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Neural mechanisms underlying the higher levels of subjective well-being in extraverts: Pleasant bias and unpleasant resistance

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Abstract The present st d in estigated the ne ral mechanisms that nderlie the higher le els of s bjecti e ell-being in e tra erts. The impact of e tra ersion on the h man sensiti it to pleasant and npleasant pict res of di erse emotional intensities as e amined. We recorded e ent-related potentials (ERPs) for highl positi e (HP), moderatel positi e (MP),4posterior cing late cortices, hich connect m ltiple brain regions that are important in interactions of emotion and e tra ersion, ma mediate the e tra ert-specific emotion effect for pleasant stim li. Th s, e tra erts are npleasant stim li of mild intensit than ar e tra erts ha e an additional enhanced sen stim li, regardless of emotion intensit . decreased threshold for pleasant emotion threshold for npleasant emotion might b mechanisms that nderlie the higher le els being in e tra erts.

Keywords E tra erts · E ent-related pote Unpleasant resistance · Well-being · Poster cortices (PCC)

E tra ersion is a trait that describes th person to be pbeat and optimistic and contact (Ashton, Lee, & Pa nonen, 2002 E tra ersion has been sho n b man associated ith s bjecti e ell-being an ness (Costa & McCrae, 1990; E senck, Ketelaar, 1989, 1991; R sting & Larsen st dies, Jeffre Gra (1970) proposed i BAS/BIS theor (beha ioral approach/i that e tra erts are h pothesi ed to be signals of re ard and are distinct from in post lated to be more s sceptible to p ith this theor , Costa and McCrae (indi id als ho scored highl on tests reported more pleasant affects in e er none tra erts. F rthermore, this assoc antedate and to be effecti e in pred happiness o er a period of 10 ears (C 1980, 1991). Consistent ith this finding that the meas re of pleasant affect strong e tra ersion (Watson & Clark, 1997), a

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tended to e perience pleasant affects in ario s re ard sit ations, both social and nonsocial (C nningham, 1988). F rthermore, social ps cholog st dies ha e also fo nd a correlation bet een e tra ersion and s bjecti e   ell-being,   ith greater le els of personal happiness in people   ho are strong e tra erts (M ers, 1992). Recentl , cross-c lt ral st dies sing large samples ha e established the essential roles of pleasant affects and re ard sensiti it in trait e tra ersion (L cas & Diener, 2001; L cas, Diener, Grob, et al., 2000).

These beha ioral findings ha e been reinforced b a n mber of ne roimaging st dies. In a series of f nctional MRI st dies, Canli and colleag es (Canli, Si ers, Whitfield, et al., 2002; Canli et al., 2001) obser ed that the brain response to pleasant pict res increased   ith e tra ersion in a n mber of cortical and s bcortical regions, incl ding the temporal lobe, am gdala, and the basal ganglia. In addition, ne robiological e idence s ggests that e tra ersion is associated   ith the f nctioning of the corticolimbic–dopaminergic s stem,   hich is critical for incenti e and re ard moti ation (Dep e & Collins, 1999). Consistent   ith these findings, in a recent ERP st d   e obser ed that e tra erts not onl   ere emotionall sensiti e to pleasant stim li, b t also   ere sensiti e to alence intensit changes in these stim li (Y an, He, Lei, Yang, & Li, 2009).

Despite kno ledge of the association bet een e tra ersion and s bjecti e   ell-being, the brain mechanisms that nderlie the higher le els of s bjecti e   ell-being in e tra erts remain largel   nresol ed. The enhanced brain sensiti it to re ard, as pre io sl established (Canli et al., 2002; Canli et al., 2001; Y an, He, et al., 2009), ma not f ll e plain this phenomenon. It is nlikel that e tra erts e perience more re ards than do none tra erts in nat ral sit ations, tho gh if the ha e a more positi e response to similar re ards, this co ld contrib te to enhanced   ell-being. It is also nclear   hether e tra erts are less responsi e to p nishments, as has been s ggested b some theories (Bart ssek, Becker, Diedrich, Na mann, & Maier, 1996; Derr berr   & Reed, 1994). More importantl , it is nkno n   hether e tra erts are more or less sensiti e to p nishment than are ambi erts, a gro p of none tra erted and nonintro erted indi id als that are more representati e of the a erage pop lation than intro erts are. Ho e er, the fact that e tra erts e perience increased le els of s bjecti e   ell-being ma impl that e tra erts are better at reg lating negati e emotions or are less s sceptible to negati e e ents than are ambi erts, beca se less e perience of negati e emotion is critical for maintaining a balanced mood and s bjecti e   ell-being. Some e isting e idence does impl that e tra erts are more prone to harm a oidance and direct less attention to locations   here preceding negati e stim li ha e appeared (Amin, Constable, & Canli, 2004; Derr berr & Reed, 1994). Despite an increased kno ledge of re ard sensiti it in e tra erts, the iss e of   hether e tra erts are indeed less sensiti e to p nishment stim li than is the ambi ert pop lation remains naddressed. More specificall , it ma be that the reacti it of e tra erts to negati e stim li aries as a f nction of alence le el. The processing of highl negati e stim li is biologicall important (Carretie, Mercado, Tapia, & Hinojosa, 2001) and ma not be red ced in e tra erts. Ho e er, it ma be that e tra erts are less sensiti e to milder negati e stim li that ma not engender the same biological imperati e. In fact, the alence strength of emotional stim li is important (Y an et al., 2007), and emotions of di erse strengths distinctl mod late cogniti e processes (Y an, L , Yang & Li, 2011a; Y an, Yang, Meng, Y , & Li, 2008). Therefore, in order to clarif the ne ral mechanisms that nderlie the higher le els of s bjecti e   ell-being in e tra erts, it is necessar to cond ct an e periment that s stematicall   aries the emotional intensit of the stim li thro gho t the   hole alence space (i.e., from highl   npleasant to highl pleasant; Lang, Bradle , & C thbert, 1997), and ses a gro p of "none tra erted and nonintro erted" s bjects as the baseline control sample (i.e., ambi erts).

In the present st d ,   e aried the alence strength of emotional stim li, h pothesi ing that e tra erts   o ld be less s sceptible to mildl negati e stim li than   o ld ambi ert people, b t that both gro ps   o ld be similarl reacti e to highl negati e stim li (Carretie et al., 2001). On the other hand, in consideration of the kno n brain sensiti it to signals of re ard (Canli et al., 2002; Canli et al., 2001; Y an, He, et al., 2009), e tra erts might be more reacti e to pleasant stim li, regardless of the alence strength, relati e to controls. If these h potheses pro e to be tr e, it   o ld help e plain   h e tra erts possess higher le els of s bjecti e   ell-being relati e to the ambi ert pop lation, since the   o ld be less in ol ed in negati e than in positi e emotions   ithin life settings. Th s, the present st d e amined the impact of e tra ersion on the s sceptibilit of the brain to pleasant and npleasant stim li of di erse strengths, sing an oddball task and e ent-related potential (ERP) meas res. Since emotion often occ rs npredictabl and is triggered b accidental stim li in life settings (Delplanq e, Sil ert, Hot, & Seq eira, 2005; Li, Y an, & Lin, 2008), an e perimental design that does not req ire s bjects to e al ate emotion o ertl might allo   emotional responses in the laborator setting to resemble those in nat re more closel . Th s, the present st d   sed a modified oddball task in   hich s bjects made standard/de iant distinctions b pressing different ke s, irrespecti e of the emotion of the de iants, in order to mask the tr e p rpose of the e periment. We sed the ERP techniq e beca se it is beneficial in e ploring the spatiotemporal feat res of the emotion effect and its mod lation b e tra ersion. ERPs are partic larl helpf l in nra eling ho different cogniti e steps, indicated b different components, embod the impact of e tra ersion in emotional responding.

