Spatial congruence in working memory: an ERP study

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Received 13 September 2004; accepted 6 October 2004

The Simon effect refers to the finding that reaction times are faster when stimulus and response locations are congruent than when they are not, even stimulus locations are task irrelevant. Zhang and Johnson reported a Simon-like spatial congruence effect in working memory. This study examined the neural mechanisms of this memory-based spatial congruence effect by recording event-related potentials to probe stimuli. Behavioral results showed a clear congruence effect. The P300 amplitudes were larger in the congruent condition than in the incongruent condition. The results suggest that the memory-based congruence effect and the classical Simon effect were mediated by similar neural mechanisms and support theories assigning response selection an essential role in spatial congruence effects. *NeuroReport* 15:2795–2799 © 2004 Lippincott Williams & Wilkins.

Key words: ERP; P300; Response selection; Simon effect; Spatial congruence effect; Working memory

INTRODUCTION

T e S effec efe e f d g a a a e e ca e e a , eac e fa e e a d e e ca a e c g e a e ey a e [1]. T e e e e c de e a effec e f e fe e ce e e e c , e e a a ca y ge e a ed e e a a a c de e fe e c e c e c de [2,3]. A e a e y, e e ce a- e fe e ce de gge , a e e- fe e ce cc bef e e e e c [4].

T e S effec a d ed a a ce a e e- f e e a decade e e a c e a ed, e a fe yea , e e e a c e e y y e [5 9]. Rece y, Z a g a d J [8] e ed a S- e a a c g e ce effec a a a f e S e be g g e y a . Pa c a f d ed a d ed e e a e e y e a b ef de ay e a a d e e ded a be e e by d ca g e e e be a e e y e. T e c ca fea e a a e dy e ca ed ef g a a ca . T e e a ce f a a c de a f d e e a de ay e a a d affec e f a ce d ce a S- e e fe e ce effec .

T e fac a e y d ffe e e e a a , a e ce a c a f ca a e S effec e a e a d a g e y a e Z a g a d J dy, d ce be a a y a a a c g e effec , de a a e e c a a d c a e e a e f e ce e e e b e f e e effec . I dy, e ec ded e e - e a ed b a e a (ERP) e a e e e e a ec a f e e y c g e ce effec e a e a a f e c a ca S effec . P e ERP d e e S effec a e e ed a P300 e a e a / ce a b a eg d a ed by e c g e ce be ee a d e e ca a ed ced e a a de a d de ayed e e c g e c d e a e e c g e c d [10 12]. T f a c a e e e e e e y c g e ce effec d a ed P300 a a a y.

T e dy de g a e a e a E e e 2 f Z a g a d J [8]. Pa c a e e f e e ed e e e e f g a f e d (F g. 1). T ey e e e e be e de y f e e e ac a de ay e a a d e dec de e e a be a a g e e ed e .

MATERIALS AND METHODS

Participants: T e e de g ad a e (f e fe a e , ea age 22 yea , age a ge 18 25 yea) f Pe g U e y a c a ed f ed c e . A e e g - a ded a c ec ed- - a . T e dy a a ed by e P yc gy De a e Acade c C - ee.

Stimuli and procedure: T e e e b ac a ga a g ay bac g d (116 cd/ ^{2}) a d e e ed a a 120 c e g d a ce. A 0.19 × 0.19° f a c a b e a e cee ce e g e e . T c a e e (eac 0.68 × 0.68° e, ce e- -ce e d a ce 0.68°) e e d a ed ayed 3.77° e ef g f e f a f dy. T e be e e a e e ed ab e e f a (ce e- -ce e d a ce 1.89°).

Eac a bega f a f 1000 . T e dy e e e e e ed f 200 . Pa c a e e a ed d e e e d ac a de ay e a a a ed a d y be ee 1000 a d 1500 . T e be e e a e e e ed f 200 . Pa c a e e a ed dec de e e e be e e a e f e dy e e a d e d by e g a ef a g b a b b . Pa c a e d e b a d a d aced e ef (g) b e ef (g) b .

