N400 and the activation of prejudice against rural migrant workers in China

Lei Wang, Qingguo Ma, Zhaofeng Song, Yisi Shi, Yi Wang, Lydia Pfotenhauer

Department of Management Science and Engineering, Zhejiang University, Hangzhou 310058, China
Neuromanagement Lab, Zhejiang University, Hangzhou 310027, China
Saint Olaf College, 510 Hilltop Drive, Madison, WI 53711, USA

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ABSTRACT

Rural migrant workers (RMWs) are a special social group under the household registration system in China. Although RMWs work in the city, they are not issued a permanent city resident card, and are hardly integrated into the city life. City residents harbour strong negative stereotypes about RMWs. Facing a word-pair comprising a status noun (RMWs vs. Urban workers) followed by an adjective, 16 young participants were required to classify the adjective as being either negative or positive, while the event-related brain potentials (ERPs) were recorded. An ERP component identified as the N400 was found, and was studied with the question whether its amplitude reflected the effects of prejudice against RMWs. The reaction times to identify the positive adjectives preceded by the nouns pertaining to RMWs were significantly longer than to those preceded by nouns denoting Urban workers. The amplitude of the N400 evoked in RMW-Positive adjective condition was significantly larger than in Urban worker-Positive adjective condition, possibly reflecting the higher conflict when participants identified the adjectives as positive primed by RMWs. These findings revealed that negative stereotypes about RMWs still exist today, although Chinese mainstream media has disseminated positive messages about the RMWs for decades.

1. Introduction

From a functional perspective, one essential part of human cognition is to classify the world into different categories quickly. The process of categorization sorts stimuli based on similarity in a spontaneous fashion, which allows individuals to efficiently process an overwhelming amount of information and apply existing knowledge to new stimuli (Bruner, 1957). To simplify the challenges of social living and to process information quickly and effectively, individuals are engaged in a constant process of sorting other people into categories according to their race, gender, age or other salient social markers (Brewer, 1988; Bavel, 2008; Fiske and Neuberg, 1990).

However, categorization is complicated since people have multiple social identities. A person usually categorizes other people into definitive social groups according to the perceiver’s conception of what characterizes that social category, which can include cultural stereotypes and personal biases. In other words, social categorization can be based upon prejudiced perceptions, thoughts, and evaluations (Bavel,
Although most overt prejudice or discrimination can disappear as a society develops, more subtle prejudice can still be pervasive. Individuals may attempt to prevent stereotypes from affecting their behavior by engaging in controlled processing, but attempts to control one’s biases are not always successful (Ma et al., 2008). Previous studies have revealed that stereotype is an automatic, implicit, and cognitive process. Stereotypes can be automatically activated by the features of a social group, following which activated prejudice could lead to acts of discrimination (Correll et al., 2006; Amodio et al., 2004; Payne, 2001).

In recent years, some sociologists have applied research techniques of cognitive science, such as methods for studying memory, language comprehension and learning, to investigate the processes behind prejudice and stereotyping. With these procedures, investigators have uncovered neural processes behind stereotyping and prejudice (Gaertner and McLaughlin, 1983; Correll et al., 2006; Amodio et al., 2004; Payne, 2001; Ma et al., 2008).

This study investigates prejudice against rural migrant workers (RMWs) in China using cognitive science research techniques. RMWs are a special social group in China under the household registration system set up in 1958 to control citizens’ movements. The system divides citizens into two groups: urban and rural residents. A citizen’s birth location determines which group they fall into, and which residency permit, or hukou, they receive. Previously, rural dwellers were prevented from living in cities if they did not possess a city hukou card. In the past 3 decades, however, with the industrialization and urbanization process in China, an increasing number of workers from rural areas have begun migrating into the cities in search of work. Generally, these migrant workers perform hard, non-agricultural labor in distasteful jobs that the city residents are unwilling to do. Due to the influence of traditional Chinese culture and the Chinese social system, RMWs have generally been associated with crude behavior. They have also been considered unintelligent and uncivilized. City residents harbor strong negative stereotypes about RMWs. Even for self-avowed egalitarians, prejudice against the RMWs has often appeared in their behavior.

