

Is it over-respectful or disrespectful? Differential patterns of brain activity in perceiving pragmatic violation of social status information during utterance comprehension



Xiaoming Jiang^a, Yi Li^a, Xiaolin Zhou^{a,b,c,d,*}

^a Center for Brain and Cognitive Sciences and Department of Psychology, Peking University, Beijing 100871, China

^b Key Laboratory of Machine Perception (Ministry of Education), Peking University, Beijing 100871, China

^c Key Laboratory of Computational Linguistics (Ministry of Education), Peking University, Beijing 100871, China

^d PKU-IDG/McGovern Institute for Brain Research, Peking University, Beijing 100871, China

ARTICLE INFO

Article history:

Received 29 September 2012

Received in revised form

19 July 2013

Accepted 24 July 2013

Available online 3 August 2013

Keywords:

Social status

Honorific form

Pronoun resolution

Utterance comprehension

Pragmatics

Sustained positivity

Sustained negativity

N400

ABSTRACT

A critical issue in the study of language communication is how extra-linguistic information, such as the social status of the communicators, is taken into account by the online comprehension system. In Mandarin Chinese, the second-person pronoun (*you/your*) can be in a respectful form (*nin/nin-de*) when the addressee is of higher status than the speaker or in a less respectful form (*ni/ni-de*) when the addressee is of equal or lower status. We conducted an event-related potential (ERP) study to investigate how social status information affects pronoun resolution during utterance comprehension. Participants read simple conversational scenarios for comprehension, with each scenario including a context describing a speaker and an addressee and a directly-quoted utterance beginning with the second-person pronoun. The relative status between the speaker and the addressee was varied, creating conditions in which the second-person pronoun was either consistent or inconsistent with the relationship between conversants, or in which the two conversants were of equal status. ERP results showed that, compared with the status-consistent and status-equal conditions, the status-inconsistent condition elicited an anterior N400-like effect on *nin-de* (over-respectful) and a broadly distributed N400 on *ni-de* (disrespectful). In a later time window, both the status-reversed and the status-equal conditions elicited a sustained positivity effect on *nin-de* and a sustained negativity effect on *ni-de*. These findings suggest that the comprehender builds up expectance towards the upcoming pronoun based on the perceived social status of conversants. While the inconsistent pronoun causes semantic integration difficulty in an earlier stage of processing, the strategy to resolve the inconsistency and the corresponding brain activity vary according to the pragmatic implications of the pronoun.

© 2013 Elsevier Ltd. All rights reserved.

1. Introduction

A critical issue in the study of verbal communication is how extra-linguistic information is taken account by the comprehension system during online processing (Grice, 1975; Hagoort & Van Berkum, 2007). Psycholinguistic research has demonstrated that the comprehender's knowledge about the characteristics or beliefs of the interlocutor affects the perception of the message being communicated (Barr, 2008; Brown-Schmidt, Gunlogson, & Tanenhaus, 2008; Hanna & Brennan, 2007; Hanna & Tanenhaus, 2004; Hanna, 2003; Horton & Keysar, 1996; Leuthold, Filik, Murphy, & Mackenzie, 2012; Nadig & Sadivy, 2002; Regal, Coulson, & Gunter, 2010; see Holtgraves & Kashima, 2008; Van Berkum, 2009 for reviews). Since the social status

of the interlocutor constrains how this person is expected to communicate (Brown, 2006; Halliday, 2007), any deviation from the expected usage of language forms (i.e., pragmatic violation) could be immediately detected and dealt with by the comprehension system.

In many languages, such as Japanese, French or Spanish, one way to convey the social status (or social distance) information during verbal communication is to use honorific forms (Agha, 2007). In Mandarin Chinese, for example, the social status of the addressee can be reflected in the respectfulness of the second-person singular pronoun, *you/your* (Lee-Wong, 2000). A speaker with lower social status is expected to use the more respectful form (*nin/nin-de*) to show deference or respect towards the addressee with higher status, and a speaker with higher social status may use the less respectful form (*ni/ni-de*) to address the addressee with lower status to show social dominance or to implement command (Leech, 1983; Lee-Wong, 2000; Zhou, 2008). Other factors, particularly the social distance (including familiarity and intimacy), the attitude of the speaker towards the

* Corresponding author at: Peking University, Department of Psychology, Beijing 100871, China. Tel.: +86 10 62756599; fax: +86 10 62761081.

E-mail address: xz104@pku.edu.cn (X. Zhou).

addressee, and the formality of the communication settings, also affect the usage of the second-person pronoun (Chao, 1956; Hong, 1985). With only one exception (Momo, Sakai, & Sakai, 2008), however, the brain activity associated with the processing of honorific forms during verbal communication has not been investigated.

Offline behavioral studies suggest that the comprehender employs pragmatic knowledge concerning social status information when interpreting sentences or utterances. The implicit causality of the verb in sentences like “A praised B because he ...” would normally make the reader initially interpret “he” as referring to B, yet this tendency can be overridden with the provision of social status information, for instance, in a sentence such as “The son praised his father because he...” (Garvey & Caramazza, 1974; Garvey, Caramazza, & Yates, 1975). Perception of the status hierarchy between conversants also helps to facilitate the understanding of the pragmatic intent (e.g., *giving an order*) in situations where a speaker of higher status than the listener makes an indirect request (e.g., “It’s so cold in here...”), as compared with the situation in which the speaker and listener are of equal status (Holtgraves, 1986, 1992, 1994; Holtgraves & Yang, 1992). Status hierarchy between the speaker and addressee also plays into a third party’s assessment of the appropriateness of responses of the addressee in indirect speech (Holtgraves, 1986).

Online event-related potential (ERP) studies (Van Berkum, Van den Brink, Tesink, Kos, & Hagoort, 2008; Van den Brink et al., 2012) have investigated the neural responses to mismatches between the content of utterance and the social identity of the speaker. A more negative-going N400 is observed when the target word in an utterance is incongruent with the speaker’s social identity (i.e., age, gender, or status) as inferred from the prosodic features of the utterance (e.g., “I have a tattoo on my back”, spoken with an upper-class accent), suggesting that a semantic unification process takes place linking the linguistic item with the social pragmatic context (Tesink et al., 2008; Van Berkum, 2009). However, when the listener has lower empathic ability, the mismatch elicits a late mono-phasic positivity (P600; Van den Brink et al., 2012); this effect has been observed for mismatches between the critical word and stereotypic information concerning the social identity of the speaker (e.g., biological gender, Lattner & Friederici, 2003; Van Berkum, Koornneef, Otten, & Nieuwland, 2007; stereotypical gender, Osterhout, Bersick, & McLaughlin, 1997) and for non-literal sentences as compared with literal sentences (e.g., irony, Regal et al., 2010; metaphor, Coulson & Van Petten, 2007; joke, Coulson & Williams, 2005; Coulson & Wu, 2005). Functional magnetic resonance imaging (fMRI) also reveals activations for such mismatches in the inferior frontal gyrus and left middle temporal gyrus, the regions that are involved in semantic processing (Tesink et al., 2008).

The only study that has specifically addressed the neural activity associated with the processing of honorific forms (Momo et al., 2008) used Japanese sentences in which the honorific markers (subject-honorific *ni-naru* or object-honorific *suru*) are attached to verbs as morpho-syntactic suffixes when the human subject or object possesses a higher social status. The critical sentences included the first-person pronoun (typically in lower status), the second-person pronoun (typically in higher status), the sentence-ending verb, and the direct object preceding the verb. A mismatching, disrespectful use of the object honorific marker engendered stronger activation in the triangular part of left inferior frontal gyrus and the left lateral premotor cortex, the regions also activated for simple morpho-syntactic violation in this study and in other studies (see Friederici, 2011; Sakai, 2005 for reviews).

The present study aims to investigate the brain activity associated with the pragmatic processing of social status information during utterance comprehension. To this end, we focused on the Mandarin Chinese second-person pronoun, the usage of which is strongly constrained by the social status of the speaker and the addressee. As

we pointed out earlier, in Mandarin Chinese the second-person pronoun (*you/your*) has a respectful form (*nin/nin-de*) when the addressee is of relatively higher status, and a less respectful or less formal form (*ni/ni-de*) when the addressee is of relatively lower status. This distinction is maintained in conversation in order to foster smooth social interactions, to avoid violation of social norms, or to avoid social misunderstanding (Lee-Wong, 2000; Zhou, 2008). The misuse of the second-person pronoun results in either an over-respectful or a disrespectful meaning. According to the pragmatic Relevance Theory (Wilson & Sperber, 2004), this confusion can be interpreted in different ways by the addressee (and third-party observers) depending on the context.

As pointed out by the Relevance Theory, a communicator provides evidence for the intention of conveying a certain meaning, which is inferred by the audience on the basis of the evidence provided. A speaker’s intention (a communicative implicature) is derived when it is relevant to the addressee (Sperber & Wilson, 1995; Wilson & Sperber, 2004). An input achieves relevance when its processing in a context of available assumptions yields a “positive cognitive effect” (e.g., leading to or strengthening an implicature rather than revising or suppressing an implicature), or when the processing effort is less-demanding (e.g., the derivation of implicature engages less inferential effort within certain context). Thus, in terms of the availability of a pragmatic implicature derived in the misuse of the second person pronoun, the Relevance Theory would have different predictions regarding the over-respectful and disrespectful use of pronouns. For example, if President Liu said to Assistant Zhang that “I’m very worried about your (*nin-de*, the respectful form) health”, then this over-respectful use of the second-person pronoun would most likely be interpreted by Assistant Zhang or by any third-party persons knowing their status as President Liu joking or being sarcastic with Assistant Zhang. Such pragmatic implicature is very unlikely when a lower-status speaker addresses a higher-status addressee because it is threatening the addressee’s “face” (Chao, 1956; Mao, 2003). However, in a reversed situation in which Assistant Zhang addressed President Liu with the less respectful form, without appropriate context, this usage would lead to a misrepresentation and probably *not* be interpreted as Assistant Zhang being intentionally impolite to President Liu (Brown & Levinson, 1987; Kuo, 2002). On the other hand, it has been suggested that when the conversants are of equal social status, the usage of the second person pronoun is also constrained by factors related to social distance between the two persons (Mao, 2003). For example, when the conversants are of equal but high status, the use of the respectful form is expected not only due to the high status of the addressee (as compared with others not in the conversation) but also due to a relatively distant relationship between the speaker and the addressee, as inferred from the status information (i.e., persons at superior positions in an organization are not expected to have close, familiar relationships).

We created conversational scenarios describing a speaker and an addressee of equal or different social status. The utterance made by the speaker began with either a respectful version of the second person pronoun (*nin-de*) or a less respectful version (*ni-de*). For each version, the pronoun was either consistent or inconsistent with the relative social status of the speaker and the addressee (see Table 1). The inconsistent condition was realized by reversing the social status of the speaker and the addressee. Previous studies have shown that inconsistency between the critical pronoun and stereotypic information concerning the gender of the antecedent in the sentence context typically elicits a P600 effect (Lattner & Friederici, 2003; Osterhout et al., 1997). Hence we might expect a P600 effect for the two status-inconsistent conditions in Table 1. However, previous studies have also shown that inconsistency between the critical word in an utterance and world knowledge or the social identity of the speaker elicits an N400 effect on the critical word with no evidence of a

Table 1
Examples of respectful and less respectful conversational scenarios used in the experiment, with each type of scenarios having three conditions. Critical pronouns and the object nouns are underlined. The segmented phrases are separated with space.

