Predictive effects of pre-stimulus energy and phase in alpha and beta bands on discrimination accuracy and visual awareness

Abstract

People are often unaware of objects that are easily aware of at other times. Because the visual stimulus itself is constant, this change in conscious experience may be related to changes in the state of the brain. It is mainly measured by the power and phase of the oscillation in the α band before the stimulus. At present, the effects of prestimulus α band activities on visual awareness in discrimination tasks were not consistent, and there were few studies on prestimulus β band. In this study, the low-contrast stimulus paradigm combined with EEG time-frequency and different awareness perception levels were added to explore the predictive effects of prestimulus α and β on visual awareness in discrimination task. It was found that the main effect of accuracy of α and β was significant, with correct was significantly lower than false. The main effect of awareness level of α was significant. The main effect of phase of accuracy of α was insignificant, but was significant on β. The main effect of phase of awareness level of α was insignificant, but was significant on β. The result showed that the power in the prestimulus α band was significantly lower under correct than false condition.The results showed that the power in the prestimulus α (but not the phase) predicted the accuracy and visual awareness, and the power in the prestimulus β predicted the accuracy, but not the visual awareness. The phase of prestimulus β predicted the accuracy and visual awareness.

Keywords: α, β, prestimulus, visual awareness, discrimination, time-frequency analysis

1. Introduction

Exploring the neural mechanisms behind visual awareness is one of the key areas of research in neuroscience. Awareness of external stimuli depends not only on the physical characteristics of the stimulus but also on the state of the brain, which can be characterized by the power and phase of the α band activity before the stimulus. The power of the low-frequency oscillations (mainly in the α band) before the stimulus is negatively correlated with subjective experiences in visual tasks (Harris et al., 2020; Iemi et al., 2017; Samaha et al., 2017, 2020).

The power of the α band before the stimulus has been shown to predict the likelihood of reporting the presence of a stimulus in detection tasks (Bagherzadeh et al., 2020; Ruzzoli et al., 2019; Guex et al. (2023), which supports the conclusion that the increase in α band power represents the suppression of visual cortical activity associated with visual awareness. However, less attention has been paid to the predictive effects of different prestimulus frequency activities on discrimination accuracy and visual awareness. The evidence for the effect of prestimulus α band power on visual awareness in discrimination tasks seems inconsistent. Most researchers found no relationship between correct and false discrimination. Although most researchers have found no relationship between prestimulus α band power of correct and false discrimination (Bays et al., 2015; Cohen & van Gaal, 2013; Hanslmayr et al., 2007, 2011; Iemi et al., 2017; Macdonald et al., 2011; Wutz et al., 2014), some researchers believe that the prestimulus α band represents a state of low awareness and thus reduces the accuracy of decision-making. They found that the prestimulus α band power of correct discrimination was lower than that of false discrimination.

Some recent studies have shown that in the prestimulus α band power affects subjective measures of self-confidence and visual awareness, but not objective measures such as accuracy (Benwell et al., 2017; Craddock et al., 2017; Iemi et al., 2017; Iemi & Busch, 2018; Lange et al., 2013; Limbach & Corballis, 2016; Samaha et al., 2017). Samaha et al. (2017) used the binary forced choice direction discrimination task and found that the discrimination accuracy was not affected by the prestimulus α band power, but the confidence level was strongly negatively correlated with the power of the prestimulus α band. Benwell et al. (2017) recorded EEG during the luminance discrimination task of threshold stimuli and found that the prestimulus α band power was negatively correlated with visual awareness, but could not predict the discrimination accuracy, while the phase could not predict the discrimination accuracy and visual awareness. The results showed a clear separation between subjective awareness and objective performance. To sum up, research on the predictive effect of visual awareness on discrimination accuracy and subjective visual awareness in discrimination tasks were inconsistent.

Based on the assumptions of the Baseline Model, because changes in criteria are associated with changes in subjective awareness(Iemi et al., 2017; Peters et al., 2016; Rahnev et al., 2011), prestimulus α may affect the level of awareness in the discrimination task, but not the discrimination accuracy. The researchers thought that the same rate of firing should be increased for both correctly discriminated neurons and those that did not. However, the Precision Model predicts that the reduced power in the α band improves the sensitivity of the detection and discrimination tasks due to reduced trial-by-trial response variability (Iemi et al., 2017).

Whether the prestimulus α band power predicts subjective visual awareness only or discrimination accuracy only, or both or neither, needs to be further studied. The activity of the prestimulus β band was explored. Low-contrast stimuli were used to measure the discrimination threshold before the experiment, and the visual awareness was measured by the Perceptual Awareness Scale (PAS, Ramsøy & Overgaard, 2004) developed by Ramsøy and Overgaard (2004), which uses a 4-point visibility scale: 1: No experience; 2: Brief glimpse; 3: Almost clear image; 4: Absolutely clear image. EEG data were analyzed in time-frequency to investigate the predictive effects of the prestimulus power and phase in the α and β bands on discrimination accuracy and visual awareness.

2. Materials and Methods

2.1. Participants

The sample size was estimated using G-power (effect size = 0.25; $p < 0.05$; power = 0.80), and the estimated result was 18. To ensure statistical testing power, a total of 32 participants were recruited. All participants were right-handed and volunteered to participate in the experiment, 7 participants were excluded due to excessive signal artifacts. Therefore, 25 participants (mean age: 21 years old, 18-28 years old, 4 males) were valid. All participants had a normal or corrected vision, no history of mental illness, provided written informed consent and received certain remuneration after the end of the experiment.

2.2. Experimental Materials

The experimental material was a low-contrast sinusoidal Gabor patch at the threshold level, tilted vertically to the left or right by 45°, with Michelson contrast ratios of 0.01, 0.02, and 0.03, respectively. The presentation time and contrast are determined in the threshold measurement procedure. And the experimental material was made from the *online Gabor-patch generator*. The background brightness of all stimuli was 22cd/m^2.