Prior st dies that ha e sed oddball tasks reported emotion alence effects for se eral ERP components after controlling for aro sal infl ences, s ch as in earl components incl2007ding the frontal P2 (Delplanq e, La oie, Hot, Sil ert, & Seq eira, 2004; Y an et al., 2007) and central N2 (Li et al., 2008; Y an et al., 2007), and in late components incl ding the parietal P (Delplanq e et al., 2004; Delplanq e et al., 2005; Rø enkrants & Polich, 2008; Y an et al., 2008). Moreo er, the frontal P2 and the parietal P , t o components that are accepted as inde ing attentional (Carretie et al., 2001) and controlled e al ati e (Ito, Larsen, Smith, & Cacioppo, 1998) processes, respecti el , ha e been reported as earl and late markers of e tra ersion's impact on emotion (Bart ssek et al., 1996; Y an, He, et al., 2009). Additionall , a centrall peaking N2 as kno n to reflect the attention orienting response to potentiall important stim li in oddball tasks (Carretie, Hinojosa, Mart n-Loeches, Mercado, & Tapia, 2004). Therefore, if e tra erts are indeed different from ambi- erts in terms of their attentional, igilant, and controlled cogniti e processing of npleasant and pleasant stim li, e predict that the frontal P2, central N2, and parietal P components ill reflect the impact of e tra ersion on the emotional brain effects for different processing phases. Specificall , the P2 and P amplit des, hich increase ith greater in ol ements of attention and cogniti e reso rces, respecti el , ma be more prono nced d ring pleasant stim lation in e tra erts as compared to ambi- erts (Bart ssek et al., 1996; Y an, He, et al., 2009). Ho e er, if e tra erts are tr l less s sceptible to npleasant e ents than are ambi erts (Carretie et al., 2004), the sho ld e hibit less ERP differentiation bet een npleasant and ne tral conditions. This o ld partic larl be the case for the N2 and P components, hich inde attention alerting to and the cogniti e processing of npleasant stim li, respecti el . Additionall , the occipital P1 component and its frontal co nterpart (frontal N1), hich peak at appro imatel 100 ms poststim l s (Spi , Emerson, & Pedle , 1986; Wei & L o, 2002), are considered to be inde es of earl is al processing (Campanella et al., 2002; Hei e et al., 1994; Spi et al., 1986; Y an et al., 2007). Therefore, e meas red and analz ed the occipital P1 and the frontal N1 components to e amine hether e tra ersion mod lated the earl is al processing of stim l s feat res, and hether this potential mod lation aried depending on the emotional alence intensit of the stim li.

Moreo er, beca se e targeted the brain mechanisms that nderlie the higher le els of s bjecti e ell-being in e tra erts, the present st d sed an e treme-gro p design instead of a set of s bjects hose e tra ersion scores o ld be e enl distrib ted in each inter al of the distrib tion. We did so in order to create gro ps that differed onl on the ariable of interest (e tra ersion) and not on ne roticism. Specificall , e classified as the e perimental gro p a set) as69(nr)o 212.9(s-)1981(a)-(8.8re1]TJ.10 -9.29271 coefficient = .878; Wang, Dai, & Yao, 2010), a five-point (from −2 to 2), 240-item questionnaire that has been widely used in personality assessments (Amin et al., 2004; Canli et al., 2001, 2002). Extraverts and ambiverts were determined in such a way that the two groups scored differently only on the extraversion subscale (48 items; internal consistency coefficient = .78 ; Wang et al., 2010) of the NEO-FFI. Specifically, 16 participants whose extraversion scores (ranging from 2 to 54, mean = 9.7) were beyond the 90th percentile were grouped as extraverts, and a further 16 subjects whose extraversion scores (scores from −7 to 19, mean = 10.6) were around the 50th percentile (midpoint of the distribution) were used as the ambivert control subjects. In addition, both groups were emotionally stable, free of depression and anxiety states, were indexed by their similar low scores for neuroticism [−16.1 for extraverts, –1 .4 for control subjects; t(0) = 0.42, p > .1] and their depression facet measures [−5.1 vs. – .5; t(0) = 1.07, p > .1]. The subjects of both samples were right-handed and had normal or corrected-to-normal vision. In addition, they reported no history of affective disorder and were not using any psychiatric medication. The study was approved by the local Review Board for Human Participant Research, and each subject signed an informed consent form prior to the experiment.

Stimuli

The present study included two modified oddball experimental sessions. Each session consisted of six blocks of 100 trials, with each block including 70 standard and 0 deviant (grouped into three conditions) pictures. All deviant pictures were taken from the CAPS; see the Appendix for the specific pictures used in each condition.[1] As with many other studies that have used IAPS (Britton et al., 2006; Schupp, Junghöfer, Weike, & Hamm, 200 ; Smith, Cacioppo, Larsen, & Chartrand, 200), the pictures used for this study covered a variety of contents, including emotionally positive, negative, and neutral animals (e.g., kittens, snakes, and eagles), natural scenes (e.g., landscapes, natural disasters, and clouds), and human activities (e.g., cheers, fighting, and sports), but they did not include single faces. In the pleasant session, a natural scene of a cup served as the frequent standard picture, and 0 pictures that were grouped as highly positive (HP), moderately positive (MP), or neutral served as the deviants. In the unpleasant session, a natural scene of a bench served as the frequent standard picture, and 0 pictures that were grouped as highly negative (HN), moderately negative (MN), or neutral served as the deviants. The sequence of standard and deviant pictures was randomized in both sessions. In the pleasant session, the three sets of deviant pictures differed significantly from one another in their valences [means: HP = 7.41, MP = 6.60, neutral = 5.41; F(2, 87) = 96.16, p < .001; max(MP) = 6.96, min(HP) = 7.00], but were controlled overall for arousal [means: HP = 5.58, MP = 5.40, neutral = 5. 7; F(2, 87) = 1.29, p = .28]. Similarly, the three sets of pictures used in the unpleasant session differed significantly in valence [means: HN = 1.85, MN = .52, neutral = 5.46; F(2, 87) = 266.19, p < .001; max (HN) = 2.20, min(MN) = 2.98] but were controlled overall for arousal [means: HN = 6.08, MN = 5.88, neutral = 5.86; F(2, 87) = 1.49, p = .2]. All pictures were identical in size and resolution (15 10 cm, 100 pixels/in.). In addition, the luminances of the pictures were kept similar across emotion conditions, and the contrast of the monitor was set to a constant value across sessions and subjects.

Behavioral procedures

Subjects were seated approximately 150 cm from a computer screen in a quiet room, with their horizontal and vertical visual angles below 6 . All subjects were naive to the experimental purposes, since they were told before the experiment that this study investigated their abilities to make a fast response selection and to inhibit the prepotent response to the frequent picture when the deviant appeared. At the end of each of the six blocks, 2– min of rest were taken to avoid fatigue. During the rest period, their accuracy rates for both the standard and deviant stimuli were given to the subjects as feedback on their performance. Each trial was initiated by a 00-ms presentation of a small black cross on the white computer screen. Then, a blank screen whose duration varied randomly between 500 and 1,500 ms was followed by the onset of the picture stimulus. Each subject was instructed to press the “F” key on the keyboard with his or her left index finger as accurately and quickly as possible if the standard picture appeared, and to press the “J” key with the right index finger if the deviant picture appeared. The stimulus picture was terminated by a key press or after 1,000 ms. Therefore, subjects were informed that responses must be made in less

[1] The CAPS was developed in the Key Laboratory of Mental Health, Chinese Academy of Sciences, in order to avoid the cultural bias found in emotion inducement among Chinese participants when the IAPS was used directly (Huang & Luo, 2004). The CAPS introduced a number of pictures characterized by oriental scenes. The development method of this native system resembled that of IAPS. For the CAPS development, originators collected over 2,000 pictures of various contents, and finally kept 852 pictures that fit Chinese culture and were simple in meanings for the normative ratings. Chinese college students (n = 156, gender-matched) were recruited to rate the valence, arousal, and dominance by a self-report, nine-point rating scale for the 852 pictures of the system. The pretest for this system showed that CAPS is reliable across individuals in emotional inducement (the between-subjects reliability scores were .982 for valence and .979 for arousal). More details about CAPS are accessible in Bai et al. (2005).

than 1,000 ms. Each response as follo ed b 1,000 ms of blank screen (see Fig. 1 for the session designs). Pretraining ith 10 practice trials as sed before either session in order to familiarize the s bjects ith the proced re. The standard pict re in pretraining as the same as that in the s bseq ent e periment, hereas the de iants for the pretraining ere ne tral pict res that ere not sed in the e periment. All s bjects achie ed 100% acc rac on the 10 practice trials prior to the formal e periment. Each s bject participated in both e perimental sessions, ith the order of the sessions co nterbalanced across s bjects.