Respectful	Status-consistent	刘同学	对	李教授	说：“	<u>您的</u>	<u>论文</u>	我已经	看完了。”
		Student Liu	to	Professor Li	said to,“	<u>your (nin-de)</u>	<u>article</u>	I have	finished reading
		(Student Liu said to Professor Li that, “I have finished reading your _[respectful] article.”)							
Less respectful	Status-inconsistent	李教授	对	刘同学	说：“	<u>您的</u>	<u>论文</u>	我已经	看完了。”
		Professor Li	to	Student Liu	said to,“	<u>your (nin-de)</u>	<u>article</u>	I have	finished reading
		(Professor Li said to Student Liu that, “I have finished reading your _[respectful] article.”)							
Respectful	Status-equal	刘同学	对	吴同学	说：“	<u>您的</u>	<u>论文</u>	我已经	看完了。”
		Student Liu	to	Student Wu	said to,“	<u>your (nin-de)</u>	<u>article</u>	I have	finished reading
		(Student Liu said to Student Wu that, “I have finished reading your _[respectful] article.”)							
Less respectful	Status-consistent	叶教授	对	吕同学	说：“	<u>你的</u>	<u>事情</u>	我已经	听说了。”
		Professor Ye	to	Student Lü	said to,“	<u>your (ni-de)</u>	<u>situation</u>	I have	heard about
		(Professor Ye said to Student Lü that, “I have heard about your _[plain] situation.”)							
Less respectful	Status-inconsistent	吕同学	对	叶教授	说：“	<u>你的</u>	<u>事情</u>	我已经	听说了。”
		Student Lü	to	Professor Ye	said to,“	<u>your (ni-de)</u>	<u>situation</u>	I have	heard about
		(Student Lü said to Professor Ye that, “I have heard about your _[plain] situation.”)							
Less respectful	Status-equal	叶教授	对	冯教授	说：“	<u>你的</u>	<u>事情</u>	我已经	听说了。”
		Professor Ye	to	Professor Feng	said to,“	<u>your (ni-de)</u>	<u>situation</u>	I have	heard about
		(Professor Ye said to Professor Feng that, “I have heard about your _[plain] situation.”)							

P600 effect (Hagoort, Hald, Bastiaansen, & Peterson, 2004; Hald, Steenbeek-Planting, & Hagoort, 2007; Van Berkum et al., 2008; Van Berkum, Holleman, Nieuwland, Otten, & Murre, 2009). Since the usage of honorific forms is part of the world knowledge of the comprehender, we might predict enhanced N400 responses for the pronoun in the status-inconsistent conditions. On the other hand, we might also observe differential ERP responses to the over-respectful and disrespectful use of the second-person pronoun since the comprehender may have different strategies to deal with the misuse, as we pointed out earlier. Specifically, the over-respectful usage would lead to a non-literal interpretation, whereas the disrespectful usage would lead to a suppression of the misrepresentation.

The experiment also included two status-equal conditions (Table 1) in which the speaker and the addressee were of equal status but were both of low social status (for the respectful use of the pronoun) or of high social status (for the less respectful use of the pronoun). Thus the social status of the addressee was always the same for the status-equal and status-inconsistent conditions. Given the general expectation that persons of low social status are inclined to use the less respectful form and persons of high social status are inclined to use the respectful form (Chao, 1956; Hong, 1985; Mao, 2003), the pronouns in the two status-equal conditions could be considered as being mildly or subtly misused; consequently, we predicted that ERP responses to these pronouns would be similar to those in the status-inconsistent conditions.

2. Method

2.1. Participants

Thirty right-handed college students (15 females, age ranging from 20 to 24 years, mean age=21.5 years; 15 males, age ranging from 20 to 26 years, mean age=22.3 years) at Peking University participated in the ERP experiment for financial compensation. All the participants were native Mandarin speakers born and raised in Beijing before entering college. They had normal or corrected-to-normal vision and did not suffer from any neurological or psychiatric disorders. Written consent of participation was obtained from each participant before the experiment. This study was approved by the Ethics Committee of the Department of Psychology, Peking University.

2.2. Design and materials

Two hundred and seventy triplets of scenarios describing events in daily life were created as critical materials (see Table 1 for exemplars). Each scenario was made up of one utterance along with a conversational context preceding the

directly quoted utterance. The conversational context described a situation in which one person was speaking to another, with the first person always serving as the speaker and the second as the addressee. The name of each communicator consisted of a common Chinese family name which had no status meanings (e.g., Li, Zhang, Yang, etc.) and a position name which conveyed a particular level of social status in the social hierarchy (e.g., higher-status position: *Professor, General, Manager, etc.*; lower-status position: *Student, Soldier, Assistant, etc.*). The status level of each name was pre-evaluated and classified into high- and low-status by the authors. A further pretest confirmed this classification (see the next paragraph). The utterance contained an object-subject-verb (OSV) structure beginning with a singular second-person possessive pronoun (*ni-de* or *nin-de*)¹ along with the speaker's action taken or attitude towards the addressee. The pronoun unambiguously referred to the addressee. There is a high frequency usage for both the respectful (*nin*, 515 per million) and less respectful form (*ni*, 39629 per million) of the pronoun (Cai & Brysbaert, 2010). Moreover, we used the same set of object nouns (e.g., *article, situation*, as seen in the exemplars in Table 1) after the pronouns across the six conditions. All the objects were status-neutral, which were equally likely to be possessed/owned by a higher- or lower-status person. The actions or attitudes described in the utterance were also status-neutral.

To minimize potential differences in the social status of conversants in scenarios with the respectful and less respectful use of the pronoun, the same position pairs (e.g., President-Student) were used for the two types of scenarios, but with different prefixed family names and different actions or attitudes in the directly quoted utterances. A group of 15 participants, who did not take part in the ERP experiment, were recruited to judge the relative social status of the conversants. For the speaker and the addressee, we assigned pairs (e.g., Student Liu, Professor Li) to one of the three lists in a Latin-square design (see the next paragraph), and each list was pretested with 5 participants. These participants were asked to judge “who had superior status” on a 5-point scale (1) “very confident the first person was superior”; (2) “the first person was possibly superior”; (3) “the two persons were of equal status”; (4) “the second person was possibly superior”; (5) “very confident the second person was superior”. Results confirmed our pre-evaluations. The participants rated the second person as being superior to the first person for the status-consistent utterances with *nin-de* (Mean=4.58, SD=0.68) and for the status-inconsistent utterances with *ni-de* (Mean=4.60, SD=0.64); they rated the first person as being superior to the second person for the status-consistent utterance with *ni-de* (Mean=1.35, SD=0.61) and for the status-inconsistent utterance with *nin-de* (Mean=1.42, SD=0.67); they also rated the two people as being equal for the status-equal utterances with *nin-de* (Mean=3.03, SD=0.32) and the status-equal utterances with *ni-de* (Mean=2.98, SD=0.32). Another 15 participants were asked to rate the social distance between the speaker and the addressee, with their names listed on a 7-point Likert scale (1 indicating extremely close, 7 indicating extremely distant). We found that, for the names used in sentences with *nin-de*, the mean distance was smaller for the status-equal condition (Mean=3.16, SD=0.88) than for the status-consistent (Mean=3.71, SD=0.81) and status-inconsistent (Mean=3.70, SD=0.92) conditions, $p < 0.05$; for the names used in sentences with *ni-de*, the mean distance was larger for the status-equal condition (Mean=4.36, SD=0.91) than for the

¹ It should be noted that the respectful form of pronoun *nin/nin-de* can only have singular reference. In some other languages, like French, the respectful form and the plural form share the same form of the pronoun.

status-consistent (Mean=3.81, SD=0.81) and status-inconsistent (Mean=3.79, SD=0.84) conditions, $ps < 0.05$.

We created three experimental lists using a Latin-square procedure, such that each scenario in each triplet was assigned to a different list. Each list had 270 critical scenarios with 45 from each condition. Ninety filler scenarios were created with the same structure, including 45 which began with a first-person pronoun (*my*) and 45 which began with a third-person pronoun (*his* or *her*). Neither the first-person nor the third-person pronoun conveyed information concerning the social status of the speaker or addressee. The names of persons in all the filler scenarios were full names, i.e., without position names.

A cloze probability test was conducted with 18 university students to examine the predictability of *nin-de* or *ni-de* in different kinds of conversational context. Contexts (e.g., Student Liu said to Professor Li that ____) were extracted from all the conversational scenarios and divided into three lists. Each list was composed of 6 participants who were asked to generate utterances relevant to the two conversants in the context. Overall, 81.7% generated utterances containing a second-person pronoun *nin-de* or *ni-de*. Among these utterances, for the context with a lower-status speaker and a higher-status addressee, 96.4% had *nin-de*, 3.4% had *ni-de*, and 0.2% had a singular *ni-de*; for the context with a higher-status speaker and a lower-status addressee, 96.2% had *ni-de*, and 2.8% had *nin-de* (which was used in a sarcastic way); for the context with two higher-status conversants, 81.4% contained *nin-de*, 18.5% contained *ni-de* that was preceded by a status word for the addressee, and 1.1% contained a singular *ni-de*; for the context with two low-status conversants, 82.7% had *ni-de*, 17.3% had *nin-de* (used in a sarcastic way). These results indicated that, (1) there was no difference in the predictability of *nin-de* and *ni-de* in the status-consistent or status-inconsistent condition; (2) the self-generated use of *nin-de* and *ni-de* was largely consistent with the constraints imposed by the social status of the conversants, with *ni-de* generally not being used for the higher status addressee and *nin-de* generally not being used for the lower status addressee; (3) *nin-de* could be used to make sarcastic statement in the context with a lower-status speaker and a higher-status addressee; (4) *nin-de* was less often used between two higher-status conversants than between a lower-status speaker and a higher-status addressee (81.4% vs. 96.4%), and *ni-de* was less often used between two lower-status conversants than between a higher-status speakers and a lower-status addressee (82.7% vs. 96.2%), $ps < 0.001$. However, it should be noted that the use of *ni-de* after a status word between two higher-status conversants (18.5%) could be considered as being polite, and the less often use of *ni-de* between two lower-status conversants was compensated by the more often use of *nin-de* in a sarcastic (17.3%).

2.3. Scenario rating

A scenario rating test was conducted prior to the ERP experiment to examine whether the use of words in the utterance appropriately manifested the social status hierarchy between the speaker and the addressee. All the critical scenarios were included and were divided into three lists using a Latin-square procedure. The pretest was composed of 36 native speakers of Beijing Mandarin (24 females, age ranging from 18 to 22 years, mean age=20.42 years; 12 males, age ranging from 18 to 22 years, mean age=20.58 years) who did not participate in the ERP experiment. They were randomly assigned to three lists and were instructed to rate the appropriateness on a 7-point Likert Scale (1 representing the least appropriate and 7 representing the most appropriate). As persons in the higher status are expected to be respected and persons in the lower status are expected to show respect, the most disrespectful or over-respectful utilization of the pronoun should be perceived when the status of the speaker and addressee was reversed in the status-inconsistent conditions. Indeed, the average appropriateness score for scenarios with *nin-de* was 6.74 (SD=0.78) for the status-consistent condition, 2.29 (SD=1.57) for the status-inconsistent condition, and 4.11 (SD=1.86) for the status-equal condition; the average score for scenarios with *ni-de* was 6.40 (SD=1.05) for the status-consistent condition, 2.13 (SD=1.31) for the status-inconsistent condition, and 3.98 (SD=1.60) for the status-equal condition (see Fig. 1). A repeated-measures ANOVA with status consistency and pronoun type as two within-participant factors revealed a main effect of consistency, $F(1,22)=432.22$, $p < 0.001$; $F(2,268)=2445.47$, $p < 0.001$, indicating that the use of the second-person pronoun was rated as less appropriate in both the status-inconsistent and the status-equal conditions than in the status-consistent conditions, and as less appropriate in the inconsistent conditions than in the equal conditions, $ps < 0.001$. Moreover, consistency interacted with pronoun, $F(1,22)=27.37$, $p < 0.001$; $F(2,268)=78.10$, $p < 0.001$. Further analysis revealed lower appropriateness ratings for utterances with *ni-de* than for utterances with *nin-de* in the consistent conditions, $F(1,11)=22.10$, $p < 0.005$; $F(2,134)=71.36$, $p < 0.001$, but the scores did not differ between the utterances with *nin-de* and with *ni-de* in the status-inconsistent or status-equal conditions. This finding suggests that (1) the consistency with status hierarchy in the use of the second-person pronoun indeed modulates the comprehenders' intuitive and subjective feeling towards the usage of the pronoun; and (2) less respectful utterances (with *ni-de*) were generally regarded as being less appropriate than the respectful utterances (with *nin-de*) even when the pronoun was status-consistent with the antecedent.