2.3. Experimental procedures

The E-Prime 2.0 software presents stimulation, with a screen resolution of 1024x768 pixels and a refresh rate of 60Hz (approximately 17ms per refresh cycle). The participants were about 100cm away from the screen. Firstly, threshold measurement was conducted and the participants were familiarized with the experimental process. Secondly, the participants performed the discrimination task while recording the EEG. In the formal experiment, the fixation point was first presented at 500ms~1000ms, and then the target stimulus was presented, and the presentation time was determined by the threshold measurement. The fixation point was presented again, and it turned dark gray after 600ms. At this time, the participants had to make a key response, judging the direction of the grating rotation, and when turning to the right they pressed the right arrow "→" key, when turning to the left they pressed the left arrow "←" key. The keys were balanced between participants. Then the level of awareness was rated, and the number keys 1-4 were selected with the left hand. There were a total of 800 trials, 8 blocks, 100 trials per block. The length of rest between blocks was controlled by the participants. The formal experiment takes about an hour. The flow chart of the experiment is shown in Figure 1.

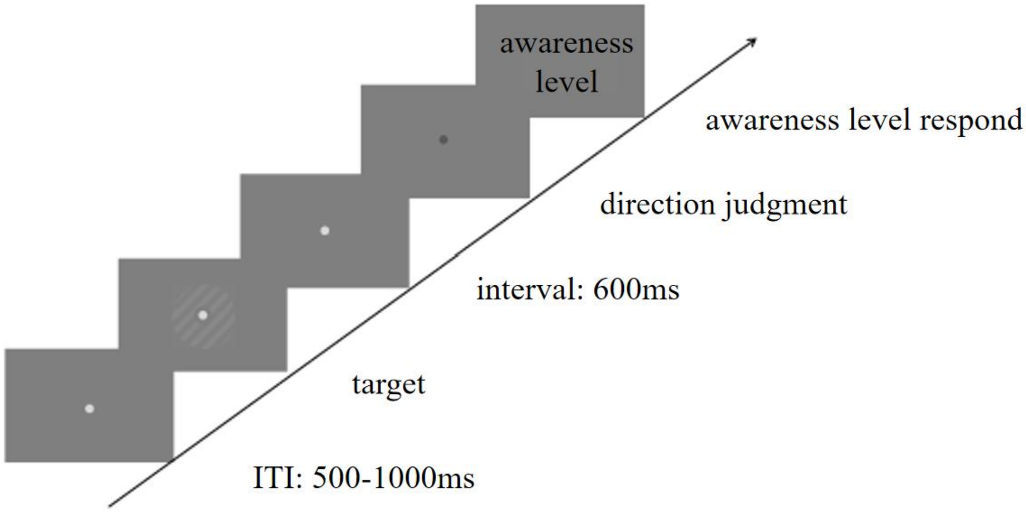

Figure. Flow chart of Experimental

The method of minimal change was used to determine the threshold for each participant separately (Chica et al., 2017; Wyart & Tallon-Baudry, 2009). The procedure is the same as the formal experiment, but there is no need to assess the level of awareness. Fixed contrast to adjust presentation time (adjusting the contrast if necessary) so that about 75% of the stimulus is identified correctly and about 25% of the stimulus is identified incorrectly. In the first calibration block, the time is 1 refresh cycle (17ms) with 0.01 Michelson contrast. A total of 30 trials were included, including 24 proposed threshold stimuli, 6 suprathreshold (Michelson contrast of 0.04) stimuli. If the participants misidentified the stimulus to less than 25% or correctly identified more than 75%, add or subtract 1 refresh cycle accordingly. If the refresh cycle exceeds 6, the contrast will be increased to 0.02 or 0.03. When the appropriate stimulus presentation time (and contrast) is found, the calibration block is repeated at the same stimulus intensity to verify the stability of the results.

2.4. EEG data recording

EEG data were collected by Curry7, and EEG recordings were performed by participants wearing an international 10-20 system extended 64 electrode cap. During online recording, the grounding is located at the midpoint of the FPz and Fz, and the reference electrode is located between CPz and Cz. The sampling rate is 1000Hz in

DC mode. Horizontal eye electricity (HEOG) in both eyes and vertical eye electricity (VEOG) in the left eye were recorded, and the resistance remained below 10kΩ.

2.5. EEG data analysis

For the analysis of awareness level, because the participants' keys 3 and 4 were less, in order to enhance the statistical effect, the keys 3, 4 were combined for high awareness level, 2 for medium awareness level, and 1 for low awareness level. Therefore, this study will obtain EEG data for the following conditions: correct, false, high level of awareness, medium level of awareness, low level of awareness. When the statistical results were not spherical, the *Greenhouse-Geisser* method was used to correct the P-value, and the LSD method was used for multiple comparisons.

Preprocessing was performed using the EEGLAB toolbox (Delorme & Makeig, 2004). By using a 0.1Hz high-pass filter and 100Hz low-pass filter, the power frequency interference of 48~52Hz is a dented filter. Offline downsampling to 250 Hz. Independent Component Analysis (ICA) was used to remove ocular and myoelectric artifacts. Segmented were presented before 1200 ms and after 1200 ms of stimulus presentation. Remove bad block above ±100μV. The participant was eliminated if the elimination trials exceeded 30% of the total trials. The reference was a bilateral mastoid process.

The time-frequency analysis used the EEGLAB toolbox's newtimef function, and the wavelet transform performs time-frequency conversion on the information in the 3-50Hz frequency band, converting the preprocessed EEG data into time-frequency domain data. The parameter cycle was selected as (3, 0.5), and the time-frequency representation of 5~30 Hz was presented. Logarithmic transformation of the power of the frequency band was calibrated with a scale of $10\times\log10(uV^2/Hz)$.

The phase analysis used the Fieldtrip toolbox ft_freqanalysis function to calculate the phase (Inter Temporal Coherence, ITC) through the coherence between trials and further calculates the Phase Bifurcation Index (PBI, abbreviated as Φ) (Busch et al., 2009), $\Phi_{t,\ f} = (ITC_{correct\ (t,\ f)} - ITC_{total(t,\ f)})\ x\ (ITC_{false\ (t,\ f)} - ITC_{total(t,\ f)})$. The value of PBI ranges from −1 to 1. A positive value indicated that the phase of the two was locked at different phase angles, and a negative value indicated that only one condition showed phase locking. Close to 0 indicated that the two phases were either random or locked at the same phase angle. Subsequent analysis will only consider whether there was a significant difference when PBI was positive.

