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Abstract

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0301-0511/01/$ - [illegible] 2001 E[illegible] B. [illegible] A[illegible].

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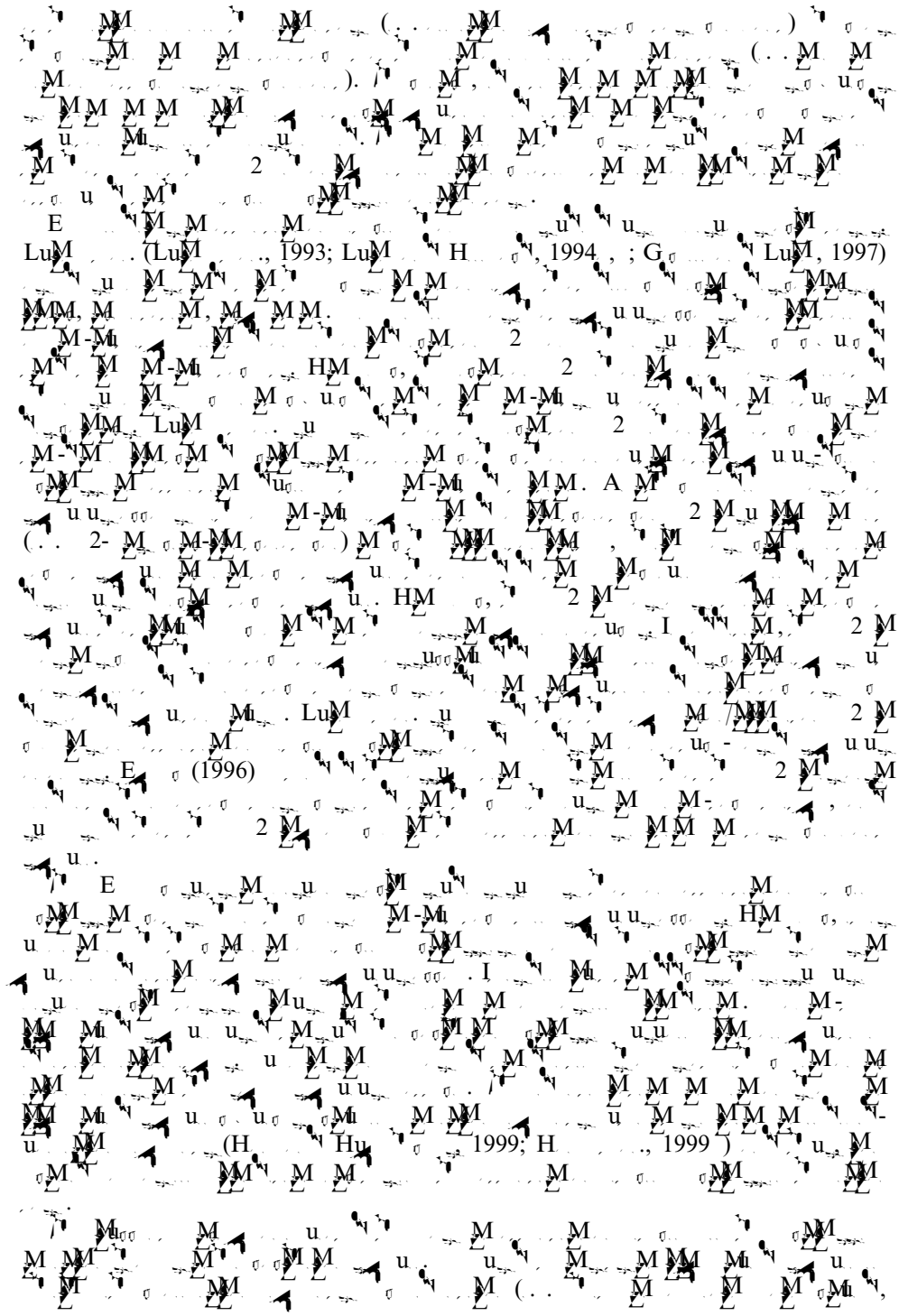
1. Introduction