Eac a c a c e ed 10 b c f 48 a af e 100 ac ce a . T e dy e e e e e ed a d y a d e a y e y e ef g f e f a . T e be a e e e dy e e a f f e a (ye a) a d ab e e e a f (a). F ye a , e be e e a e a y e y be e f ec d dy e e . Ha f f e a c a e ed e ef b f ye a d e g b f . F e e a f, e a a ge e a e e ed.

ERP recording and data analysis: T e e ec e ce a - g a (EEG) a ec ded f 29 ca e ec de ca ed acc d g e I e a a 10-20 y e . E ec de O , P , CP , C , FC , a d F e e a a ged a g e d e. O e e ec de e e ca ed y e ca y e de f e . T e g a d a ed a efe e ce. Eye b e e ed e ec de ca ed be e ef eye. T e a e ec - c g a a ec ded f e ec de aced 1.5 c a e a e ef a d g e e a ca . T e EEG a a f ed a a f-a de ba d a f 0.05 70 H a d d g ed - e (a g a e 250 H). T e ERP e be e e a e aged ff- e 1000 e c a g 200 bef e be e . T a c a a ed by eye b , eye e e , a f e c g, c e e a <100 µV (ea - - ea a de) e e e c ded. Pea a e c e e e ea ed e a e e .

Z a g a d J [8] f d a e c g e ce effec e ac ed e e y e, .e., e c g e ce effec a e f e ye a (eac e a fa e e c g e c d a e c g e c d) a d ega e f e a (eac e a fa e e c g e c d a e c g e c d). We e ef e c a f ed eac a , add be g e e a

e c g e c d be g e e a e

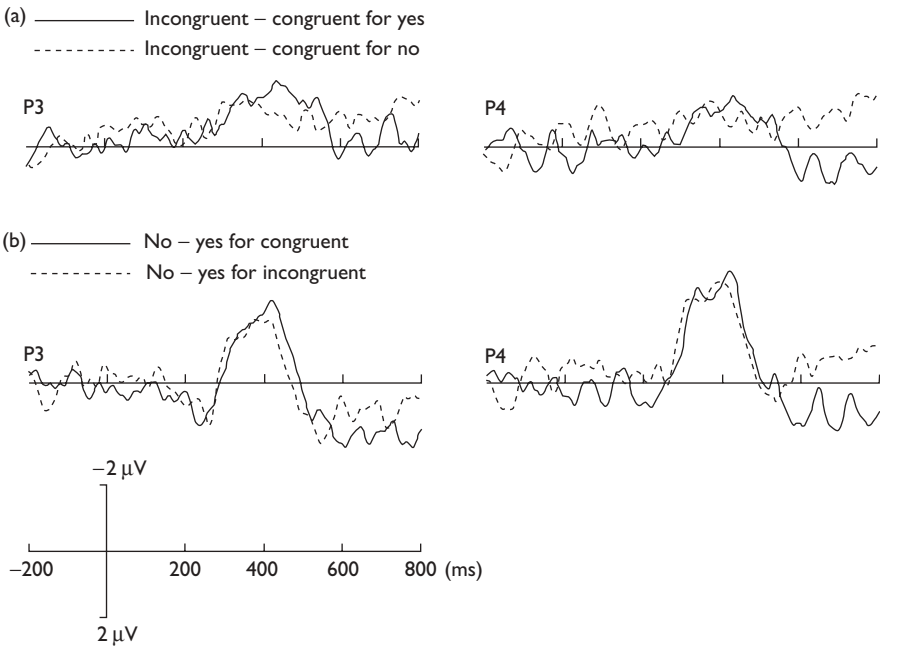

Fig. 3. Difference ERP waveforms over P3 and P4 electrodes, (**a**) incongruent minus congruent separated by response type; (**b**) no minus yes separated by congruence.