To investigate the relationship between the prestimulus α power and the correct rate, false rate, the proportion of low/medium/high awareness level in more detail, the power was grouped using the method proposed by Limbach and Corbalis (2016). Fast Fourier Transform (FFT) was performed on each segment within a specified time zone to obtain the power index. All trials were divided into five equal parts (bins) based on the prestimulus α power. For each bin, repeated measured ANOVA was used to explore the difference of correct rate, false rate, proportion of low awareness level, proportion of medium awareness level and proportion of low/medium/high awareness level, as well as their correlation with the Spearman rank between power bins.

All experimental procedures and data in the experiment are publicly available https://www.scidb.cn/surl/xlxb. (DOI:https://doi.org/10.57760/sciencedb.18384)

3. Results

3.1. Behavioral Results

6 participants had a contrast ratio of 0.01 and a time of 1-4 refresh cycles, and 19 participants had a contrast ratio of 0.02 and a time of 1-2 refresh cycle.

The average accuracy of the discrimination task was 0.81 (*SD*=0.07). The accuracy increased with the level of awareness, as shown in Figure 1.2. The awareness level of correct (*M*=2.44, *SD*=0.28) was significantly higher than that of false (*M*=1.52, *SD*=0.31), $t_{(24)}$=12.47, $p < 0.001$, Cohen's *d*=1.79. The distribution of the PAS was as follows: the proportion of no experience was 0.25 (*SD*=0.10), the proportion of brief glimpse was 0.28 (*SD*=0.15), the proportion of almost clear image was 0.41 (*SD*=0.19), and the proportion of absolutely clear image was 0.06 (*SD*=0.09).

Trials with reaction times (RTs) exceeding plus or minus 3 standard deviations were not included in the analysis, which accounting for 98.45% of the total trials.

The paired sample *t*-test showed that the main effect of accuracy was significant ($t_{(24)}$ =-10.81, $p<0.001$, Cohen's *d*=4.33), with the RTs of correct (566ms±180) was significantly shorter than the false (882ms±253). Repeated measure ANOVA showed the main effect of awareness level was significant (F (2, 48) =9.39, p<0.001, η_p^2 =0.28). Post hoc test showed low (482ms±153) and high (534ms±233) awareness level was significantly shorter than medium (647ms±270) awareness level (p<0.01).

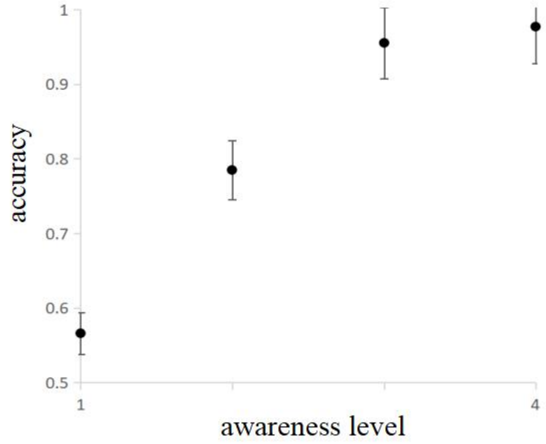

Figure 2 Relationship between accuracy and awareness level

3.2. EEG Results

3.2.1. Time-frequency analysis

Based on previous relevant literature and time-frequency maps (Samaha et al., 2016; Samaha et al., 2017), the posterior occipito-temporal lobe (P7, P5, P3, P1, PZ, P2, P4, P6, P8, PO7, PO5, PO3, POZ, PO4, PO6, PO8, O1, OZ, O2) electrode clusters were selected, and a topographic distribution map was created using whole brain data from different frequency/time. Select the α band of 8-12Hz with time windows of [-600, -500], [-500, -400], [-400, -300], [-300, -200], [-200, -100], [-100, 0]. In addition, conduct exploratory analysis on the β band of 13-30Hz with intervals of 100ms between time windows of [-900, 0].

Accuracy: the time-frequency figure of prestimulus α band of PZ was shown in Figure 3 below. The t-test results of paired samples showed that: [-600,-500], the main effect of accuracy was significant, $t_{(24)}$=-2.08, p<0.05, Cohen's d=0.42, correct was significantly lower than false; [-500,-400], the main effect of accuracy was significant, $t_{(24)}$=-2.59, p<0.05, Cohen's d=0.52, correct was significantly lower than false; [-400,-300], the main effect of accuracy was significant, $t_{(24)}$=-2.75, p<0.05, Cohen's d=0.55, correct was significantly lower than false; [-300,-200], the main effect of accuracy was significant, $t_{(24)}$=-2.69, p<0.05, Cohen's d=0.54, correct was significantly lower than false; [-200,-100] and [-100,0], the main effect of accuracy was insignificant (p=0.07; p=0.07). The topographic map of the time-frequency with significant differences was shown in Figure 4.

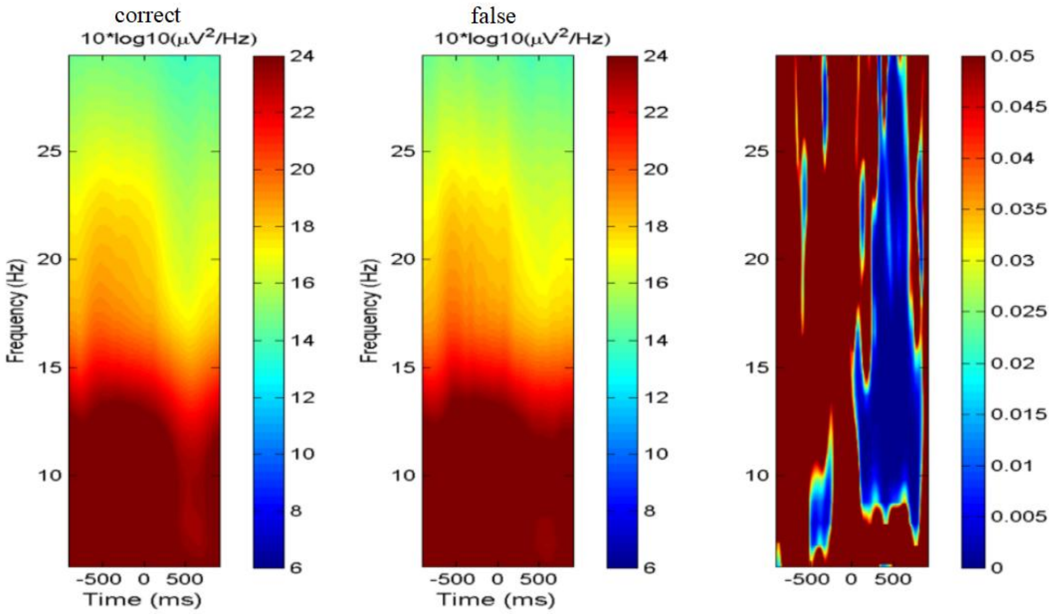

Figure 3. Time-frequency diagram of PZ and corresponding difference P-value time-frequency diagram under accuracy

