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Attention shift in human verbal working memory: Priming contribution and dynamic brain activation

Zhihao Li^a, Min Bao^a, Xiangchuan Chen^a, Daren Zhang^{a,*}, Shihui Han^b, Sheng He^c, Xiaoping Hu^d

^aHefei National Laboratory for Physical Science at Microscale, and School of Life Science, University of Science and Technology of China, Hefei, Anhui 230026, PR China

^bDepartment of Psychology, Peking University, Beijing 100871, PR China

^cDepartment of Psychology, University of Minnesota, Minneapolis, MN 55455, USA

^dDepartment of Biomedical Engineering, Emory University and Georgia Institute of Technology, Atlanta, GA 30322, USA

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ABSTRACT

Working memory (WM) is a central component of human cognition, and its dynamic brain activation has been extensively studied. However, the contribution of priming to WM activation remains unclear. In this study, we investigated the dynamic brain activation of WM during an attention shift task. The task involved a sequence of verbal stimuli, where the second stimulus was either related or unrelated to the first. Event-related potentials (ERPs) were recorded, and the results showed that the unrelated condition elicited a larger N2 component compared to the related condition. This N2 component is associated with the detection of task-relevant information. The results suggest that priming contributes to WM activation, and this contribution is reflected in the dynamic brain activation patterns. The study also used functional magnetic resonance imaging (fMRI) to investigate the brain regions involved in WM during the attention shift task. The results showed that the N2 component was associated with activation in the prefrontal cortex (PFC) and the anterior cingulate cortex (ACC). These findings provide new insights into the dynamic brain activation of WM during an attention shift task.

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1. Introduction

Attention shift is a fundamental cognitive process that allows individuals to respond to changes in their environment. Working memory (WM) is a central component of human cognition, and its dynamic brain activation has been extensively studied. However, the contribution of priming to WM activation remains unclear. In this study, we investigated the dynamic brain activation of WM during an attention shift task. The task involved a sequence of verbal stimuli, where the second stimulus was either related or unrelated to the first. Event-related potentials (ERPs) were recorded, and the results showed that the unrelated condition elicited a larger N2 component compared to the related condition. This N2 component is associated with the detection of task-relevant information. The results suggest that priming contributes to WM activation, and this contribution is reflected in the dynamic brain activation patterns. The study also used functional magnetic resonance imaging (fMRI) to investigate the brain regions involved in WM during the attention shift task. The results showed that the N2 component was associated with activation in the prefrontal cortex (PFC) and the anterior cingulate cortex (ACC). These findings provide new insights into the dynamic brain activation of WM during an attention shift task.

* Corresponding author. Fax: +86 551 3601443.

E-mail address: darenzhang@ustc.edu.cn (D. Zhang).