2. Methods

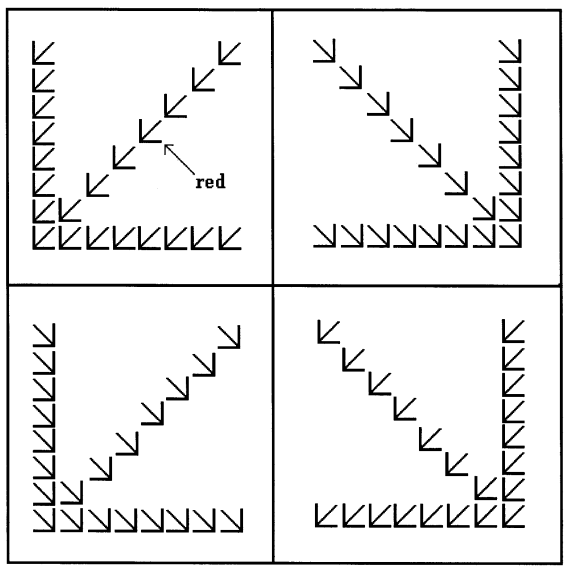
2.1. Subjects

2.2. Stimuli

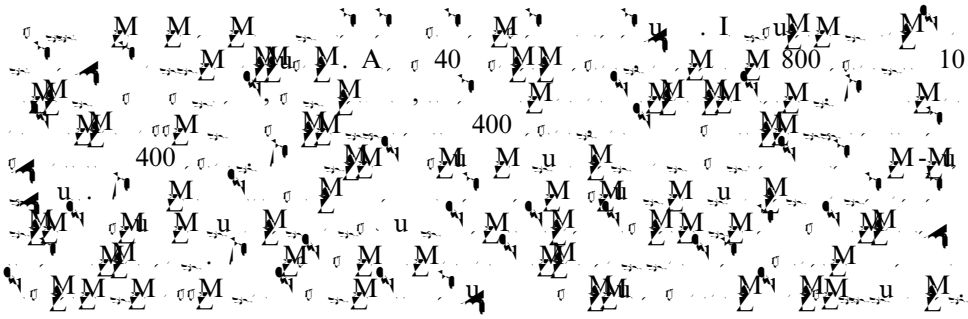
CM Mu u M MM u -MM M M M M 60
M M u M u F . 1. E M M M
u M M MM M M M M M MM M MM
M M M M M . M M 8 × 8
. M MM M u M 4.1 × 4.8 0.38 ×
0.48 M . M M Mu u M M M Mu .
M-Mu u M M M Mu u MM
MM M M . M Mu u M M 0.02 M/ 2.
E M M M M M M M Mu M-Mu u
u M M 0.68 M/ 2 (CIE MM M 0.237/0.285) 0.66 M/ 2
(CIE MM M 0.228/0.219), M .

2.3. Procedure

M MM MM M, M u
0.2 × 0.2 M u , M u u , M
M u M M 400 / M Mu Mu
u u M M 600 1000
M, Mu M u M u M M M M
MM M M M M M Mu u M M



F . 1. I u M MM Mu u u . HM M Mu u MM
M M MM (M M Mu) M-Mu u MM MM
M MM M M.



2.4. ERP recording and analysis

EEG M MM M I M 10/20 F 1, F 2, F3, F4, F7, F8, 3, 4, C3, C4, 5, 6, 3, 4, 1, 2, Fz, Cz, z, M 10 10/20 . FC1/2 M Cz F3/4, C 1/2 M z C3/4. A M M M M 1 M 1 M 3 5, M MM M M 2 M ; (I 3)

