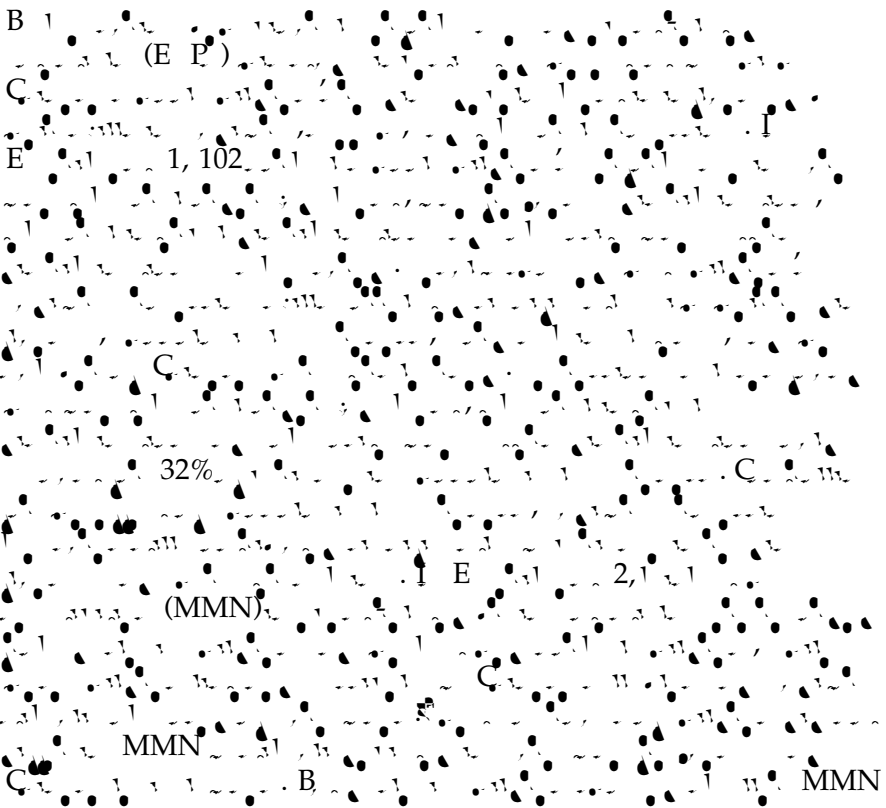


Figure 1. Grand average ERP waveforms for the MMN component. The MMN component is indicated by the asterisks. \*p < 0.05, \*\*p < 0.01, \*\*\*p < 0.001.



100871, C. N. P. : +86-10-6276-1081, F. : 7104@...; C. N. P. : 95-...-09; C. N. P. : 30200078, 30070260, 30470569, 60435010; C. N. P. : M. E. : 01002, 02170, 01JA L 015

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Keywords: (MMN)

INTRODUCTION

P & (1994). L (B & B 1978, 1983; B & B 1985; L, F, & P 1988). P D E (B & B 1978; M, C, & 1993; & 1995; & 1994), (1981), (K, 1986), ( & 1988; , 1985), (B & , 1993; D & , 1976), ( & G, 1997; B, 1997). I

47(-352)-332.747.5( 5.9 010( 1( ( )-7.828. )2( )0 .9( )-4.9( ), ).6(



C... ( ... )  
 C...  
 & F... ( ... , C... , A... , & ... , 2003;  
 & H... , 2000; H... & B... , 1997). B...  
 I...  
 E... 1... C...  
 102... C...  
 E... 2... E P...  
 C...

E PE IMEN 1

R... ? I...  
 ? E...

Method

Participants

Q... (52... 50...  
 = 129... )... B...  
 A... M... C...