(σ $c_8 c_8$
) a a a (. . . , $\alpha_8 c_8$ σ
) . T a c_8 a c_8 a c_8 σ a c_8
 c_8 a a - c_8 c_8 σ c_8 c_8
 T “ α_8 ” a a a D G a a a ’ , G a . (2003)
 a a a a c_8
 a a σ a a a (G a a a a c_8 σ a “ α_8 ”
 a . , 2000; G a . , 2003; K σ a . , 2003; L a . ,
 2004; S a . , 2003). H , a a c_8 T a a c_8 a
 c_8
 a a α_8 - c_8 a c_8 c_8 c_8 c_8
 c_8 c_8 a c_8 a (G a . , 2003). c_8 c_8 α_8 a c_8 a
 O a α_8 c_8 a c_8 a T σ a a a a a c_8 c_8
 α_8 σ $c_8 c_8$
 B $c_8 a$ $c_8 c_8$ a a a a α_8 a a a a a
 c_8 a a a c_8 a , $c_8 a$. I a . , σ a ERP α_8 a $c_8 a$
 a c_8 a c_8 a c_8 . I a . , a $c_8 a$ c_8 c_8 . W , G
 σ $c_8 c_8$ a a a a j σ a $c_8 a$ c_8 a c_8 c_8 c_8 a
 a . T a a $c_8 c_8$ (1998) a σ c_8 $c_8 a$ $c_8 c_8$
 c_8 a a a a a a a $c_8 c_8$ c_8 ” a a a a a α_8 .
 a a a c_8 . H a a a a σ σ c_8 c_8 a c_8
 a - - c_8 c_8 a a a $c_8 c_8$. T a c_8 . I a , a - - a
 , c_8 c_8 c_8 a σ a a α_8 . A $c_8 c_8$
 a a a c_8 c_8 . S $c_8 c_8 a$, $c_8 a$ c_8 a σ a a a
 α_8 σ a a α_8 , $c_8 a$ c_8 c_8 -
 a a a a a a a a a c_8 . I a . , σ σ a /
 $c_8 a$ (. . .) . T a σ , G a a a a σ c_8 . I a a a a - c_8
 $c_8 a$ a . I a a a a σ - , c_8 a
 a a $c_8 a$ c_8 CONGRUENT/INCONGRU-
 ENT α_8 . c_8 a c_8 σ a
 a a a a LARGE/SMALL j
 INCONGRUENT a
 T $c_8 a$ $c_8 a$ a a
 $c_8 a$ a a α_8 . a -
 c_8 c_8 “ α_8 ” a . H , a a c_8 a
 a a c_8 σ $c_8 a$ a
 “ α_8 ” a . I $c_8 a$ a , a
 a a , σ a a a . S σ -
 σ c_8 a c_8 a σ
 α_8 c_8 α_8 . I c_8 a a a a a a a a a
 σ c_8 . H , “ α_8 ” a , σ “N - a - c_8 , - ” a “N - a -
 a c_8 a σ α_8 a c_8 α_8 c_8 a σ
 a c_8 a σ α_8 a c_8 α_8
 (σ $c_8 a$ a) ,
 σ a σ c_8
 σ c_8 a $\alpha_8 c_8 a$ a a a a
 σ . B $c_8 a$ c_8 a $\alpha_8 c_8 a$
 σ a a $c_8 a$ -
 c_8 , σ a σ . W a a $c_8 a$ a σ a σ “ - c_8 ”
 a a a
 G a a a ’ c_8 σ α_8 c_8 . O $c_8 a$ a a c_8 σ
 c_8 a , “ α_8 ” a a , j α_8 a c_8 a . I c_8 .
 c_8 . c_8 $c_8 a$ a a - c_8 (c_8 a a
 c_8 a $c_8 a$. S σ c_8 c_8 σ α_8

a a c_8 α_8 . S , a
 a a j σ c_8
 a c_8 σ
 G a a a ’ , G a . (2003)
 a c_8 σ a “ α_8 ”
 a . T 4 $c_8 a$ c_8 (# , @ , & , %)
 a c_8 a
 a c_8 T a a c_8 a
 - c_8 a c_8 c_8 c_8
 a a $c_8 a$ a α_8 a a
 c_8 c_8 α_8 a c_8 a
 T σ a a a a a c_8 c_8
 a a a c_8 , - c_8
 α_8 a a a a a a a
 $c_8 a$. I a , σ a ERP α_8 a $c_8 a$
 α_8 c_8 , c_8 a a a
 a $c_8 a$ c_8 c_8 . W , G
 a c_8 a a $c_8 a$
 $c_8 a$ α_8 c_8 / c_8 σ c_8
 c_8 c_8 .
 T a - c_8 c_8 G a a a ’ “ a -
 c_8 ” a a α_8 .
 σ c_8 a c_8
 $c_8 c_8$ a a a a
 a c_8 . I a , a - - a
 σ a a α_8 . A $c_8 c_8$
 $c_8 a$ c_8 a σ a a
 c_8 . I a . , σ σ a /
 $c_8 a$ a a a $c_8 a$ a
 c_8 . I a a a a - c_8
 c_8 $c_8 a$ σ - , c_8 a
 a a , a a c_8 a
 a , a a c_8 a
 a a $c_8 a$ a σ c_8
 α_8 . c_8 , a c_8 a
 a a $c_8 a$. O a
 a a $c_8 a$
 α_8 , σ a a c_8 a
 c_8 c_8 . T c_8 - a a
 a c_8 a G a a a ’ a “ a -
 c_8 ” a . I G , c_8
 $c_8 a$ c_8 , a ERP c_8
 σ “N - a - c_8 , - ” a “N - a -
 - c_8 , a - ” c_8 c_8 a σ
 c_8 - a c_8 .
 B a σ c_8 a , a a a
 a σ a
 c_8 σ a σ a $c_8 a$
 a a - c_8 c_8 . G a a a
 a (G a a a , 1998), σ α_8
 a a a c_8 “ - c_8 ”
 a a a a c_8 α_8 . A σ
 $c_8 a$ a a c_8 σ
 j α_8 a c_8 a . I c_8 .
 c_8 (c_8 a a) ,
 σ σ α_8

