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R 25 M 2 7; 28 2 7; 3 2 7

6 2 7

Abstract

. H w ,

. T w -

R) w w w w . S J

J k k w w .

T R w w 14 . -

w 38 w .

T w , , - w .

, R 14 18 w w J

M - . T R .

2 L . .

Keywords: R ; ; ;

1. Introduction

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w w w R G) (& L , 1989; & ,

(& k , 2 4; & L , 2 6). T 198). H w , J -

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(& S , 2 6). R

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Y : +86 1 6276 1 81.

E-mail address: k . . (S. H).

28-3932/$ 2 . .

:1 .1 16/J. .2 7. 7. 23 L

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w J

(k ., 2 5; ., 2 7) w / w (., 2 4), w k w w - J . , k w w - w , - .

2. Methods

2.1. Subjects

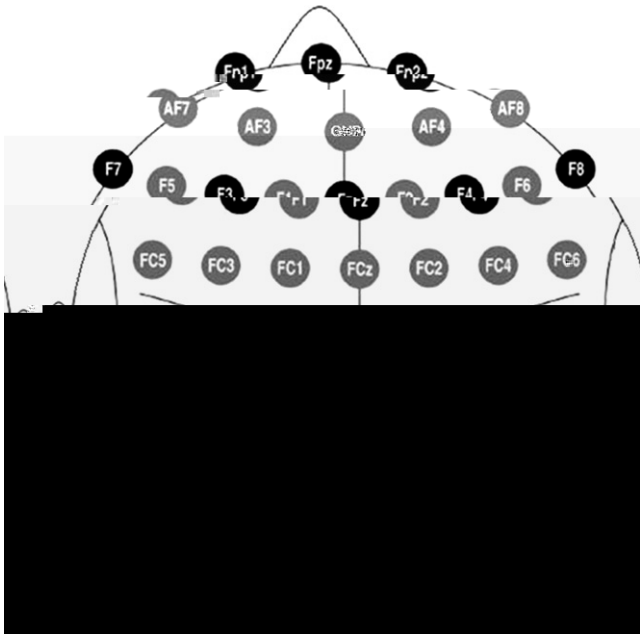
T - (16 15) k . J (3 2) w G . T G w 26 J (13 , 13 , w 18 25 , ± . . = 2 .96 ± 1.87). J . w - , - - , w . w J . T w , k .

2.2. Stimuli and procedure

4 w w V , R (G & H , 2 7). T w - , . 1. . Tw w (1 8 w 12). T w , , . w w w w , , . T w → → w . T w - k w . T w (128 / 2) k 21- w 7 × 5.5 (w ×), 4° × 3.15° w 1 . J 16 k k . k , J (1) J - ; (2) ; (3) J - ; (4) . k w 3 , w k (. ., J) k. T w 8 k. w 2 , w w w w w 8 16 . T k k w J . S J .

2.3. ERP data recording and analysis

T G) w 62 w 1 2 (. 2), w w . T w . T w k 5 k k w - w w . T



. 2. T 62- . G , . N

- w 1.5 . T G w (.1 1 H) 25 H . T R w - w 2 12 . T k , - , ±5 μV w . 8.89% w (: J =9. %; =9.3%; : J =8.5%; - =8.8%). R w - . T R w 2 - w . R w ( ) 2 - 8 - 38 - ( ) 4 - 38 82 - . w - (, S , 3 4, 3 4), (, , 3 4, 3 4), (, 3 4), (T7 T8, T 7 T 8, 7 8), - (, , 3 4, 7 8) . R (RT) w J (N V) w (.), T k(J .), R (.) w - J . T S R w J w , T k, R - , H (N V) S w - J . R w N V , w 3 4 7 8.

2.4. Measurement of subjective reports

G , J w k - . S J w k w w - . T w 6- (1 = , 6 = , 1 = , 6 =) w -R (-R) (, R , S , , &Z , 199), w S w .