Design and procedure

I... C...  
 P... M... ( ... & ... , 1985)

DMD (Fuchs & Fuchs, 2003)

2000

60 B.

*Linguistic Tests*

*vocabulary test* (Fuchs & Fuchs, 1996) 210

10

P

( )

P

*Reading fluency test* 95

5

P

C

10

*phonological awareness test* (Baker & Baker, 1978)

20

I

50° (109/1000)  
 (20/1000)

*Auditory and temporal tests*

I tone frequency discrimination task,  
 (700 Hz), 500, 300, 120 Hz, 7

I tone temporal order judgment,  
 2000 Hz, 800 Hz, 50, 5, 10, 10, 75%

I temporal interval discrimination,  
 (1000 Hz), 500, 100, 10, 50, 100, 75%

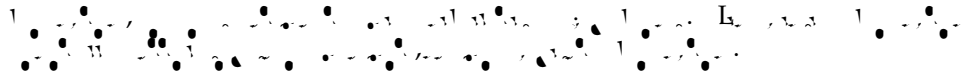
composite tone pattern discrimination task,  
 2000 Hz, 800 Hz, 150, 50, 150, 75%, 25%

**Results**

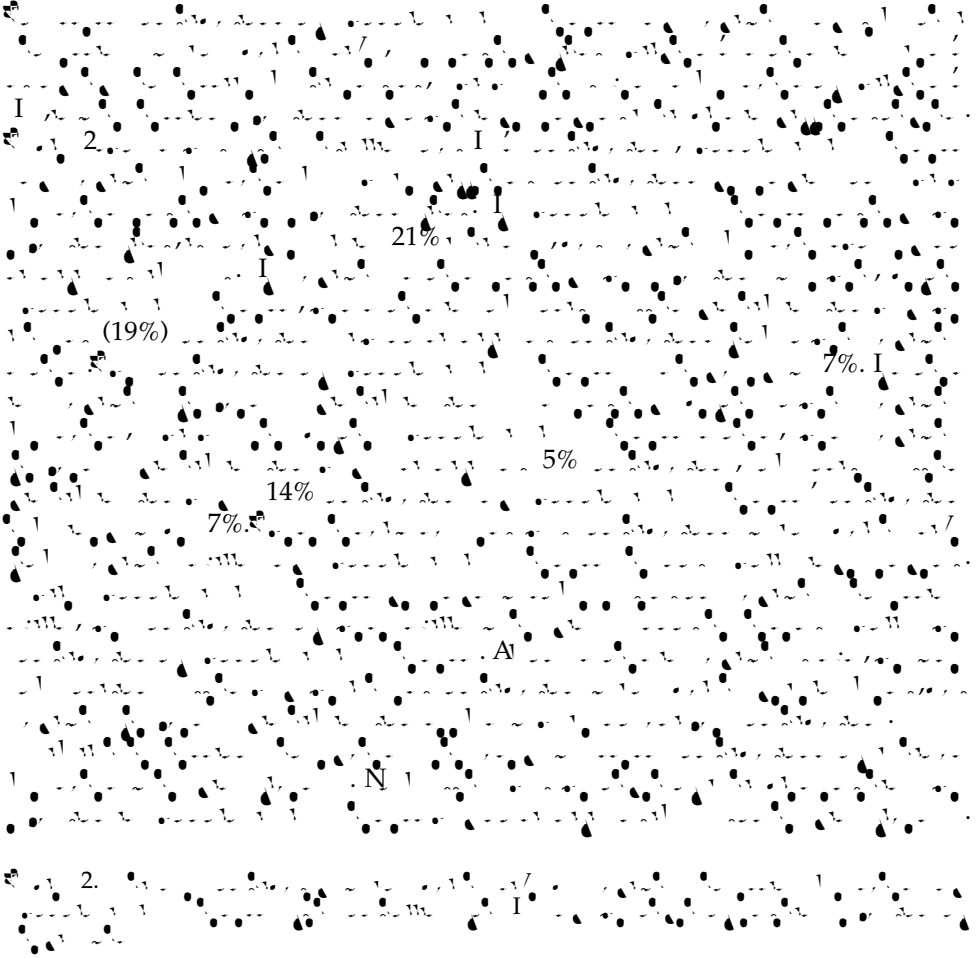
I

	1	2	3	4	5	6	7	8	9	10
1. M										
2. P	0.24*									
3. C	0.16	0.33**								
4. P	0.35**	0.50**	0.22*							
5. C	0.10	-0.18	-0.27**	-0.20*						
6. C	0.02	-0.34**	-0.37**	-0.18	0.38**					
7. C	-0.20*	-0.35**	-0.14	-0.30**	0.01	0.06				
8. C	-0.28**	-0.25**	-0.26**	-0.30**	0.18	0.10	0.06			
9. C	-0.01	-0.22*	-0.31**	-0.26**	0.18	0.25**	0.02	0.34**		
10. C	-0.27**	-0.23*	-0.28**	-0.46**	0.07	-0.01	0.14	0.21*	0.55**	
11. C	-0.17	-0.43**	-0.22*	-0.56**	0.08	0.31**	0.22*	0.26**	0.26**	0.35**

N = 100; \* <0.05; \*\* <0.01; \*\*\* <0.001.