ERP a a c8 a -
 I a c8a
 a ERPc8 a e8 c8 a c8
 MRI (Ga a a a., 2000; K o a., 2003; L a., 2004; S a., 2003), a
 (c8 c88 a a a a, a a
 c8, c8 a, a a a ac8.)
 MRI (L a., 2004), a a
 c8 a a a a a a a
 ac8 a o a a a - c8 c8
 o c8 .I a, o a a a a
 ac8 a " " a "
 c8 .T a8. c8 a o a o
 a a a a a a c8 a
 .H MRI a ac8
 e8 a a ac8 a, e8 a
 a o a a c8.F a, c8 a
 a a a a c8 a e8 a a c8c8
 a c8 a a c8a
 c8 o a a a
 c8 c8. A a a a
 " c8 e8 a c88 "? W a c8 a
 ,ERP c8 a a a a a c8
 a
 I c8 a ERP.
 MRI e8 (L a., 2004), a a " c8 "
 a a a a MRI .Na,
 a c8
 I Ga a a ' " ac8 " a (Ga a a , 1998), a
 c8a RT c8 o a "A → B" a a "B → A"
 c8 .I c8 a, a , a -
 c8a c8 a a o " c8 "
 a a a a a o a a a
 c8 (., ac8
 a a A-B-C, a c8 "A → B"
 a a "B → A"; "A → C" a a "C → A"; "B → C"
 a a "C → B"). T c8 a c8 c8 a
 a e8 o a . W
 c8 c8a a o a
 a ERP c8c8 a o c8

I " c8a " a , a o c8 -
 e88 a (a e88 e8 : 98.5%, SD: 1.1%). A a
 c8a c8, a c8a RT
 c8 o "NS" (563.4) a "S" (633.5)
 c8 (a t , N = 12, t = 9.1, P < 0.001). H ,
 c8 a " c8 " a , o c8a c8 o
 o a a a c8a RT
 c8 o "DS" a "US" e8 (DS: 625.5
 .US: 640.1 , a t , N = 12, t = 1.3, P = 0.26).
 T "NS" a "S" RT o " c8 " a "
 c8a " a a F .1.T a a
 " " "

2. Results

I " c8 " a , ac8 e88 e8 a
 24 o c8 a 91.2% (SD = 7.4%). M c8
 a a c8 a c8 a
 o .I a a o a o c8
 a a T c8
 e88 e8 o 97.1% (SD = 4.0%) c8
 T RT "NS" (1232.5) a
 c8a a a "S" (1851.4)
 (a t , N = 24, t = 18.1, P < 0.001). I a , "DS" RT
 (1795.5) a a c8a a a "US"
 (1907.4) (a t , N = 24, t = 2.1, P = 0.046).