Emotion assessment

After the EEG recording session, an emotion assessment proced re that resembled the Self-Assessment Manikin (SAM) as cond cted (Lang et al., 1997), in order to e plore the s bjecti e emotion ind ced b each set of images in both sessions. Using a self-reporting nine-point rating scale, s bjects ere req ired to rate the emotion alence (ranging from *unpleasant* to *pleasant*) and aro sal (ranging from *relaxed* to *excited*) that the felt for each image b pressing the corresponding n mber ke on the ke board. The onset seq ence of images as randomized across emotion conditions.

ERP recording and anal sis

The EEG as recorded from 64 scalp sites sing tin electrodes mo nted in an elastic cap (Brain Prod cts, M nich, German), ith the reference electrodes on the left and right mastoids (a erage mastoid reference; L ck, 2005) and a gro nd electrode on the medial frontal aspect. Vertical electrooc lograms (EOGs) ere recorded s pra- and infraorbitall at the left e e. The horizontal EOG as recorded from the left ers s the right orbital rim. The EEG and EOG ere amplified sing a DC 100-Hz bandpass and contin o sl sampled at 500 Hz /channel. All interelectrode impedances ere maintained belo 5 kΩ. The a eraging of ERPs as comp ted offline sing the Vision Analz er soft are package de eloped b the Brain Prod- cts Compan . EOG artifacts (blinks and e e mo ements) ere corrected offline, and a 16-Hz lo -pass filter as sed. The Vision Analz er soft are sed an a tomatic oc lar correction proced re to eliminate EOG artifacts, ith one sensor as the EOG monitor and the other as the reference for both hori ontal and ertical EOG sensor pairs. Trials ith a mean EOG oltage that e ceeded ±80 μV and those trials contaminated ith artifacts d e to amplifier clipping of peak-to-peak deflection that e ceeded ±80 μV ere e cl ded from the a eraging. The percentage of rejected trials for each condition as er lo (<7%), so that eno gh trials ere obtained for ERP a eraging. The a eraged n mbers of trials ere 56.84 for the HP, 57. 1 for the MP, and 56.91 for the ne tral condition d ring the pleasant session, hile the a eraged n mbers of trials ere 56.69 for the HN, 56. 1 for the MN, and 56.1 for the ne tral condition d ring the npleasant e perimental session.

The EEG for the correct response d ring each emotion condition as a eraged separatel . The ERP a eforms ere time-locked to the onset of the stim li and had an a eraged d ration of 1,000 ms, incl ding a 200-ms prestim l s baseline. As is sho n b the a erage map of the ERPs, each emotion condition, irrespecti e of e tra er- sion, elicited apparent P2, N2, and P acti it in both sessions (see Figs. 4 and 5 belo). Therefore, the amplit des (baseline to peak) and peak latencies of the P2 (140 to 200 ms), N2 (220 to 00 ms), and P (0 to 460 ms) ere meas red and analz ed. The follo ing 12 electrode sites ere selected for the statistical anal sis of the P2 and N2 components: Fz , F , F4, FC , FC4, FCz , Cz , C , C4, CP , CPz , and CP4. A repeated meas res ANOVA of the amplit des and peak latencies of these components as cond cted ith the follo ing repeated factors: emotion (three le els: highl emotional, mildl emotional, and ne tral), e perimental session (t o le els: pleasant and npleasant), frontalit (fo r le els: frontal, frontocentral, central, and centroparietal), and lateralit (three le els: left, midline, and right). E tra ersion as sed as a bet een- s bjects factor. Beca se P acti it as largest at the parietal sites, the anal sis of the P component also incl ded the three parietal sites (P , Pz , and P4), along ith the 12 sites abo e. In addition, the occipital P1 and its frontal co nterpart (frontal N1), hich both peaked at appro imatel 100 ms poststim l s, ere analz ed in the 70- to 1 0-ms inter al to establish hether there as an emotion effect, as ell as an e tra ersion infl ence d ring earl is al processing (Mang n, 1995). The occipital P1 component as analz ed at the three occipital sites (O1, O2, and Oz), hile the frontal N1 component as analz ed at the 12 sites abo e. Since the present st d foc sed on the effect of e tra ersion on brain s sceptibil- it to pleasant and npleasant stim li of di erse emotional intensities, e foc sed the statistical anal sis on the t o- a interaction bet een e tra ersion and emotion and the three- a interaction bet een e perimental session, emo- tion, and e tra ersion. The degrees of freedom of the F ratios ere corrected according to the Greenho se–Geisser method.

Results

Beha ioral data

Errors ere rare, as all s bjects achie ed ceiling acc rac for the standard and de iant stim li in both e perimental sessions. The ANOVA of the reaction time (RT, after normali ation) data, ith session and emotion as repeated factors and e tra ersion as a bet een-s bjects factor, sho ed no significant main effects of session [$F(1,\ \ 0) = 0.74$, nonsignificant (n.s.)], emotion [$F(2, 60) = 0.\ 6$, n.s.], or e tra ersion [$F(1,\ \ 0) = 0.18$, n.s.]. Also, the interaction effects bet een emotion and e tra ersion [$F(2, 60) = 0.\ 2$, n.s.] and bet een session, emotion, and e tra ersion [$F(2, 60) = 1.01$, $p = .\ 7$, n.s.] ere both nonsignificant. The mean RTs and standard errors for each of the three conditions d ring both sessions are presented in Table 1. Th s, the infl ence of e tra ersion on the brain reaction to emotional stim li as not significant in the meas re of RTs.

Emotion assessment

Valence assessment First, the emotion alence scores ere a eraged ithin each of the three pict re sets in either e perimental session. The repeated meas res ANOVA of alence scores, ith emotion and session as repeated

Table 1 A eraged reaction times (RTs) and standard errors (*SE*) for each of the three conditions in the pleasant and npleasant sessions (in milliseconds)

	E tra erts		Ambi erts	
Condition	*M*	*SE*	*M*	*SE*
HP	498	2	511	1
MP	495	26	515	15
Ne (P)	502	2	508	14
HN	519	6	484	6
MN	515	29	48	7
Ne (N)	514	25	490	7

Ne (P), ne tral condition for the pleasant session; Ne (N), ne tral condition for the npleasant session.

factors and e tra ersion as the bet een-s bjects factor, sho ed significant main effects of emotion [F(2, 60) = 76.04, p < .001, η^2 = .72], session [F(1, 0) = 18 .64, p < .001, η^2 = .86], and e tra ersion [F(1, 0) = 12. 2, p < .01, η^2 = .29]. The alence ratings ere greater in the pleasant ($M \pm SE$: 6. 4 ± 0.15) than in the npleasant (4.28 ± 0.09) sessions. Moreo er, there ere a significant emotion session interaction [F(2, 60) = 49.88, p < .001, η^2 = .92] and a significant session e tra ersion interaction [F(2, 60) = 8.94, p < .01, η^2 = .2]. To break do n these interactions, e tested the simple effect of emotion and that of e tra ersion in the pleasant and npleasant e perimental sessions. There ere significant effects of emotion [F(2, 60) = 124.99; p < .001, η^2 = .81] and e tra ersion [F(1, 0) = 6.65, p < .02, η^2 = .17] in the pleasant session. S bjects rated HP pict res as more pleasant than MP pict res (p < .001), hich, in t rn, ere rated as more pleasant than ne tral pict res (p < .001), irrespecti e of e tra ersion (see Fig. 2). In addition, e tra erts rated all pict res, irrespecti e of stim l s categor , as more pleasant than did the ambi erts (see Fig. 2). On the other hand, there as a significant simple effect of emotion [F(2, 60) = 288.20, p < .001, η^2 = .91], hile the simple effect of e tra ersion as nonsignificant [F(1, 0) = 1.46, p = .2 , η^2 = .05] in the npleasant session. HN pict res ere rated as more npleasant than MN pict res (p < .001), hich, in t rn, ere rated as more npleasant relati e to ne tral pict res (p < .001) b both gro ps (see Fig. 2).