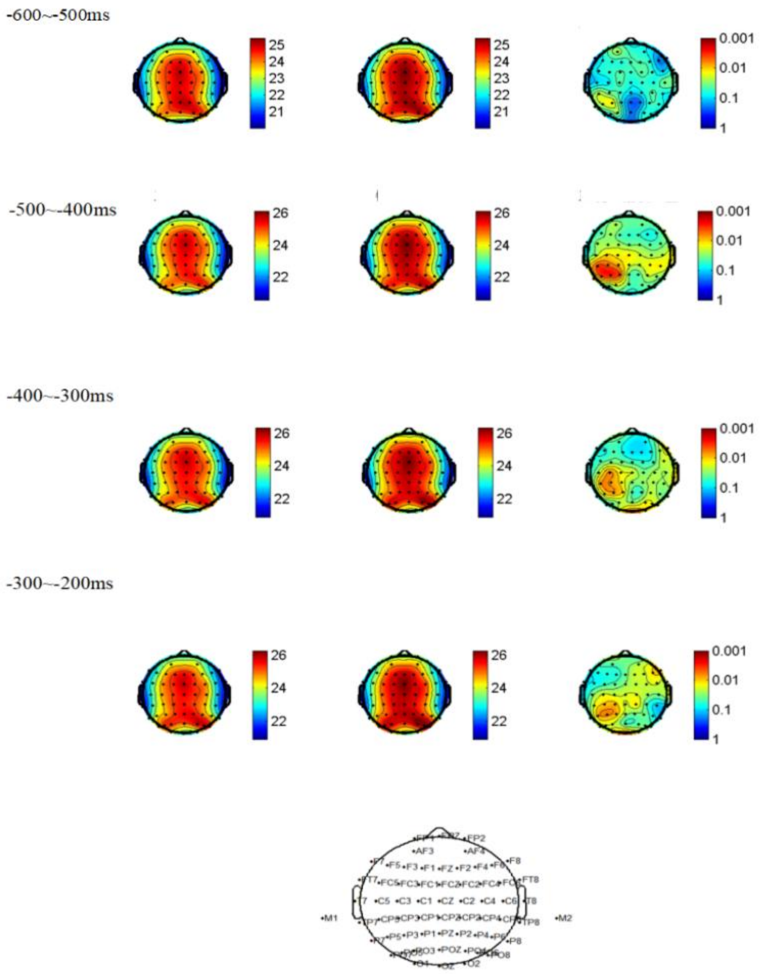

Figure 4. Topographic maps of correct (left) and false(middle) conditions and the *P*-value (right)

Note: the bottom was the distribution of electrodes on a topographic map

The *t*-test results of paired samples of prestimulus β showed that: [-600,-500], the main effect of accuracy was significant, $t_{(24)}$=-2.09, $p<0.05$, Cohen's d=0.42, correct was significantly lower than false; [-400,-300], the main effect of accuracy was significant, $t_{(24)}$=-2.15, $p<0.05$, Cohen's d=0.43, correct was significantly lower than false; other time windows of interest, the main effect of accuracy was insignificant (p=0.30; p=0.82; p=0.20; p=0.21; p=0.19; p=0.78; p=0.31). The topographic map of the time-frequency with significant differences was shown in Figure 5.

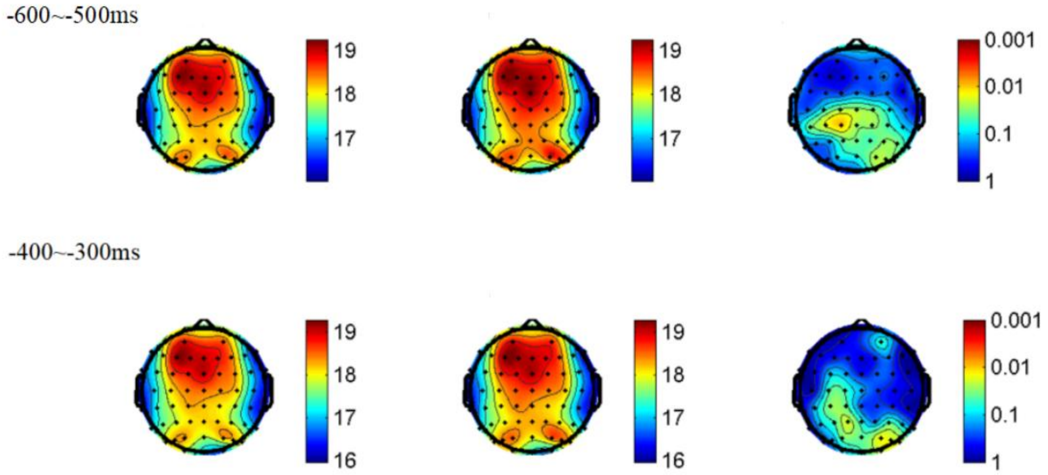

Figure 5. Topographic maps of correct (left) and false(middle) conditions and the *P*-value (right)

Awareness level: the time-frequency figure of prestimulus α band of PZ was shown in Figure 6 below. Repeated measure ANOVA showed that: [-400,-300], the main effect of awareness level was significant (F (2, 48) =3.20, p=0.05, η_p^2 =0.12), with medium was significantly higher than high awareness level (p<0.05); [-200,-100], the main effect of awareness level was significant (F (2, 48) =3.28, p<0.05, η_p^2 =0.12), with medium was significantly higher than high awareness level (p<0.05); [-100,0], the main effect of awareness level was significant (F (2, 48) =3.82, p<0.05, η_p^2 =0.14), with low was significantly higher than high awareness level (p<0.05). [-600,-500], [-500,-400], and [-300,-200], the main effect of awareness level was insignificant (p=0.15; p=0.11; p=0.10). The topographic map of the time-frequency with significant differences was shown in Figure 7.