/ 1
E

1	80	140	90	130	/ 5, / 6, 3, 4, / 1, / 2, 1, 2, I 3, I 4
1	130	210	150	200	/ 5, / 6, 3, 4, / 1, / 2, 1, 2, I 3, I 4
2	160	220	170	210	F3, F4, FC1, FC2, C3, C4
F / 2	220	360	240	340	F3, F4, FC1, FC2, C3, C4
/ / 2					/ 5, / 6, 3, 4, / 1, / 2, 1, 2, I 3, I 4
H u	200	350	250	320	
u 3	200	350	230	300	C3, C4, 3, 4, / 5, / 6, 1, 2
Homogeneous stimuli					
G	300	700	310	430	
L	300	700	380	500	
Pop-out stimuli					
G	300	700	310	430	
L	300	700	370	490	

/ 2
( ) (%)

	G		L	
	C	I	C	I
Homogeneous stimuli (n = 14)				
/	377	379	425	459
E	6.5	6.3	8.9	16.8
Pop-out stimuli (n = 20)				
/	375	384	440	465
E	1.2	1.8	1.5	2.6

3. Results

3.1. Behavioral performance

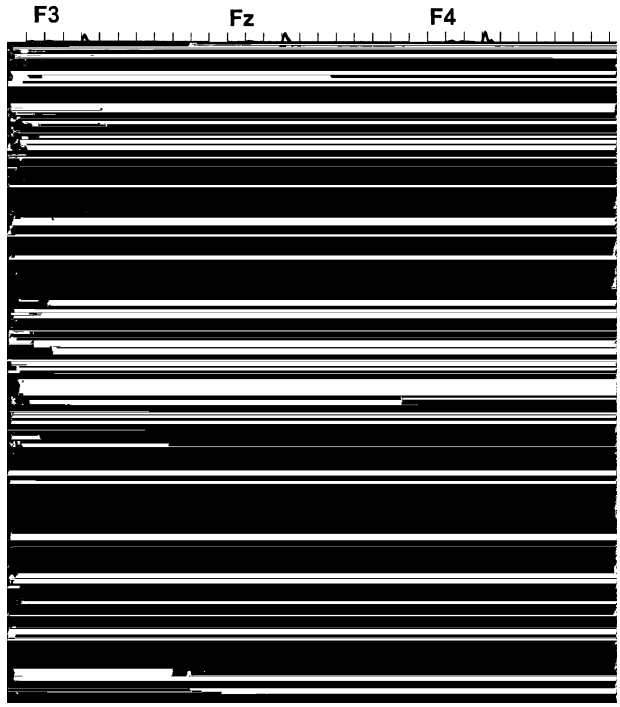
M M MM M M 2. M MM MM M $F(1,32) = 123.7$, $P < 0.0005$ I MM u M - M M M M MM M M $F(1,32) = 140.9$, $P < 0.0005$ M M M M MM M $F(1,32) = 32.0$, $P < 0.0005$ M M u u M M $F < 1$ HM M M G M × CM M × u u M $F(1,32) = 3.93$, $P < 0.05$ u M M M M-Mu M M Mu u . MM M MM , M M M Mu u , M M M MM M $F(1,13) = 70.4$, $P < 0.0005$ u M M MM M $F(1,13) = 1.25$, $P > 0.2$ FM M-Mu u , M , M M M MM M MM M $F(1,19) = 5.73$, $P < 0.0005$, ($F(1,19) = 3.72$, $P < 0.002$, M E M MM (6.5%) M (3.5%) MM M $F(1,32) = 141.0$, $P < 0.0005$ M M M MM MM $F(1,32) = 35.2$, $P < 0.0005$ M M M M M Mu M-Mu u $F(1,32) = 126.7$, $P < 0.0005$ M M G M × CM M M $F(1,32) = 12.3$, $P < 0.002$ M M M MM M M M M u u × G M $F(1,32) = 13.6$, $P < 0.001$ M M M M uM M M-Mu M M M G M × CM M × u u M M $F(1,32) = 8.96$, $P < 0.005$ A A M M M M M u M , M M M Mu u , M M M MM M M $F(1,13) = 20.4$, $P < 0.0005$ FM M-Mu u , M , M M MM u M M M MM M M $F < 1$

3.2. Electrophysiological data

E M MM u M M MM , M MM - MM MM , MM MM MM M M M u . E M M MM M u F 2 3. FM M M u , E M M M M MM 1 80 140 1 130 200 M 2 200 350 A M M E M M M 2 160 260 M 2 220 360. A M 3 300 700 M M u M u .