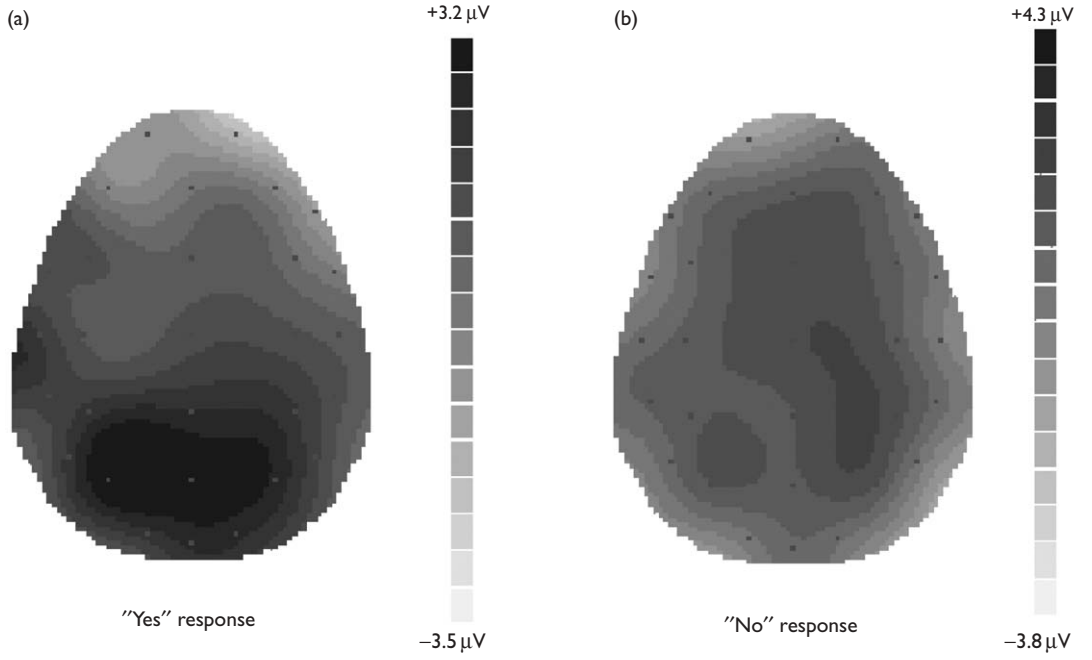

Fig. 4.

T e be a a a d ERP d ffe e ce be ee ye a d e e ef ec a e e y e effec [16,17], c be a c a ed ef a c e ac a [18,19].

O be a a e a e ca ed Z a g a d J [8] f d g a e e y e by c g e ce e ac , e c g e ce effec a e f ye a b ega e f a . H e e, e ERP a ef ed g f c a e ac e eac e da a. Ra e, e c g e ce fac d a ed P300 e a e ay f e ye a a d f e a . G e a e e y e a d c g e ce e e ed c g e- [8] f d g a e e y e by c g e ce e ac , e e, f d g a P300 a e e b fac c g e ce effec a e f ye a b ega e f b e e ac e a be de d.

CONCLUSION

W e ERP ec e, e e e dy de f ed a e a ec a f e e y-ba ed a a c g - e ce effec a a f e c a ca S effec . T e e e g a e e ec a e e a ec a f e a a c g e ce effec a d f e gge a e effec ec f c e ce a ce e b ay ef ec ge e a fea e f e a dec a g ce e .

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Acknowledgements: This research was supported by the Key International Collaboration Project (NSF F2003-79), the Natural Science Foundation of Guangdong, China (#010434), National Natural Science Foundation of China (#30225026), the Ministry of Science and Technology of China (#2002CCA01000), the Beijing Key Laboratory, and Hong Kong Research Grants Council Central Allocation Vote (RGC CAV) grant (HKU 3/02C).