·Original Article·

# Personality correlates of reporting Chinese words from the Deutsch "high-low" word illusion by Chinese-speaking people

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**Abstract: Objective** When English-speaking people listen to the Deutsch "high-low" word illusion, they report hearing English words. Whether Chinese-speaking people report Chinese words when listening to the illusion, or whether any reported words might be correlated with personality traits as previous investigations have demonstrated for listening to music in other cultures, is open to question. The present study aimed to address this. **Methods** A total of 308 right-handed, healthy volunteers (177 women and 131 men) were given the illusion test and asked to answer the Zuckerman-Kuhlman personality questionnaire (ZKPQ). Their depressive tendency was measured by the Plutchik-van Praag depression inventory (PVP). **Results** There was no gender effect regarding either the PVP score or the number of reported Chinese words from the illusion. Women scored higher on ZKPQ neuroticism-anxiety than men. The number of meaningful Chinese words reported was correlated with the ZKPQ impulsive sensation-seeking, aggression-hostility, and activity scores. Some words reported by participants who scored higher on these three traits were related in meaning to those scales. **Conclusion** Our preliminary results suggest that when Chinese-speaking people listen to the Deutsch "high-low" word illusion, they might use personality-related, specific cognitive schemata.

**Keywords:** Chinese words; Deutsch "high-low" word illusion; five-factor model; personality trait; Zuckerman-Kuhlman personality questionnaire

# 1 Introduction

Music evokes both physiological and psychological responses<sup>[1-5]</sup> which justifies its use in the management of psychiatric or psychological disorders such as schizophrenia, mood disorders, and pain<sup>[6-10]</sup>. Previous work has shown that a consonant excerpt often elicits calmness while a dissonant one elicits excitement<sup>[11,12]</sup>. Since music sometimes produces illusions, psychologists have been

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trying to elucidate how humans perceive musical illusions. The auditory octave illusion composed by Deutsch<sup>[13]</sup> is one example. It occurs when a dichotic pair of tones spaced an octave apart is repeatedly presented in alternation through stereo earphones to both ears. When the right ear receives the high tone, the left ear receives the low tone and *vice versa*, or the input ear for each tone switches repeatedly. In this case, participants typically perceive a single low tone at one ear alternating with a single high tone at the other. This was further improved into the Deutsch "high-low" word illusion by Deutsch<sup>[14]</sup>, using natural sounds such as the words "high" and "low" pronounced by a woman instead of the tones. After listening to this pattern through stereo loudspeakers for a while, English-speaking

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people report hearing English words such as "buy loan", "long time", "no, no" and "boatman"<sup>[14]</sup>.

Some investigators have demonstrated a correlation between the cognitive processes of speech and music<sup>[15]</sup>, and the pitch experience in either music or language can transfer from one domain to another<sup>[16]</sup>. In native Chinese (Mandarin) speakers, musical and lexical pitch perceptions are also strongly correlated<sup>[17]</sup>. On one hand, some investigators have demonstrated a positive relationship between illusion perception and happiness<sup>[18,19]</sup>, and an enhanced effect on the emotional response to music<sup>[20]</sup>. In addition, overly positive self-perception appears to be a kind of illusion, which implies that personality trait is correlated with illusion perception<sup>[18,21]</sup>. Personality traits are also involved in the emotional response to or preference for music<sup>[22-27]</sup>: higher extraversion individuals prefer cheerful music<sup>[28,29]</sup>. high sensation-seekers prefer rock music<sup>[30-32]</sup>, and strong emotional responses to music are linked to the antisocial personality trait<sup>[29,33,34]</sup>. However, how personality relates to the perception of the Deutsch "high-low" word illusion remains unanswered.

On the other hand, little is known about Chinese words reported by Chinese-speaking people when listening to the Deutsch "high-low" word illusion. In tonal languages such as Chinese, Thai, and Vietnamese, words take on arbitrarily different lexical meanings depending on the tones in which they are enunciated<sup>[35]</sup>. In Chinese for example, the first tone is characterized as high and level; the second mid-high and rising; the third low, initially falling and then rising; and the fourth high and falling<sup>[35]</sup>, as described in The Contemporary Chinese Dictionary-Extended Edition (Beijing, The Commercial Press, 2002, p. 1197). However, the potential for lexical ambiguity in the absence of inflectional morphology is greater in Chinese than in English or German, but the ambiguity can be reduced in Chinese by lexical tones in the auditory modality<sup>[36]</sup>. Furthermore, when processing the absolute pitch that is involved in lexical meanings, English participants display pitch levels of speech in qualitatively different ways than Chinese participants<sup>[35]</sup>. Considering these differences, it is of interest how communication in the Chinese language influences the perception of the Deutsch "high-low" word illusion.