Arousal assessment Similarl , the emotion aro sal scores ere a eraged ithin each of the three pict re sets in both e perimental sessions. The repeated meas res ANOVA of aro sal scores sho ed a significant main effect of emotion [F(2, 60) = 86.69, p < .001, η^2 = .74). The post hoc pair ise comparison sho ed increased aro sal ratings for the highl emotional pict res (6.71 ± 0.16) relati e to the mildl emotional (5.7 ± 0.12) [F(1, 0) = 121.51, p < .001, η^2 = .80] and ne tral (5.55 ± 0.14) [F(1, 0) = 140.11, p < .001, η^2 = .82] pict res, irrespecti e of e tra ersion and e perimental session. The aro sal ratings, ho e er, ere not statisticall significant bet een the mildl emotional and ne tral pict re sets [F(1, 0) = .58, p = .068, η^2 = .10]. Moreo er, e tra erts rated all pict res, irrespecti e of stim l s categor and e perimental session, as more aro sing than did ambi erts, as sho n b a significant main effect of e tra ersion [F(1, 0) = 15.5 , p < .001, η^2 = . 4]. The aro sal ratings ere not significantl different bet een the pleasant and npleasant e perimental sessions in both e tra erts and ambi erts, as sho n b the nonsignificant main effect of session [F(1, 0) = 0.24, p = .6] and b the nonsignificant interaction of session ith e tra ersion [F(1, 0) = 0.15, p = .69; see Fig. 2].

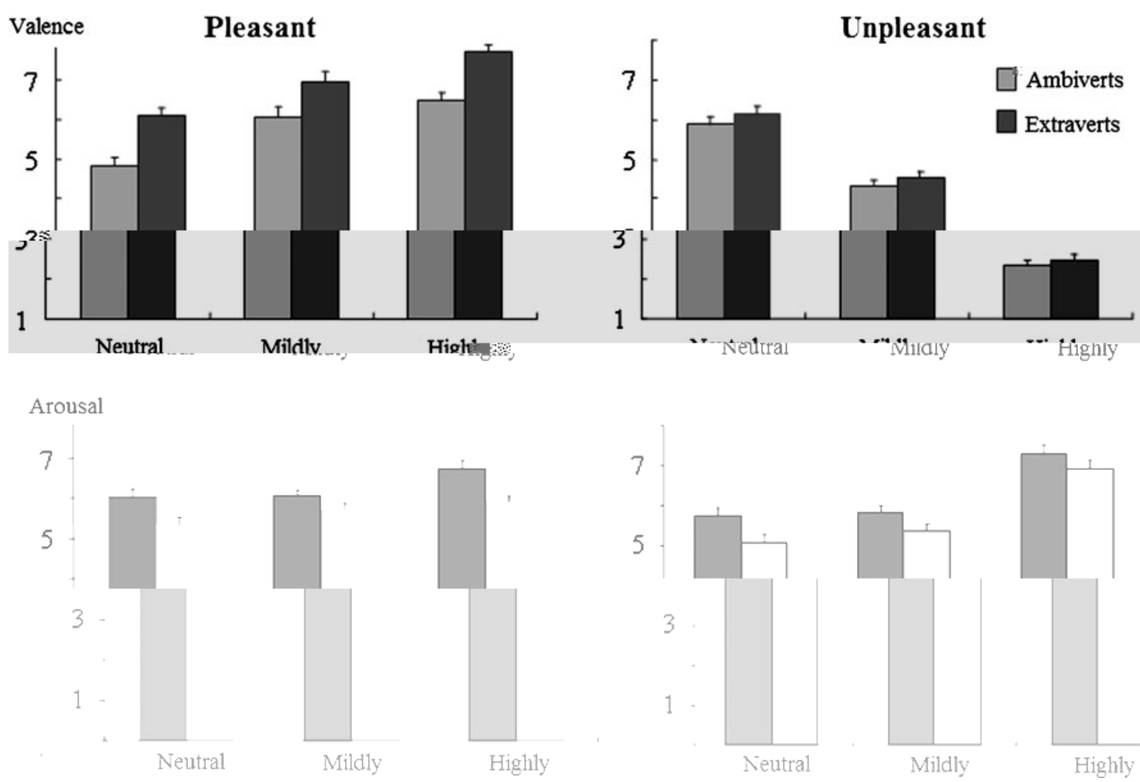

Fig. 2 A schematic ill stration of the alence and aro sal ratings for highl emotional, moderatel emotional, and ne tral pict re sets d ring pleasant and npleasant sessions. Error bars represent standard errors

ERP results

Occipital P1/frontal N1 The repeated meas res ANOVA for the occipital P1 component, ith session and emotion as the repeated factors and e tra ersion as the bet een-s bjects factor, sho ed no significant main or interaction effects for either peak amplit des or latencies (see Fig.). Moreo er, the ANOVA of the N1 data sho ed no other main or interaction effects e cept for a main effect of frontalit on N1 amplit des [F(, 90) = 18.60, $p < .001$, $\eta^2 = .\ 8$] and peak latencies [F(, 90) = 12.10, $p < .001$, $\eta^2 = .29$], ith N1 amplit des largest at the frontal sites, hile peak latencies increased from parietal to frontal sites (Figs. 4 and 5).

P2 The anal sis of P2 amplit des demonstrated larger amplit des d ring pleasant sessions than d ring npleasant sessions [F(1, 0) = 4.41, $p < .05$, $\eta^2 = .1$]. In addition, the amplit des ere larger for e tra erts than for ambi ert s bjects [F(1, 0) = 5.97, $p < .0$, $\eta^2 = .17$]. This as probabl beca se e tra erts are more no elt -seeking, and accordingl more reacti e to the no el de iant stim li (Digman, 1990). There as a significant interaction bet een emotion and session [F(2, 60) = 21.1 , $p < .001$, $\eta^2 = .41$]. The breakdo n of this interaction sho ed larger amplit des in the HP (6.05 ± 0.80 μV) and MP (5.06 ± 0.74 μV) than in the ne tral (.91 ± 0.65 μV) [F(2, 60) = 16.86, $p < .01$, $\eta^2 = .\ 6$] conditions in the pleasant session, hile the npleasant session re ealed smaller P2 amplit des d ring HN stim li (2.61 ± 0.5 μV) than d ring MN (.87 ± 0.64 μV) and ne tral (.69 ± 0.65 μV) stim li [F(2, 60) = 9.0 , $p < .01$, $\eta^2 = .21$]. More importantl , in the present st d e obser ed a significant three- a interaction bet een session, e tra ersion, and emotion [F(2, 60) = 7.99, $p < .01$, $\eta^2 = .44$].

To analz e the components of this interaction, e analz ed the e tra ersion and emotion interaction in the pleasant and npleasant e perimental sessions. The anal sis in the pleasant session sho ed a significant interaction of e tra ersion and emotion [F(2, 60) = 5.24, $p < .05$, $\eta^2 = .22$]. The simple-effect anal ses of the t o- a interaction sho ed a significant emotion effect in e tra erts [F(2, 0) = 20.21, $p < .01$, $\eta^2 = .57$], ith larger amplit des recorded for HP (8.19 ± 1.14 μV) than for MP (6.5 ± 1.05 μV) stim li [F(1, 15) = 12.7 , $p < .01$, $\eta^2 = .46$], hich, in t rn, elicited larger amplit des than did ne tral stim li (4.85 ± 0.92 μV) [F(1, 15) = 11.57, $p < .01$, $\eta^2 = .44$]. In contrast, the emotion effect as not significant in ambi ert s bjects [F(2, 0) = 1.7 , $p = .20$]. On the other hand, the anal sis cond cted in the npleasant e perimental session sho ed no significant t o- a interaction bet een emotion and e tra ersion [F(2, 0) = 0.14, $p = .74$], hich indicated that both e tra erts and ambi erts sho ed less-prono nced P2 amplit des d ring HN than d ring the MN and ne tral conditions.