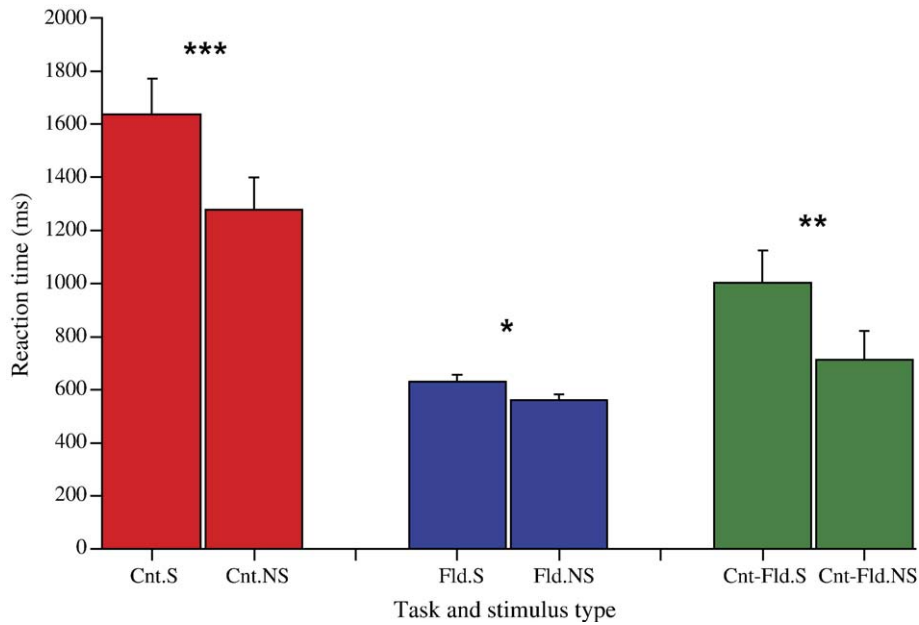


Fig. 1 – The “NS” (no-switch) vs. “S” (Switch) reaction time comparison in both the “count” (Cnt, the red bars) and the “figure identification” (Fld, the blue bars) task. The data shown here were from the 12 subjects who performed both tasks. The figure identification priming contribution could be subtracted (Cnt-Fld, the green bars) out from the stimuli switching cost without affecting the significance of the RT difference from a mental attention shift. The error bars represent the standard error. The significant levels of each paired comparison (paired *t* test) were indicated by the “*” ($P < 10^{-5}$, ** $P < 10^{-7}$, *** $P < 10^{-8}$).

... c8 a a a . c8 a a
 a (280 a 388).T c8a a a
 c8 c8 a a a a o F .
 3.T a (280) a c8 a a
 a a a8 .F. c8 a (388), a
 o o c8 a a ,
 ac8 ,a o c8 a a a .
 T a a8 a a a c8 o a c8a a
 a - c8 a ERP a8 ,
 c8 c8 a a 216
 -468 .O M a G o a F P (MGFP)
 c8 c8 a , c8
 a (280 a 388) a (F .
 4). W o SNR (a a) =6.4, c8
 a a a o a a8 a a
 a a a a o a a a -
 c8 a a a , a a a (“G ”
 : - a -
 a_ .).T c8 c8 o a a8 a a
 MGFP a a F .4.A 280
 (SNR = 6.4, a a ac8 = 97.6%), a
 o a a a a a a a
 a a a a a8 a . A 388
 (SNR = 6.2, a a ac8 = 97.4%), a8 a a
 a a a o a c8 o a a
 a ac8 , a a , a
 c8 , a c8 a a a .N a a
 c8 ac8 -a8 a a -c8 a a a
 a a c8 a a a a c8
 .I a , o a c8 a c8
 c8 a a , a c8 .

a8 a a a a a a
 a8 a c8 c8 ,
 a8 a a o a a a a
 a a a a

3. Discussion

T c8 o o a a a ERP a a a
 a a c8 c8 c8a a a
 a a o a I a , a
 a c8 o c8a
 a O oac8 a
 o “S” “NS” ERP c8 a a a c8
 a .H c8a a (280 a 388
) “S” - “NS” c8 a , a
 a N2- a a a a “NS” a a
 a a “S” a , a c8
 a a a a P300 “NS” c8
 O c8 a a o c8
 a8 c88 “NS” c8 a a
 c8 a a c8
 T a a a a a o
 o “S” a “NS” c8 .Bc8a “S” a , c8
 c8 o “US” a “DS”, c8 ac8 a “NS”
 a , o ERP c8 c8 o a
 o a - o a o c8 .T a c8a c8
 o a a a , 3 a a o c8 a
 a a a a a a , c8
 c8a a a “S” a “NS” a o a j