T 1
RT ( ) (%) ( )

M

	J	H	J	H
RT				
	6 9. 5 (51.56)	469.83 (4 . 4)	596.13 (43.52)	463.17 (38.66)
N	613.52 (58.33)	466.33 (38. 6)	6 4.21 (49.57)	461.55 (37.37)
	75.95 (11.85)	96.15 (2.84)	81.47 (9.23)	96.25 (2.4)
N	84.77 (6.39)	97. 2 (1.83)	87.19 (6.1)	96.97 (1.96)

3. Results

3.1. Behavioural performance

T RT w T 1. N V RT w T k ($F(1,25) = 3\ 7.12$, $p < .\ 1$) - R ($F(1,25) = 1\ .42$, $p < .\ 1$). RT w S J k k. S J w . T N V - w ($F(1,25) = 13.\ 2$, $p < .\ 1$), T k ($F(1,25) = 157.39$, $p < .\ 1$), R ($F(1,25) = 74.32$, $p < .\ 1$). R S w , J k , . T w × T k ($F(1,25) = 9.\ 7$, $p < .\ 1$), - w w J k k.

3.2. Electrophysiological data

G - R w - . 3 4. k - S w 9 13 (11) . T N 11 w w w 14 2 N (18) w k w 2 28 (24) . T w N k 34 (34) w - - N w 36 8 (3) w R - w w w w 8 14 (1), w w 14 2 (17), w w 2 45 (32). N - w - . T . 3 4 w R .