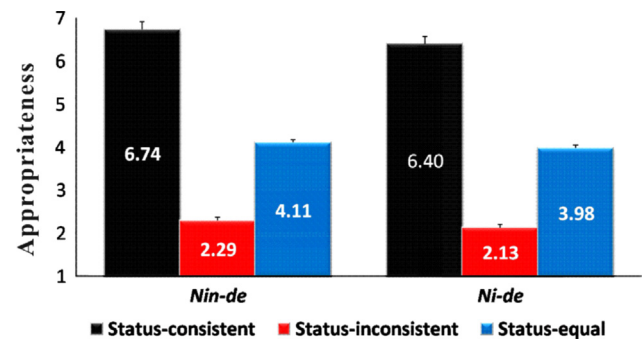


Fig. 1. Bar graphs showing the mean scores of appropriateness rating in the pretest. Standard errors of each condition are also provided.

Furthermore, Pearson pair-wise correlation analysis revealed a positive correlation between the scores for the status-inconsistent and the status-equal conditions, $r=0.36$, $p < 0.05$ for utterances with *nin-de*, $r=0.37$, $p < 0.05$ for utterances with *ni-de*, suggesting that, across participants, the lower the rating for the status-inconsistent condition, the lower the rating for the status-equal condition. However, the correlation between the ratings for *nin-de* and *ni-de* did not reach significance in either condition, $ps > 0.1$. These findings suggest that participants had consistent perceptions of the mildly and strongly inappropriate use of pronouns associated with the status of the speaker and addressee but had different responses to the disrespectful and over-respectful use of the pronouns.

2.4. Procedures

Participants were seated comfortably in a sound-proofed and electrically shielded chamber. They were instructed to move their head or body as little as possible and to keep their eyes fixated on a sign at the center of the computer screen before the onset of each scenario. The fixation sign was at the eye-level and was approximately 1 m away. Scenarios were presented segment-by-segment in a rapid serial visual presentation (RSVP) mode at the center of the screen. Each scenario consisted of a series of eight frames, with four segments for the conversational context and four segments for the utterance (see Table 1 for detailed segmentation). The two-character pronoun was presented as a whole. Segments were presented in white against a black background, with 0.2–1° of visual angle horizontally and 0.2° vertically. Each segment was presented for 400 ms followed by a blank screen lasting 400 ms. This presentation rate and manner was natural and comfortable for reading Chinese (Jiang & Zhou, 2009; Jiang, Tan, & Zhou, 2009; Ye & Zhou, 2009, 2008). At the end of each sentence, participants were presented with a probe statement (e.g., Student Liu has finished reading the article written by Professor Li.) and were asked to verify whether the statement was consistent or inconsistent with the message conveyed by the scenario. The statement probed the actor, the recipient, the object, or the matrix verb described in the sentence. This task was irrelevant to the social status information in the conversational context and was related only to the comprehension of the directly quoted utterance (see also Regal et al., 2010). Participants were asked to carry out the verification as accurately as possible by pressing a button on a joystick with their left or right index fingers. The mapping between finger and yes/no answer was counter-balanced across participants. The numbers of consistent and inconsistent probes were equal for each type of scenario. Each probe statement was presented 500 ms after the offset of the last segment of the scenario and remained on the screen until the participants made a “yes” or “no” response. The next trial began 500 ms after the button press.

Participants were randomly assigned to one of the three experimental lists, with 5 males and 5 females for each list. For each list, scenarios (trials) were pseudo-randomized so that no more than three consecutive scenarios contained the same condition and no more than four consecutive scenarios had pronouns consistent or inconsistent with the conversational context. Before the formal test, each participant received 24 practice scenarios which had the same composition as the critical stimuli. To ensure that the participants indeed perceived the status-inconsistent and the status-equal scenarios as being less appropriate than the status-consistent ones, we randomly selected a set of 90 scenarios (15 for each condition) from the critical stimuli and asked each participant to rate them post-experiment. They were asked to judge whether the utterances appropriately manifested the social status of the speaker and addressee in the conversational context. One participant did not participate in this rating and thus the rating scores reported in Results was based on the remaining 23 participants. The rating scores confirmed the findings in the pretest (see Section 3).

After the EEG test, participants were asked to report the use of the respectful and less respectful forms of the second-person pronoun in their daily life. The participants reported using both respectful (*nin* or *nin-de*) and less respectful (*ni* or

ni-de) forms frequently in writing, and they used the respectful form more often than the less respectful form in daily verbal communication.

2.5. EEG recording

EEGs were continuously recorded from 62 scalp electrodes in a secured elastic cap (Electrocap International). The vertical electro-oculogram (VEOG) was recorded from electrodes located above and below the left eye. The horizontal EOG (HEOG) was recorded from electrodes placed at the outer cantus of each eye. The EEGs on the scalp electrodes were referenced online to the left mastoid and were re-referenced offline to the average of the activity at left and the right mastoids. Electrode impedance was kept below 5 k Ω . The biosignals were amplified with a band pass from 0.01 to 70 Hz and digitized on-line at a sampling rate of 500 Hz.

2.6. EEG analysis

Trials with incorrect responses or with amplitudes greater than 65 μ V were excluded from the averaging procedure, leaving 76.7% of the trials in the statistical analysis. For utterances with *nin-de*, there were on average 34.2, 34.7 and 34.8 of trials for the consistent, the status-inconsistent, and the status-equal conditions, respectively; for utterances with *ni-de*, there were 35.5, 34.2 and 33.8 of trials for the three conditions, respectively. The number of rejected trials did not differ between the conditions. ERPs were computed separately for each participant and for each experimental condition. Epochs comprised of 200 ms pre-stimulus baseline and 1600 ms after the onset of the second-person pronoun (spanning from *nin-de* or *ni-de* to the following object noun). Baseline correction was performed with the 200-ms pre-stimulus average EEG activity.

Repeated-measures analyses of variance (ANOVAs) were conducted on the ERP amplitudes in the selected time windows (300–500 ms for N400, 500–800 ms for the positivity, 800–1600 ms for the sustained effect) with respect to Consistency (status-consistent, status-inconsistent vs. status-equal), Pronoun type (*nin-de* vs. *ni-de*), and topographical factors. The topographical factors included Hemisphere, which had 3 levels (left, medial, right), Region, which had 5 levels (frontal, fronto-central, central, centro-parietal, parietal) and Electrode, which had 3 levels. Thus there were 15 regions of interests (ROI), each having three representative electrodes: left frontal (F3, F5, F7), left fronto-central (FC3, FC5, FT7), left central (C3, C5, T7), left centro-parietal (CP3, CP5, TP7), left parietal (P3, P5, P7), medial frontal (F1, FZ, F2), medial fronto-central (FC1, FCZ, FC2), medial central (C1, CZ, C2), medial centro-parietal (CP1, CPZ, CP2), medial parietal (P1, PZ, P2), right frontal (F4, F6, F8), right fronto-central (FC4, FC6, FT8), right central (C4, C6, T8), right centro-parietal (CP4, CP6, TP8), and right parietal (P4, P6, P8). Comparisons were planned for each ROI if interactions reached significance. The Greenhouse-Geisser correction was applied when the evaluated effects had more than one degree of freedom in the numerator. For planned comparisons between the three levels of Consistency, the probability levels were adjusted according to a modified Bonferroni procedure (Keppel, 1991).

Apart from ERP differences between experimental conditions in different time windows, we also computed the correlations, over individual participants (with one participant absent), between these differences and the post-experiment rating of the appropriateness of pronoun usage in different types of scenarios. This correlational analysis provided additional evidence for the interpretations of the ERP effects.

3. Results

3.1. Behavioral data

3.1.1. Online verification accuracy

The average accuracy for scenarios with *nin-de* was 94.8% (Mean=42.67, SD=1.65) in the status-consistent condition, 94.6% (Mean=42.57, SD=1.95) in the status-inconsistent condition, and 94.2% (Mean=42.39, SD=2.12) in the status-equal condition. The average accuracy for scenarios with *ni-de* was 94.4% (Mean=42.50, SD=2.15) in the status-consistent condition, 94.4% (Mean=42.47, SD=1.89) in the status-inconsistent condition, and 93.7% (Mean=42.17, SD=2.25) in the status-equal condition. An ANOVA with consistency and pronoun type as two within-participant factors revealed neither a main effect of consistency, $F(2,58)=1.85$, $p > 0.1$, nor a main effect of pronoun type, $F(1,29)=1.26$, $p > 0.1$, nor the interaction between the two, $F(2,58)=1.52$, $p > 0.1$.

3.1.2. Post-experiment scenario rating

All the participants except one male participated in the scenario rating task. The average appropriateness score for the respectful utterances with *nin-de* was 6.68 in the status-consistent condition, 3.27 in the status-inconsistent condition, and 4.85 in the status-equal condition. The averaged score for the less respectful utterances with *ni-de* was 6.31, 2.54, and 4.87, respectively, for the three conditions. ANOVA revealed a significant main effect of status consistency, $F(2,56)=253.97$, $p < 0.001$, with the rating decreased over the status-consistent, status-equal, and status-inconsistent conditions, replicating the findings of the pretest. Status consistency interacted with pronoun type, $F(2,56)=13.52$, $p < 0.001$. Further tests revealed an effect of pronoun type for the status-consistent scenarios, $F(1,28)=7.49$, $p < 0.001$, and for the status-inconsistent scenarios, $F(1,28)=19.62$, $p < 0.001$, indicating that utterances with *nin-de* were rated as being more appropriate than the utterances with *ni-de* in the two types of scenarios. Moreover, the average scores for the status-inconsistent condition positively correlated with the average scores for the status-equal condition, with $r=0.69$, $p < 0.001$ for the *nin-de* utterances and $r=0.45$, $p < 0.05$ for the *ni-de* utterances.

These findings confirmed the results of the pretests, suggesting that participants were sensitive to the social status of the communicators and to the respectful, over-respectful, and disrespectful use of the second-person pronoun in utterance comprehension. Moreover, the post-test showed that, the disrespectful use of *ni-de* was perceived as less appropriate as compared with the over-respectful use of *nin-de*.

3.2. ERPs

ERP responses time-locked to the second-person pronoun are shown in Figs. 2 (for *nin-de* scenarios) and 3 (for *ni-de* scenarios), spanning from the onset of the pronoun to the offset of the following object noun. Compared with the status-consistent, respectful use of the pronoun *nin-de*, the status-inconsistent condition appeared to elicit an anteriorly-distributed negativity effect in the 300–500 ms window and a late, sustained positive-going effect in the 500–1800 ms window; the status-equal condition elicited only a late, sustained positivity effect (Figs. 2 and 4). In contrast, when compared with the less respectful use of the pronoun *ni-de* in the status-consistent condition, the status-inconsistent condition appeared to elicit a broadly-distributed negativity effect in the 300–500 ms window and a late, sustained negativity effect in the 500–1800 ms window; the status-equal condition elicited only a late, sustained negativity effect (Figs. 3 and 4). Moreover, the two status-consistent conditions had differential ERP responses to the respectful form *nin-de* and to the less respectful form *ni-de*, with a more positive P200 and more negative-going later responses for the former than for the latter. [The P200 effect, not analyzed further here, may reflect the difference in the orthographic processing of the pronouns, with increased P200 responses to the orthographically more complex *nin-de* (Liu, Perfetti, & Hart, 2003; Meng et al., 2008)]. Although the two status-inconsistent conditions and the two status-equal conditions also showed the difference on the P200, the less respectful form elicited more negative-going responses on the N400 and in the later time windows than the respectful form (Fig. 5). These observations were confirmed by the statistical analysis.