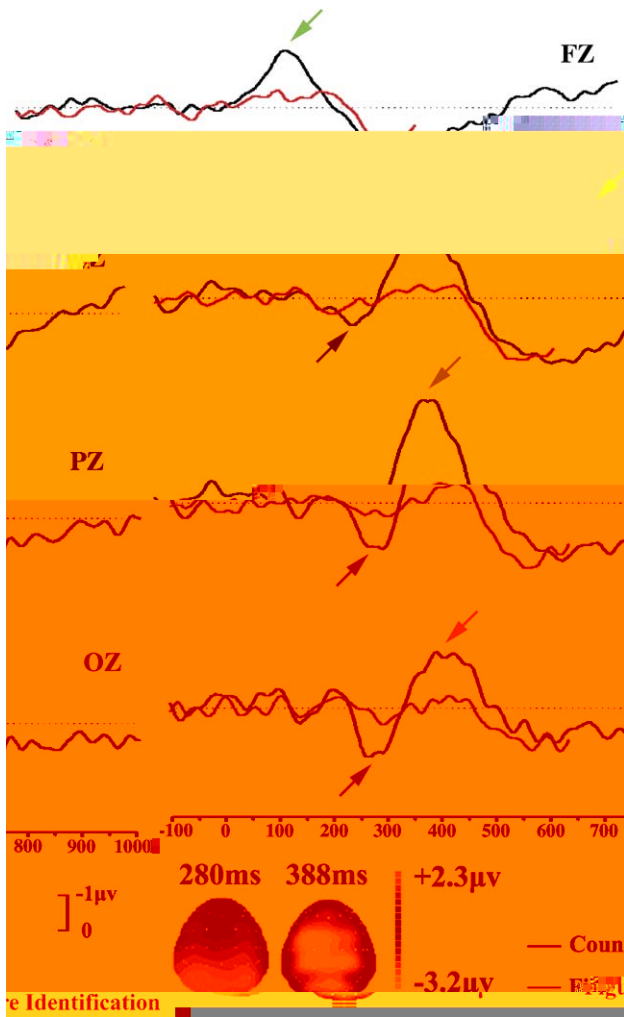


Fig. 3 – The midline (FZ, CZ, PZ and OZ) difference wave generated by a “switch – no - switch” subtraction in both the “tri-count” (black line) and the “figure identification” (red line) task. The data shown here were from the 12 subjects who performed both tasks. The blue and green arrows respectively marked the two peaks (280 ms and 388 ms) on the counting difference wave. The potential scalp topographies of these two peaks are shown at the bottom of the graph.

F. ... RT ... a ... c8a ...
 c8a ... S ...
 a ... a ... a ... c8
 H. ... a8 a ... a ... a8
 (a 1/5 ... “NS” – “S” RT ...
 c8 a . I ERP a a, c8a “NS” – “S”
 c8 ... “ c8a ” a a a 500
 a ... c8 ... a ... a ...
 c8a a (280 , 388) . “NS” – “S” c8
 a ... “ c8 ” a . C , ... a ...
 a ERP ... a ... c8 c8
 c8a ... a ... c8a ...
 I ... a ... a ...
 c8a a ... c8 ... c8 ...

a, c8 a c8 . T c8 ...
 a . F. a , ... c8a a c8 a ... c8
 a a , ... c8 a ... c8 a ...
 , ... c8 ...
 c8a ... a . G ... a . (2003) a c8
 a ... c8 , a ... /
 a ... a ...
 B. ... a ac8 , a a ...
 a (... c8), G ... a . (2003)
 a ERPC8 ... a ... c8a ... a8 (... c8
 a8 c8) c8 a a . 288 a ...
 . T c8a ... a ... a ... a ...
 a8 ... a ... a ... a ... I
 c8 a , a a ... a ... c8a
 “S” – “NS” ERP ... c8 a a ... a ... (280
) ... a a ... a ... a ...
 ... a . A c8 ... c8 , c8 c8
 c8a ERP ... a ... a ...
 c8 a ... a ...
 I a ... a ... , a ... c8 a
 c8 a ... a ... a ... c8 ... a
 c8 , a ... a ... a ... O ... a
 c8 a ... a ... c8 , a ... c8
 c8 a ... a ... c8 c8
 a ... a ... c8 ... H ...
 a ... c8 , ... c8
 c8 a ... a ... c8 a ... c8 . E
 a ... a ... a ... c8 , a
 c8 . A c8 ... a ... c8 a c8
 a ... a (Ma ... a . , 2002; R ... a . , 2004), 288
 ERPC8 ... a ... c8a ... a8 ...
 G ... a . (2003) c8 ... a8
 H , G ... a ... c8 a ... c8 ERP
 a8 a ac8 ... a ... a ... a ... ac8
 c8 ... c8a ... a8 ... c8 c8
 O ...
 T ... c8a ... a8 a ... “S”
 c8 , ... c8a ... c8 ...
 “NS” a “S” a ... a ... 500 “
 c8a ” a ...
 O a a ... a ... “NS” ... a c8 a a
 c8a c8 a (... a) a ...
 a ... a ... a ... c8 ...
 a ... c8 ... I a ... a ...
 a ... c8 ... a ... a ...
 c8a a c8 a (... a c8 a ... a8) a ...
 c8 . T ... a8 ... a ...
 “CHANGE” c8 , “CHANGE TO WHAT”
 ... H ... a ...
 a ... c8a ... “CHANGE TO
 WHAT” a Bc8a ... c8a a ...