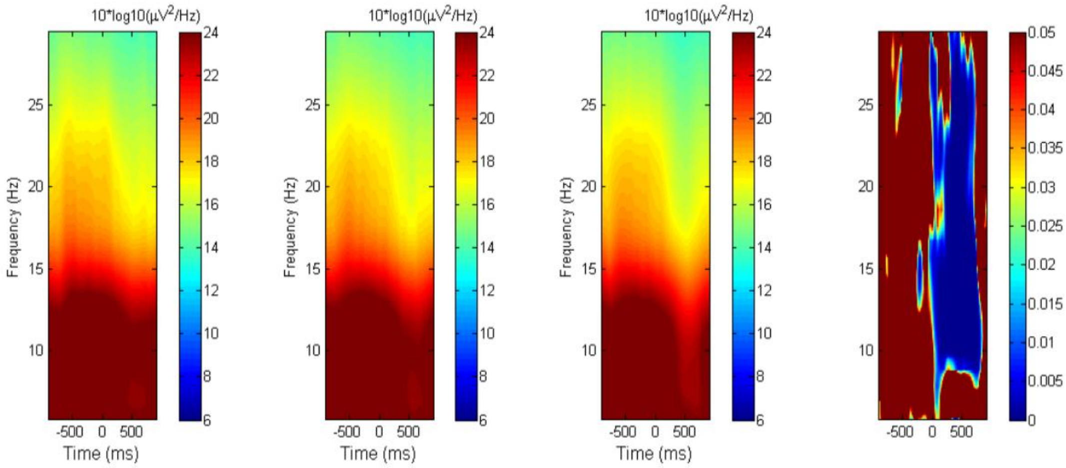

Figure 6 Time-frequency diagram of PZ and corresponding difference P-value time-frequency diagram under low(left)/medium(middle)/high(right) awareness level

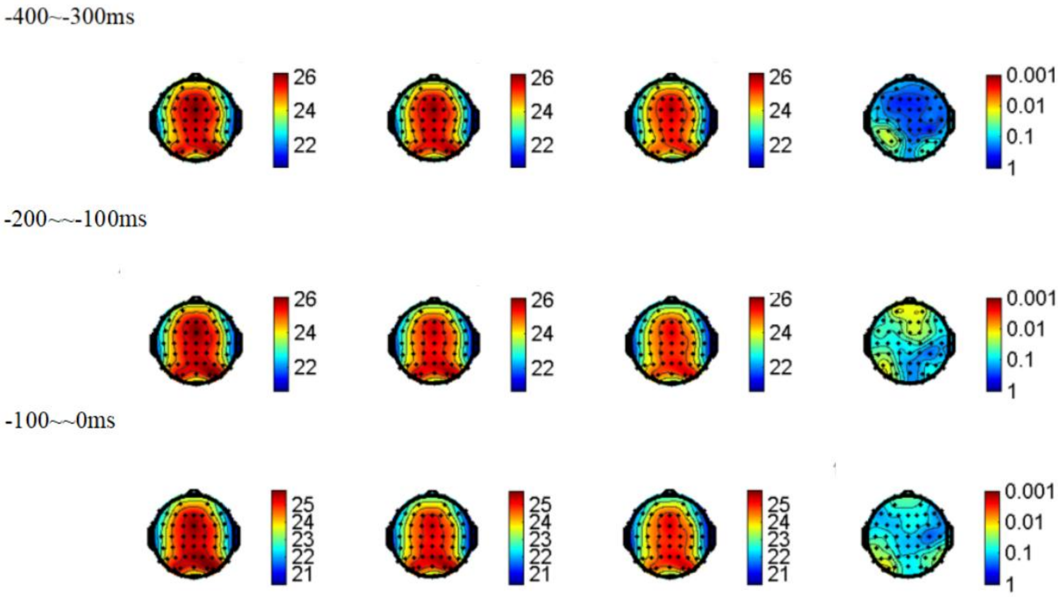

Figure 7. Topographic maps of low (left), medium (middle 1), high (middle 2) conditions and the *P*-value (right)

Repeated measure ANOVA of prestimulus β showed that: within the interest time window, the main effect of awareness level was insignificant (p=0.86; p=0.44; p=0.30; p=0.17; p=0.39; p=0.14; p=0.20; p=0.56; p=0.22).

3.2.2. Phase analysis

Accuracy: The PBI time-frequency map and topographic map were shown in Figure 8. The single-sample t-test of prestimulus α showed that: within the interest time window, the main effect of accuracy was insignificant (p=0.01, the value was negative; p=0.35; p=0.35; p=0.20; p=0.20; p=0.87). The single-sample t-test of prestimulus β showed that: [-200,-100], the main effect of accuracy was significant, $t_{(24)}=2.57$, $p<0.05$, Cohen's $d=0.37$; other time windows of interest, the main effect of accuracy was insignificant ($p=0.003$, the value was negative; $p=0.38$; $p=0.35$; $p=0.18$; $p=0.14$; $p=0.06$; $p=0.23$; $p=0.09$).