3.2.1. P1 and N1

M M G M M MM , M , M M 5 6: $F(1,32) = 15.40$, $P < 0.0005$; 1 2: $F(1,32) = 15.28$, $P <$



F . 2. G E M M M M M M M M M M u .
GC, M MM ; GI, M MM , LC, M MM , LI, M MM .

0.0005; I 3 I 4: $F(1,32) = 19.25$, $P < 0.0005$; 3 4 ($F(1,32) = 10.56$, $P < 0.003$ / 1 M u MM M M MM M 1 / M M u u CM M, M M Mu MM M M $P > 0.05$ / A A M M M M 1 u M

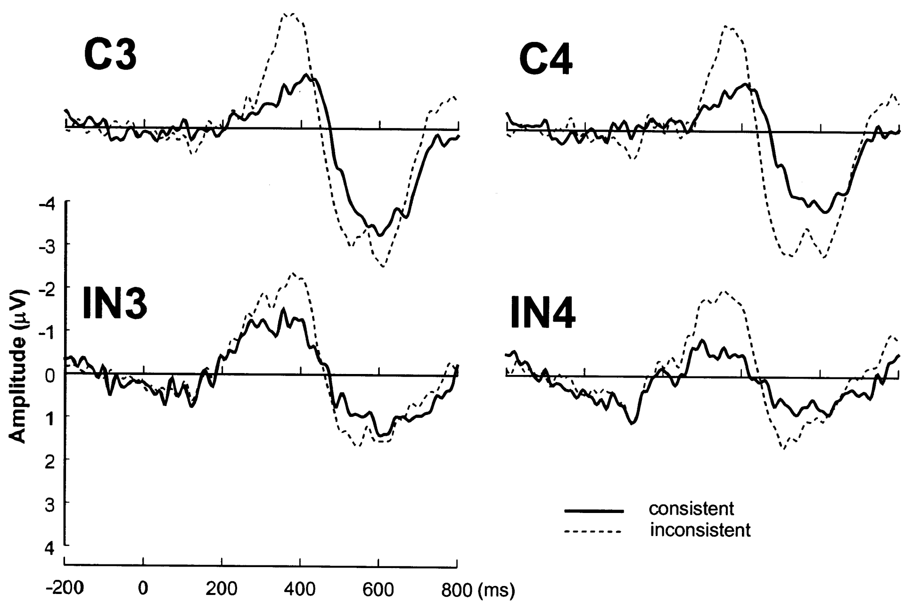
3.2.2. Frontal/central N2

/ u M M /M 2 MM M M MM M F3 F4: $F(1,32) = 18.16$, $P < 0.001$; FC1 FC2: $F(1,32) = 32.13$, $P < 0.001$; C3 C4: $F(1,32) = 36.68$, $P < 0.001$ I M, M M M u u × G M (F3 F4: $F(1,32) = 8.13$, $P < 0.007$; FC1 FC2: $F(1,32) = 8.66$, $P < 0.006$; C3 C4: $F(1,32) = 8.77$, $P < 0.006$ M M M /M 2 M M M M M-Mu M M Mu u . M u M M /

1 MM Mu M M 1 u M /MM MM M M M M Mu Mu ($P < 0.03$) u M M M-Mu Mu ($P > 0.1$), Mu M M M M Mu HM , M M u u M M , M M MMu 1 M M Mu M u M

