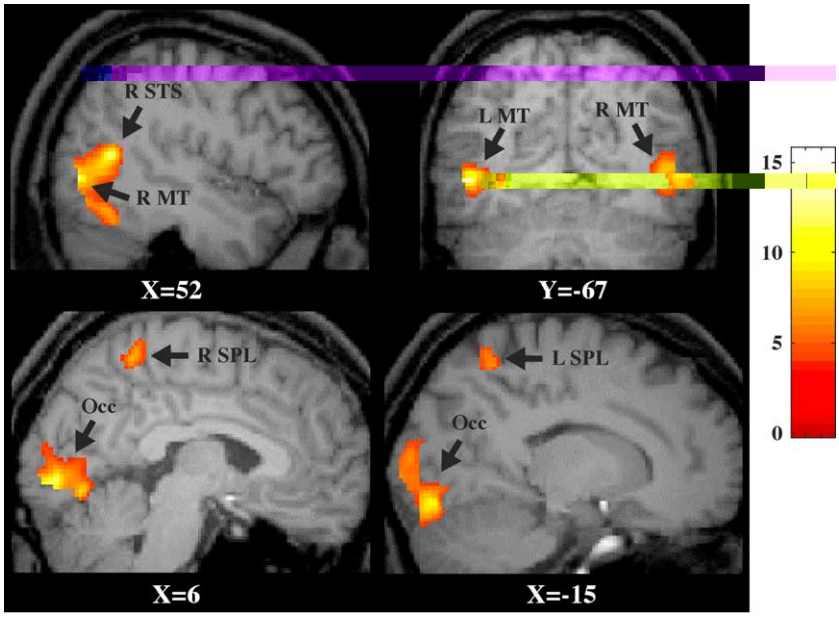


. 6. a a a a l' a w a l' a a a a a a . A a w a a a l' a l' a l' a a ( ).

a l' C a a a _ l' l' l' a a a l' a w , C , w l'a l' a wa l' l' l'a a wa a a l' a a a a (. 1). l' a w l' a a a a l' w a a a a a l' (a −51, −66, 3, $Z = 5.70$, $P < 0.001$, , a 51, −73, 2, $Z = 5.39$, $P < 0.001$,), l' a a x (a −2, −91, −2, $Z = 5.74$, $P < 0.001$,), a l' (a −14, −53, 61, $Z = 4.31$, $P < 0.001$, , a 6, −44, 57, $Z = 4.39$, $P < 0.03$, , . 7). w , l' wa a a a l' C l' .

Discussion

a a a a l' wa w l'a a w l' l' a a a w . A a a w a a _ a l' w l' a a , a



. 7. a a a a l' a w a a a a a a a a . A a w a a a l' , l' a a x ( ), a l' a l' a a ( ).

3, 3.25, 2.88, 4, 5-

$F(1,11) = 0.25$, $P > 0.5$

Acknowledgments

This work was supported by the National Natural Science Foundation of China (30225026 and 30328016), the Key Project of Chinese Academy of Sciences (2002CCA01000), the Natural Science Foundation of Beijing (02170), the Program for New Century Excellent Talents in University (), and the Program for Changjiang Scholars and Innovative Research Team in University ().

References

Bo, C.J., Wang, L.L., 2004. Using clustering to make the mean-field approximation for the Ising model: application to the Potts model. Phys. Rev. Lett. 60, 317–330.

Bu, L., Cao, J., Liang, J., Lu, J., Yao, D., Wang-Ba, X., 2000. Automatic detection of artifacts in the electroencephalogram data from long-term monitoring using the standardized low-resolution brain electromagnetic tomography (sLORETA). Clin. Neurophysiol. 11, 157–166.

Cao, J., Cai, L., Liu, J., Liu, L., 2000. Chaotic dynamics of the firing synchronization in a neuronal network model with small-world connectivity. Neurocomputing 12, 314–325.

Ch, C.C., Ch, A.A., 1998. Chaotic synchronization: applications to living systems. Phys. Rev. E. 2, 355–362.

Ch, C.C., Ch, C.M., Ch, H.C., Ch, C.C., 1995. Ch Ch Ch Ch? Ch. Ch. Ch. Ch. 21, 628–634.

Ch, C.C., Ch, C.M., Ch, H.C., Ch, C.C., Ch, C.M., Ch, H.C., 1995. Ch Ch Ch: Ch Ch Ch "Ch Ch" Ch Ch-Ch. Ch 57, 109–128.

Ch, C., Ch, H., 1999. Ch Ch Ch Ch. 286, 1692–1695.

Ch Ch, C.C., Ch, C.M., Ch, H.C., Ch, C.C., Ch, C.M., Ch, H.C., 2000. Ch Ch Ch: Ch Ch, Ch Ch Ch Ch. Ch 38, 11–21.