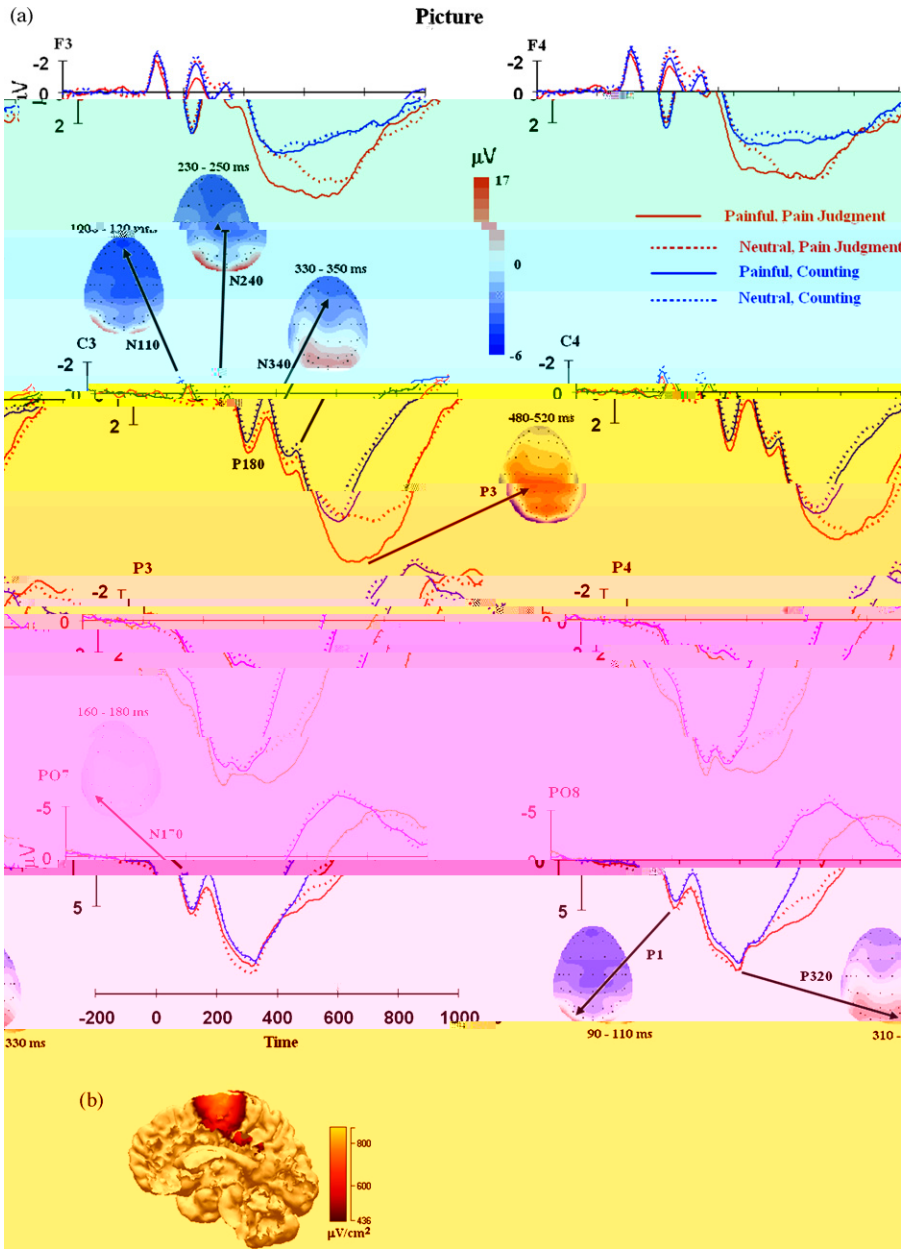
3.2.1. ERPs to picture stimuli

3.2.1.1. Automatic versus controlled processes of empathy.

N V R w 14 2 ($F(1,25) = 14.832$, $p < .\ 1$), 2 28 ($F(1,25) = 16.457$, $p < .\ 1$), 28 36 ($F(1,25) = 15.\ 95$, $p < .\ 1$), 36 66 ($F(1,25) = 3\ .384$, $p < .\ 1$). R - , R w w . T T k w 1 28 ($F(1,25) = 15.\ 61$, $p < .\ 1$), J k w w k. T w T k 46 82 ($F(1,25) = 116.442$, $p < .\ 1$), 3 w J k k. T w w k , w × T k. T w × T k 38 5 ($F(1,25) = 6.6\ 4$, $p < .\ 5$), 3 w J J k ($F(1,25) = 29.846$, $p < .\ 1$) w k (38 46 , $F(1,25) = 3.257$, $p > .\ 5$).

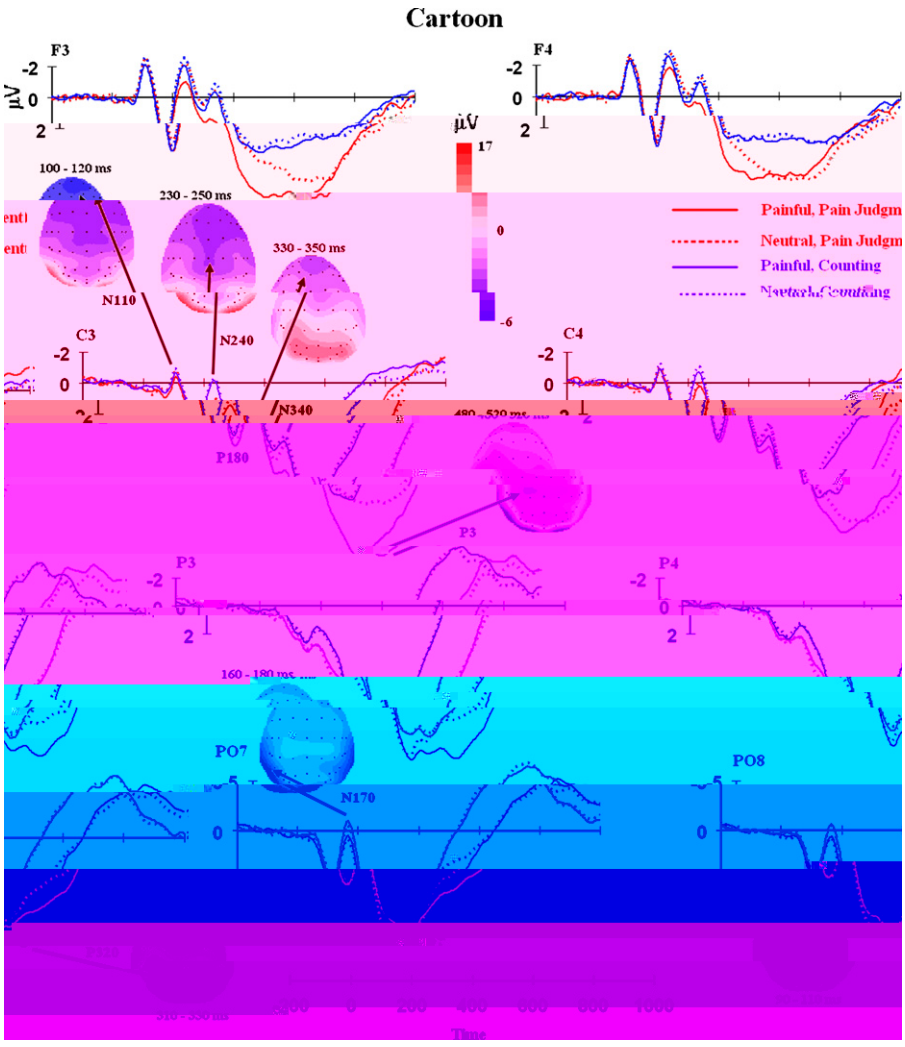
T R - w w 42 66 ($F(1,25) = 9.4\ 8$, $p < .\ 1$), 32 . T w - T k - 8 32 ($F(1,25) = 18.383$, $p < .\ 1$) 46 78 ($F(1,24) = 73.497$, $p < .\ 1$), J 8 32 k, w k k - 46 78 .