3.2.1. The status-consistency effects in the 300–500 ms window

Repeated-measures ANOVA with consistency, pronoun type, hemisphere, region and electrode as five within-participant factors revealed a significant main effect of consistency, $F(2,58)=4.45$, $p < 0.05$, suggesting that, when collapsing over the utterances with *nin-de* and with *ni-de*, the status-inconsistent conditions

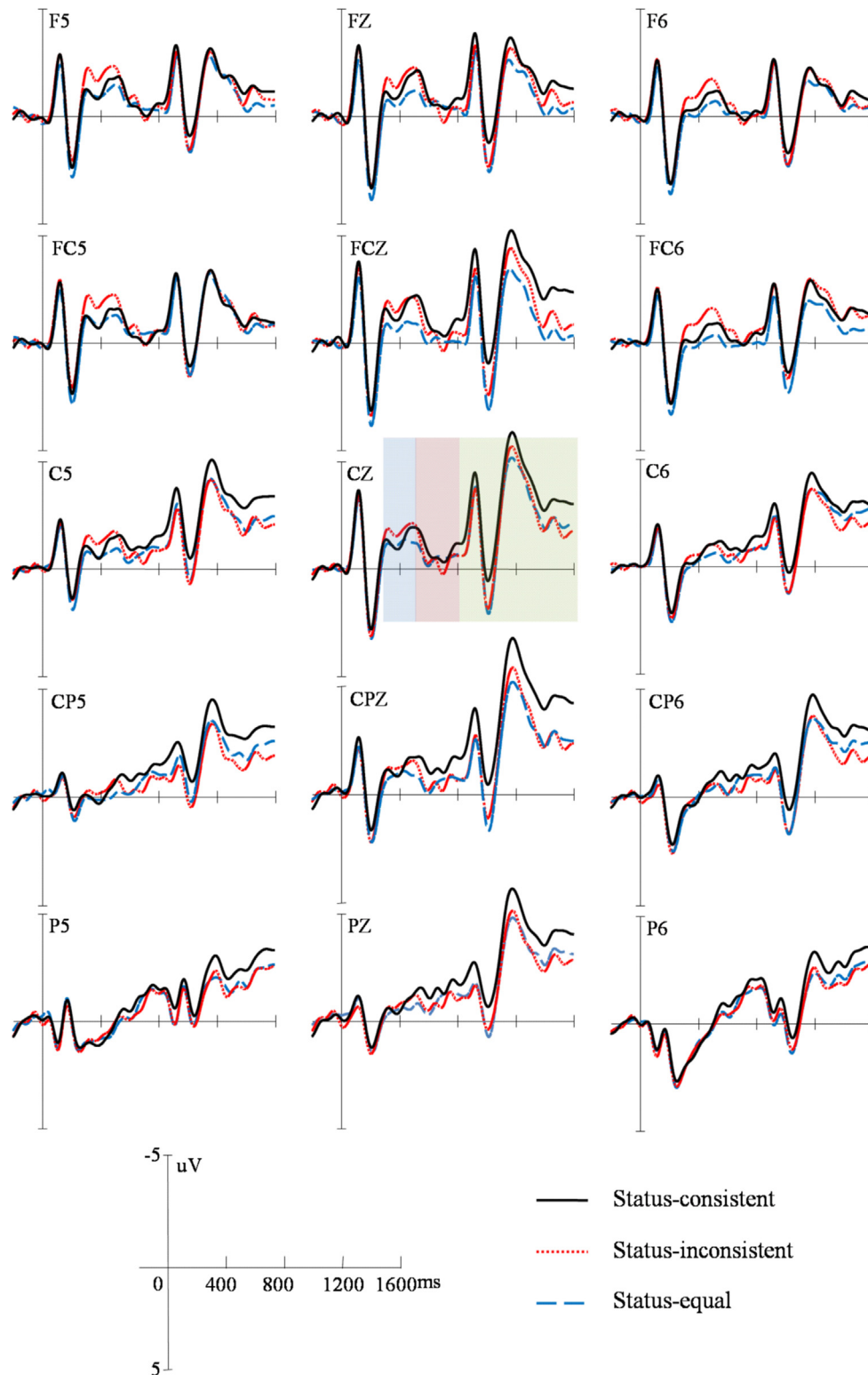


Fig. 2. Grand average waveforms at 9 exemplar electrodes, epoched from 200 ms before to 1600 ms after the onset of the respectful pronoun *nin-de*, spanning the durations of *nin-de* and the following noun.

elicited more negative-going ERP responses as compared with the status-consistent and the status-equal conditions (the differences being -0.57 and $-0.53 \mu\text{V}$, respectively). The main effect of pronoun type was also significant, $F(1,29)=5.59$, $p < 0.05$, with more negative responses to *ni-de* than to *nin-de*. Moreover, there was a significant three-way interaction between consistency, pronoun type, and region, $F(8,232)=3.78$, $p < 0.05$, suggesting

that the consistency effects for the two types of utterance were distinct in scalp distribution.

Separate analyses for each type of utterance were then conducted. For utterances with the respectful form *nin-de*, ANOVA with consistency, hemisphere, region and electrode as four within-participant factors revealed a marginal main effect of consistency, $F(2,58)=2.65$, $0.05 < p < 0.01$, and a significant two-way

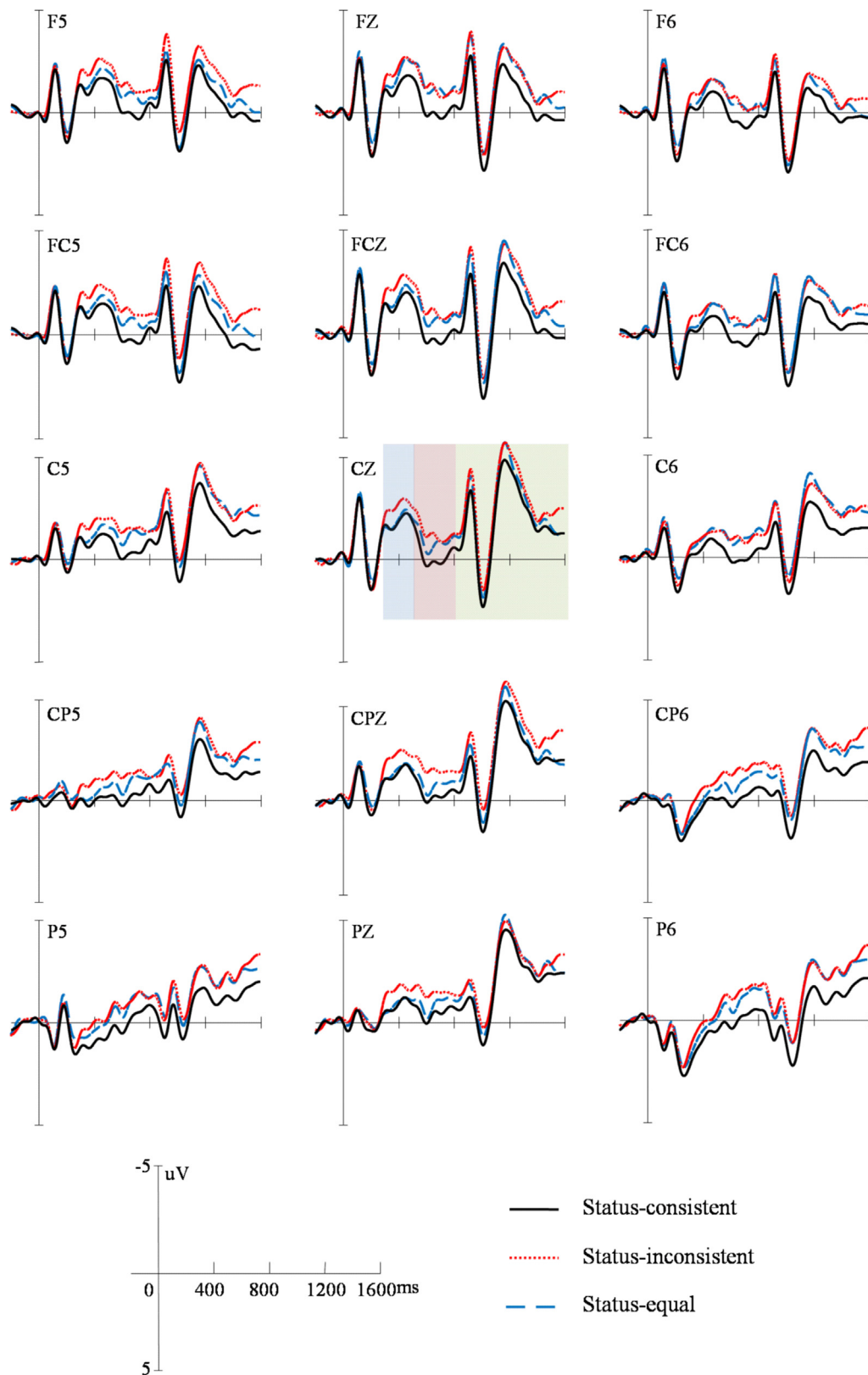


Fig. 3. Grand average waveforms at 9 exemplar electrodes, epoched from 200 ms before to 1600 ms after the onset of the less respectful pronoun *ni-de*, spanning the durations of *ni-de* and the following noun.

interaction between consistency and region, $F(8,232)=4.20$, $p < 0.001$. Further tests showed that, for the status-inconsistent vs. status-consistent comparison, there was a main effect of consistency, $F(1,19)=8.02$, $p < 0.01$, and a significant interaction between consistency and region, $F(4,116)=3.45$, $p < 0.05$; for the

status-inconsistent vs. status-equal comparison, only the interaction between consistency and region reached significance, $F(4,116)=7.63$, $p < 0.005$. The status-inconsistent condition elicited an anteriorly distributed negativity effect as compared with the status-consistent condition (Fz: $F(1,29)=3.05$, $0.05 < p < 0.1$; FCz:

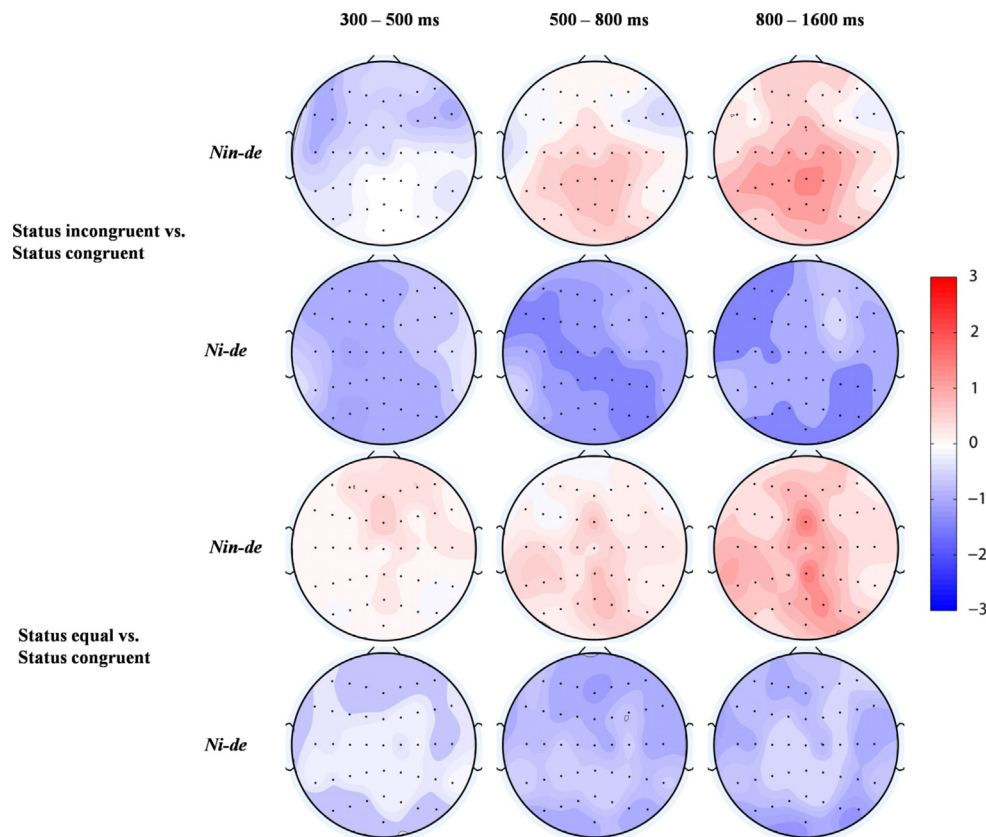


Fig. 4. Topographic maps showing the scalp distribution of the ERP differences in three different time windows between the status-inconsistent and status-consistent conditions, and between the status-equal and status-consistent conditions.