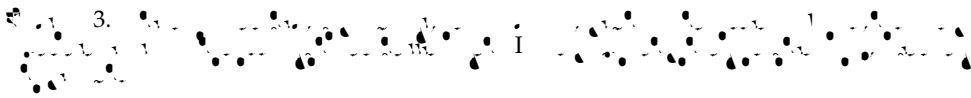
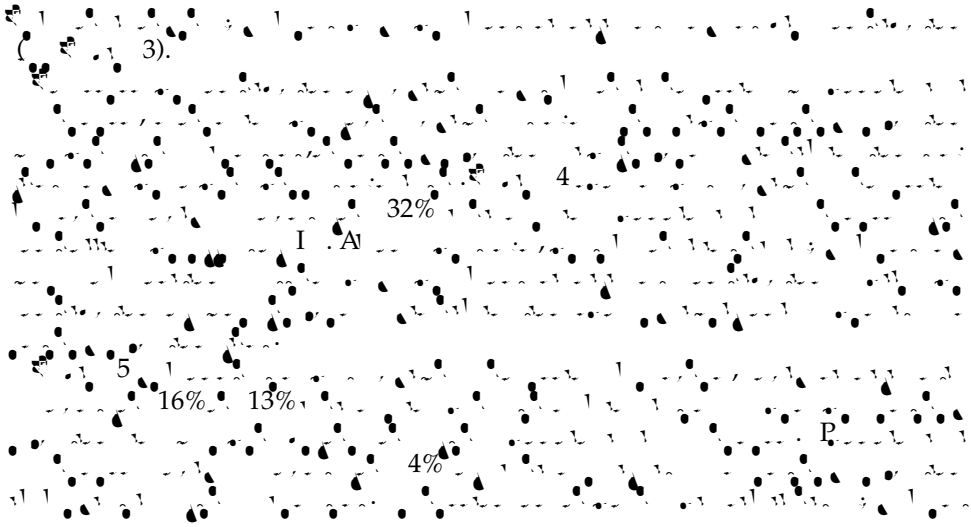
Multiple regressions



D	P	R <sup>2</sup>	R <sup>2</sup>	t
	1.	0.05	0.05*	2.29*
	2. C	0.24	0.19***	-3.55***
	3. P	0.31	0.07**	2.86**
	1.	0.05	0.05*	2.29*
	2.	0.10	0.05*	-2.22*
	3. C	0.24	0.14**	-3.55***
	4. P	0.31	0.07**	2.86**
	1.	0.05	0.05*	2.29*
	2. P	0.26	0.21***	5.02***
	3. A	0.31	0.05	

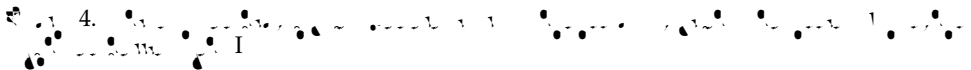
N.B.: \* <0.05; \*\* <0.01; \*\*\* <0.001.





D	P	R <sup>2</sup>	R <sup>2</sup>	t
E	1.	0.03	0.03	
	2.	0.17	0.14*	-2.01*
	3. P	0.172	0.002	
	1.	0.03	0.03	
	2.	0.09	0.06*	-2.30*
	3.	0.17	0.08*	-2.01*
	4. P	0.172	0.002	
	1.	0.03	0.03	
	2. P	0.06	0.03	
3. A	0.172	0.11*		

N<sub>1</sub>: \* <0.05.



P	R <sup>2</sup>	R <sup>2</sup>	t	
P	1.	0.12	0.12**	2.46**
	2.			-2.63**
	C	0.44	0.32**	-4.9***
	1.	0.12	0.12**	2.46**
	2.	0.16	0.04*	-2.14*
	3.			-2.63**
C	0.44	0.28**	-4.9***	

N<sub>1</sub>: \* <0.05; \*\* <0.01; \*\*\* <0.001.