× T k w S - 22 3 ($F(1,24) = 5.378$, $p < .\ 5$) 42 58 ($F(1,24) = 6.691$, $p < .\ 5$), - 32 J k. - J k 32 w - w (22 3 , $F(1,25) = 7.432$, $p < .\ 5$) w w - 32 (42 58 , $F(1,25) = 14.377$, $p < .\ 1$). H w , w w k w w w (22 3 , $F(1,25) = .\ 77$, $p > .5$; 42 54 , $F(1,25) = .296$, $p > .5$).



. 3. (R R 3 4, 3 4, 3 4, 7 8 w . T R R w 5 59 .

3.2.1.2. Hemispheric difference. , w H w 8 14 ($F(1,25) = 7.886$, 38 7 ($F(1,25) = 5.853$, $p < .1$), $p < .1$), 22 36 ($F(1,25) = 8.518$, $p < .1$), 3 . H w- 66 82 ($F(1,25) = 6.53$, $p < .5$) , , w , N 11 , N 24 N 34 w 38 54 ($F(1,25) = 12.2$, $p < .1$) , 54 7 ($F(1,25) = .551$, $p > .5$). T 3 w w . . T w × H - T w 38 7 ($F(1,25) = 25.726$, $p < .1$) T k × H N V 2 38 ($F(1,25) = 19.61$, $p < .1$) , 3 , - w N 24 N 34 w w , J k - S



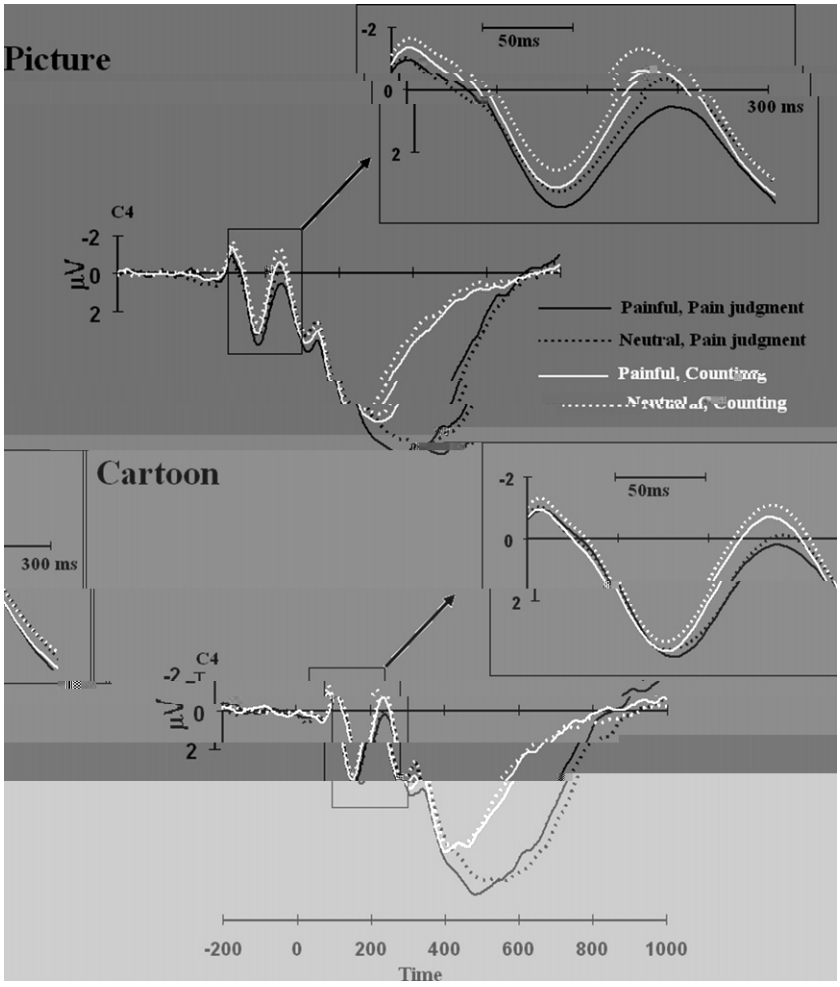
. 4 R R 3 4, 3 4, 3 4, 7 8 w . T R .