Event-related brain potentials (ERPs) offer an approach for researchers to study cognitive processes (Coles, 1989; Semlitsch et al., 1986). They are considered to be electrical manifestations of brain activity in response to, or preparation for, specific events (Fabiani et al., 2007; White et al., 2009). When people see or hear a stimulus, a sequence of neural units are activated to analyze the stimulus and to prepare for a response. Using voltage detectors distributed over the scalp, the electroencephalogram (EEG) can measure the endogenous neural activation of the brain, or the ERPs. These ERPs or segments of the ERPs are defined as specific components (e.g., N200, N400, and P200) which indicate the type of electrical brain activity associated with the stimuli. ERPs studies have certain advantages over traditional methods. For example, ERPs allow researchers to instantaneously assess an individual’s underlying neural activities and map their cognitive processes (White et al., 2009; Rhodes and Donaldson, 2008). Compared to functional magnetic resonance imaging (fMRI), ERPs have better temporal resolution, which helps researchers determine how early a cognitive process can take place. By assessing how various factors affect ERP components, researchers have uncovered important information about cognitive processes like attention, categorization, memory, language process, error monitoring, and expectancy (Fabiani et al., 2007). For this study, similar methods will also be used to study stereotypes and automatic prejudice.

Amodio et al. (2004) demonstrated how an ERP component called error related negativity (ERN) could be used to analyze the neural processes involved in the regulation and control of prejudice in an experiment that paired faces (black vs. white) with objects (tool vs. gun). Ma and colleagues (2008) also examined this neural process in a similar experiment by observing whether and how subjects associated gender with an object (kitchenware vs. tools). They found that the ERN amplitude for trials that combined the male gender with kitchenware (male-kitchen) was significantly larger than trials combining the female gender with kitchenware. Therefore, they concluded that gender stereotype activation might be strongly correlated with the differences in ERN amplitude. Correll, et al. (2006) learned that neural processes that can lead to stereotypes against Black also affected shooter bias in a shooting video game experiment. They found that participants shot armed targets more quickly and frequently when the armed targets were Black rather than White. Additionally, participants decided not to shoot unarmed targets more quickly and more frequently when the unarmed targets were White rather than Black. The experiment also showed that ERP segment, N200, which reflects activities in the anterior cingulate cortex (ACC) and plays a critical role in the detection of conflict, may be responsible for generating stereotypes. Furthermore, their results suggested ERP component, P200, which regulates threat perception, was related to race and its firing may manifest stereotypical prejudice as well.

Amodio (2008) and other researchers (Devine, 1989; Smith and Decoster, 2000) suggested that the predominant theories of implicit social cognition (including implicit racial bias), which are rooted in associative models of information processing and stereotyping, might correlate with semantic memory. This process is often referred to as “conceptual priming” in cognitive neuroscience literature (Gabrieli, 1998). Models of conceptual priming assumed that abstract concepts are represented in a parallel-distributed semantic network and may activate or inhibit semantically related concepts.

Kutas and Hillyard (1980) first studied the N400 component using an anomalous sentence task. During the task, the N400, which is a negative ERP deflection that typically peaks around 400 ms at central-parietal electrode sites, appeared when the word at the end of the sentence did not match the meaning of the entire sentence. When two words appeared sequentially in pairs, N400 could also be elicited if the second word had no relationship to the first word in terms of semantics (Franklin et al., 2007). Kutas and Federmeier (2000) suggested that a word-pair paradigm could be used to examine associations in lexical memory. They also claimed that the N400 amplitude correlated positively with the difficulty of accessing information. According to previous research, a stereotype may be defined as a specific class of semantic association sorted by memory (White et al., 2009; Amodio, 2008). Thus, semantic association techniques can be used to explore stereotypes and prejudice.
In previous studies, researchers used semantic association to investigate stereotypes with the Implicit Association Test. Dovidio and colleagues conducted an experiment (1997) where the primes were schematic faces of Black and White men or women as well as a control prime (X). The primes were masked by figures representing specific categories of people and houses. The target word stimuli were positive and negative words used by Dovidio and Gaertner (1993) in their studies of racial associations and evaluations. Dovidio et al. (1997) found that White participants responded faster to positive words following a White prime versus following a Black prime. White participants also responded faster to negative words following a Black prime versus following a White prime. In another experiment (Kawakami et al., 1998), participants were presented with a category prime (Black, White, or CCC [a neutral baseline]) followed by a positive or negative target word that is either stereotypically associated with Blacks or non-stereotypical. The task was simply to pronounce the target word. Participants’ responses to non-stereotypical words were faster after viewing White category primes compared to Black category primes.