$F(1,29)=3.94$, $p < 0.05$) or with the status-equal condition (Fz: $F(1,29)=10.75$, $p < 0.005$; FCz: $F(1,29)=12.25$, $p < 0.005$; Cz: $F(1,29)=7.01$, $p < 0.05$). No differences were found between the status-consistent and status-equal conditions ($F_s < 1$, see Fig. 1).

For utterances with less respectful form *ni-de*, ANOVA revealed only a significant main effect of consistency, $F(2,58)=3.44$, $p < 0.05$. Further tests revealed a significant main effect of consistency for the status-inconsistent vs. status-consistent comparison, $F(1,29)=7.75$, $p < 0.01$, and a marginally significant effect of consistency for the status-inconsistent vs. status-equal comparison, $F(1,29)=2.74$, $0.05 < p < 0.1$. No interactions between consistency and region were found, $F_s < 1$. These findings suggest that the status-inconsistent condition elicited a broadly distributed negativity as compared with the status-consistent condition ($-0.78 \mu\text{V}$) or the status-equal condition ($-0.72 \mu\text{V}$). Again, no significant difference was observed between the status-equal and the status-consistent conditions ($F_s < 1$, see Fig. 2).

The interaction between consistency, pronoun type, and region was also analyzed from the other direction. For the status-consistent conditions, there was no difference between ERP responses to *nin-de* and *ni-de*, $F < 1$. For the status-inconsistent conditions, however, the responses were more negative ($-0.55 \mu\text{V}$) to *ni-de* than to *nin-de*: $F(1,29)=4.02$, $0.05 < p < 0.1$, and this effect was larger at posterior regions ($-0.68 \mu\text{V}$), $F(1,29)=4.79$, $p < 0.05$. Similarly, for the status-equal conditions, the responses were also more negative ($-0.76 \mu\text{V}$) to *ni-de* than to *nin-de*: $F(1,29)=5.59$, $p < 0.05$.

3.2.2. The status-consistency effects in the 500–800 ms window

The omnibus ANOVA revealed neither a significant main effect of consistency, $F < 1$, nor a significant main effect of pronoun type, $F < 1$, but did reveal a two-way interaction between consistency

and pronoun type, $F(2,58)=4.86$, $p < 0.05$, suggesting that the consistency effect differed between pronoun types.

For utterances with *nin-de*, an ANOVA with consistency, hemisphere, region and electrode as four within-subject factors found no significant effect of consistency, $F(2,58)=1.76$, $p > 0.1$, although the status-inconsistent and the status-equal conditions appeared to elicit more positive-going ERP responses than the status-consistent condition ($0.29 \mu\text{V}$ for status-inconsistent vs. status-consistent; $0.33 \mu\text{V}$ for status-equal vs. status-consistent). Over individual participants, the size of the late positivity effect (averaged over all the electrodes included in ANOVA) correlated with the rating difference between the status-inconsistent and status-consistent conditions, $r=0.40$, $p < 0.05$. A similar correlation was also found for the difference between the status-equal and status-consistent conditions, $r=0.37$, $p < 0.05$.

For utterances with *ni-de*, the ANOVA revealed a significant effect of consistency, $F(2,58)=4.38$, $p < 0.05$, with both the status-inconsistent and the status-equal conditions eliciting more negative-going ERP responses than the consistent condition ($-1.04 \mu\text{V}$ for inconsistent vs. consistent, $F(1,29)=10.53$, $p < 0.005$; $-0.73 \mu\text{V}$ for equal vs. consistent, $F(1,29)=5.17$, $p < 0.05$). No interaction between consistency and topographic factors were found, $F_s < 1$. Over individual participants, significant correlations were observed between the magnitude of the late negativity effect (averaged over all the electrodes covered in ANOVA) and the difference in appropriateness rating between the status-inconsistent or status-equal condition and the status-consistent condition: $r=0.45$, $p < 0.05$, and $r=0.33$, $p < 0.05$, respectively.

3.2.3. The status-consistency effects in the 800–1600 ms window

Again, the omnibus ANOVA revealed neither a significant main effect of consistency, $F < 1$, nor a significant main effect of pronoun

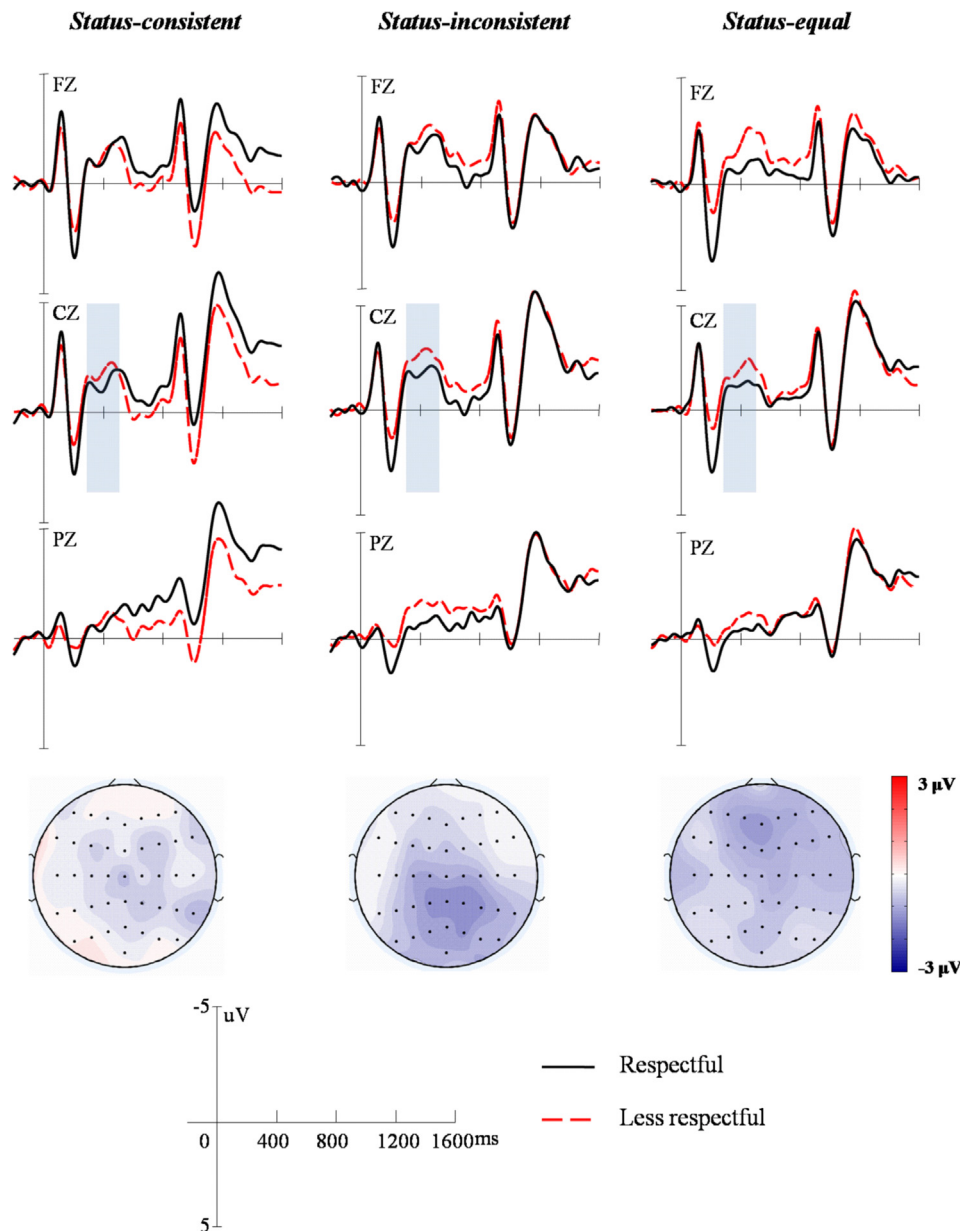


Fig. 5. Grand average waveforms at 3 midline electrodes showing the pronoun effect between *ni-de* and *nin-de*, epoched from 200 ms before to 1600 ms after the onset of the pronouns, spanning the duration of the pronoun and the following noun. The ERP differences in 300–500 ms window (early negativities) are shown in the three topographic maps at the bottom.

type, $F < 1$, however a two-way interaction was found between consistency and pronoun type, $F(2,58) = 4.91$, $p < 0.05$. We then conducted separate analyses for the two types of utterances.

For utterances with *nin-de*, there was a significant main effect of consistency, $F(2,58) = 3.97$, $p < 0.05$, with both the status-inconsistent and status-equal conditions eliciting more positive-going responses than the status-consistent condition ($0.72 \mu\text{V}$ for status-inconsistent vs. status-consistent, $F(1,29) = 4.18$, $p < 0.05$; $0.62 \mu\text{V}$ for status-equal vs. status-consistent, $F(1,29) = 3.44$, $p < 0.05$). The interaction between consistency and hemisphere was also significant, $F(4,116) = 4.56$, $p < 0.05$, suggesting a larger effect over the medial sites ($1.03 \mu\text{V}$) than over the lateral sites ($0.71 \mu\text{V}$ for the left hemisphere; $0.54 \mu\text{V}$ for the right hemisphere). A significant correlation was observed between the magnitude of the positivity effect (averaged over all the electrodes included in ANOVA) and the difference of appropriateness rating between the status-inconsistent and status-consistent conditions, $r = 0.41$, $p < 0.05$.

For utterances with *ni-de*, the main effect of consistency was also significant, $F(2,58) = 3.34$, $p < 0.05$, with the status-inconsistent and status-equal conditions eliciting more negative-going ERP responses as compared with the consistent condition ($-0.92 \mu\text{V}$ for inconsistent vs. consistent, $F(1,29) = 3.74$, $p < 0.05$; $-0.78 \mu\text{V}$ for equal vs. consistent, $F(1,29) = 3.40$, $p < 0.05$, see Fig. 2). No interaction between consistency and topographic factor was found, $F_s < 1$.

To examine whether the ERP effects observed in this time window were elicited by the critical pronouns or by the subsequent nouns, the EEGs on the object nouns were segmented separately and corrected with a baseline using a 0–100 ms time window (see also Jiang et al., 2009). A significant effect between the conditions in the 100–700 ms time window would be consistent with the view that the long, sustained effects seen on the pronouns is actually triggered by, or at least increased by, the nouns after the pronouns. However, no significant differences were found between the conditions, $F_s < 1$, suggesting that the

status-consistency effects obtained in the above 800–1600 ms window were indeed elicited by the critical pronouns.

4. Discussion

The main purpose of this study was to investigate how extralinguistic social status information affects the brain activity in response to the use of honorific forms during verbal communication. The respectful or less respectful form of the Chinese second-person pronoun in directly quoted speech was either consistent or inconsistent with the constraints from the social status of the speaker and the addressee. Behavioral ratings revealed a graded status-consistency effect in perceiving the appropriateness of utterances beginning with the respectful form *nin-de* or the less respectful form *ni-de*, with utterances in the status-consistent conditions being rated as the most appropriate and utterances in the status-inconsistent conditions rated as the least appropriate. Moreover, utterances with *nin-de* tended to be regarded as more appropriate than utterances with *ni-de*, regardless of whether these forms had been misused or not. These findings suggest that comprehenders are sensitive to the constraints of social status upon the use of honorific forms and that people generally prefer using respectful or polite expressions during verbal communication (see [Chao, 1956](#); [Hong, 1985](#); [Lee-Wong, 2000](#); [Mao, 2003](#); [Zhou, 2008](#)).