Therefore, uncovering the word illusion and its personality correlates would contribute to our knowledge of language processing and related cognition. In the current design, we hypothesized that Chinese-speaking participants would report Chinese words when listening to the Deutsch "high-low" word illusion in a way close to their personality traits, such as those measured by a five-factor model. Since music or illusion perception sometimes relates to a sensation-seeking trait<sup>[30-32]</sup>, we used the Zuckerman-Kuhlman personality questionnaire (ZKPQ)<sup>[37]</sup> that measures impulsive sensation-seeking, neuroticism-anxiety, aggression-hostility, activity and sociability. We also used the Plutchik-van Praag depression inventory (PVP)<sup>[38]</sup> to measure the depressive mood of the participants.

### 2 Subjects and methods

2.1 Participants Healthy volunteers, 177 women aged  $21.22 \pm 1.97$  years (range 18–39) and 131 men aged 21.76  $\pm$  2.07 years (range 20–40), were recruited. Educational levels 1, 2, 3, 4, 5, 6 and 7 indicate primary school, junior middle school, secondary middle school, junior college, bachelor, master, and doctoral degrees respectively. The mean educational level for women  $(5.11 \pm 0.49)$  was comparable with that for men  $(5.17 \pm 0.50)$ . All participants had no or minimal musical training, and had no somatic or psychiatric disease, including hearing problems. They were all born and grew up in China, and speak Chinese as their mother language. Their handedness was determined using a Chinese translation of the Edinburgh handedness inventory<sup>[39]</sup>. Each of the 12 items of the inventory was scored 1, 2 or 3 according to the left, either left or right, or right hand preference. All participants scored between 29 and 36, and were thus considered to be moderate or strong right-handers. In addition, as hunger influences the perception of music<sup>[14]</sup>, their hunger at the test time was also noted using a visual analogue scale, with no sign coded as 0 and the maximum as 10.

**2.2 Deutsch "high-low" word illusion** Experiments were conducted in a sound-proof room. Participants sat with a relaxed posture for 20 min before the experiment. Then,

the participant listened to the illusion through two stereo loudspeakers (MUVGD and CR6504, Shenzhen MUVGD Electronics Co. Ltd., China) 1.5 m apart in front of the participant's chair. The two loudspeakers and the participant formed a right triangle 1.5 m on a side. The participant sat comfortably on the chair and the sound level was adjusted to a comfortable level according to the participant's feedback.

The illusion consisted of repeatedly alternated "high" and "low" words pronounced by a woman, in the same way as the high and low tones of the octave illusion. Briefly, when the right ear received the "high" word, the left ear received the "low" word and vice versa. The presentation of the illusion lasted for 1 min and 59 s. Participants noted down all the Chinese words they heard, and later these words were scrutinized by six judges (1 PhD holder, 3 PhD and 2 Master's degree candidates) to be labeled as meaningful or not. Each word was voted on by five judges independently and labeled as meaningful if it received more than three "ves". If a word received three "ves" and two "no", the sixth judge (the PhD holder) made the final decision. The reference tools were The Contemporary Chinese Dictionary-Extended Edition (Beijing, The Commercial Press, 2002) and A Chinese-English Dictionary, Revised Edition (Beijing, Foreign Language Teaching and Research Press, 1995).

#### 2.3 Questionnaires

**2.3.1 ZKPQ** This test has five sub-scale measurements: (a) impulsive sensation-seeking (such as experience seeking or the willingness to take risks for the sake of excitement or novel experience) (19 items); (b) neuroticism-anxiety (19 items); (c) aggression-hostility (17 items); (d) activity (17 items); and (e) sociability (17 items). Each item was given 1 point. In this questionnaire, 10 items on another scale of dissimulation (infrequency or lying) were randomly inserted during the test. Scores above 3 on the dissimulation scale suggests either inattention to the content of the items and acquiescence or a very strong social desirability set; therefore, the dissimulation scale was used as a test validity indicator for individuals<sup>[37]</sup>. The test has proven to be reliable in Chinese culture<sup>[40]</sup>. In the current study, when

a participant scored  $1.96 \times$  standard deviation (SD) higher than the mean score on a scale, we defined him/her as having a higher trait on that scale.

**2.3.2 PVP** This inventory contains 34 items; each item has a three-point scale (0, 1, 2), which corresponds to depressive tendencies. Participants have "possible depression" if they score between 20 and 25, or "depression" if they score higher than 25. The internal reliability of the inventory is 0.94 in a Chinese sample<sup>[41]</sup>.