M 2 M M M MM M M M M M u P > 0.1 u M M MM M M M-Mu u F3 F4: $F(1,19) = 27.92$, $P < 0.001$; FC1 FC2: $F(1,19) = 43.76$, $P < 0.001$; C3 C4: $F(1,19) = 41.12$, $P < 0.001$ / MM u M M MM MuM M M 2 u M) MM M MM M u M M M G M × CM M F3 F4: $F(1,32) = 8.43$, $P < 0.007$; FC1 FC2: $F(1,32) = 10.75$, $P < 0.003$; C3 C4: $F(1,32) = 9.96$, $P < 0.004$ / MM u M M MM M 2 M F3 F4: $F(1,32) = 8.15$, $P < 0.007$; FC1 FC2: $F(1,32) = 4.58$, $P < 0.04$; C3 C4: $F(1,32) = 7.69$, $P < 0.009$ / M M MM M M MM M u M M G M × CM M FC1 FC2: $F(1,32) = 4.19$, $P < 0.05$; C3 C4: $F(1,32) = 4.70$, $P < 0.05$ / 2 M M M M M M M M M-Mu u , M M M u u × G M F3 F4: $F(1,32) = 6.06$, $P < 0.02$ / M M M u u × G M × CM M M M F3 F4 $F(1,32) = 7.24$, $P < 0.01$ M M M M M M M M M M M-Mu u .

F . 3. G E M M M M M M M M M-Mu u . GC, M MM ; GI, M MM , LC, M MM , LI, M MM .



F . 4. D [illegible] E [illegible]