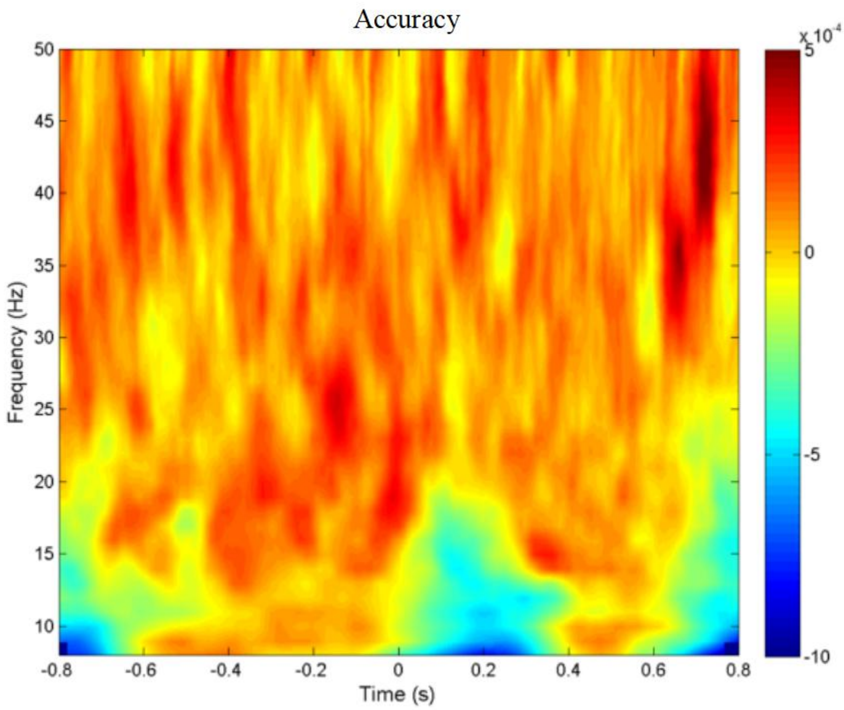

Figure 8. PBI time-frequency graph of accuracy

Awareness level: the time-frequency figure of low/medium awareness level was shown in Figure 9. The single-sample *t*-test of prestimulus α showed that: within the interest time window, the main effect of awareness level was insignificant ($p=0.05$; $p=0.64$; $p=0.28$; $p=0.38$; $p=0.23$; $p=0.28$). The single-sample *t*-test of prestimulus β showed that: [-200,-100], the main effect of awareness level was significant, $t_{(24)}=3.92$, $p<0.01$, Cohen's $d=0.79$; [-100,0], the main effect of awareness level was significant, $t_{(24)}=2.15$, $p<0.05$, Cohen's $d=0.44$; other time windows of interest, the main effect of awareness level was insignificant ($p=0.008$, the value was negative; $p=0.98$; $p=0.07$; $p=0.11$; $p=0.16$; $p=0.24$; $p=0.12$).

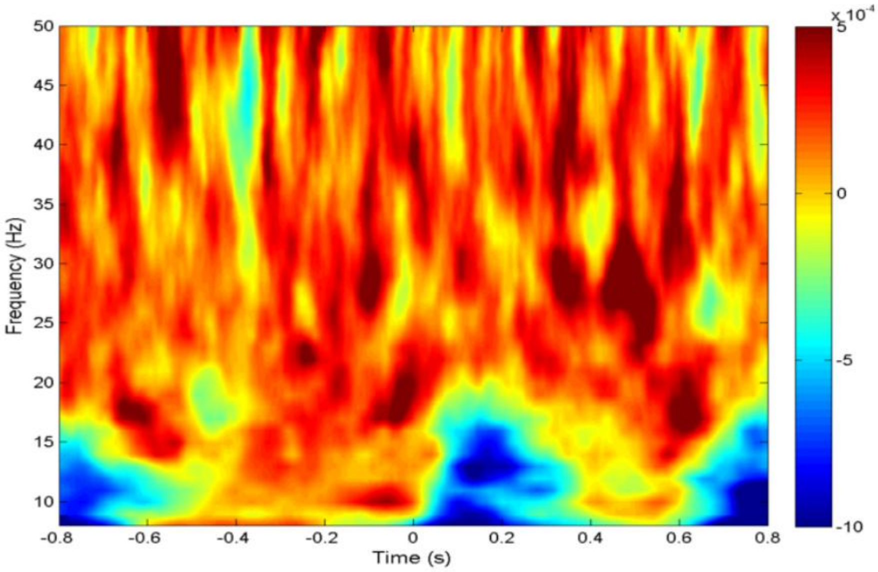

Figure 8. PBI time-frequency graph of low/medium awareness level

The time-frequency figure of low/high awareness level was shown in Figure 9. The single-sample *t*-test of prestimulus α showed that: within the interest time window, the main effect of awareness level was insignificant (p=0.03, the value was negative; p=0.10; p=0.59; p=0.21; p=0.21; p=0.09). The single-sample *t*-test of prestimulus β showed that: [-500,-400], the main effect of awareness level was significant, $t_{(24)}$=2.99, p<0.01, Cohen's d=0.61; [-400,-300], the main effect of awareness level was significant, $t_{(24)}$=2.73, p<0.05, Cohen's d=0.53; [-300,-200], the main effect of awareness level was significant, $t_{(24)}$=2.17, p<0.05, Cohen's d=0.41; [-200,-100], the main effect of awareness level was significant, $t_{(24)}$=3.03, p<0.01, Cohen's d=0.67; other time windows of interest, the main effect of awareness level was insignificant (p=0.02, the value was negative; p<0.001, the value was negative; p=0.77; p=0.10; p=0.11).