Ch Ch, C.C., Ch, C.M., Ch, A., Ch, A., Ch, C., 2002. Ch Ch Ch Ch. Ch 16, 814–821.

Ch, C., Ch, C., Ch, H., 1999. Ch Ch Ch Ch Ch-Ch. Brain 122, 1875–1887.

Ch, C.C., Ch, C.M., 2001. Ch Ch: Ch Ch Ch Ch. Ch., 2, 685–694.

Ch, C.B., Ch, C.C., Ch, C.C., 2000. Ch Ch-Ch Ch. Ch. 3, 284–291.

Ch, C.C., Ch, C.M., Ch, H.C., Ch, C.C., Ch, C.M., Ch, H.C., 2004. Ch Ch-Ch Ch Ch Ch Ch Ch Ch. Ch 21, 1167–1173.

Ch, C.C., Ch, C.M., Ch, H.C., Ch, C.C., Ch, C.M., Ch, H.C., 2001. Ch Ch Ch Ch Ch-Ch Ch. Cl. Ch. 13, 1048–1058.

Ch Ch, C.C., Ch, C.M., Ch, H.C., Ch, C.C., Ch, C.M., Ch, H.C., 1998. Ch Ch Ch Ch Ch. Cl 68, B1–B11.

Ch, C.C., Ch, C.M., Ch, A., Ch Ch, C.C., Ch, C.M., Ch, H.C., Ch, C.C., Ch, C.M., Ch, H.C., 2003. Ch Ch Ch Ch: Ch. 32, 1247–1257.

Ch, C.C., Ch, C.M., Ch, H.C., 1998. Ch, Ch-Ch, Ch Ch: Ch Ch, Ch. 240, 740–749.

Ch, A.C., Cl, C.C., Ch Ch, C.M., Ch, C.C., 2003. Ch Ch Ch Ch Ch: Ch Ch Ch. Ch 18, 91–103.

Ch, C., Ch, C.M., 1978. Ch Ch Ch Ch Ch? Ch Ch. Ch. 1, 515–526.

Ch, A., Ch, C.M., Ch, C.C., Cl, C.C., 1998. Ch Ch Ch Ch Ch. Ch. 18, 2188–2199.

Ch Ch, C.C., Ch, C.M., Ch, H.C., 2004. Ch Ch Ch Ch Ch Ch Ch. Ch. 7, 85–90.

Ch, C.C., Ch, C.M., 1999. Ch Ch Ch Ch Ch: Ch, Ch Ch. Ch. Ch. 13, 343–382.

Ch, C.C., 1986. Ch Ch Ch Ch. Ch: Ch, C.C., Ch Ch, C.C., Ch Ch, C.C. (Ch.). Ch Ch Ch Ch. 2. Ch, Ch, 1–71. Cl Ch. 33.

Ch, C.C., Ch, C.M., Ch, H.C., Ch Ch, C.C., Ch Ch, C.M., 2002. Ch Ch: Ch Ch Ch Ch Ch Ch. Ch 17, 988–998.

Ch, C.C., Ch, C.M., 2001. Ch Ch: Ch Ch Ch Ch. Ch. 4, 546–550.

Ch, C.C., Ch, C.M., Ch, H.C., Cl Ch, C.C., Ch, C.M., 2004. Ch Ch Ch Ch, Ch. Ch. 7, 499–500.

Chu, C.C., Ch Ch, C.C., 2003. Ch Ch Ch Ch. Ch Ch Ch-Ch Ch "Ch Ch". Ch 19, 1825.

Ch, C.C., Cl Ch, C.C., 1999. Ch Ch Ch, Ch Ch? Ch Ch Ch Ch Ch Ch. Ch, Ch.

Ch, C.C., Ch-Cl Ch, C.C., Ch, C.C., 1998. Ch Ch-Ch Ch. Cl. Ch. 10, 640–656.

Ch, C.C., Ch, C.C., Chu, C.C., Chu, C.C., 2001. Ch Ch Ch Ch 'Ch Ch'. Ch 124, 279–286.

Chu Ch, C.C., Chu, C., 1998. Cl-Ch Chu Ch Ch Ch. Ch, Ch.

Ch, C.B., Ch, C.B., Ch, C.C., Ch Ch, C.C., Ch, C.C., Ch Ch, C.C., Ch, C.C., Ch, C.B., Ch Ch, C.C., Ch, C.M., 1995. Ch Ch Ch Ch Ch Ch Ch Ch Ch Ch Ch Ch. Ch. 15, 3215–3230.

Ch, C.C., 1990. Ch Cl' Ch Ch. Ch, Ch, A.