5.

D	P	$R^2$	$R^2$	$P$
C	1. I	0.00	0.00	0.84
	2. A	0.16	0.16	0.00**
	3. P	0.17	0.007	0.66
	2. P	0.04	0.04	0.05*
	3. A	0.17	0.13	0.01**

N.B.: \* <0.05; \*\* <0.01.

## Discussion

7%

C

C

2

H

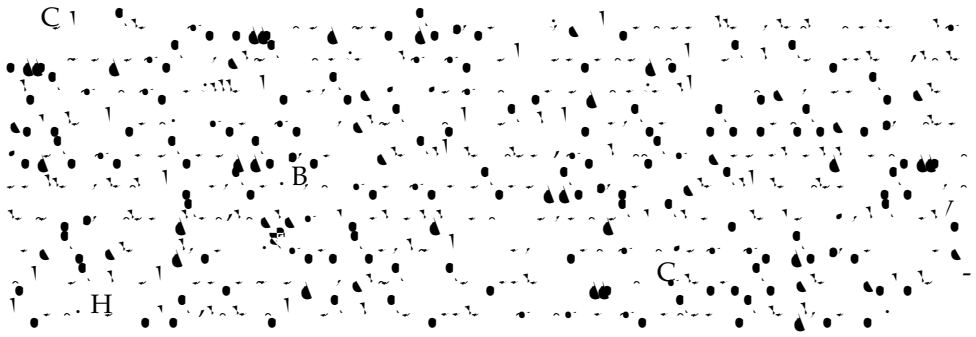
C

C

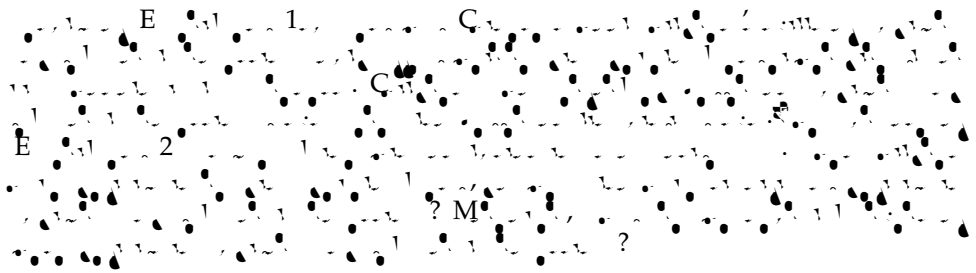
et al., 2000; et al., 1998). I

per se

C



EXPERIMENT 1



Method

Participants

Participants were 23 (12 males, 11 females) aged 19–23 (M = 20.1, S.D. = 1.34) from the University of Illinois at Chicago. They were recruited from psychology courses and received partial credit for their participation. The experiment was approved by the Institutional Review Board at the University of Illinois at Chicago.

The experiment was controlled using a personal computer (HP) running the software (HAKLD) (HAKLD, C. Meng, & L. D. Levine, 2000). The stimuli were presented on a 15-inch monitor at a viewing distance of 40 cm. The background was black, and the points were white. The points were arranged in a regular grid, with some points missing or replaced by other symbols (e.g., 'M', '?').

The experiment consisted of two parts. In the first part, participants were shown a grid of points and asked to identify the missing points. In the second part, participants were shown a grid of points and asked to identify the points that were not in the original grid. The results showed that participants were able to identify the missing points and the points that were not in the original grid.