**2.4 Data analyses and statistics** Only meaningful Chinese words that the participants reported when listening to the Deutsch "high-low" word illusion were counted. A two-way ANOVA plus the independent Student's t test were applied to the five ZKPQ sub-scale scores in the two gender groups; the independent Student's t test was also applied to the numbers of reported meaningful Chinese words and the PVP scores in the two gender groups. The relationships among scale scores of PVP, ZKPQ and number of meaningful Chinese words, participant handedness and hunger scale were assessed by the Spearman rank order correlation test. P < 0.05 was considered significant.

## **3** Results

3.1 Personality trait score There were significant gender differences when five ZKPQ scores were considered (group effect,  $F_{[1, 306]} = 7.27$ , MSE = 95.84, P < 0.01; scale effect,  $F_{[4, 1224]} = 46.61$ , MSE = 456.48, P <0.001; group×scale interaction effect,  $F_{[4, 1224]} = 7.40$ , MSE = 72.49, P < 0.001). Post-hoc Student's t test showed that women scored significantly higher on neuroticism-anxiety than men (Table 1). Moreover, the individual data showed that several women and men scored 1.96×SD higher than the mean score on ZKPQ scales (Table 1). The mean PVP score in women  $(8.15 \pm 6.46)$  was not significantly different from that in men (6.33 ± 5.22) ( $t_{[1,306]}$  = -0.97, P = 0.33). The mean hunger scale score in women  $(1.84 \pm 2.09)$  was not statistically different from that in men  $(1.97 \pm 2.24)$ , and five women and eight men scored 1.96×SD higher than the mean hunger scale score.

**3.2 Number of reported meaningful Chinese words** All participants reported hearing Chinese words during

	Women		Men	
	Score	Higher number	Score	Higher number
Impulsive sensation-seeking	8.59 ± 3.40	5	8.61 ± 3.25	3
Neuroticism-anxiety	8.80 ± 3.83 *	2	$6.56 \pm 3.12$	0
Aggression-hostility	$5.31 \pm 2.76$	9	$5.21 \pm 2.63$	5
Activity	$7.28\pm3.42$	6	$7.39 \pm 3.19$	0
Sociability	$7.72 \pm 3.21$	0	$7.40 \pm 3.21$	3

Table 1. Mean scores of subscale measurements (mean  $\pm$  SD) in the Zuckerman-Kuhlman personality questionnaire and the number of participants scoring 1.96 × SD higher than the mean score (higher number) in women (n = 177) and men (n = 131)

\*P <0.05 vs men.

Table 2. Examples of Chinese words reported by participants who scored 1.96 × SD higher than the mean score on correlated Zuckerman-Kuhlman personality questionnaire scales

	Sample size	Example words (English translation)	
Impulsive sensation-seeking	5 women, 3 men	太乐(very happy), 太冷(too cold), 感觉(feeling), 赶快(hurry up, at once), 真悬(really dangerous, almost)	
Aggression-hostility	9 women, 5 men	滚开(get out, scram), 冷看(look coldly), 痛快(greatly satisfied), 痛苦(suffering), 断开 (break off)	
Activity	6 women	再一个(once more), 转换(transform), 走开(go away), 放松(relax), 躲开(avoid)	

the test, some of which were meaningful, such as "开端 (beginning)", "看一看(have a look)", "买(buy)", and "快 点 (hurry up, at once)". The total number of meaningful Chinese words reported by 308 participants was 481. The average number of meaningful Chinese words reported by women  $(1.65 \pm 1.49)$  was not statistically different from that reported by men (1.44  $\pm$  1.27) ( $t_{[1, 306]} = 0.86$ , P = 0.39). 3.3 Relationship between personality traits and number of meaningful Chinese words The number of reported meaningful Chinese words was positively correlated with ZKPQ impulsive sensation-seeking (n = 308, r = 0.16, P = 0.01), aggression-hostility (r = 0.14, P = 0.04) and activity (r = 0.15, P = 0.02). No other correlation was found between the number of reported Chinese words, age, educational level, handedness, hunger, and PVP scores in all participants.

Following the correlations detected above, we scrutinized the meaningful Chinese words reported by the participants who scored higher on ZKPQ impulsive sensationseeking, aggression-hostility and activity. Interestingly, participants who scored higher on impulsive sensationseeking reported hearing words such as "太乐(very happy)", "感觉(feeling)", "赶快(hurry up, at once)", "果断 (decisive)", "远看(look far)", and "真悬(really dangerous, almost)", which might represent the experience of rapidity, excitement or a novel sensation. Participants who scored higher on aggression-hostility reported hearing words such as "滚开(get out, scram)", "冷看(look coldly)", "断开 (break off)", and "痛苦(suffering)", which might express verbal aggression, rudeness, or antisocial behavior. Participants who scored higher on activity reported hearing words such as "再一个(once more)", "转换(transform)", "放松 (relax)", and "走开(go away)", which might represent a preference for challenging work, or situations associated with an active life (Table 2).