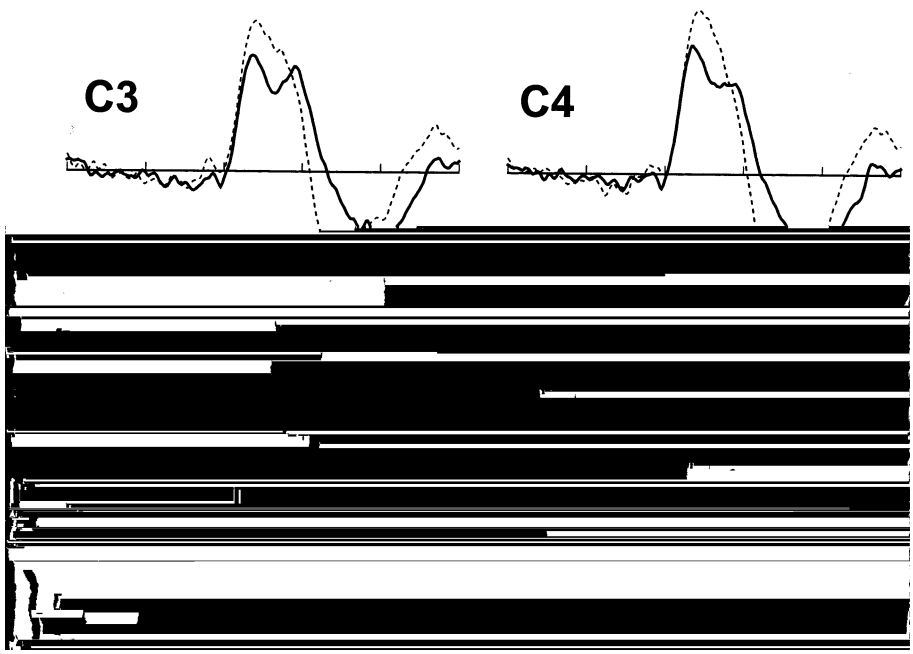
3.2.3. *Temporal/occipital N2*

[illegible] /[illegible] 2 [illegible] 5 [illegible] 6: $F(1,32) = 17.05$, $P < 0.001$; [illegible] 1 [illegible] 2: $F(1,32) = 7.43$, $P < 0.01$; I 3 I 4: $F(1,32) = 5.08$, $P < 0.03$ [illegible] /[illegible] 2 [illegible] 5 [illegible] 6: $F(1,32) = 12.63$, $P < 0.002$; [illegible] 1 [illegible] 2: $F(1,32) = 4.64$, $P < 0.04$ [illegible] /[illegible] 2 [illegible] 5 [illegible] 6: $F(1,32) = 26.63$, $P < 0.001$; [illegible] 1 [illegible] 2: $F(1,32) = 28.45$, $P < 0.001$; 1 [illegible] 2: $F(1,32) = 31.46$, $P < 0.001$; I 3 I 4: $F(1,32) = 48.89$, $P < 0.001$ [illegible] G [illegible] × C [illegible] 5 [illegible] 6: $F(1,32) = 4.94$, $P < 0.03$; [illegible] 1 [illegible] 2: $F(1,32) = 5.07$, $P < 0.03$ [illegible] × G [illegible] I 3 I 4 $F(1,32) = 4.39$, $P < 0.04$ [illegible] /[illegible] 2 [illegible] /[illegible] 2 [illegible] 5 [illegible] 6: $F(1,32) = 11.64$, $P < 0.002$; I 3 I 4: $F(1,32) = 6.42$, $P < 0.02$ [illegible] /[illegible] 2 [illegible] /[illegible] 2 [illegible] E [illegible]

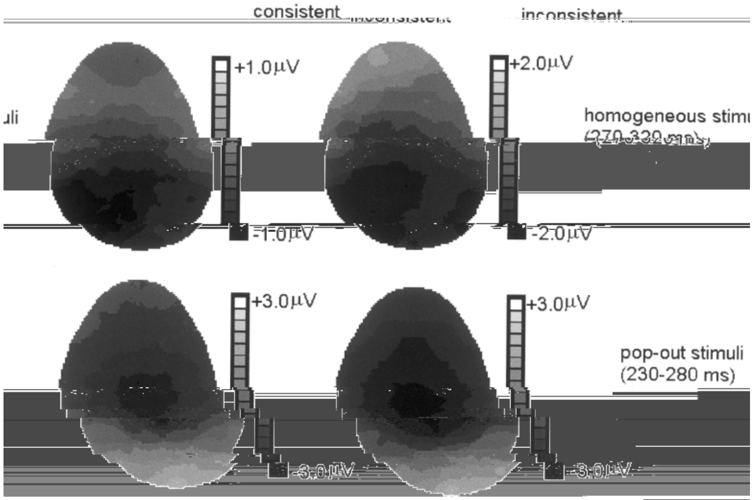
E u MM M M M u (F 4 5). F . 6 u
M M M M 2 M . M , M
M M M u , M 2 M M M
M /MM (M , u M
M M M). FM M-M u , M , u M
M 2 M M M M /MM
u M M M .

3.2.4. P2 and P3

/ 2 M M M MM MM M
M M M F3 F4: $F(1,32) = 8.02$, $P < 0.008$; FC1 FC2: $F(1,32) = 4.57$, $P < 0.04$ / u M A A M 3 u M M
/ 3. 3 u M MM MM MM M /
M M M M M M M u
M M M M G M × CM M. 3 M M M
MM M M M M u M M
M MM Mu u . / M M M G M × CM M -
, u M M M 3 M MM
M MM M / M M u u M M M
MM M M .



F . 5. D M M u M E M MM M M E
M MM M M M-M u u M MM / M
M M M M M M M .



F. 6. [illegible]

4. Discussion

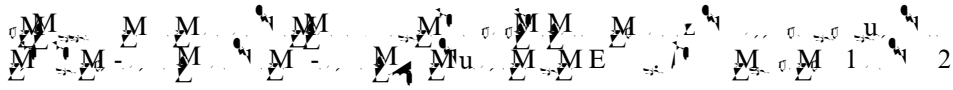
[illegible]