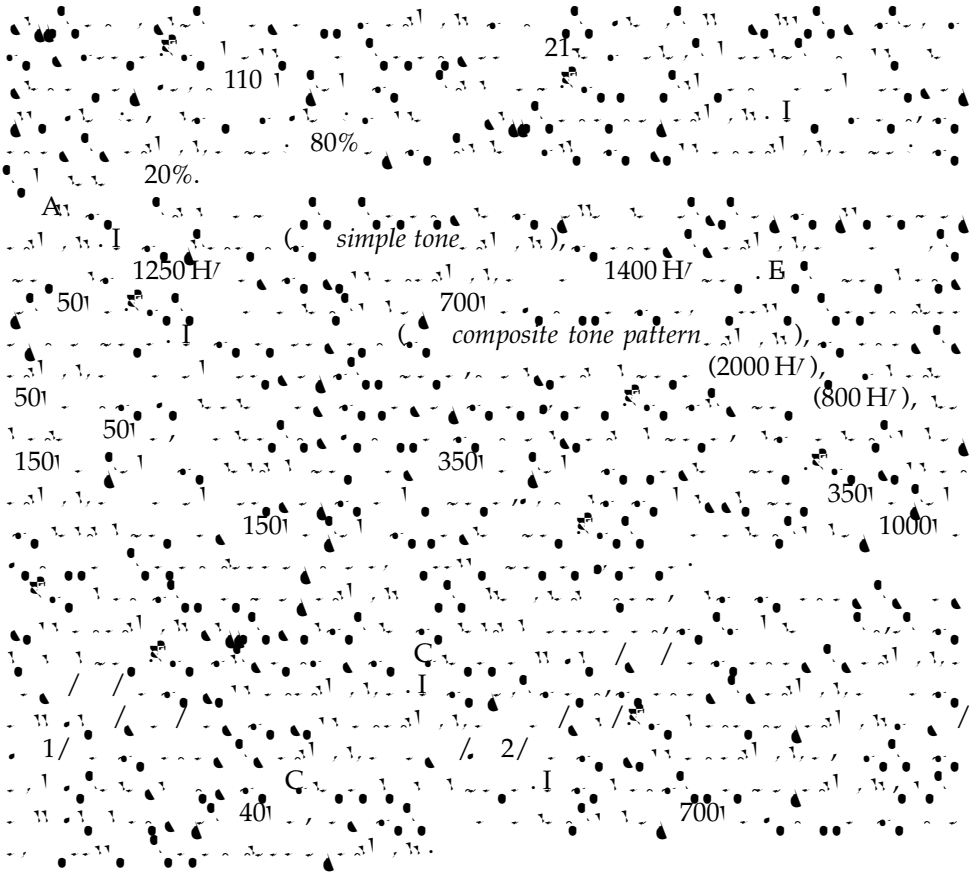
Stimuli

The stimuli were generated using a software program (HAKLD) that created a grid of points. Some points were missing, and some points were replaced by other symbols (e.g., 'M', '?'). The grid was presented on a computer monitor, and participants were asked to identify the missing points and the points that were not in the original grid.

Figure 6: Behavioral performance and ERP components for simple and composite tones.