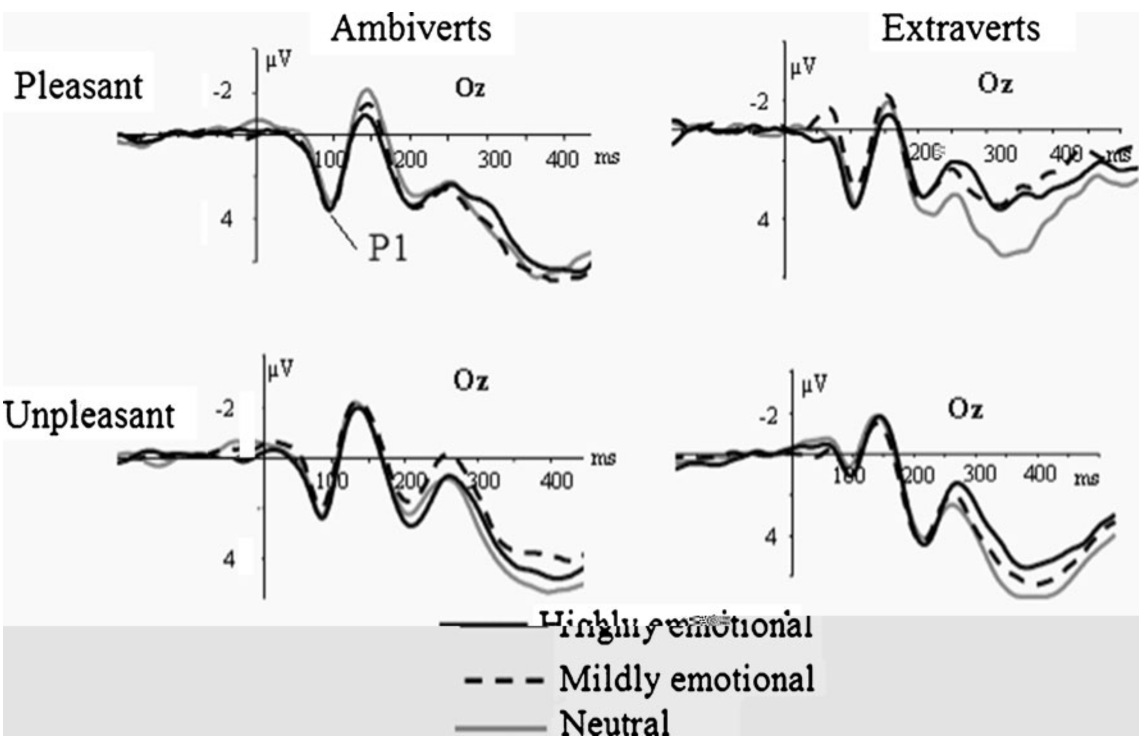

Fig. 3 A eraged ERPs at electrode Oz for the pleasant (top panels) and npleasant (bottom panels) sessions in ambi erts (left col mn) and e tra erts (right col mn)

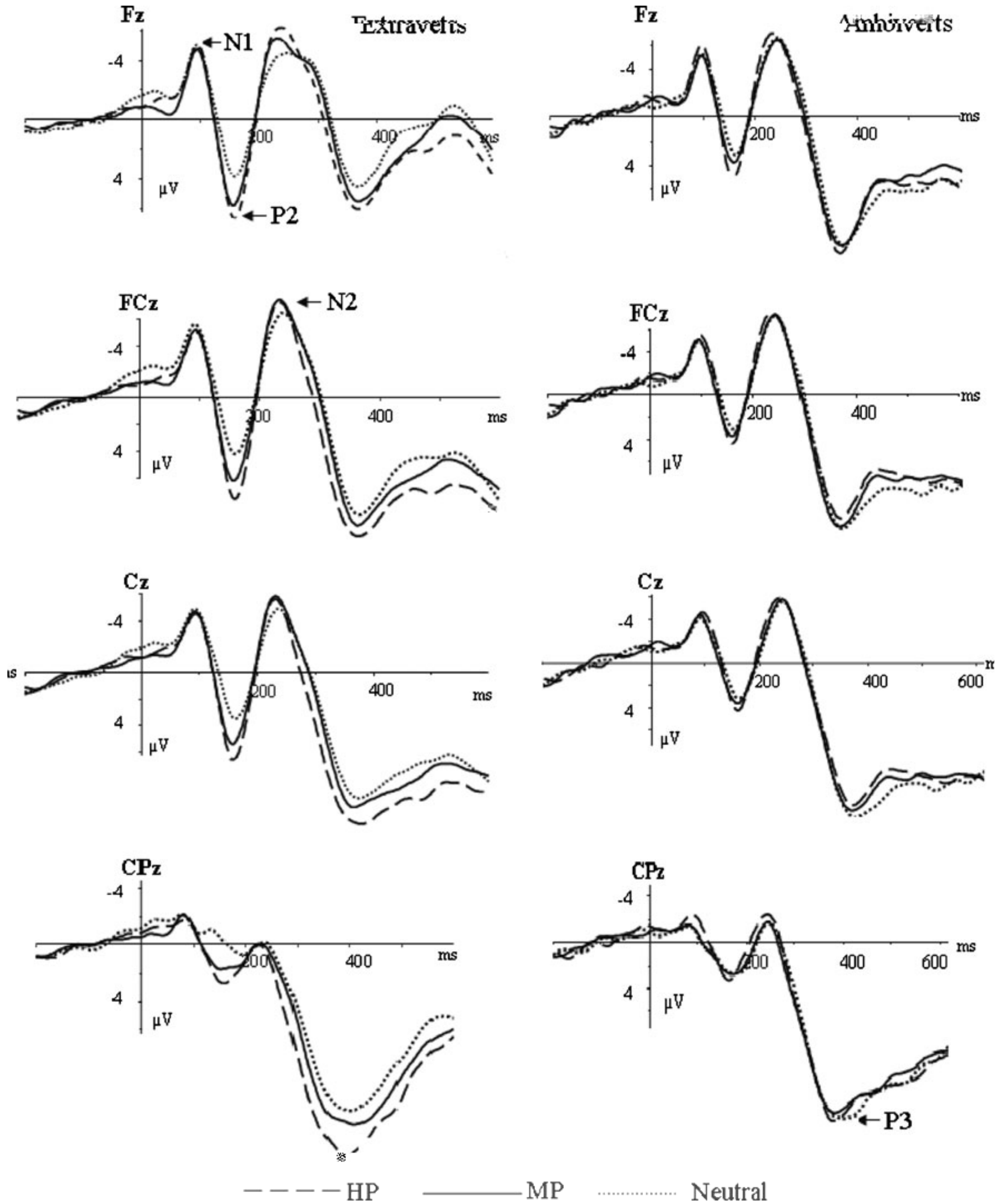

Fig. 4 A eraged ERPs for e tra erts (left) and ambi ert control (right) s bjects d ring the highl   positi e (HP; dashed lines), moderatel   positi e (MP; solid lines), and ne tral (dotted lines) conditions in the pleasant e perimental session

In addition, the P2 amplit des   ere more prono nced at left (4.29 ± 0.46 μV) and midline (4.12 ± 0.47 μV) sites than at the right-laterali ed (.41 ± 0.59 μV) sites, as sho n b   a significant main effect of lateralit   [$F(2, 60) = 1\ .92$, $p < .001$, $\eta^2 = .\ 2$]. There   ere significant main effects of frontalit   [$F(\ , 90) = 7.48$, $p < .01$, $\eta^2 = .20$] and emotion [$F(2, 60) = 4.5\ $, $p < .05$, $\eta^2 = .1\ $],   hile frontalit   significantl   interacted   ith e tra ersion [$F(\ , 90) = 5.\ 9$, $p < .05$, $\eta^2 = .15$]. The effect of larger amplit des for e tra erts relati e to ambi erts   as prono nced at both the central and frontal scalp regions, b t not at the parietal sites ($p > .1$; see Figs. 4 and 5). Additionall , the anal sis of P2 latencies sho ed no other effects, e cept for significant main effects of emotion [$F(2, 60) = 12.10$, $p < .001$, $\eta^2 = .29$] and frontalit   [$F(2, 60) = 4.09$, $p < .05$, $\eta^2 = .12$]. Highl   emotional stim li (155.7 ±