More importantly, the ERPs showed that, compared with the status-consistent use of the second-person pronoun, the overuse of the respectful form *nin-de* in the status-inconsistent condition elicited an anterior negativity effect, whereas the misuse of the less respectful form *ni-de* in the status-inconsistent condition elicited a wide-spread negativity effect in the 300–500 (N400) time window. Pronouns in the status-equal conditions elicited ERP responses similar to those in the status-consistent conditions. In the late time windows (from 500 to 1600 ms post onset), however, the status-inconsistent and the status-equal conditions elicited sustained positive-going responses on *nin-de* whereas the two conditions elicited sustained negative-going responses on *ni-de*. These findings demonstrate differential brain responses to pragmatic violations of social status information associated with the use of honorific forms of the Chinese second-person pronoun during verbal communication.

In the following paragraphs, we discuss issues related to (1) N400 and the integration of honorific forms of pronouns with social-status information; (2) late ERP effects and the differential processing of over-respectful and disrespectful meanings; (3) the processing of social status and honorific information in utterance comprehension.

4.1. N400 and integration of honorific forms of a pronoun with social-status information

Previous studies on language comprehension suggested that the reader/listener builds up semantic context on the basis of social pragmatic information. The mismatch between the upcoming target word and social pragmatic information causes difficulty in semantic integration during lexical processing ([Wang et al., 2011](#); [White, Crites, Taylor, & Corral, 2009](#)), utterance comprehension ([Van Berkum et al., 2008, 2009](#); [Van den brink et al., 2012](#)), comprehending two-sentence social vignettes ([Leuthold et al., 2012](#)) and discourse ([Egidi & Nusbaum, 2012](#)), leading to increased N400 responses. N400 effects have also been observed on critical words incongruent with the voice-inferred social identity of the speaker (e.g., a speaker with upper-class accent saying *I have tattoo on my back*, [Van Berkum et al., 2008](#); [Van den brink et al., 2012](#)) or on words clashing with the reader's moral-ethical attitudes (e.g., a strict

Christian reading *Euthanasia is an acceptable course of action*; [Van Berkum et al., 2009](#)).

Note that, in the above studies, the N400 effect was obtained on words which had strong reference to the social context (e.g., utterances beginning with first person pronoun in [Van Berkum et al., 2008](#) and [Van den brink et al., 2012](#); attitude statements in [Van Berkum et al., 2009](#)). Consistent with the literature and with the pretest rating, here we found enhanced N400 (or anterior negativity) responses on the honorific forms of the second-person pronoun when these forms were inconsistent with constraints of the conversants' relative social status. This finding suggests that the participants, acting as a third party, built up a semantic expectation for the use of the honorific form of the pronoun in directly quoted speech. The second-person pronoun in the directly quoted speech unambiguously referred to the addressee in the context, and the process of integrating the target word (i.e., the pronoun) with its antecedent (i.e., the addressee) became difficult when the honorific form of the pronoun clashed with information concerning the relative social status of the addressee.

In the above arguments, we have implicitly assumed that the anterior negativity observed for the overuse of the respectful form *nin-de* had functioned in the same way as the more typical N400 effect observed for the misuse of the less respectful form *ni-de* in the status-inconsistent condition. Indeed, an anterior N400 effect was reported on movie endings which were contextually incongruent with the preceding movie scenes ([Sitnikova et al., 2009](#)), on pictures which were preceded with the unrelated object pictures ([Mcpherson & Holcomb, 1999](#)), on picture endings which were incongruent with the preceding picture stories ([West & Holcomb, 2002](#)), or on pictures showing an incongruent object embedded in the visual scene ([Kutas & Federmeier, 2011](#)). These anterior N400 effects have been suggested to reflect the process of integrating semantic information into a higher-level image-based conceptual representation. We speculate the anterior N400 may result from the overlap between early-starting positivity and negativity effects (see below). Indeed, when we checked individual participants' data, we found that a subset of 14 participants showed a mono-phasic broad positivity effect starting from the N400 window, while the other participants showed either an anterior negativity followed by a late positivity or an anterior-centrally maximized negativity.

In the behavioral rating, the speaker's use of the respectful and less respectful forms in the status-equal conditions was regarded as less appropriate than in the status-consistent conditions ([Fig. 1](#)). However, this difference between the two conditions did not have a corresponding ERP effect in the N400 window (although it did in later windows; see below). Thus it appears that although the outright pragmatic violations in the use of honorific forms can be detected in the semantic integration process, the more subtle misapplications of the forms do not impair the initial semantic process but may lead to a second-pass process in which the over-respectful use of the pronoun was linked to a non-literal interpretation (see [Section 4.2](#)), and the disrespectful use of the pronoun caused re-interpretation of initially built mental representations (see [Section 4.3](#)).

4.2. The sustained positivity for the over-respectful utterances

The overuse of the respectful form of the pronoun in the status-inconsistent or status-equal conditions elicited more positive-going responses from 500 to 1600 ms post onset, although these positivity effects tended to be weak initially in time course. One might link this positivity effect to the P600, which has been observed for third-person pronouns inconsistent with the biological or stereotypical gender of the antecedents ([Osterhout et al., 1997](#); [Van Berkum et al., 2007](#); [Xu, Jiang, & Zhou, 2013](#)), or for nouns inconsistent with voice-induced gender of the speaker ([Lattner & Friederici, 2003](#)). The P600 was larger when the pronominal constituent was marked with the

explicit orthographic form (e.g., plural marking, with a suffixed morpheme 们, /men/ in Chinese) than when it was in the default, singular form (Xu et al., 2013). In these studies, the P600 effect was monophasic and was interpreted as reflecting the processing failure in establishing the link between the anaphoric expressions and its antecedent referent. This account could be used to explain the late positivity for the over-respectful use of *nin-de*, which might reflect a processing failure given that the second person pronoun cannot fulfill the social status constraints on the speaker and the addressee. The respectful form could be treated as a marked version of the pronoun, with orthographic features (e.g., the semantic radical embedded in the character) explicitly marking its respectfulness. However, it is difficult for this account to predict an opposite pattern of ERP effects for the misuse of the less respectful form *ni-de* (see Section 4.3).

The differential late ERP effects seem to fit the Relevance Theory (Wilson & Sperber, 2004), which has different predictions towards the interpretation of over-respectful and disrespectful utterances. The Relevance Theory predicts that the over-respectful utterances would lead to a non-literal interpretation (of speaker's intention) whereas the dis-respectful utterances would not. In this framework, the overuse of the respectful form by a speaker of higher status addressing the addressee of lower status could be interpreted as the speaker deliberately making an ironic assertion (e.g., *sarcastic irony*, see *Chao, 1956; Hong, 1985; Mao, 2003; Okamoto, 2002*). Likewise, in the status-equal condition, a speaker of lower status using the respectful form could be interpreted as the speaker making a joke or sarcastic remark. Such interpretation is unlikely for a speaker of lower status addressing the addressee of higher status, since it causes a face-threatening situation.

The late positivity effect has been observed on target words in non-literal language processing (Coulson & Van Petten, 2007; Regal et al., 2010), although this effect was usually preceded by an N400 effect in such studies. In these studies, the late positivity effect was interpreted as reflecting the pragmatic inference process (contextual updating) after the initial detection of an unexpected word following a predictive context. The system may search for an alternative interpretation (i.e., shifting from the literal frame to the non-literal frame of interpretation) by linking the current input word with the previous context. The ironic or metaphorical use of critical words in such sentences (e.g., ten years in "I let my accountant do my taxes because it saves time; last spring it saved me ten years") may involve not only the integration difficulty but also an inferential process that derives indirect meanings from the literal words (Garvey & Caramazza, 1974; Garvey et al., 1975; Holtgraves, 1999). In reading a scenario describing another person's behavior, a sustained positivity effect was also elicited on words that were evaluatively inconsistent with the other's trait inferred from the preceding scenario (Van Duynslaeger, Van Overwalle, & Verstraeten, 2007; White et al., 2009).

Consequently, in the present study, the sustained positivity effect observed on the respectful form of the pronoun can be interpreted as reflecting the triggering of *additional* inferential processes to yield contextually appropriate meanings. Such inferential processes were invited by the availability of the non-literal interpretation. As we reported earlier, the late positivity effect positively correlated with the rating difference between status-inconsistent and the status-consistent condition. Given that the larger rating difference can be interpreted as reflecting the increased difficulty in making inferences for the over-respectful use of the pronoun (i.e., in accessing the alternative, ironic interpretation), the positive correlation may demonstrate that, over individual participants, the larger the late positivity effect, the more effort is exerted to derive an alternative interpretation for the over-respectful use of the pronoun.

4.3. The sustained negativity for the disrespectful utterances

As predicted by Relevance Theory, the misuse of the less respectful form of the pronoun cannot lead to a non-literal interpretation of speaker's intention but will lead to a misrepresentation that requires revision/suppression. Specifically, although one might treat the use of *ni-de* in the status-equal condition as an attempt by the conversants to be informal (i.e., shortening the social distance between the speaker and the addressee), the use of *ni-de* in the status-inconsistent condition is clearly a violation of the politeness principle (Brown & Levinson, 1987). Facing this violation, the addressee or the third-party persons might adopt either one of the following strategies during comprehension: treating the use of the less respectful form *ni-de* as a kind of unintentional mistake or treating the use as an expression of unhappiness or intentional insult towards the addressee. For the later strategy, we would expect to observe a later *positivity*, rather than *negativity*, effect as this pragmatic inference should be similar to the process of making an ironic re-interpretation for the use of the over-respectful form. Importantly, given the limited context in the status-inconsistent or status-equal condition and given that individuals are generally unwilling to make inferences that may threaten the "face" (i.e., reputation) of the addressee (Holtgraves, 1992, 1998; Kuo, 2002), it is unlikely that the comprehender would make such "insult" or "unhappiness" inference upon reading the less respectful form of the pronoun. The predictability of a lower-status speaker using *ni-de* towards a higher-status addressee was almost zero, as indicated in the cloze probability pretest.

Consistent with the hypothesis, the misuse of the less respectful form of the pronoun in either the status-inconsistent or status-equal condition elicited a broadly distributed late sustained negativity effect. This effect appears to be different in scalp distribution from the sustained anterior negativity effect that has been observed for pronominal expressions or NPs referring to ambiguous referents as compared with unambiguous referents (Nieuwland & Van Berkum, 2006, 2008a; see Nieuwland & Van Berkum, 2008b for a review), for words in complex sentences as compared with word in simpler sentences (King & Kutas, 1995; Müller, King, & Kutas, 1997), or for words constituting non-canonical word-order as compared with words forming canonical word-order (Felsler, Clahsen, & Münte, 2003; Matzke, Mai, Nager, Rüsseler, & Münte, 2002). While the anterior negativity effect has been interpreted as indexing a heavy load of maintaining information in working memory, the sustained negativity effect here can be attributed to a second-pass process to re-interpret the initially constructed semantic representation (Baggio, van Lambalgen, & Hagoort, 2008; Jiang et al., 2009; Qiu and Zhou, 2010). In Jiang et al. (2009), a larger sustained negativity effect was observed in sentences with the incorrect use of a universal quantifying adverbial for a singular object (e.g., *Xiaohong BA *nake kouzi*_(object noun) *dou* (quantifier) *fengzai*_(verb) *yifu shang*/*Xiaohong sewed all (quantifier) the button onto the clothing). The sustained negativity effect was obtained on verbs immediately following the misused quantifier, suggesting an effortful revision to either discard the adverbial *all* or to change the singular object noun (*button*) into a plural one (*buttons*). In Baggio et al. (2008), a similar sustained negativity was observed on words implying incompleteness of an action goal which was suggested as having already been achieved in the previous context. Sustained negativity effects have also been observed in sentences where a previously computed pragmatic (Jiang, Li, Zhou, 2013; Politzer-Ahles, Fiorentino, Jiang, & Zhou, 2013) or discursive (Pijnacker et al., 2011) inference is proven incorrect and must be revised.