In ERP studies, some researchers applied semantic methods to researching of stereotypes and prejudice (Osterhout et al., 1997; Gonzalez et al., 2008; Bartholow et al., 2003, 2001). Osterhout et al. (1997) presented participants with sentences containing a gendered reflexive pronoun that described a stereotypically male or female antecedent noun (e.g. “the grateful niece asked herself/himself how she could repay her aunt”). Pronouns that mismatched gender descriptions or gender stereotypes associated with the antecedent noun elicited large amplitude positive waves. The results indicated that ERP responses to stereotype violations were similar to the P600 effect elicited by a variety of syntactic anomalies. Bartholow et al. (2001, 2003) sought to examine the cognitive process of social expectancies based on stereotypes. Participants were presented with a series of sentences that first established the personality traits of a target person. Then participants were presented with a sentence that described the target’s behavior in a manner that contradicts previously established traits. The results demonstrated that behaviors that contradict expectations elicited larger late positive potentials (LPP). One should note that even though researchers used semantic incongruencies to study stereotypes, they found that stereotypes uniquely affected the LPP amplitude. These experiments detected no change in the N400 amplitude, which has a close connection with semantic stimuli. In short, the question of whether stereotypes and prejudice could affect the N400 amplitude in a study using semantic methods remained unanswered. In a study by White et al. (2009), participants were primed by the gender category (Women or Men) followed by a word which was either consistent or inconsistent with a gender stereotype. The stereotype-incongruent word pairs elicited larger N400 amplitudes compared to the stereotype-congruent word pairs. The authors suggested that the N400 amplitude may be an independent indicator to measure stereotypes.

This study used semantic stimuli to investigate stereotypes and prejudice. Considering the N400 amplitude has typically been interpreted as a reflection of difficult semantic/pragmatic integration (Lattner and Friederici, 2003; Friederici et al., 1993), we believed that semantic mismatch would affect the amplitude of N400 and possibly reveal a negative stereotype associated with RMWs in Urban resident Chinese.

We hypothesized that an incongruity between the meaning of the second word and the first word would elicit a large N400 amplitude. We speculated that the first word would activate stereotypes in the participants that correspond to either social group. If the stereotype of RMWs was negative, the N400 elicited by positive adjectives following “RMWs” would be larger than if that adjective were paired with “urban workers,” and larger than the N400 triggered by negative adjectives following “RMWs.” Logically for the converse, we predicted that the N400 evoked by negative adjectives following “urban workers” would be larger than those following “RMWs,” and larger than the N400 triggered by positive adjectives following “urban workers.” For example, the adjective “clean” following RMW would elicit larger N400 than did the adjective of “dirty.” For the reaction time, we hypothesized that if the participants had prejudice toward “RMWs,” they would identify adjectives more quickly when the primed name was congruent to that adjective. Subjects would identify negative adjectives more quickly after being primed with any of the names for RMWs, than they would if they had been primed with “urban worker” names, and would identify positive adjectives more quickly after being primed with any of the “urban workers” names than after the names of RMWs.

2. Results

2.1. Behavioral data

Behavioral data are shown in Fig. 1 and Table 1. The reaction times for correct responses to adjectives from the trials on which the participants’ responses were analyzed with a 2 (noun: rural migrant worker vs. urban worker) × 2 (adjective: positive vs. negative) ANOVA. This analysis did not show a significant main effect for the status noun (rural migrant worker vs. urban worker), $F(1, 15)=0.436, p=0.519>0.05$. Also, the analysis did not show significance for the adjective ($F(1, 15)=1.971, p=0.181>0.05$).