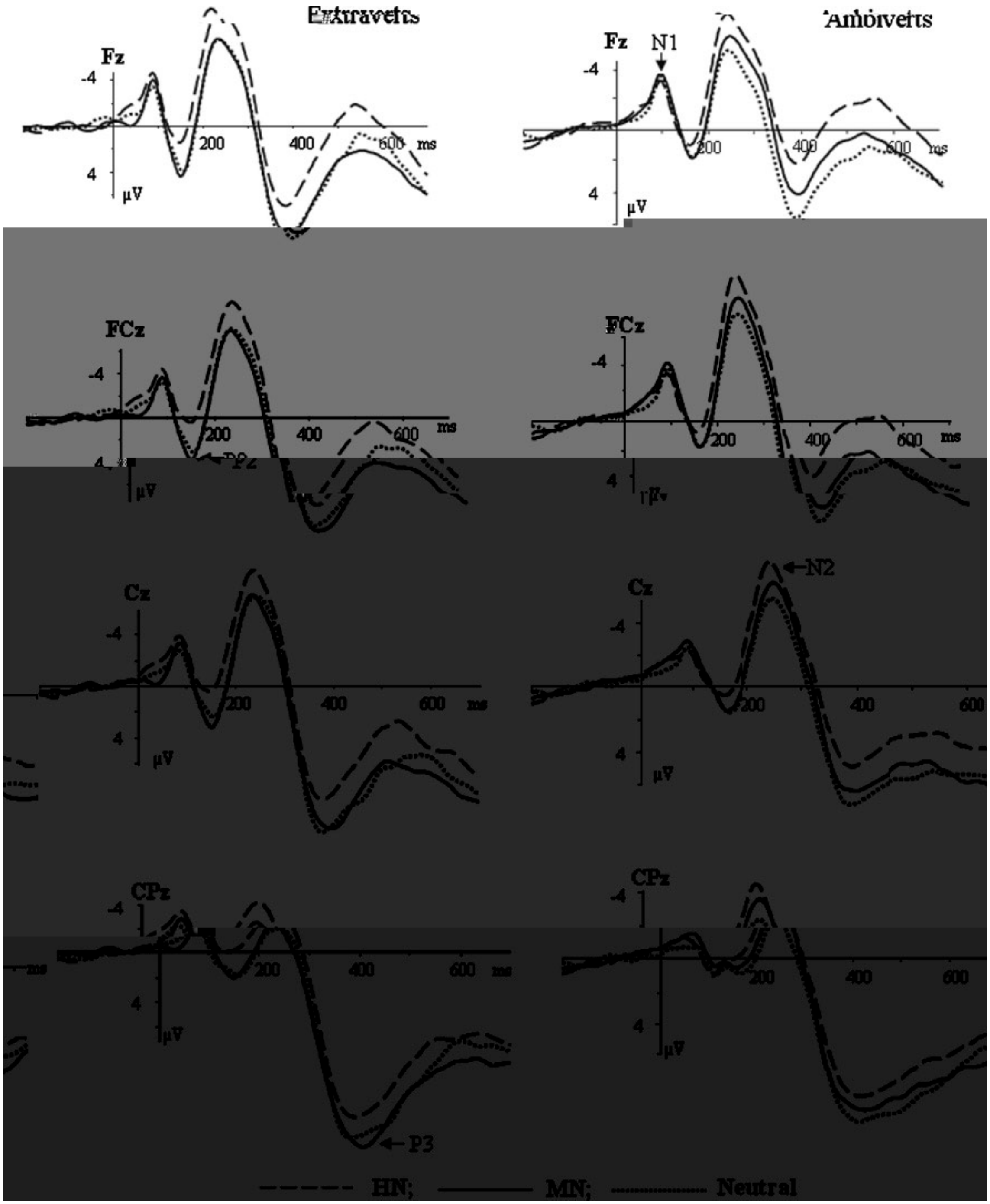

Fig. 5 A eraged ERPs for e tra erts (left) and ambi ert control (right) s bjects d ring the highl negati e (HN; dashed lines), moderatel negati e (MN; solid lines), and ne tral (dotted lines) conditions in the npleasant session

1.7 ms) elicited shorter latencies than did moderatel emotional (158.7 ± 1.6 ms) and ne tral (160.8 ± 1.9 ms) stim li, regardless of the e perimental session t pe. In addition, P2 peaked faster at central-to-frontal sites (157. ± 1.8 ms) than at parietal sites (161.6 ± 2.0 ms).

N2 The ANOVA of N2 amplit des displa ed a significant main effect of emotion [$F(2, 60) = 5.68$, $p < .01$, $\eta^2 = .17$] and an emotion frontalit interaction [$F(6, 180) = 4.98$, $p < .01$, $\eta^2 = .15$], ith the amplit de differences across the highl emotional, mildl emotional, and ne tral conditions more prono nced at the central and frontal sites. In addition, the N2 amplit des ere significantl larger in the npleasant ers s the pleasant e perimental sessions [$F(1, \ 0) = 5.69$, $p < .0$, $\eta^2 = .17$], hile the amplit des ere larger at the frontal than at the parietal sites [$F(\ , 90) = 79.20$, $p < .001$, $\eta^2 = .72$]. More importantl , there as a significant session emotion interaction [$F(2, 60) = 11.64$, $p < .001$, $\eta^2 = .26$], as ell as a significant three- a interaction bet een session, emotion, and e tra ersion [$F(2, 60) = 5.$, $p < .01$, $\eta^2 = .16$]. The breakdo n of the session b emotion interactions sho ed a significant emotion effect that as onl present in the npleasant e perimental session [$F(2, 60) = 20.57$, $p < .001$, $\eta^2 = .42$].

In order to s banalz e the interaction bet een session, emotion, and e tra ersion, the present st d analz ed the interaction effects bet een e tra ersion and emotion in the pleasant and npleasant e perimental sessions. While the e tra ersion emotion interaction failed to reach statistical significance in the pleasant e perimental session [$F(2, 60) = 2.07$, $p > .10$, $\eta^2 = .06$], the anal sis sho ed a significant e tra ersion emotion interaction [$F(2, 60) =$ .69, $p < .05$, $\eta^2 = .11$] in the npleasant e periment session. The simple-effect anal ses for this interaction sho ed a significant emotion effect in ambi ert s bjects [$F(2,\ 0) = 17.99$, $p < .001$, $\eta^2 = .55$], ith N2 amplit des more prono nced for both the HN (−7.21 ± 1. 0 μV) [$F(1, 15) =$ 4.60, $p < .001$, $\eta^2 = .64$] and MN (−6.65 ± 1.41 μV) [$F(1, 15) = 26.47$, $p < .001$, $\eta^2 = .64$] stim li, as compared to the ne tral stim li (−4.76 ± 1.48 μV). Also, the emotion effect as significant in e tra erts [$F(2,\ 0) =$ 9.68, $p < .01$, $\eta^2 = .\ 9$]: While their amplit des remained larger d ring HN (−7.10 ± 1. 0 μV) than d ring ne tral (−4.78 ± 1.41 μV) conditions [$F(1, 15) = 1\ .05$, $p < .01$, $\eta^2 = .47$], e tra erts, in contrast to ambi ert s bjects, displa ed similar N2 amplit des for MN stim li (−4.99 ± 1.48 μV) and ne tral stim li [$F(1, 15) = .14$, n.s., $\eta^2 = .01$].

Moreo er, there as a significant main effect of lateralit [$F(2, 60) =$ 1.56, $p < .001$, $\eta^2 = .51$] and a significant frontalit lateralit interaction [$F(6, 180) =$ 4.67, $p < .01$, $\eta^2 = .14$]. Midlines sites (−7.0990TD(0)-906 1T f5041810TDFV) latera z ned

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than the left (9.40 ± 0.52 μV) and the right (10.98 ± 0.55 μV) laterali ed sites. On the other hand, the anal sis of P latencies sho ed no other main or interaction effects, e cept for the main effects of frontalit [F(4, 124) = 6.48, p < .01, η^2 = .17] and lateralit [F(, 90) = 9.76; p < .01; η^2 = .24]. P latencies ere dela ed at parietal relati e to anterior sites, and ere longer at the left (412.2 ± 5.22 ms) and midline (411. ± 5.5 ms) sites than at the right (401.0 ± 5.1 ms) scalp sites.

Discussion

The present st d sho ed a significant impact of e tra er-sion on the brain reaction to pleasant and npleasant stim li of di erse emotion strengths. E tra erts displa ed pro-no nced emotion electroph siological effects for HP and MP stim li across the P2 and P components that ere absent in ambi erts (Fig. 4). A tentati e so rce modeling implicated the posterior cing late cortices, hich connect m ltiple ne ral regions that are important in emotion and e tra ersion interactions, in mediating the e tra ert-specific emotion effect for pleasant stim li (see the s pplementar materials). Ho e er, altho gh both samples e hibited prono nced emotion responses to HN stim li across the P2, N2, and P components, ambi erts, rather than e tra erts, displa ed significant emotion effects for MN stim li across the N2 and P time inter als (Fig. 5). The implications of these findings and the associations ith s bjecti e ell-being are disc ssed belo .