In the present study, the expectation towards the respectful form (*nin-de*) of the pronoun by an initially constructed mental representation concerning a lower-status speaker addressing a higher-status addressee was disconfirmed upon encountering a less respectful form (*ni-de*). The comprehender might try to recover the "unintended" use of the pronoun upon the "mistaken" form (*ni-de*) and

use the “correct” form (*nin-de*) to re-build the utterance representation. This process is clearly different from the process of making pragmatic inference and building up alternative interpretation for the overuse of the respectful form (*nin-de*) that we discussed in the last section.

Indeed, we found significant correlations over individual participants between the magnitude of the late negativity effect and the difference in appropriateness rating between the status-inconsistent or status-equal condition and the status-consistent condition. One could argue that such positive correlations simply suggest that bigger offline rating differences were associated with greater online processing cost. However, the opposite polarity of ERP effects suggest that different sources of processing difficulty may arise with the function of reinterpreting the mis-application of different forms of the pronoun. One might also link these correlations with participant sensitivity to the incongruence between the pronoun and the social status of conversants (c.f., [Van den Brink et al., 2012](#)), rather than with the effort to resolve the incongruence. The absence of a significant correlation between the rating and the size of the N400 effect, however, indicate that this sensitivity account would most likely not hold. We would like to argue that, the more inappropriateness the participants found with the use of the less respectful form *ni-de*, the larger the late negativity effect and the more effort put forth by the participants to find an alternative form to replace the current input.

4.4. Processing social status and honorific information in utterance comprehension: Implications

Taken together, the different patterns of late ERP effects for over-respectful and disrespectful utterances can be attributed to the availability of a non-literal interpretation of the pronoun in a given context (e.g., the speaker’s intention). Given the minimal context in the current setup and given the comprehender’s pragmatic knowledge about the use of honorific forms, the over-use of the respectful form initiated the activation of a non-literal interpretation and the associated inference process. In contrast, the misuse of the less respectful form did not permit a non-literal interpretation, and a direct revision or replacement of the current word was then triggered to recover the intended form, which is consistent with pragmatic constraints of the pronoun. It is likely that the accessibility of a non-literal interpretation would increase when contextual information more explicitly licenses a non-literal interpretation or when a comprehender is more capable of making inferences about the misuse of a less respectful form (see related arguments in Relevance Theory, [Wilson & Sperber, 2004](#)). Further studies are needed to specifically examine whether the late positivity/negativity effect is modulated by contextual factors or by the individual’s inferential ability.

Similar differentiations can be found in previous research, although not within a single study. For example, a pronoun/quantifier with no obvious antecedent but with a possible resolution by referring to a referent outside of the discourse (**Mary told Linda that he...*) elicited a late (sustained) positivity effect ([Van Berkum et al., 2007](#)), whereas the pronoun with ambivalent reference to antecedents but with no potential way of resolution (**Britney Spears had several pieces of jewelry, including a golden necklace and a silver one. One day she was about to leave for a gala. She was admiring the necklace when suddenly her date called to cancel.*) elicited a sustained negativity effect ([Van Berkum et al., 2008](#)). What are the implications of these differential effects, together with the earlier, common N400 effects, for theories of pragmatic processing in discourse/sentence comprehension?

The N400 effects can be accommodated by an account which assumes that both linguistic and extra-linguistic information are immediately and simultaneously used both to constrain the integration/unification of the upcoming word and to construct the

global discourse/sentence representation (“early-use account”; [Hagoort & Van Berkum, 2007](#)). The pronoun inconsistent with the constraints of social status information conveyed by the context would elicit increased N400 responses, and this N400 effect could be magnified by the disrespectful, compared with the over-respectful, use of the pronoun, indicating early and immediate use of pragmatic information in discourse integration/unification. This N400 effect cannot be explained by the difference in lexical frequency between the respectful and the less respectful form of the pronoun, since the less respectful form had higher frequency of use per million and would expect to show less N400 effect.

The later positivity/negativity effects are generally not observed in studies carried out by the proponents of these accounts ([Van Berkum et al., 2008, 2009](#); [Van den Brink et al., 2012](#)). These studies manipulated the congruency between the target word and contextual information, world knowledge, and speaker information (e.g., “I have a tattoo on my back”, spoken with an upper-class accent). Biphasic N400 and late positivity effects were observed on metaphorical words, as compared with literal words ([Coulson & Williams, 2005](#); [Coulson & Van Petten, 2007](#)), on words indicating that a character’s socio-emotional response was incongruent with the context (e.g., Abby was an honest coach, who informed the golf pro that he had a good chance of winning the next open. The golf pro was distraught; [Leuthold et al., 2012](#)), and on words which were incongruent with the comprehender’s mood ([Chung et al., 1996](#)). One possible reason for the appearance of the P600 effect (preceded by an N400 effect) in these studies ([Coulson & Williams, 2005](#); [Coulson & Van Petten, 2007](#); [Leuthold et al., 2012](#)) and for the appearance of only an N400 effect in other studies for the incongruency between target words and social and stereotypical expectations ([Van Berkum et al., 2008, 2009](#); [Van den Brink et al., 2012](#)) is that the context strongly predicted a target word, which was mismatched by the input, in the former but not in the latter groups of studies. In the current study, the social status information conveyed in the minimal context allowed the comprehender to make strong predictions concerning which form of the second-person pronoun would be used in the directly quoted utterance, as indicated by the cloze probability pretest, which showed that the accuracy for using appropriate forms of the second person pronoun was over 80%.

However, the “early-use” accounts may have no difficulty accommodating the late positivity/negativity effects observed in this study, given that, for example, the “memory, unification and control” (MUC) model ([Hagoort, 2005](#)) has a built-in control mechanism that would “operate in the context of communicative intentions and actions (p. 421)” and function in a strategic way. It is possible to link the late positivity/negativity effects to the functioning of this control mechanism ([Ye & Zhou, 2008, 2009](#)). The conflict between the predicted form and the actual input has to be resolved eventually, resulting in the later ERP effects ([Kuperberg, 2007](#); [Ye & Zhou, 2008](#); [Zhou et al., 2010](#)). Importantly, however, it seems that the functioning of the control mechanism does not depend on the overt detection of integration failure (as demonstrated by the N400 effect). The subtle misapplication of the honorific forms of the pronoun in the status-equal conditions in this study was sufficient to initiate the control mechanism.

One might wonder why the status-equal and the status-inconsistent conditions elicited comparable late positivity/negativity effects while the former was judged to be less inappropriate than the latter in the offline scenario rating. We suggest that there are two possible reasons for the discrepancy between the patterns of the ERP effects and the offline rating. First, the differences between experimental conditions in the offline rating could be reflected not only in the late effects but also in the earlier, N400 effects. In other words, the increased inappropriateness rating for the status-inconsistent conditions, as compared with the status-equal conditions, may have been reflected in the increased N400 responses for the status-inconsistent conditions. Second, apart from the social status information, other

social factors (e.g., the perceived social distance between the conversants) that constrain the use of honorific forms may additionally contribute to the late positivity/negativity effects (and to the offline appropriateness rating). Indeed, as compared with the other conditions, participants in the status-inconsistent condition perceived a smaller social distance for the names used in sentences with *nin-de* and a larger social distance for the names used in sentences with *ni-de*. Given that the two conversants of lower-status are generally supposed to be less likely to use the respectful form *nin-de* and the two conversants of higher-status are supposed to be less likely to use the less respectful form *ni-de* (Mao, 2003), the differences between the status-equal conditions and the status-inconsistent conditions may suggest that the social distance constraints on the use of honorific forms were violated more in the former conditions than in the latter conditions. This violation could increase the late positivity/negativity effects for the status-equal conditions, rendering the overall effects similar to the effects for the status-inconsistent conditions. Future studies are needed to tease apart the contributions for social status and social distance to the late ERP effects.

5. Conclusion

This study investigates how extra-linguistic social status information affects the brain activity in response to the use of honorific forms during verbal communication. We manipulated the constraints of the status hierarchy upon the use of honorific forms of the Chinese second-person pronoun. ERP results demonstrated that the over-respectful use of the pronoun elicited an anterior N400 followed by a late positivity effect, whereas the disrespectful use of the pronoun elicited an N400 followed by a late negativity effect. These findings suggest that the comprehender builds up expectance towards the upcoming pronoun based on the perceived social status of conversants. While the inconsistent pronoun causes integration difficulty in an earlier stage of processing, the strategy to resolve the inconsistency and the corresponding brain activity vary according to the pragmatic implications of the pronoun.

Acknowledgments

This study was supported by National Basic Research Program (973 Program: 2010CB833904) from the Ministry of Science and Technology of China, by grants from Natural Science Foundation of China (J1103602, 30970889, 30110972) and from National Social Science Foundation of China (12&ZD119). Dr. Xiaoming Jiang was also supported by grants from China Postdoctoral Science Foundation (20100480150, 2012T50005). We thank Miss Mengyan Zhu and Miss Sai Li for the help in material creation and data collection. We thank Dr. Hiromu Sakai, Dr. Stephen Politzer-Ahles, Miss Rachel Schwartz and two anonymous reviewers for their constructive comments on an earlier version of the manuscript.