. S T k 2 36 ($F(1,25) = 11.469$, $p < .1$) J k R k. , T k w 2 26 ($F(1,25) = 29.385$, $p < .1$) 26 38 ($F(1,25) = .35$, $p > .5$) , J . , w × T k × H N V 42 78 ($F(1,25) = 32.895$, $p < .1$) . S w w × H 42 78 J k ($F(1,25) = 34.566$, $p < .1$). w , J k, w - 42 7 ($F(1,25) = 37.814$, $p < .1$), w w 42 5 - ($F(1,25) = 4.195$, $p < .5$). , × H w k ($F(1,25) = .853$, $p > .5$), w 46 66 ($F(1,25) = 7.852$, $p < .1$). T w T k × H 38 58 - ($F(1,25) = 13.32$, $p < .1$), k . T k 42 S58 ($F(1,25) = 22.56$, $p < .1$) 46 58 (F

w 22 28 ($F(1,25) = 6.475$, $p < .5$), 28 36 ($F(1,25) = 9.894$, $p < .1$) 36 62 ($F(1,25) = 28.382$, $p < .1$), , - , R w w . T T k w 18 26 ($F(1,25) = 15.163$, $p < .1$) 46 82 ($F(1,25) = 75.41$, $p < .1$), - J k 18 26 k, 3 w J k k.

T w × T k w 32 54 ($F(1,25) =$ 1 .528, $p < .1$). S 3 J k ($F(1,25) = 31.44$, $p < .1$) k w 38 54 ($F(1,25) = 2.73$, $p > .1$). - , w 16 3 ($F(1,25) = 15.822$, $p < .1$) 38 62 ($F(1,25) = 22.524$, $p < .1$), k - w w . T w T k - 12 26 ($F(1,25) = 26.975$, $p < .1$), 28 34 ($F(1,25) = 5.69$, $p < .5$), 42 78 ($F(1,25) = 54.291$, $p < .1$) J k w w k. , × T k w M - 22 26 ($F(1,25) = 12.129$, $p < .1$) 38 58 ($F(1,25) = 22.889$, $p < .1$). k S 32 J k ($F(1,25) = 34.974$, $p < .1$) k ($F(1,25) = 2.664$, $p > .1$). H w , k 32 J k ($F(1,25) = 31.3$, $p < .1$) - k ($F(1,25) = .629$, $p > .5$).

3.2.2.2. Hemispheric difference. T w H 22 36 ($F(1,25) = 6.343$, $p < .5$), N 24 34 w N . T H w 66 82 ($F(1,25) = 8.463$, $p < .1$) -



. 5. w R .

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	N , ( )	
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S		
4.36(.71)	4.3 (.74)	1.17 (.25)
4.3 (.71)	4.23 (.7)	1.22 (.2)

3
.
T w × H
w 38 74
($F(1,25) = 21.955$, $p < .1$),
. S 3
(38 66 , $F(1,25) = 39.17$, $p < .1$) (5 66 ,
$F(1,25) = 1.998$, $p > .1$). T w
T k × H 14 42
($F(1,25) = 13.93$, $p < .1$) 58 82 ($F(1,25) = 11.995$, $p < .1$), k
. T k J -
k w w
($F(1,25) = 21.175$, $p < .1$). H w-
, T k w 18 26
58 82 ($F(1,25) = 22.672$, $p < .1$).

3.2.3. Effects of stimulus reality

T w
, w
× R
2 24 S ($F(1,25) = 4.394$, $p < .5$)
. T w
w w ($F(1,25) = 16.457$, $p < .1$)
($F(1,25) = 1.839$, $p > .1$). T
w
w w. .5 -
w
. T k × S
R w 12 16
($F(1,25) = 5.559$, $p < .5$), T k
w w w ($F(1,25) = 1 .272$, $p < .1$)
($F(1,25) = .572$, $p > .5$),
k w J
.