![Fig. 1 - Reaction time for four conditions: “Rural migrant worker-positive” (RP), “Rural migrant worker-negative” (RN), “Urban worker-positive” (UP), and “Urban worker-negative” (UN).](image-url)
However, the interaction between the adjective and the status noun was significant ($F(1, 15)=5.251; p=0.037<0.05$). Simple effect analyses revealed that participants identified positive adjectives significantly quicker following the “urban workers” (M=584.76 ms) than following “RMWs” (M=596.21 ms), $t(15)=3.269; p=0.033<0.05$. On the other hand, they did not classify positive words (596.21 ms) significantly faster than negative words (595.96 ms) after the “rural migrant worker” stimulus; $t(15)=0.032; p=0.975>0.05$. The mean reaction times for different conditions and the corresponding standard deviations (S.D.s) are shown in Table 1.

2.2. ERP analyses

Previous studies revealed that the N400 was widely distributed and the peak potential was usually found in the frontal-central areas (Kutas et al., 1988; Johnson and Hamm, 2000; Ganis, 1996). Based on this information on peak potential distribution, the electrode sites F3, FZ, F4, FC3, FCZ, FC4, CZ, C3, and C4 were chosen for analysis. To analyze the N400 amplitude, we conducted a 2 (Prime: Rural migrant worker/Urban worker) × 2 (Target: positive/negative word) × 9 (Electrode: FZ, F3, F4, FCZ, FC3, FC4, CZ, C3, and C4) within-subjects repeated measure ANOVA test for the mean N400 amplitude across a time window of 350–450 ms after the adjective onset. Fig. 2 shows the ERP waveforms for each electrode site from –100 ms to 800 ms under four stimulus conditions. Table 2 shows the results of the mean amplitude of N400 in the time window of 350–450 ms and pair comparison t-test.

The ANOVA analysis for the N400 amplitude showed that both the status noun (rural migrant worker vs. urban worker) and the electrode site had significant main effects, $F(1, 15)=9.696, p=0.007<0.05$, and $F(8, 120)=6.766, p=0.000<0.05$, respectively, but the target word (negative vs. positive adjective) had no such effect, $F(1, 15)=1.16, p=0.298>0.05$. The status noun (rural migrant worker vs. urban worker) had a significant interaction with the target adjective ($F(1, 15)=19.934, p=0.000<0.05$). A paired t-test showed that the N400 amplitude elicited by the RP (rural migrant worker-positive) stimulus pair (M=1.676 μV) was significantly larger than the amplitude for the UP (urban worker-positive) (M=3.331 μV) stimulus pair; $t(15)=-5.823, p=0.000<0.05$. No significant difference for N400 amplitude was observed between the RP stimulus pair and the RN (rural migrant worker-negative) stimulus pair (M=2.041 μV); $t(15)=-0.726, p=0.479>0.05$. The N400 amplitude elicited by the UN (urban worker-negative) stimulus pair (M=2.067 μV) was similar to the amplitude elicited by the RN stimulus pair (M=2.041 μV); $t(15)=0.071, p=0.944>0.05$. Yet, the amplitude elicited by the UN stimulus pair was significantly larger than the UP stimulus pair (M=3.331 μV); $t(15)=-3.149, p=0.007<0.05$.

To further analyze differences in the N400 amplitudes between the RN and RP conditions, and the RN and UN conditions, we selected the FC6 electrode site to compare them (Fig. 3). A paired t-test showed that the N400 amplitude occurring at FC6 in the RP condition (M=1.032 μV) was significantly larger than the amplitude in the RN condition (M=2.366 μV); $t(15)=-2.527, p=0.023<0.05$. The N400 amplitude elicited by the RN condition (M=2.366 μV) was significantly smaller than the amplitude triggered by the UN condition (M=1.137 μV); $t(15)=3.396, p=0.004<0.05$.

3. Discussion

Many previous studies successfully examined gender stereotypes and racial prejudice with scalp-recorded ERPs. Most of these studies used pictures as the prime and target stimuli (Amodio, 2008; Ma et al., 2008; Correll et al., 2006; White et al., 2009; Amodio et al., 2004), while only a few studies employed a semantic valence-classification priming task (Osterhout et al., 1997; Bartholow et al., 2003, 2001). We employed the semantic paradigm and selected Chinese words as prime and target stimuli because it would have been difficult for participants to identify RMWs based on their appearance.