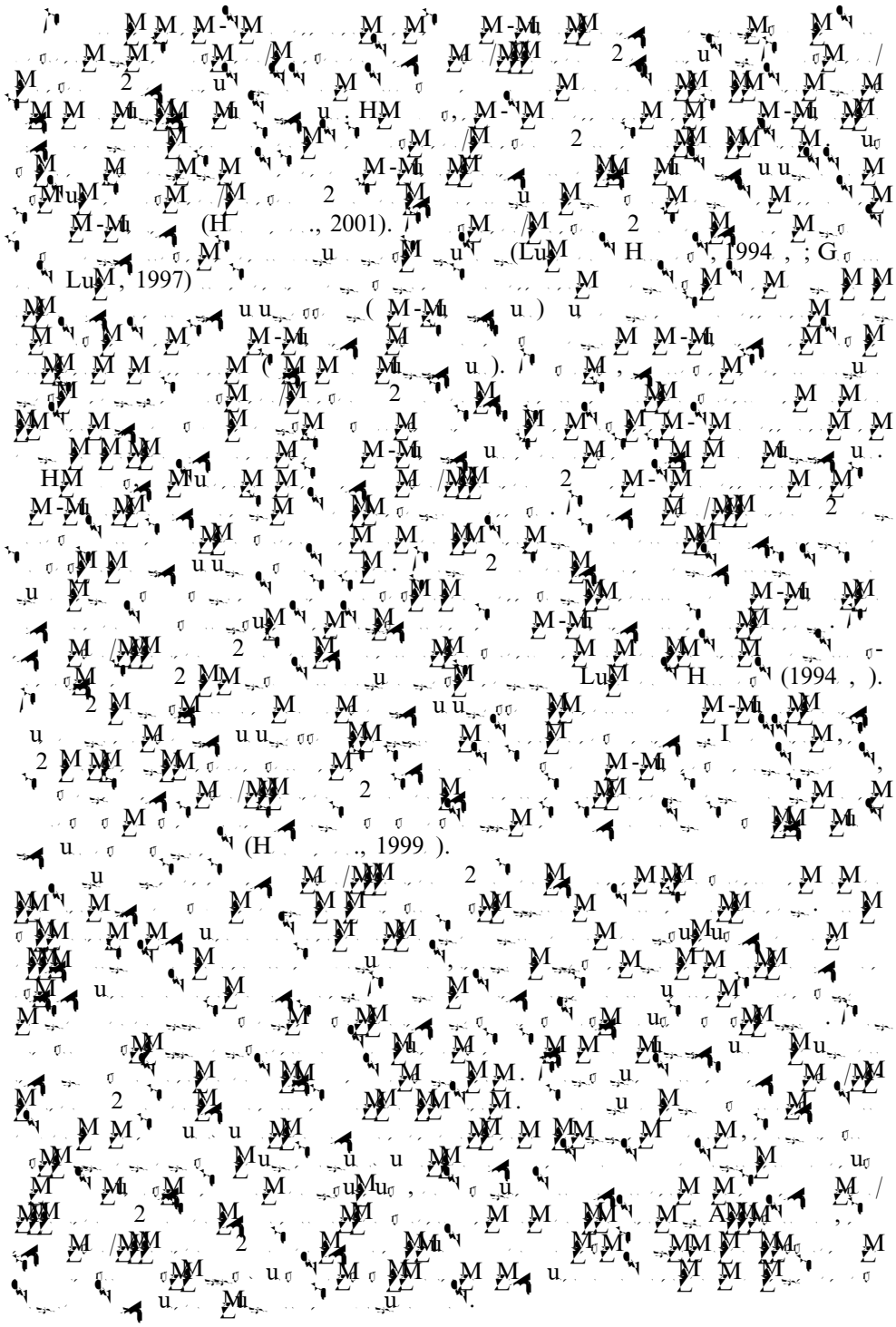
Table 3

[illegible]

	G	C	G × C
P3 amplitudes			
C3 C4	0.002	[illegible]	0.003
[illegible]3 [illegible]4	0.001	[illegible]	0.003
[illegible]5 [illegible]6	0.001	[illegible]	0.017
[illegible]1 [illegible]2	0.001	[illegible]	0.002
P3 latencies			
C3 C4	0.001	0.001	0.001
[illegible]3 [illegible]4	0.001	0.002	0.001
[illegible]5 [illegible]6	0.001	0.001	0.001
[illegible]1 [illegible]2	0.001	0.001	0.001

G, G[illegible]; C, C[illegible]; G × C, G[illegible] × C[illegible].