3.2.4. Subjective reports and their correlation with neural activity

T J
-
w T 2. T w J
w (.) R
(N V .) . T w S
($F(1,25) = 565.51$, $p < .1$),
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w w
, - (-
: $t(25) = .545$, $p > .5$; : $t(25) = .5\ 3$, $p > .5$).
, w
M ($t(25) = .782$, $p > .1$),
- ($t(25) = .618$, $p > .5$). W
w
- w
w w w ($r = .688$, $p < .1$) ($r = .498$, $p < .1$).
T w
w w J
, - , w -
w R
w w S -R
, .6. J
J k, R W 14 18
w w
, ($r(1,25) = -.485$, $p < .5$)
- ($r(1,25) = -.464$, $p < .5$). H w ,
R k 14 2
J k w w
, ($r(1,25) = -.641$, $p < .1$)
w - ($r(1,25) = -.152$, $p > .1$).
w R -
N w k
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4. Discussion

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4.1. Sustained neural activity underlying the pain judgment task

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J w J k
k, J k

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k. T J k w w
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. M -
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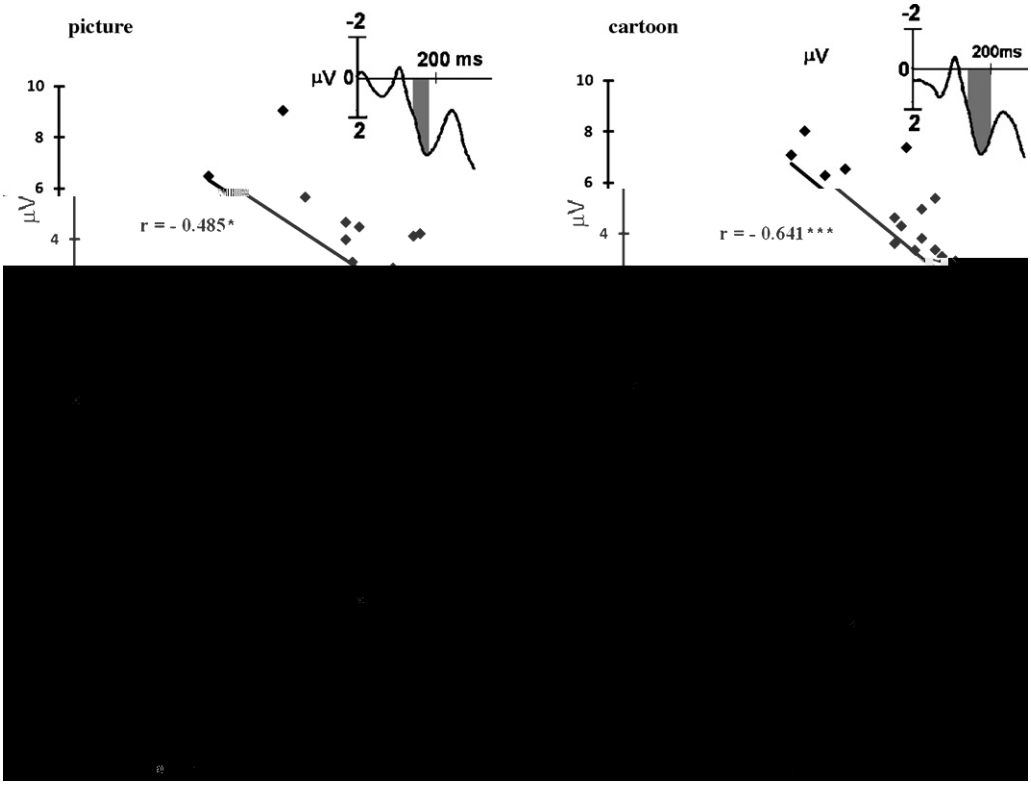

. 6. w R S-R , S-R - .