	A I (D)	I I (D)	C	D	
C	10.91 (0.34)	75.84 (4.24)	9.56	9.97	10.02
D	11.18 (0.48)	81.81 (2.36)	5.7	7	5.875

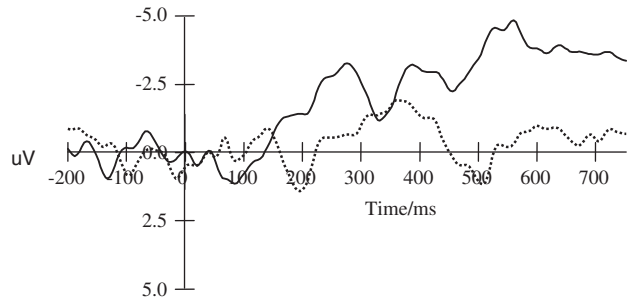
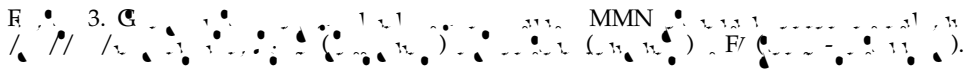
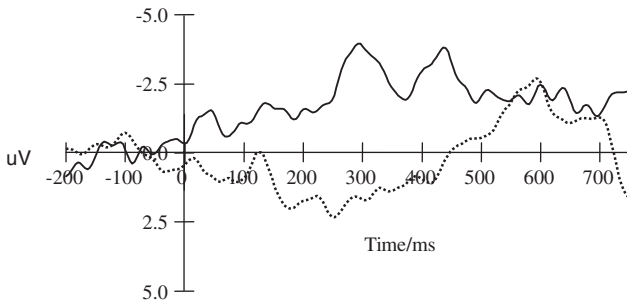
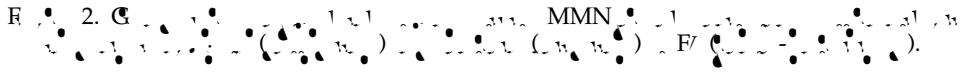
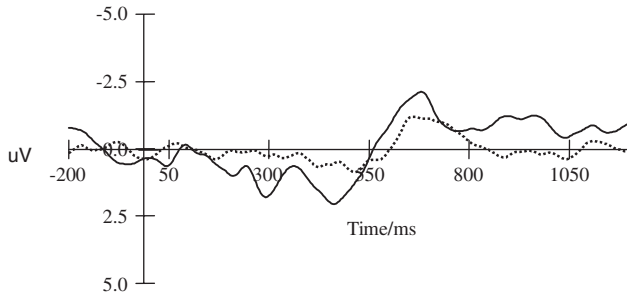
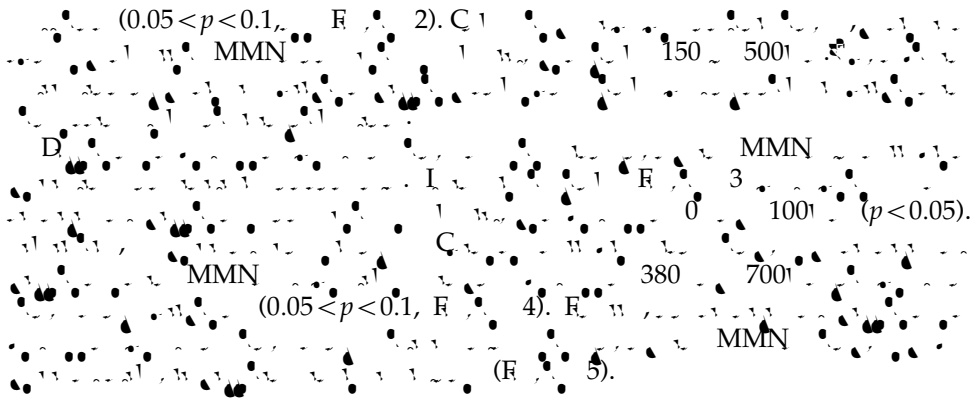
$p < 0.01$ .



Procedure

Participants were seated in a sound-attenuated room. They were presented with a series of tones (C, M, P) and were required to respond (yes/no) to each tone. The tones were presented through headphones. The ERP components (A, I, C, D, E) were recorded from the scalp. The components were identified based on their latency and amplitude. The components were then analyzed using statistical methods.