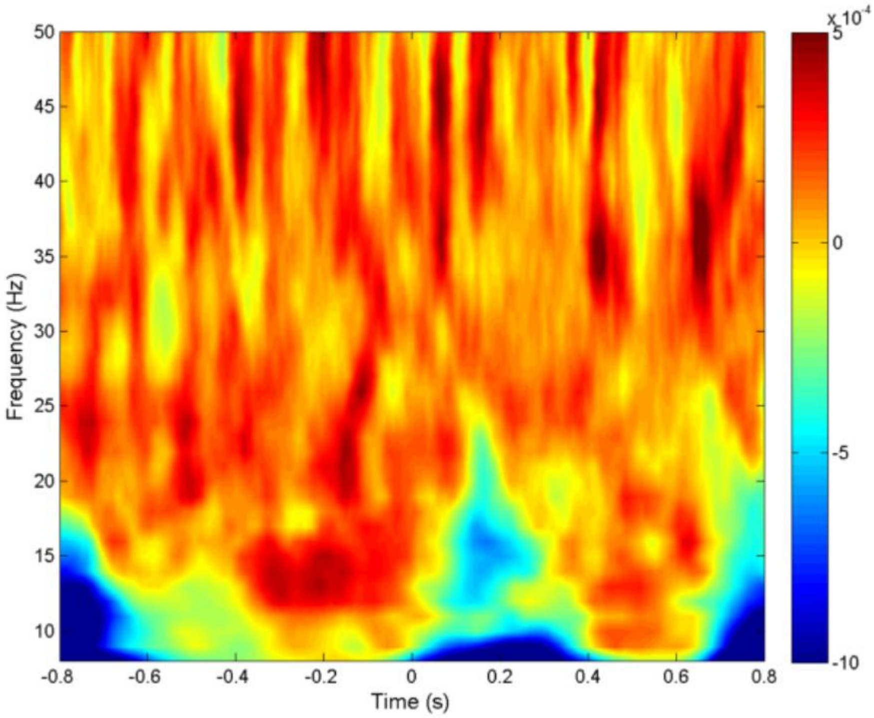

Figure 9. PBI time-frequency graph of low/high awareness level

The time-frequency figure of medium/high awareness level was shown in Figure 10. The single-sample *t*-test of prestimulus α showed that: within the interest time window, the main effect of awareness level was insignificant (p=0.003, the value was negative; p=0.89; p=0.52; p=0.91; p=0.33; p=0.91). The single-sample *t*-test of prestimulus β showed that: [-600,-500], the main effect of awareness level was significant, $t_{(24)}$=2.92, p<0.01, Cohen's d=0.43; [-500,-400], the main effect of awareness level was significant, $t_{(24)}$=3.79, p<0.01, Cohen's d=0.86; [-400,-300], the main effect of awareness level was significant, $t_{(24)}$=3.38, p<0.01, Cohen's d=0.67; other time windows of interest, the main effect of awareness level was insignificant (p=0.09; p=0.60; p=0.11; p=0.11; p=0.09; p=0.86).

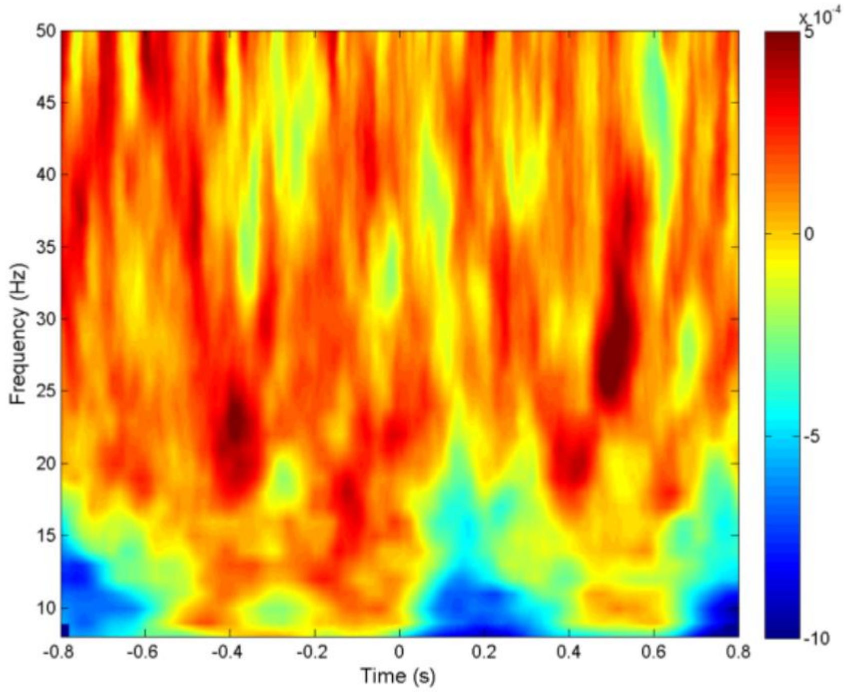

Figure 10. PBI time-frequency graph of medium/high awareness level

3.2.3. Power bin analysis

Accuracy: According to the time-frequency results, the time windows of [-600, -500], [-500, -400], [-400, -300] and [-300, -200] were selected, with the power bin of α as the independent variable and the correct proportion of different power bin as the dependent variable for repeated measurement ANOVA. The results showed that: [-600, -500], the main effect of α power bin was significant, $F(4, 96)=4.73$, $p<0.01$, $\eta_p^2 =0.17$, the linear trend was significant, $F(4, 96)=11.45$, $p<0.01$, $\eta_p^2 =0.32$; [-500, -400], the main effect of α power bin was significant, $F(4, 96)=2.58$, $p<0.05$, $\eta_p^2 =0.10$, the linear trend was significant, $F(4, 96)=6.05$, $p<0.05$, $\eta_p^2 =0.20$; other time windows of interest, the main effect of α power bin was insignificant ($p=0.13$; $p=0.48$). The trend figure was shown in Figure 11.

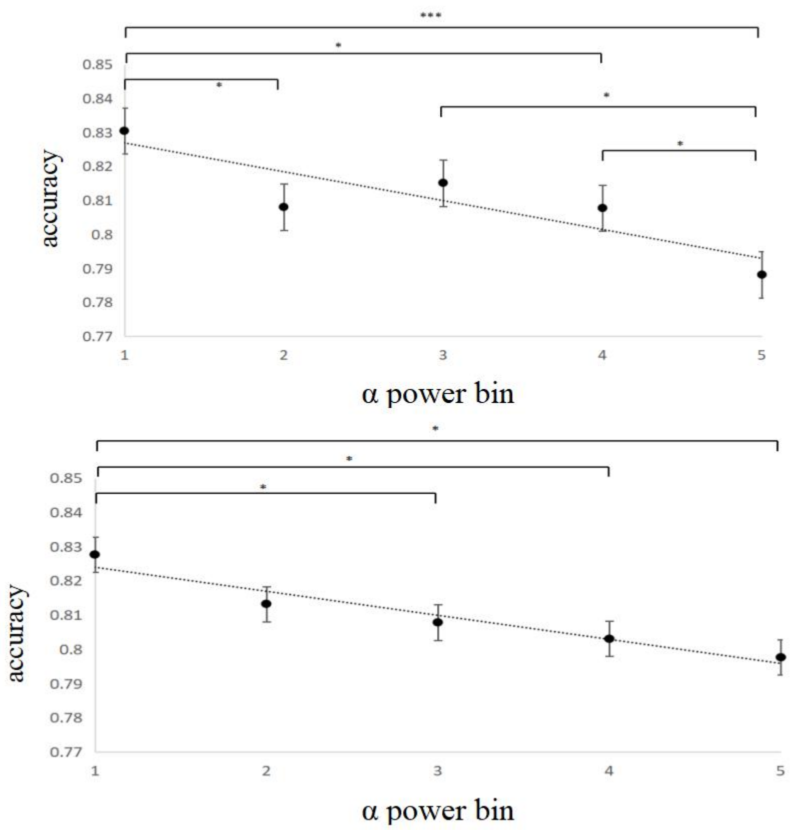

Figure 11. [-600, -500] (above) and [-500, -400] (below) of the power bin linear trend of the accuracy