(k ., 2 5; G & H , 2 7; k ., 2 5, 2 6; ., 2 4; S ., 2 4) w k , , . T w - k J . G H (2 7) - J J - . ( ) w , - w w k (. ., / , , ,) J k . H w , w w J - - . T w k M R - . R M R - -J . T R - w -J - , . ., w w w (k ., 2 5; G & H , 2 7; k ., 2 5, 2 6; ., 2 4; S ., 2 4) w k , , . T w - k J . G H (2 7) - J J - . ( ) w , - w w k (. ., / , , ,) J k . H w , w w J - - . T w k M R - . R M R - -J . T R - w -J - , . ., w w w 1 w - . 1 k (H & - , 1998; , , G , & , 1998), V M , J k, - . T w , R M , (., 1998; , , k w , , L , 2 4). R S w N , & M k w w 38 58 . H w , k , J - w , - w J . w w . T -J k w - w . w 8 32 - J k w k. T R - w w 1 w - . 1 k (H & - , 1998; , , G , & , 1998), V M , J k, - . T w , R M , (., 1998; , , k w , , L , 2 4). R S w N , & M k w w 38 58 . H w , k , J - w , - w J .

4.2. Automatic versus controlled processes of empathy for pain

R w k w - w k - . R w w 14 66 , . ., R w - . T - k w . 14 38 w , 14 38 w k . T 14 38 w J k . T 38 5 , w , w J k w k. - w w k w J , w w w . S , R S , N 11 N 24 , . 3 4. T - R (3) w . T w w . T , R w w . , - R w J k w / . , - R w w J , - . T - R , w , w w J . T R - . - w (& L , 2 6; G ., 2 5), M R w w k (k L ., 2 5; k ., 2 5, 2 6; S ., 2 7; S ., 2 4). w M R w w k w , w w w (G & H , 2 7), M R k- k . R w - , w , , . T k (14 -) w - . T w J , . T J R - . 14 18 w k w J , w - , , , w . S , J M R . , - w J (k ., 2 5) w J , & W , 2 3) - w L . S - . w R , R - , w , , . T , w , . , w R M w w w J - J , . T - , . ., , , w w R M W w (k ., 2 5; G & H , 2 7; k ., 2 5, 2 6; S ., 2 7; S ., 2 4), R - w , w . T , , . T 3 k - . T 3 w , , - (- ,

1981; - & , 1981; & , 1981). T 3 w , w , w - (, w , & G , 2 1 w). 3 , w 3 J k w w . , w J , . S , w S w, w . T - . , , w k , J k - k (G & H , 2 7), k R - . H w , w J ' (k ., 2 5), . T w R M , , (., 2 7). H w , w S w (R k ., 2 6). T - . T - 24 , - . , 32 J k, w . T k w . T k , R . T , w w k . H , , H , Z , T k , R

4.3. Contextual reality of stimuli and empathic responses

T w - , w J w , R (G & H , 2 7). M W w . , , , ( ) - (14). , w k . T , w w k . , R k S 14 2 w w , , - , . H w , R k w w - . T R w w w J , - . T , w R w w (12 16) w k , k R (18 26). T w 3 J - k. M , w w k, w . T R . S - . , . (2) w k w - . H , , H , Z , (2 5) , w w - w - - (. .,), w . , . - , , ,

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4.4. Conclusion

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Acknowledgements

T w k w -
(J 3 63 N 25, 3 225 26, S 3 328 16).
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S .), *Empathy and its development* (. 356 36). N w Y k:
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. *Pain*, *41*, 139 15 .
k, M ., , . ., , L M ., , S ., S , R ., &
k M, . (2 5). V w
. *Neuroimage*, *25*, 312 319.
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R .), *Empathy and its development* (. 361 373). N w Y k:
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M w .
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V w *Trends in Cognitive Science*, *10*, 435 441.
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G V . (2 1). T :
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G V ., & G , . (1998). M
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G L ., , . ., V , T., , S ., S M . L W , , ., , ., , ., & 7 M , G. (2 5). M . L W : T
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G X ., & H , S . (2 7).
. *Neuroimage*, *36*, 256 267.
H , S ., Y ., H , G., W ., Z , T., & , . (2 5).
w . *Neuroimage*, *24*, 928 935.
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L , ., , . ., & , . (2 7). T
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M 3 . *Science*, *211*, 77 8 .
M , ., L , ., , G., & R , N . (2 4). V
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M . *Neuroimage*, *14*, 749 758.
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