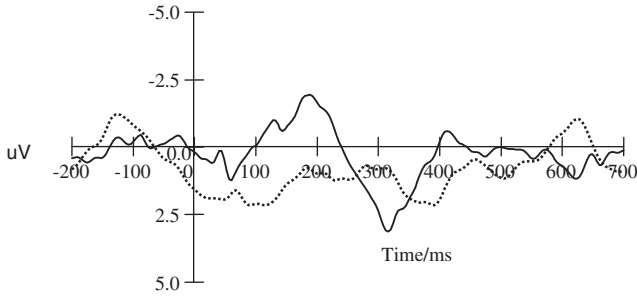


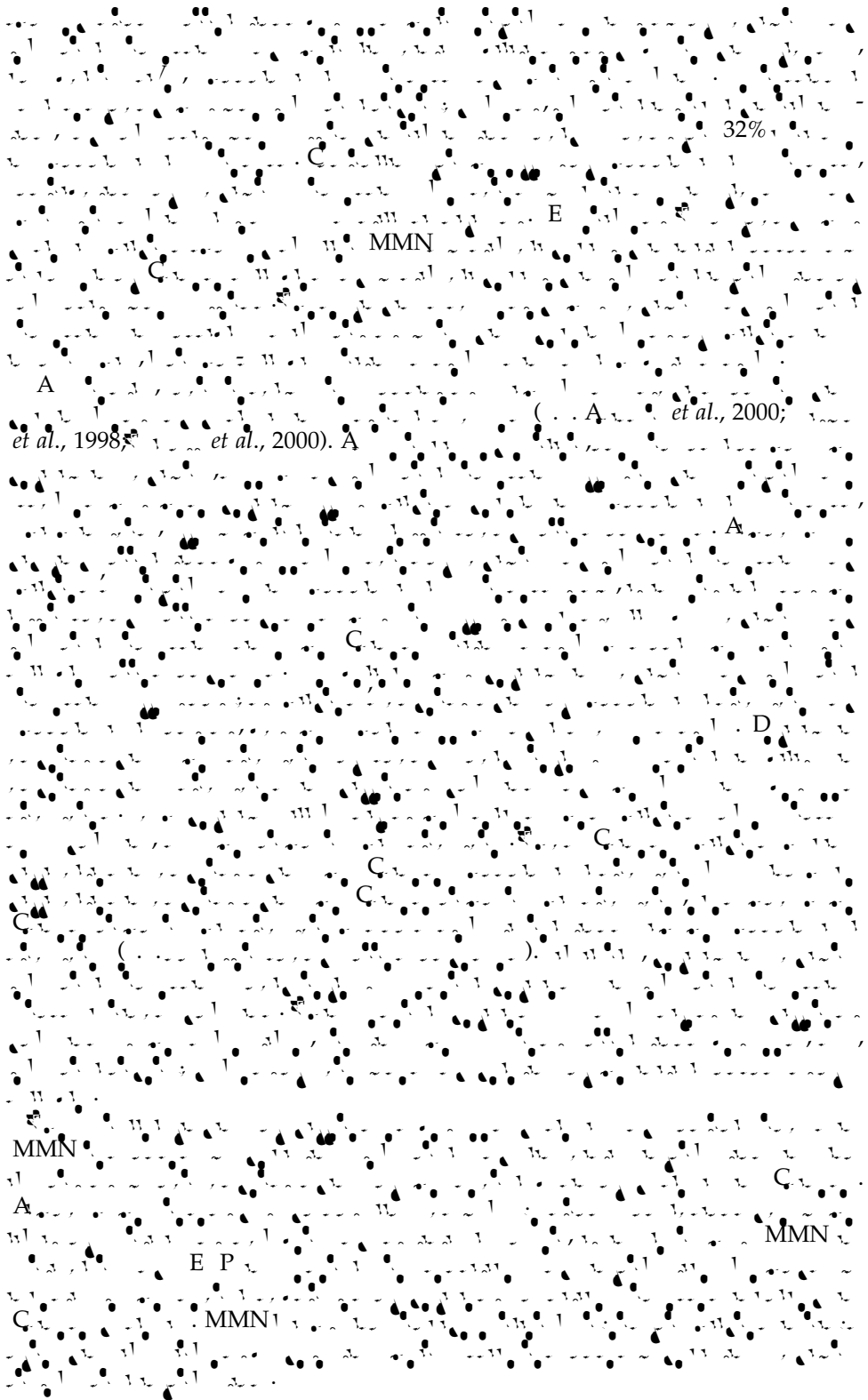
Figure 5. MMN (Mismatch Negativity) waveforms. The solid line represents the MMN component, showing a positive peak around 200ms. The dotted line represents the MMN component, showing a negative peak around 300ms.

Discussion

Our study investigated the MMN component in response to pitch deviations. The MMN component was observed in the early time window (around 200ms) for the solid line and in the later time window (around 300ms) for the dotted line. These findings are consistent with previous research (Mäkelä et al., 1996; Kujala et al., 1999). The MMN component is thought to be generated in the auditory cortex and is related to the detection of pitch deviations. The MMN component is also thought to be related to the processing of pitch contours (Mäkelä et al., 1995; Ahissar & Ahissar, 2000). The MMN component is also thought to be related to the processing of pitch intervals (Ahissar et al., 2000; Kujala et al., 2001). The MMN component is also thought to be related to the processing of pitch direction (Bregman et al., 1999). The MMN component is also thought to be related to the processing of pitch amplitude (Pöhlmann et al., 2001).

GENERAL DISCUSSION

The MMN component is a key component in the processing of pitch deviations. It is thought to be generated in the auditory cortex and is related to the detection of pitch deviations. The MMN component is also thought to be related to the processing of pitch contours, pitch intervals, pitch direction, and pitch amplitude.





I  
D  
C

## ACKNOWLEDGEMENT

C. N. P. (95-09), N. N. E. C. (30200078, 30070260, 30470569, 60435010), M. E. (01002, 02170, 01JA L 015). E. P.

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