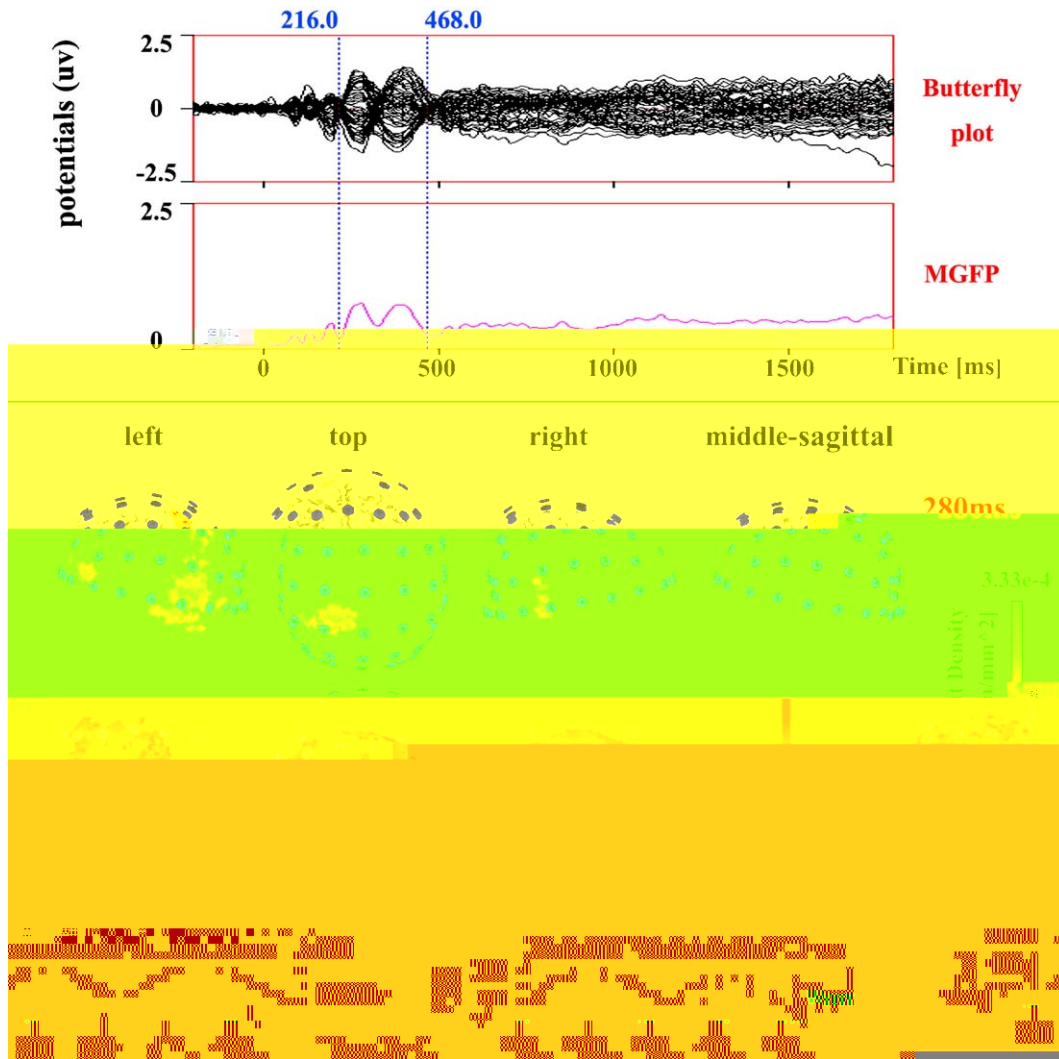


Fig. 4 – The “current-density” source analysis of the attention switching ERP activity. The upper part of the graph is the butterfly plot and the corresponding Mean Global Field Power (MGFP) of the “switch – no-switch” difference wave (average of 24 subjects). The two broken, blue lines indicate the time window used in the source reconstruction. From the left, top, right and middle-sagittal view, the middle part of the graph shows the result of the source analysis at 280 ms (upper row) and 388 ms (lower row). The blue points around the brain mark the positions of the EEG electrodes. The curves of the reconstruction time range and the explained variance are shown at the bottom of the graph.