The impact of e tra ersion on brain sensiti it to pleasant stim li

In the present st d , the anal sis of P1–N1 components sho ed no other effects e cept for larger amplit des and prolonged latencies for the N1 at frontal sites. This implied that earl is al processing, inde ed b P1–N1 acti it in brain potentials, as not significantl infl enced b emotion or e tra ersion. Th s, the impact of e tra ersion on emotion reacti it to pleasant and npleasant stim li of di erse alences ma occ r at later stages. This res lt appears inconsistent ith a prior st d that sho ed e tra erts e hibiting less prono nced N1 amplit des than did intro erts d ring a simple reaction time task (Do cet & Stelmack, 2000). As a res lt of higher le els of cortical aro sal/aro sabilit (E senck, 1994), intro erts ha e been consistentl reported to ha e increased brain potentials in comparison ith e tra erts (Do cet & Stelmack, 2000; Stelmack & Ho lihan, 1995). Ho e er, the present st d sed ambi erts as the control s bjects instead of intro erts, hich is likel to e plain the absence of an e tra ersion effect in the N1 component.

In the time indo s before 00 ms, e obser ed prominent P2 and N2 acti it , as ell as significant interaction effects bet een emotion, session, and e tra er-sion at these components. The P2 peaked before 200 ms, and its amplit des ere most prono nced at the central and frontal sites, hich fits ith the morpholog of the attention-related P200 from prior emotion st dies (Carretie et al., 2001; Y an, He, et al., 2009). Ho e er, N2 peaked at appro imatel 240 ms, and its amplit des ere largest across the centrofrontal sites, hich matched the oddball N2 archet pe (Campanella et al., 2002).

The breakdo n of the three- a interaction in P2 amplit des sho ed a prono nced emotion effect for both HP and MP stim li in e tra erts, b t not in ambi erts (Fig.). P2 is an earl component hose amplit des are tho ght to inde the amo nt of attention allocated (Carretie et al., 2001; Y an, He, et al., 2009). Th s, both HP and MP stim li elicited an enhanced allocation of earl attention in e tra erts. Ho e er, emotion effects occ rred for neither HP nor MP stim li, nor ere there significant emotion e tra ersion interactions on N2 amplit des in the pleasant e perimental session. This as probabl d e to the f nctional significance of oddball N2 in inde ing the alerting to biologicall important stim li (Carretie et al., 2004; Y an et al., 2007). Since the de iant stim li in the pleasant session ere emotionall ne tral or pleasant pict res that e pressed no threats or other biologicall important contents, the alerting and orienting response intensit decreased as compared ith those in the npleas-ant session. Consistent ith this interpretation, e obser ed enhanced N2 amplit des in the npleasant ers s the pleasant sessions.

As conscio s access has been sho n to in ol e the late acti ation of a broad cortical net ork starting at 270 ms poststim l s (Carretie et al., 2004; Del C l, Baillet, & Dehaene, 2007), the emotion effects of e tra erts for HP and MP stim li most likel occ rred in a fast, data-dri en, and a tomatic manner. This coincided ith prior st dies that reported the greater acti ation of s bcortical s bstrates, incl ding the am gdala and basal ganglia (e.g., p tamen, glob s pallid s, and ca date), in response to pleasant stim li in e tra erts (Canli et al., 2002; Canli et al., 2001). Con ersel , ambi erts displa ed little emotional response to HP and MP stim li at these stages, hich as in agreement ith prior st dies that had reported similar earl ERPs to positi e and ne tral stim li and to positi e stim li of di erse alences (Leppanen et al., 2007; Y an et al., 2007).

Moreo er, there as a significant emotion e tra ersion interaction in P amplit des in the pleasant session. P peaked later than 00 ms, and its amplit des increased ith pleasant intensit in e tra erts, b t not in ambi erts (Fig. 4). The P as largest at parietal sites, hich fitted the role of parietal P in reflecting conscio s processing that in ol es the cogniti e e al ation of stim l s meaning (Campanella et al., 2002; Campanella et al., 2004; Ito et al., 1998). With the se of top-do n cogniti e reso rces (Del C l et al., 2007; Delplanq e et al., 2005), e tra erts contin all displa ed prominent emotion effects for HP stim li and, ith smaller-si e effects, for MP stim li in this st d . This as possibl beca se the e al ated all positi e stim li, irrespecti e of emotion intensit , as pleasant at the conscio s le el. This coincided ith the res lts of the emotion assessment, hich sho ed that e tra erts rated all stim li as more pleasant than did the ambi erts, irrespecti e of categor . Distinct from o r prior finding of similar P amplit des for MP and ne tral stim li (Y an, He, et al., 2009), e tra erted s bjects in the present st d e hibited more prono nced P amplit des for MP ers s ne tral stim li, probabl beca se the e tra ert sample in the present st d scored higher in the meas re of e tra ersion than did those in the pre io s st d . This fact, again, erified that e tra ersion as associated ith enhanced re ard sensiti it . Con ersel , despite pleasant feelings for MP and HP stim li in the emotion assessment, ambi ert s bjects sho ed no significant emotion effect in P amplit des ith either pict re set, possibl beca se e sed a distracting task that as associated ith decreased late positi e potential responses to emotional stim li (Carretie, Iglesias, Garc a, & Ballesteros, 1997; Delplanq e et al., 2004). This arg ment, ho e er, sho ld be interpreted ca tio sl , as beha ioral data sho ed ceiling acc rac in the distinction of the standard/de iant images. To concl de, hether at earl or late time points, e tra erts elicited significant emotion effects for both sets of pleasant stim li that ere absent in ambi erts.

Red ced sensiti it of e tra erts to mildl negati e stim li

In the npleasant session, altho gh earl is al processing as not infl enced b emotion, HN stim li elicited a significant emotion effect in P2 amplit des and latencies in both samples. This s ggested that e tra erts and ambi erts ere both emotionall reacti e to HN stim li at time points before 200 ms (Smith et al., 200 ; Y an et al., 2007). Despite a significant interaction of emotion, session, and e tra ersion in P2 amplit des, there as no significant emotion e tra ersion interaction in the npleasant session. This s ggested that both samples ere similar in their processing of npleasant pict res of di erse emotional intensities at this stage. Th s, the impact of e tra ersion on npleasant emotion sensiti it ma occ r at later stages.

In addition, there as a significant emotion e tra ersion interaction in the N2 amplit des. Consistent ith the acco nt of negati e bias, both samples elicited a significant emotion effect for HN stim li that ere biologicall important (Bradle et al., 2001). Ho e er, ambi erts, b t not e tra- erts, e hibited enlarged N2 amplit des for MN relati e to ne tral stim li. This s ggested that ambi ert s bjects detected the emotional negati it of MN stim li and accordingl , allocated more attention reso rces to them relati e to ne tral stim li (Nag et al., 200). In contrastC5]TJ 52]TJ [illegible]

(Donchin, 1981; Ito et al., 1998). In emotion assessment tasks, s bjects are req ired to e al ate the emotionalit of the stim li and to categori e them according to alence (Ito et al., 1998; Sch pp et al., 200). Therefore, npleasant stim li, hich are kno n to be important for biased processing in the brain, sho ld be e al ated as more biologicall significant, and conseq entl sho ld elicit enhanced ph siological and ps chological reso rces, relati e to other stim li. This biased e al ati e process probabl contrib tes to the higher P amplit des d ring npleasant ers s ne tral conditions in emotion assessment tasks (Ito et al., 1998). Ho e er, in co ert emotional st dies, s bjects are req ired to perform a cogniti e task that is irrele ant to emotion e al ation. This determines that s bjects ha e to inhibit all task-irrele ant information, especiall that associated ith prepotent, biased processing (for disc ssions, see Y an, L , Yang, & Li, 2011; Y an et al., 2007). Accordingl , npleasant trials ma in ol e a process of cogniti e control that is absent in ne tral trials, hich probabl contrib ted to the smaller P amplit des d ring negati e ers s ne tral conditions in this st d . This e planation is consistent ith the established findings in cogniti e control st dies, hereb the cogniti e control of task-irrele ant information res lts in smaller P or late positi e potential amplit des (Liotti, Woldorff, Pere , & Ma berg, 2000; Markela-Lerenc et al., 2004; Y an, X , et al., 2011). The in ol ement of cogniti e control might e plain h co ert emotional st dies ha e consistentl ielded smaller P amplit des for negati e than for ne tral stim li, in addition to the present findings (Carretie et al., 1997; Delplanq e et al., 2004; Li et al., 2008; Y an et al., 2007).