References

- Agha, A. (2007). *Language and social relations*. New York: Cambridge University Press.
- Barr, D. (2008). Pragmatic expectations and linguistic evidence: Listeners anticipate but do not integrate common ground. *Cognition*, 109, 18–40.
- Baggio, G., van Lambalgen, M., & Hagoort, P. (2008). Computing and recomputing discourse models: An ERP study. *Journal of Memory and Language*, 59, 36–53.
- Brown, D. (2006). Social class and status. *Encyclopedia of Language & Linguistics*, 440–446.
- Brown, P., & Levinson, S. (1987). *Politeness: Some universals in language usage*. Cambridge, England: Cambridge University Press.
- Brown-Schmidt, S., Gunlogson, C., & Tanenhaus, M. (2008). Addressees distinguish shared from private information when interpreting questions during interactive conversation. *Cognition*, 107, 1122–1134.
- Cai, Q., & Brysbaert, M. (2010). SUBTLEX-CH: Chinese word and character frequencies based on film subtitles. *PLoS One*, 5, e10729.
- Chao, Y. (1956). Chinese terms of address. *Language*, 32, 217–241.
- Chung, G., Tucker, D. M., West, P., Potts, G. F., Liotti, M., Luu, P., et al. (1996). Emotional expectancy: Brain electrical activity associated with an emotional bias in interpreting life events. *Psychophysiology*, 33, 218–233.
- Coulson, S., & Williams, R. (2005). Hemispheric asymmetries and joke comprehension. *Neuropsychologia*, 43, 128–141.
- Coulson, S., & Wu, Y. (2005). Right hemisphere activation of joke-related information: An event-related brain potential study. *Journal of Cognitive Neuroscience*, 17, 494–506.
- Coulson, S., & Van Petten, C. (2007). A special role for the right hemisphere in metaphor comprehension?: ERP evidence from hemifield presentation. *Brain Research*, 1146, 128–145.
- Egidi, G., & Nusbaum, H. (2012). Emotional language processing: How mood affects integration processes during discourse comprehension. *Brain and Language*, 122, 199–210.
- Felser, C., Clahsen, H., & Münte, T. (2003). Storage and integration in the processing of filler-gap dependencies: An ERP study of topicalization and wh-movement in German. *Brain and Language*, 87, 345–354.
- Friederici, A. (2011). The brain basis of language processing: From structure to function. *Physiological Review*, 91, 1357–1392.
- Garvey, C., & Caramazza, A. (1974). Implicit causality in verbs. *Linguistic Inquiry*, 5, 459–464.
- Garvey, C., Caramazza, A., & Yates, J. (1975). Factors influencing assignment of pronoun antecedents. *Cognition*, 3, 227–243.
- Grice, H. (1975). Logic and conversation. In: Peter Cole, & Jerry Morgan (Eds.), *Syntax and Semantic 3: Speech Acts* (pp. 41–58). New York: Academic Press.
- Hagoort, P. (2005). On broca, brain, and binding: A new framework. *Trends in Cognitive Sciences*, 9, 416–423.
- Hagoort, P., & Van Berkum, J. (2007). Beyond the sentence given... *Philosophical Transactions of the Royal Society Biological Sciences*, 362, 801–811.
- Hagoort, P., Hald, L., Bastiaansen, M., & Peterson, K. (2004). Integration of word meaning and world knowledge in language comprehension. *Science*, 306, 438–441.
- Hald, L., Steenbeek-Planting, E., & Hagoort, P. (2007). The interaction of discourse context and world knowledge in online sentence comprehension: Evidence from the N400. *Brain Research*, 1146, 210–218.
- Halliday, M. (2007). In: J. J. Webster (Ed.), *Language and society*. London: Continuum Intl Pub Group.
- Hanna, J. (2003). The effects of common ground and perspective on domains of referential interpretation. *Journal of Memory and Language*, 49, 43–61.
- Hanna, J., & Brennan, S. (2007). Addressers' eye gaze disambiguates referring expressions early during face-to-face conversation. *Journal of Memory and Language*, 57, 596–615.
- Hanna, J., & Tanenhaus, M. (2004). Pragmatic effects on reference resolution in a collaborative task: Evidence from eye movements. *Cognitive Science*, 28, 105–115.
- Holtgraves, T. (1986). Language structure in social interaction: Perceptions of direct and indirect speech acts and interactants who use them. *Journal of Personality and Social Psychology*, 51, 305–314.
- Holtgraves, T. (1992). The linguistic realization of face management: Implications for language production and comprehension, person perception, and cross-cultural communication. *Social Psychology Quarterly*, 55, 141–159.
- Holtgraves, T. (1994). Communication in context: Effects of addresser status on the comprehension of indirect requests. *Journal of Experimental Psychology: Learning, Memory and Cognition*, 20, 1205–1218.
- Holtgraves, T. (1998). Interpreting indirect replies. *Cognitive Psychology*, 37, 1–27.
- Holtgraves, T. (1999). Comprehending indirect replies: When and how are their conveyed meanings activated? *Journal of Memory and Language*, 41, 519–540.
- Holtgraves, T., & Kashima, Y. (2008). Language, meaning, and social cognition. *Personality and Social Psychology Review*, 12, 73–94.
- Holtgraves, T., & Yang, J. (1992). Interpersonal underpinnings of request strategies: General principles and differences due to culture and gender. *Journal of Personality and Social Psychology*, 62, 246–256.
- Hong, B. (1985). Politeness in Chinese: Impersonal pronouns and personal greetings. *Anthropological Linguistics*, 27, 204–213.
- Horton, W., & Keysar, B. (1996). When do speakers take into account common ground. *Cognition*, 59, 91–117.
- Jiang, X., Li, Y., & Zhou, X. (2013). Even a rich man can afford that expansive house: ERP responses to construction-based pragmatic constraints during sentence comprehension. *Neuropsychologia*, 51(10), 1857–1866.
- Jiang, X., Tan, Y., & Zhou, X. (2009). Processing the universal quantifier during sentence comprehension: ERP evidence. *Neuropsychologia*, 47, 1799–1815.
- Jiang, X., & Zhou, X. (2009). Processing different levels of syntactic hierarchy: An ERP study on Chinese. *Neuropsychologia*, 47, 1282–1293.
- Keppel, G. (1991). *Design and analysis* (3rd ed.). Englewood Cliffs, NJ: Prentice-Hall.
- King, J., & Kutas, M. (1995). Who did what and when? Using word and clause level ERPs to monitor working memory usage in reading. *Journal of Cognitive Neuroscience*, 7, 376–395.
- Kuperberg, G. (2007). Neural mechanisms of language comprehension: Challenges to syntax. *Brain Research*, 1146, 23–49.
- Kutas, M., & Federmeier, K. (2011). Thirty years and counting: Finding meaning in the N400 component of the event-related brain potential (ERP). *Annual Review of Psychology*, 62, 621–647.

- Kuo, S. (2002). From solidarity to antagonism: The uses of the second-person singular pronoun in Chinese political discourse. *TEXT*, 22, 29–55.
- Lattner, S., & Friederici, A. (2003). Talker's voice and gender stereotype in human auditory sentence processing: Evidence from event-related brain potentials. *Neuroscience Letters*, 339, 191–194.
- Leech, G. (1983). *Principles of pragmatics*. London: Longman.
- Lee-Wong, S. M. (2000). Politeness and face in Chinese culture. In: E. Hess-Lüttich, & R. Watts (Eds.), *Cross cultural communication*. Peter Lang.
- Leuthold, H., Filik, R., Murphy, K., & Mackenzie, G. (2012). The online processing of socio-emotional information in prototypical scenarios: Inferences from brain potentials. *Social Cognitive and Affective Neuroscience*, 7(4), 457–466.
- Liu, Y., Perfetti, C. A., & Hart, L. (2003). ERP evidence for the time course of graphic, phonological, and semantic information in Chinese meaning and pronunciation decisions. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 29, 1231–1247.
- Mao, Y. (2003). Yingxiang Hanyu Di'er Rencheng Shiyong de Shehui Wenhua Yinsu [Social and cultural factors in the use of second-person pronoun in Mandarin Chinese]. Unpublished master dissertation. Beijing Language and Culture University.
- Matzke, M., Mai, H., Nager, W., Rüsseler, J., & Münte, T. (2002). The costs of freedom: An ERP study of non-canonical sentences. *Clinical Neurophysiology*, 113, 844–852.
- McPherson, W. B., & Holcomb, P. J. (1999). An electrophysiological investigation of semantic priming with pictures of real objects. *Psychophysiology*, 36, 53–65.
- Meng, X., Tian, X., Shu, H., Jian, J., & Zhou, X. (2008). ERP correlates of the development of orthographical and phonological processing during Chinese sentence reading. *Brain Research*, 1219, 91–102.
- Momo, K., Sakai, H., & Sakai, K. (2008). Syntax in a native language still continues to develop in adults: Honorification judgment in Japanese. *Brain and Language*, 107, 81–89.
- Müller, H., King, J., & Kutas, M. (1997). Event-related potentials elicited by spoken relative clauses. *Cognitive Brain Research*, 5, 193–203.
- Nadig, A., & Sadviv, J. (2002). Evidence of perspective-taking constraints in children's on-line reference resolution. *Psychological Science*, 13, 329–336.
- Nieuwland, M. S., & Van Berkum, J. J. (2006). Individual differences and contextual bias in pronoun resolution: Evidence from ERPs. *Brain Research*, 1118(1), 155–167.
- Nieuwland, M. S., & Van Berkum, J. J. (2008a). The interplay between semantic and referential aspects of anaphoric noun phrase resolution: Evidence from ERPs. *Brain and Language*, 106, 119–131.
- Nieuwland, M. S., & Van Berkum, J. J. (2008b). The neurocognition of referential ambiguity in language comprehension. *Language and Linguistics Compass*, 2, 603–630.
- Okamoto, S. (2002). Politeness and the perception of irony: Honorifics in Japanese. *Metaphor and Symbol*, 17, 119–139.
- Osterhout, L., Bersick, M., & McLaughlin, J. (1997). Brain potentials reflect violations of gender stereotypes. *Memory & Cognition*, 25, 273–285.
- Pijnacker, J., Geurts, B., Van Lambalgen, M., Buitelaar, J., & Hagoort, P. (2011). Reasoning with exceptions: An event-related brain potentials study. *Journal of Cognitive Neuroscience*, 23, 471–480.
- Politzer-Ahles, S., Fiorentino, R., Jiang, X., & Zhou, X. (2013). Event-related potential investigation of scalar implicature processing in Chinese using picture-sentence verification. *Brain Research*, 1490, 134–152.
- Qiu, Y., & Zhou, X. (2010). Perceiving the writing sequence of Chinese characters: An ERP investigation. *Neuroimage*, 50, 782–795.
- Regal, S., Coulson, S., & Gunter, T. (2010). The communicative style of an addresser can affect language comprehension? ERP evidence from the comprehension of irony. *Brain Research*, 1311, 121–135.
- Sakai, K. (2005). Language acquisition and brain development. *Science*, 310, 815–819.
- Sitnikova, T., Goff, D., & Kuperberg, G. R. (2009). Neurocognitive abnormalities during comprehension of real-world goal-directed behaviors in schizophrenia. *Journal of Abnormal Psychology*, 118, 256–277.
- Sperber, D., & Wilson, D. (1995). *Postface to the second edition of Relevance: Communication and cognition*. Oxford: Blackwell Publishers.
- Tesink, C., Petersson, K., Van Berkum, J., Van den Brink, D., Buitelaar, J., & Hagoort, P. (2008). Unification of speaker and meaning in language comprehension: An fMRI study. *Journal of Cognitive Neuroscience*, 21, 2085–2099.
- Van Berkum, J. J. (2009). The neuropragmatics of 'simple' utterance comprehension: An ERP review. In: U. Sauerland, & K. Yatsushiro (Eds.), *Semantic and pragmatics: From experiment to theory*. Palgrave.
- Van Berkum, J. J., Holleman, B., Nieuwland, M., Otten, M., & Murre, J. (2009). Right or wrong? The brain's fast response to morally objectionable statements. *Psychological Science*, 20, 1092–1099.
- Van Berkum, J. J., Koornneef, A., Otten, M., & Nieuwland, M. S. (2007). Establishing reference in language comprehension: An electrophysiological perspective. *Brain Research*, 1146, 158–171.
- Van Berkum, J. J., Van den Brink, D., Tesink, C., Kos, M., & Hagoort, P. (2008). The neural integration of addresser and message. *Journal of Cognitive Neuroscience*, 20, 580–591.
- Van den Brink, D., Van Berkum, J. J., Bastiaansen, M., Tesink, C., Kos, M., Buitelaar, J., et al. (2012). Empathy matters: ERP evidence for inter-individual differences in social language processing. *Social Cognitive and Affective Neuroscience*, 7, 173–183.
- Van Duynslaeger, M., Van Overwalle, F., & Verstraeten, E. (2007). Electrophysiological time course and brain areas of spontaneous and intentional trait inferences. *Social Cognitive and Affective Neuroscience*, 2, 174–188.
- Wang, L., Ma, Q., Song, Z., Shi, Y., Wang, Y., & Pfotenhauer, L. (2011). N400 and the activation of prejudice against rural migrant workers in China. *Brain Research*, 1375, 103–110.
- West, W. C., & Holcomb, P. J. (2002). Event-related potentials during discourse-level semantic integration of complex pictures. *Cognitive Brain Research*, 13(3), 363–375.
- White, K., Crites, S., Jr., Taylor, J., & Corral, G. (2009). Wait, what? Assessing stereotype incongruities using the N400 ERP component. *Social Cognitive and Affective Neuroscience*, 4, 191–198.
- Wilson, D., & Sperber, D. (2004). Relevance theory. In: L. Horn, & G. Ward (Eds.), *The handbook of pragmatics*. Oxford: Blackwell.
- Xu, X., Jiang, X., & Zhou, X. (2013). Processing biological gender and number information in Chinese pronoun resolution: ERP evidence for functional differentiation. *Brain and Cognition*, 81, 223–236.
- Ye, Z., & Zhou, X. (2008). Involvement of cognitive control in sentence comprehension: Evidence from ERPs. *Brain Research*, 1203, 103–115.
- Ye, Z., & Zhou, X. (2009). Executive control in language processing. *Neuroscience and Biobehavioral Reviews*, 33, 1168–1177.
- Zhou, X. (2008). *Xiandai Hanyu Limao Yuyan Yanjiu [A study of politeness language in modern Chinese]*. Beijing: China Social Science Press.
- Zhou, X., Jiang, X., Ye, Z., Zhang, Y., Lou, K., & Zhan, W. (2010). Semantic integration processes at different levels of syntactic hierarchy: An ERP study. *Neuropsychologia*, 48, 1551–1562.