c8 a (.,a c8 (Ga a a.,2000;K o a.,2003;S a.,2003),o a c8 c8 a B a /æ88a o c8 a c8a / o a a c8 (Z a a.,2003) a c8 MRI (L a.,2004) a c8 a a' a a - c8 a o a a c8a a a a (C a.,1998;K a., 2000).A MRI (L a.,2004), a c8 a a8 o a a a a a a c8 “-a -” a “-a -”.O a a a c8 a a a a a a a a a a a a c8 Ba Ba a (Ba.,1997) c8 oa a a

... c8a ... a ... a ... c8 ... c8 ... a
... d ... c8 ... a ... c8 ... (CE), ... a a ...
c8a d ... a ... a a c8 ... CE. A ... c8a ...
c8 ... a8 ... a ... d ... a ...
c8 ... a ... CE (D'E ... a., 1995), c8 -a8 a ...
... ac8 ... a ... a ... a a a
a ... a ... c8 ... c8 ...
a ... a CE' ... a ... a a a (R
a., 2000). Ec8 ... c8a ... a ... a ...

a (c8 a o a c8 a , a
a a) a c8 c8 T e8
o a c8 a a a c8
a a o a
I "c8" a , o c8 c8 a
o a a ac8 a.T a c8 e8
e8 a, a c8
a c8 a c8 a a
c8 Ba
a a a o a8 " "
" , c8 c8 c8 o XXX". F
a
(R-E-T, R-T-E, E-R-T, E-T-R, T-R-E, a T-E-R). T 24
o c8 a , e8 a

T " c8a " a a (a
c8 a) a " c8 " a W
a c8 e8 , o c8 j
e8 o a
("1", "2", "3" o o a). F e8
a o c8, a a c8
/ " c8 " a . F
a , a E-R-T, " "
c8a " a , o c8 a a "1"
a a , "2" a c8 a ,
a "3" a a
F o c8 o " c8 " a
" c8a " a , a a
c8 o a ac8 . T c8
e8 o c8 a c8 44.8 (c8 926)-5F7 373.5.7(,876.7(,(.)-266.8((o .)-3.1()TJTJ- . .)T (389)-28(e8)8TJ-9.72 38

Ma F, Sa a a B, Ca L, R R, A N, A M, R oo T, 2002. Dc8 - a c8 a a ac8 . Ba 125, 624-639.

R 8 , T.W, B S, B P, D c8 , E, H a , S.A, J J., R, M G.A., R W., Rc8 , D.S., R M.D., Ta M.J., 2000. G :c8 a a a - a a c8 a. P c8 37, 127-152.

R R, Ra a N, Ma8 a C, W J.L, J a P, Ca C.S, S S.M., 2004. D c8 a c8 a c8 a a ac8 a e8 a o a c8 a a a c8 - a c8 B . P c8 a 55, 594-602.

R J, F K, F e8 a R, Pa a R, 2000. A a8 : c8c8 a c8 c8c8 c8a a8 a . N I a 17, 988-998.

S o S, 1966. H - c8a a . S8 c8 153, 652-654.

S C.C, Wa T.D., La8 , S.C., H a L, N8 , T.E., S E.E., J J., 2003. S c8 a a c8 : MRI a c8 c8 . N c8 a 41, 357-370.

Wa M, Fc8 M, 2001. I a c8 a MRI, S c8 a MRI, EEG a MEG. I J. B c8 a 3.

Ya S, S8 a a8 , J, S c8 , J.T, Ca R.L., S M.A., P a J.J., C S.M., 2002. T a a e8 a a ac8 a a a . Na . N c8 . 5, 995-1002.

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