## **4** Discussion

In this study, women scored significantly higher on ZKPQ neuroticism-anxiety than men, which corresponds to the well-documented gender differences in personality traits<sup>[42]</sup>. Among the reported meaningful Chinese words from the Deutsch "high-low" word illusion, some were re-

lated to the respective personality traits. In a recent study, emotion-related Chinese words helped to understand personality traits, since some Chinese words, i.e., adjectives that describe emotion, were highly correlated with a given personality trait<sup>[43]</sup>. Our findings are also in line with the report that positive music makes people more likely use happy words in their continuations while negative music makes them more likely to use sad words<sup>[44]</sup>. In our participants, the number of reported meaningful Chinese words was positively correlated with ZKPQ impulsive sensationseeking, aggression-hostility and activity traits, which supports the idea that personality traits influence the perception of music<sup>[22-26]</sup>.

Our finding that ZKPQ impulsive sensation-seeking was correlated with the number of reported meaningful Chinese words may be supported by music emotionrelated studies. For instance, high sensation-seekers prefer heavy metal or rock music to soundtracks<sup>[30,31]</sup>. This highly arousing music would fit their optimal level of stimulation<sup>[29,31,45]</sup>, which might be linked to an antisocial personality<sup>[33]</sup>. In our study, participants with higher impulsive sensation-seeking scores reported Chinese words relating to this trait, implying that they had mobilized the cognitive schema associated with the experience of rapidity, excitement or a novel sensation when processing the illusion. They might particularly maintain their specific illusions to reach the optimal cortical arousal level, just as participants with openness to experience choose their music<sup>[25,26]</sup>. Openness to experience is, on the other hand, co-loaded with impulsive sensation seeking in a group of American students<sup>[37]</sup>.

There is currently no plausible explanation for the correlation of the number of reported Chinese words with ZKPQ aggression-hostility in this study. However, previous work has shown that the preference for heavy metal, rock, alternative, rap, or dance music is positively related to the antisocial personality<sup>[29,31]</sup>. On the other hand, people with lower scores on psychoticism, a trait highly correlated with aggression-hostility<sup>[37]</sup>, prefer less aggressive but more consonant music<sup>[46]</sup>. In our study, participants who scored higher on aggression-hostility might have mobilized

their cognitive strategy to process the illusion, and reported hearing words that expressed anger and psychopathy. Similarly, people exhibit more emotional problems and more anger when they listen to heavy music<sup>[47,48]</sup>.

Similarly, there is no direct evidence to support our finding that the number of reported meaningful Chinese words was correlated with activity. However, extraversion, an activity-related personality factor<sup>[37]</sup>, may mediate the physiological response to emotionally powerful music<sup>[34]</sup>. Moreover, action, a trait facet of openness to experience, is correlated with preference for rock music<sup>[49]</sup>. Participants who scored higher on activity and reported Chinese words relating to this trait might mobilize the cognitive schema for preferring challenging work, or situations associated with an active life. Indeed, individuals with the conscientiousness trait are more likely to have a rational, or cognitive use for music<sup>[23,50]</sup>, and conscientiousness is co-loaded with activity in a group of American students<sup>[37]</sup>.

Nonetheless, it should be noted that our preliminary study has several limitations. First, English-speaking subjects were not included, so we could not determine whether these findings are unique to a tonal language (Chinese). Second, other meaningful Chinese words were reported besides those relating to ZKPQ traits. Whether these words could be clustered further to disclose the implicit cognition of illusion perception remains unsettled. Third, patients with personality disorders were not included. Whether they report Chinese words more associated with disordered personality traits remains unknown. Finally, the neural mechanisms underlying the relationship between illusion perception and personality trait remain to be uncovered by using techniques such as cerebral event-related potential recordings and functional magnetic resonance imaging.

In conclusion, we have demonstrated that perception of the Deutsch "high-low" word illusion has personality correlates, especially the impulsive sensation seeking, aggression-hostility and activity traits. Our preliminary results imply that when Chinese-speaking people listen to the illusion, they might use their personality-related, specific cognitive schemata. Moreover, based on our results and others<sup>[51]</sup>, future studies might focus on the brain areas responsible for processing both the illusion and the Chinese language using cerebral potential recording or neuroimaging techniques, or be extended to clinical use such as in psychiatric patients who frequently suffer auditory hallucinations or illusions.

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