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tion-dependent activities of autonomic nervous system. Considering the advantages of ERPs, researchers began to use the components of ERPs to detect guilty knowledge, such as P300 (Fang and Shen, 1998; Rosenfeld, 2002) and N400 (Boaz et al., 1991). All these studies focused on the ERP components with latency less than 1000 ms. These components, P300 and N400, mainly reflected the cognitive processing of stimulus. After processing the stimulus, subjects make a response decision, then execute this response. It is very straightforward to think there would be some differences in cognitive processing prior to making honest and deceptive responses. This kind of difference is what we wanted to address in this study.

The contingent negative variation (CNV) (Walter et al., 1964) is a slow negative EEG shift which develops in the interval between two stimuli. The first stimulus, the 'S1' or 'cue' is a warning signal and the second one, the 'S2' or 'imperative stimulus,' that signals the subject to make a response. The CNV is characterized as a sustained negativity over wide areas of the scalp. It varies systematically in its distribution across the scalp as a function of stimulus modality, task parameters and response requirements. The CNV is presumed to highlight the functional equivalence of underlying processes, such as cortical excitability, arousal, attention, uncertainty, preparedness, receptiveness, resource mobilization, level of effortful involvement and motivation, however, no consensus has been reached (see review McCallum and Curry, 1993). For longer inter-stimulus intervals, two components can be distinguished: an early initial component (iCNV) with a maximum over anterior regions(Simons et al., 1983) and a late terminal component (tCNV), immediately preceding S2, with a central maximum shifted contralaterally to the side of the responding hand (Brunia and Damen, 1988). iCNV is thought to reflect the ongoing processing of information provided by S1(Gaillard and van Beijsterveldt, 1991) and probably indicates activity related to response selection (van Boxtel et al., 1993). tCNV, is largest at the vertex and is similar to the readiness potential preceding self-paced movements; it has been assumed to reflect response preparation (Rohrbaugh and Gaillard, 1983). Other sources can also contribute to the tCNV, such as the anticipation of S2 (Kotani and Aihara, 1999), working memory activity

Table 1
The mean difference of CNV amplitudes for three kinds of stimuli

Pair	Mean difference	S.D.	Pair	Mean difference	S.D.
C3_FA—C3_TA	1.5527*	1.7780	FT7_FA—FT7_TA	1.5566***	1.2805
C3_ST—C3_TA	3.7268***	0.6338	FT7_ST—FT7_TA	0.3887	2.2127
C4_FA—C4_TA	3.8044***	0.7215	FT8_FA—FT8_TA	1.7196**	1.4405
C4_ST—C4_TA	4.1051***	0.7980	FT8_ST—FT8_TA	2.6068***	1.0649
CP3_FA—CP3_TA	3.7207***	1.2103	FZ_FA—FZ_TA	3.6878***	1.1913
CP3_ST—CP3_TA	1.4180*	1.8974	FZ_ST—FZ_TA	3.9766***	1.0928
CP4_FA—CP4_TA	3.8054**	3.6318	O1_FA—O1_TA	4.6856***	1.8098
CP4_ST—CP4_TA	4.8002*	5.6465	O1_ST—O1_TA	4.3894***	1.3684
CPZ_FA—CPZ_TA	4.0177***	1.3239	O2_FA—O2_TA	3.2669***	0.9814
CPZ_ST—CPZ_TA	0.3575	2.1820	O2_ST—O2_TA	4.1339***	1.1250
CZ_FA—CZ_TA	3.8297***	1.0607	OZ_FA—OZ_TA	3.6444***	1.9489
CZ_ST—CZ_TA	3.3241***	1.0372	OZ_ST—OZ_TA	4.0926***	1.3938
F3_FA—F3_TA	2.8382***	1.3789	P3_FA—P3_TA	3.2633***	0.6630
F3_ST—F3_TA	5.0759***	1.7798	P3_ST—P3_TA	5.0285***	1.6654
F4_FA—F4_TA	2.3970***	0.9838	P4_FA—P4_TA	2.8740***	0.8767
F4_ST—F4_TA	2.6069***	0.7988	P4_ST—P4_TA	3.2381***	1.6565
F7_FA—F7_TA	1.3439***	0.7804	T5_FA—T5_TA	4.4426***	1.4524
F7_ST—F7_TA	−0.6576	2.2805	T5_ST—T5_TA	2.4476***	0.7026
F8_FA—F8_TA	0.8413	1.8820	T6_FA—T6_TA	2.4892***	0.8839
F8_ST—F8_TA	0.6620	1.8953	T6_ST—T6_TA	3.0276***	1.3044
FC3_FA—FC3_TA	3.0750***	2.0488	PZ_FA—PZ_TA	4.9859***	2.1882
FC3_ST—FC3_TA	3.4607***	0.9714	PZ_ST—PZ_TA	3.6706***	1.1260
FC4_FA—FC4_TA	1.7687***	0.8925	T3_FA—T3_TA	2.4485***	0.7175
FC4_ST—FC4_TA	3.4840***	0.9234	T3_ST—T3_TA	1.2398*	1.4373
FCZ_FA—FCZ_TA	3.3584***	1.0723	T4_FA—T4_TA	3.1259***	1.5017
FCZ_ST—FCZ_TA	1.5681*	2.4022	T4_ST—T4_TA	4.6654***	0.9967
FP1_FA—FP1_TA	1.7599***	0.7709	TP7_FA—TP7_TA	3.8507***	1.2372
FP1_ST—FP1_TA	0.81086	1.3573	TP7_ST—TP7_TA	2.6081***	1.2904
FP2_FA—FP2_TA	−0.2086	1.4902	TP8_FA—TP8_TA	4.1991***	1.1437
FP2_ST—FP2_TA	0.8593*	1.0420	TP8_ST—TP8_TA	6.1272***	1.9090