[illegible] (B[illegible] ., 1990; Hu[illegible] ., 1990; L[illegible], 1993, 1996[illegible] Hu[illegible], 1997). [illegible], 1987; [illegible], 1999). [illegible]

Acknowledgements

[illegible] (MH-41544), [illegible] (-32893), [illegible] G A. [illegible]

[2] [illegible] (H[illegible] H, 2001) [illegible]

References

B MM, J.C., M , F.A., B MM, D. ., LM M , .J., 1990. LM - u M M M - M u . M M 19, 617 629.

B M M.J., , K., 1992. / M M M u - M M . M M 51, 465 472.

DMM , E., 1977. E - M : MM u M u M M MM . I : B , H. (E .), E M B M B M. u , M , . 13 88.

E , M., 1996. / 2 MM M M M M M M . E M M M M C . u M M 99, 225 234.

F , G. ., H , . ., M , J.C., F , C.D., F MM , . .J., DM , .J., 1996. M u M M M ? u 382, 626 628.

G , M., Lu M , .J., 1997. A M M u M M u M MM, M M, M M? J. CM . u MM. 9, 238 253.

H , ., C , L., 1996. M M M MM M A M M C C 39, 179 188.

H , ., Hu G. ., 1999. I M M M u M z M M G M M M M MM . M . M 6, 1287 1298.

H , ., H , ., 2001. LM z M M MM M M M M MM , u M M.

H , ., F , ., C , L., uM ., 1997. MM M M : M M MM M u . J. CM . u MM. 9, 686 697.

H , ., F , ., C , L., uM ., 1999 . MMu M M M : - E u . B / MM. 11, 171 183.

H , ., Hu G. ., C , L., 1999 . MM MM M M : M u M MM M MMu . J. E . M M: Hu . M . . 25, 1411 1432.

H , ., H , ., MM D.L., 2000. H M M M - M M M M MM 37, 817 830.

H , ., H , ., u , E. ., MM D.L., 2001. LM M-M M MM M M M G u .

H z , H.J., Mu , F., 1993. E M M MM M M M M u u M : M M M M M M M M . u M M MM 31, 841 852.

H z , H.J., H M H., M , M., Bu M , ., M u , G. ., 1998. u M M M M MM MM . A M E/ E u . J. CM . u MM. 10, 485 498.

Hu , ., 1997. / M M u M M M M M M M M . MM , 59, 187 201.

Hu , H.C., F M , ., u -LM z, .A., 1990. G M u MM MM M M M u M J. CM . u MM. 2, 272 282.

I , .B., M M, L.C., 1999. / / M M M M. MI / C , MA.

K M , .A., M , J.M., 1979. / M M u M : M- M ', M M -u ', M - M ', M . M . MM , 25, 225 231.

L , M. ., u , E. ., 1993. / M M u M M M M z u . M . MM , 47, 489 496.

L , M. ., u , E. ., 1996. u M M: M M -, -, MM M- M M M MM M M M M M , 58, 363 373.

Lu M, .J., H , .A., 1994 . E M M MM M M u u u M. MM MM 31, 291 308.

Lu M, .J., H , .A., 1994 . u u M: M M u M M MM . J. E . MM : Hu . M . . 20, 1000 1014.

Lu M, .J., F , ., H , .A., 1993. A M- Mu M M M - M M u M . J. CM . u MM. 5, 188 195.

M , M., 1979. LM M MM : M M . M . CM . 7, 476 484.

M C , G., D M , E., 1981. A M M M : M M M 300 M M
. M M 211, 77 80.
Mu , G., 1986. M M M u M 23.3()- M M2( )-0 M2( )-0I : u H73(M) M .2(1986J)-473.2