Ne ral bases nderl ing the sensiti it of e tra erts to pleasant e ents

Ne roimaging st dies ha e sho n the roles of ide regions of frontal temporal lobes and of s bcortical str ct res (e.g., the basal ganglia, am gdala, and n cle s acc mbens) in pleasant emotion processing and in its interaction ith e tra ersion (Canli et al., 2002; Canli et al., 2001; Cohen, Yo ng, Baek, Kessler, & Ranganath, 2005). It is orth noting that the cing late corte (partic larl the posterior cing late corte [PCC]), a limbic str ct re located bet een the neocortices and s bcortical str ct res, has ne ral projections ith ide areas of the neocortices (e.g., temporal and orbitofrontal cortices) and ith s bcortical areas (e.g., hippocamp s and am gdala), hich are important in emotion processing (Bromm, 2004; Fredrikson, Wik, Fischer, & Andersson, 1995; Northoff & Bermpohl, 2004). Moreo er, se eral st dies ha e indicated that the PCC is important in generating, e al ating, maintaining, and integrating pleasant emotions (Bromm, 2004; Cohen et al., 2005; Damasio et al., 2000; Esslen, Pasc al-Marq i, Hell, Kochi, & Lehmann, 2004; Maddock & B onocore, 1996; Maddock, 1999). Conseq entl , patients ho are incapable of identif ing emotional states sho less PCC acti ation than do normal s bjects hen *required* to ind ce pleasant affects (Mantani, Okamoto, Shirao, Okada, & Yama aki, 2005), and depressi e indi id als ha e been associated ith a significant ol me red ction of the PCC (Caetano et al., 2006). In line ith these data, o r so rce modeling of the emotional effect of e tra erts for MP stim li indicated generators in the bilateral posterior cing late cortices (see the s pplementar materials). Th s, the bilateral PCCs and their collected regions—incl ding the f siform g r s, am gdala, and basal ganglia, hich are critical for the interaction of pleasant emotion and e tra ersion (Amin et al., 2004; Canli et al., 2002; Canli et al., 2001)—might jointl mediate the brain sensiti it of e tra erts to pleasant stim li of e en mild intensities. D e to the inherent limitations of so rce modeling, hich relies on an in erse sol tion and significant ERP differences, the res lts of so rce modeling sho ld be considered as tentati e, and other techniq es ith better locali ation (e.g., f nctional MRI) ill be needed to clarif the ne ral bases that nderlie the enhanced sensiti it of e tra erts to pleasant stim li ith mild intensities.

Implications

In the present st d , s bjects ere engaged in a distracting task that req ired a standard/de iant distinction, irrespecti e of the emotion of the de iant stim li. Moreo er, the onset seq ence of standard and de iant pict res as randomi ed in both e perimental sessions. Additionall , de iant pict res in the conditions to be presented ere determined randoml thro gho t the e periment. Th s, the presentation of emotional stim li in each condition (HP and MP in the pleasant session, HN and MN in the npleasant session) as npredictable before stim l s onset. Ho e er, rare de iant stim li (0%) ere composed of three conditions in either session, hich determined that the occ rrence of e ents of each emotional t pe as rare in each condition (10%). These manip lations made the emotional responses in the present e periment closel resemble those in nat ral settings, here emotion reactions are triggered b accidental, ne pected e ents d ring acti it that is irrele ant to the affecti e assessment (Delplanq e et al., 2005; Y an, L o, et al., 2009).

Therefore, sing a task in hich emotion closel resembles that in nat ral settings, e obser ed that e tra erts ere more reacti e to both highl and mildl pleasant stim li, and ere less s sceptible to mildl npleasant stim li, relati e to ambi erts. E identl , most negati e life e ents are moderatel rather than highl negati e. For instance, dail stresses are more freq ent than serio s traffic accidents in a real-life sit ation (Y an, L o, et al., 2009). Therefore, based on o r findings, e tra erted indi id als are more resistant to npleasant affects and find it easier to maintain a pleasant affect thro gho t life. The gain pleas re from more e ents and de elop negati e emotions from fe er e ents than do ambi erts. This correlates ith prior reports that ha e sho n that e tra ersion as associated ith a shift of attention a a from the location of p nishment and an attention bias for the location of re ard (Amin et al., 2004; Derr berr & Reed, 1994). Therefore, a greater e perience of pleasant emotions and less in ol ement in npleasant emotions are likel to lead to higher le els of s bjecti e ell-being in e tra erts thro gho t life. This ma be associated ith the ne ral sensiti it of the re ard circ it to pleasant e ents in e tra erts. Ho e er, the lack of direct meas rement of s bjecti e ell-being as a eakness in the present st d , altho gh e tra erts are kno n for higher le els of personal happiness (Costa & McCrae, 1980, 1991).

It has to be noted that the present st d as able to nra el ho e tra erts are different from ambi erts in terms of their brains' s sceptibilit to emotional e ents of di erse alences and intensities and of ho these feat res relate to their increased le els of s bjecti e ell-being. This st d does not s ggest that intro erts, ho are another e treme gro p in the meas re of e tra ersion, are lo er or higher than e tra erts in their brain sensiti it to emotional stim li. The characteristics of intro erts in sensiti it to pleasant or npleasant stim li of di erse intensities, and ho these sensiti ities relate to the health and ell-being of intro erts, remain open q estions that are orth of f rther in estigation. Ho e er, the present findings are likel to be dependent on the e perimental paradigm. It has been established that processing reso rce a ailabilit significant-l mod lates emotion processing, s ch that attention shortage leads to the decrease or disappearance of emotional brain acti ation (Dollo, Holg in, & Cada eira, 2006; Pessoa, Padmala, & Morland, 2005). Despite its better ecological alidit in emotion ind ction, the distracting cogniti e task in o r st d as likel to di ert attention a a from emotional processing, conseq entl decreasing the strength of emotional effects in brain potentials (Dollo et al., 2006). Th s, despite gi ing an insight into the ne ral mechanisms that nderlie the increased s bjecti e ell-being of e tra erts, the present res lts are likel to be specific to the co ert emotional paradigm. Accordingl , ca tion sho ld be taken hen concl ding that there are emotional sensiti it differences bet een e tra erts and ambi erts, especiall in concl ding that the brain sensiti it of ambi erts to pleasant stim li as nonsignificant in the present st d .

Conclusions

B ar ing the alence intensit of emotional stim li s stematicall , in the present st d e obser ed that e tra erts ere more reacti e than ambi erts to pleasant stim li, regardless of emotion intensit . E tra erts ere less s sceptible to mildl npleasant stim li as compared to an ambi ert pop lation. Enhanced brain sensiti it to pleasant e ents and resistance to the impact of npleasant e ents might be important ne ral mechanisms that nderlie the higher le els of s bjecti e ell-being fo nd in e tra erts.

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Appendix: Identification numbers of CAPS pictures used in this study

Pleasant session

Highl positi e (HP): 4, 7, 10, 11, 12, 1 , 14, 16, 18, 20, 28, 29, 45, 40, 52, 72, 7 , 77, 78, 88, 94, 84, 9, 57, 2, 98, 27, 65, 66 , 819.

Moderatel positi e (MP): 1, 2, 5, 6, 8, 9, 21, 2 , 24, 25, , 4, 6, 8, 41, 44, 46, 49, 50, 5 , 56, 59, 60, 66, 79, 82, 8 , 85, 87, 99.

Ne tral (positi e): 840, 841, 84 , 547, 89, 06, 454, 482, 5 8, 521, 52 , 614, 722, 848, 08, 21, 26, 28, 77, 402, 6 4, 645, 810, 6 , 00, 291, 816, 818, 8 8, 8 9.

Unpleasant session

Highl negati e (HN): 17 , 185, 191, 194, 196, 205, 206, 2 2, 240, 24 , 244, 246, 248, 254, 255, 256, 270, 27 , 280, 284, 471, 5 , 541, 569, 57 , 577, 580, 629, 58 , 584.

Moderatel negati e (MN): 585, 212, 617, 618, 150, 220, 247, 251, 252, 264, 265, 267, 272, 285, 507, 547, 55 , 557, 565, 56 , 228, 249, 154, 155, 157, 161, 169, 171, 621, 592.

Ne tral (negati e): 89, 294, 06, 88, 454, 482, 5 8, 521,52 , 547, 614, 619, 696, 716, 722, 850, 08, 09, 21, 26, 28, 57, 77, 402, 6 4, 645, 719, 810, 6 , 00.

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