*$P<0.05$, **$P<0.01$, ***$P<0.001$ by paired *t*-test, FA-familiar face, ST-strange face, TA-target face.

trode impedances did not exceed 5 kΩ. EEG and EOG signals were filtered with a band pass of 0.05 to 30 Hz and digitized at 250 Hz/location and stored on disk for later analysis. The eye activity correction was conducted by the software SCAN in ESI-128. Its algorithm was proposed by Semlitsch et al. (1986) and [illegible]

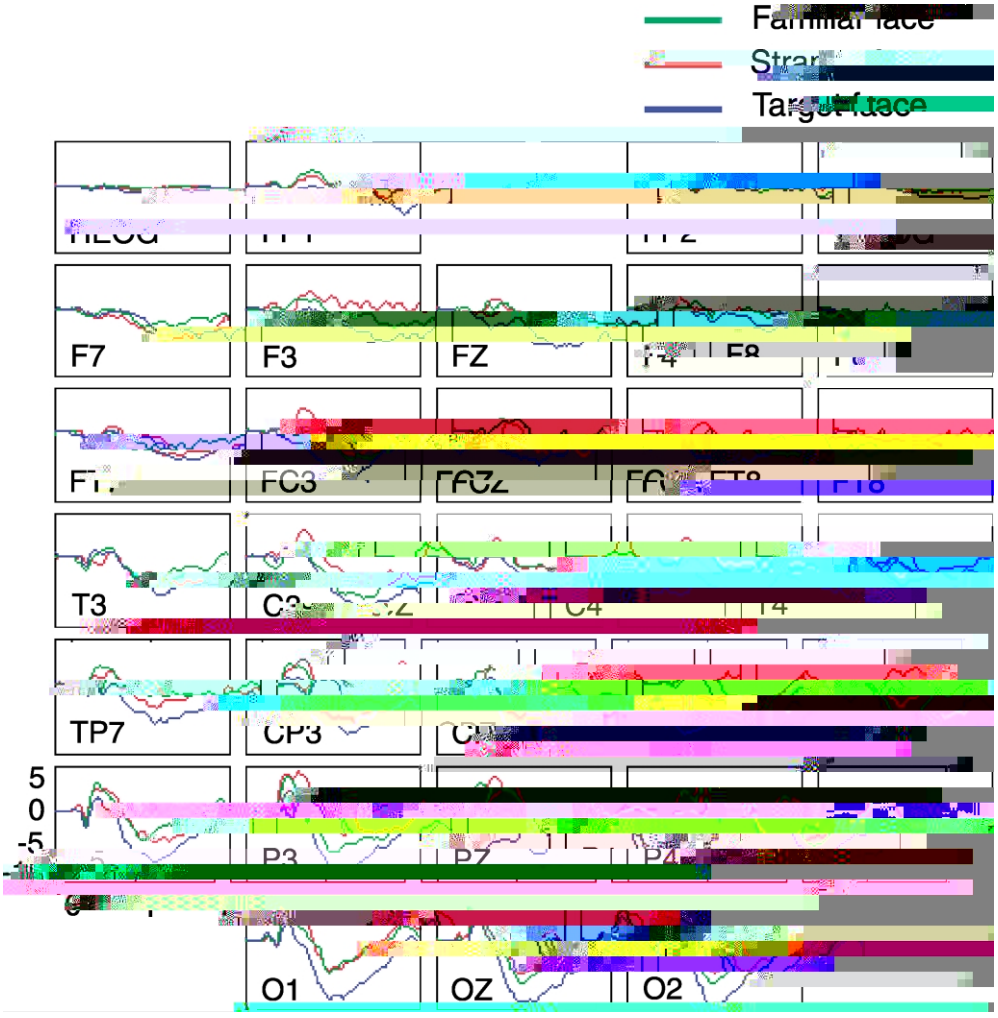

Fig. 1. Grand average ERPs ($N=12$) for three types of face pictures at each electrode. The units of ordinate and abscissa are microvoltage and second, respectively.

condition before being applied with ANOVA for examining its topography.

Because the ANOVA F statistics may become overly large when repeated-measurement factors have more than two levels (i.e. the case here with electrode position in the topographical analysis), the *P* values of all effects resulting from these factors were corrected towards conservative interpretation by reducing their degree of freedom. This was done by multiplying the original degrees of freedom with Huynh–Feldt epsilon and truncating the product to an integer. The uncorrected degrees of freedom along with the Huynh–Feldt epsilons are reported in the result section.