Awareness level: According to the time-frequency results, the time windows of [-400, -300], [-200, -100], and [-100, 0] were selected, with the power bin of α as the independent variable and the awareness level proportion of different power bin as the dependent variable for repeated measurement ANOVA. The results showed that: [-400, -300], the main effect of α power bin of high awareness level was significant, $F(4, 96)=2.55$, $p<0.05$, $\eta_p^2=0.10$, the linear trend was significant, $F(4, 96)=5.15$, $p<0.05$, $\eta_p^2=0.18$; [-200, -100], the main effect of α power bin of low awareness level was significant, $F(4, 96)=3.06$, $p<0.05$, $\eta_p^2=0.11$, the linear trend was significant, $F(4, 96)=5.34$, $p<0.05$, $\eta_p^2=0.18$; [-100, 0], the main effect of α power bin of low awareness level was significant, $F(4, 96)=3.35$, $p<0.05$, $\eta_p^2=0.13$, and the main effect of α power bin of high awareness level was significant, $F(4, 96)=4.03$, $p<0.05$, $\eta_p^2=0.14$, the linear trend was significant, $F(4, 96)=5.12$, $p<0.05$, $\eta_p^2=0.17$. The trend figure was shown in Figure 12.

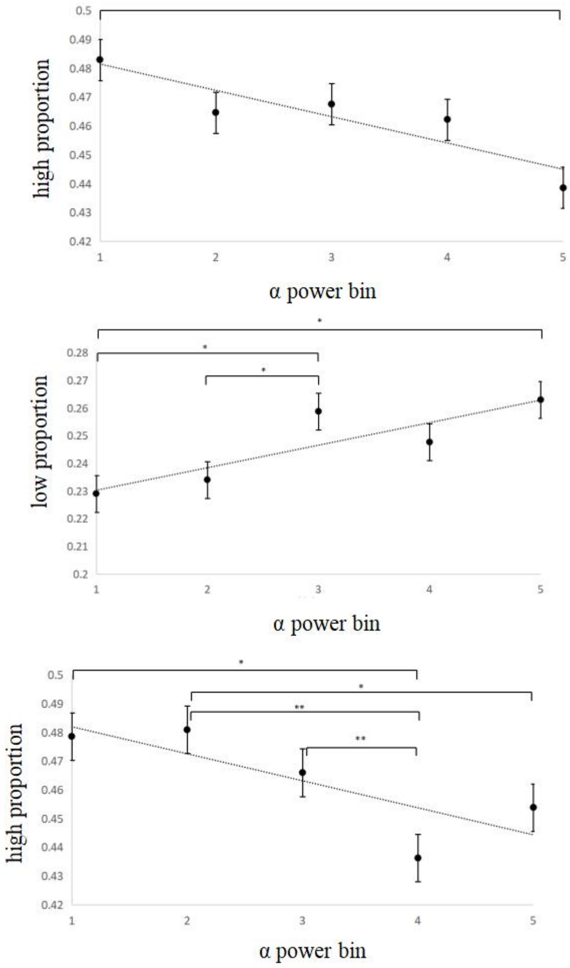

Figure 12. [-400, -300] (above), [-200, -100] (middle), and [-100, 0] (below) of the power bin linear trend of the of the awareness level

The Spearman rank correlation analysis results showed that: [-600, -500], [-500, -400], and [-300, -200], the α power bin was significantly negatively correlated with accuracy (r=-0.9, p<0.05; r=-1， p<0.001; r=-0.9, p<0.05); [-600, -500], the β power bin was significantly negatively correlated with accuracy (r=-0.9, p<0.05); [-400, -300], the α power bin was significantly positively correlated with low awareness level proportion (r=1, p<0.001), negatively correlated with high awareness level proportion (r=-0.9, p<0.05); [-200, -100], the α power bin was significantly positively correlated with low awareness level proportion (r=0.9, p<0.05), negatively correlated with high awareness level proportion (r=-0.9, p<0.05).

4. Discussion

This study appeared to be inconsistent with the majority of evidence regarding the impact of prestimulus α band activity on visual awareness in discrimination tasks, with most researchers finding no significant difference between correct and false discrimination (Bays et al., 2015; Iemi et al., 2017; Wutz et al., 2014; Samaha et al., 2017). This study found that the power of the prestimulus α band under correct was significantly lower than that false conditions, which was consistent with other studies (Lou et al., 2014; Roberts et al., 2014). Ronconi and Marotti (2017) investigated the power and phase differences in the prestimulus α and β for accuracy in letter crowding recognition tasks, where unrelated letters were placed in closer (strongly crowded) or farther (moderately crowded) positions relative to the target. The results showed that the power in the prestimulus α was related to accuracy under moderate crowding conditions, but not under strong crowding conditions. Meanwhile, accuracy under strong crowding conditions was predicted through the phase of α and the power of β. Consistently, differences in power between the α and β were found , but the phase results were different. The power of the prestimulus α under correct was lower than that under false condition, and the power of the the prestimulus α was negatively correlated with awareness levels. Previous studies have found that the higher the power in the prestimulus α, the lower the possibility of being aware (Ergenoglu et al., 2004; Hanslmayr et al., 2007; Benwell et al., 2017; Guex et al., 2023), which was also confirmed in this study. This study supported the viewpoint that the power of the prestimulus α was negatively correlated with the accuracy in the discrimination task in the Precision Model.

This study did not find any differences in the phase of accuracy and awareness levels. However, some studies have not found the predictive effect of phase (Iemi et al., 2017; Vigué-Guix et al., 2022), which may be due to the predictability of stimulus appearance. A fixed time interval between the fixation point and stimulus presentation may limit the effect of the phase. In this study, the time interval was not fixed, and future studies may consider using fixed and non-fixed intervals to further investigate the role of the phase.

Under the conditions of this study, it was found that the power in the prestimulus α (but not the phase) predicted the accuracy and visual awareness, and the power in the prestimulus β predicted the accuracy, but not the visual awareness. The phase of prestimulus β predicted the accuracy and visual awareness. This study complements the role of prestimulus β in the baseline and precision models.

Declaration of interest statement

The authors report there are no competing interests to declare.

Data availability statement

The data that support the findings of this study are openly available in ["Science Data Bank"] at https://doi.org/10.57760/sciencedb.18384.

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