3. Results

3.1. Behavioral data

99.9 percent of responses made by subjects followed experimenter's instruction, that is, mak-

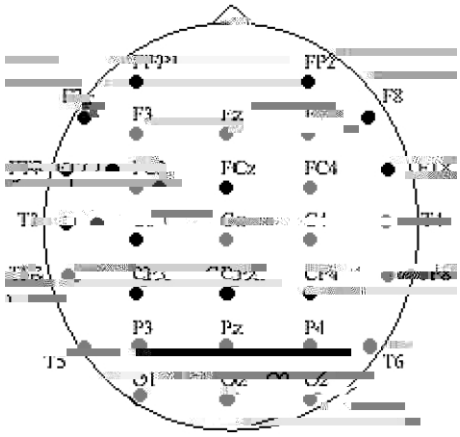

Fig. 3. Highly significant difference ($P < 0.001$) between target face and strange, familiar face was indicated by gray mark ($n = 12$).

global indicator for lie detection and is even better than the CNV amplitude at individual sites.

Based on the discussion above we conclude that CNV is a reliable indicator for lie detection within the experimental paradigm of delayed response and that both local and global data can offer the information necessary to reliably detect deception.

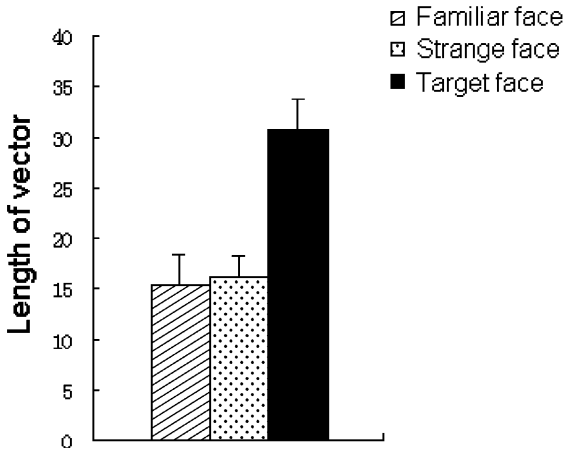

Fig. 4. Length of vectors for three kinds of faces ($n = 12$). Vertical bars denote 1 S.D.

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References

Boaz, T.L., Perry, N.W., Raney, G., Fishler, I., Shuman, D., 1991. Detection of guilty knowledge with event-related T,ON*CCRsApF;R*$TQJ[d1991.:TR,pN,C$iphydabCl.:Tsychs438–795.