Our study differed from previous studies also with regard to the relevant ERP components. The pertinent ERP components in other stereotype studies using pictures as stimuli were always N2, P2, and ERN components (Amodio et al., 2004; Ma et al., 2008; Correll et al., 2006). For stereotype studies using words as stimuli, the main ERP component was the Late Positive Potential (LPP) component (Osterhout et al., 1997; Gonzalez et al., 2008; Bartholow et al., 2003; 2001). However in contrast to these prior studies, our research found that the primary ERP component indicating the presence of prejudice or stereotype priming was the N400 component.

In 1998, Greenwald et al. conducted a study in which the prime stimulus was a name that was often used either by Whites or by Blacks and the target stimulus was an adjective. Participants were required to identify the target word as positive or negative. The authors reported that participants took a longer time to identify the positive word primed by characteristically “Black” names than by “White” names. Our results were similar to the findings mentioned above. In China, RMWs are frequently stereotyped as uncivilized, barbaric people who received low wages and performed only hard labor. People viewed RMWs as
negative figures more easily than positive figures. In our study, the priming word activated stereotypes about RMWs and urban workers. Participants made quicker judgments for stereotypically congruent prime-target word pairs (urban worker: clean), compared to incongruent word pairs (rural migrant worker: clean).

**Table 2 – Results of ANOVA and pair comparison t-test.**

<table>
<thead>
<tr>
<th>Experiment condition</th>
<th>N400 (μV)</th>
<th>Pair comparison</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural migrant worker-positive</td>
<td>1.68</td>
<td>“RP” vs. “UP”</td>
<td>t (15) = -5.823, p = 0.000 &lt; 0.05</td>
</tr>
<tr>
<td>Rural migrant worker-negative</td>
<td>2.04</td>
<td>“RN” vs. “UN”</td>
<td>t (15) = 0.071, p = 0.944 &gt; 0.05</td>
</tr>
<tr>
<td>Urban worker-positive</td>
<td>3.33</td>
<td>“UP” vs. “UN”</td>
<td>t (15) = -3.149, p = 0.007 &lt; 0.05</td>
</tr>
<tr>
<td>Urban worker-negative</td>
<td>2.07</td>
<td>“RP” vs. “RN”</td>
<td>t (15) = -0.726, p = 0.479 &gt; 0.05</td>
</tr>
</tbody>
</table>

**Fig. 2 – Grand averaged ERP waveforms for four stimulus conditions at electrode sites F3, FZ, F4, FC3, FCZ, FC4, C3, CZ, and C4.**

**Fig. 3 – ERPs evoked under four stimulus conditions at electrode site FC6.**
In contrast with the findings of Greenwald et al. (1998), we not only found that participants took a longer time to classify positive adjectives primed by “RMWs” versus “urban workers,” but also found that the N400 potentials were higher, in negative-polarity, when the positive adjective was presented after the word “RMWs” compared to “urban workers.” These results showed that there were higher cognitive conflicts when participants identified positive adjectives with the RMW prime.

Recently, White et al. (2009) found that gender stereotypes could affect the N400 amplitude when semantic priming stimuli were used. Participants were primed by the gender category “Women” or “Men” followed by a word that was either consistent with a gender stereotype (e.g., Women: Nurturing) or inconsistent (e.g., Women: Aggressive). Then participants were asked to determine whether the gender word matched the second word. As predicted, stereotype-incongruent word pairs were associated with larger N400 amplitudes than stereotype-congruent word pairs. White et al. (2009) suggested that the N400 amplitude revealed the difficulty of accessing information from memories that were formed over a long time. This difficulty explains why some previous researches failed to observe differences in evoked N400 potentials.

The results of our research experiment were similar to White’s findings. The N400 component was sensitive to stereotypes in an associative priming paradigm. Congruent prime-target word pairs elicited smaller N400 amplitudes relative to incongruent word pairs. For example, “urban worker-positive” word pairs were associated with smaller N400 compared with “rural migrant worker-positive” word pairs.

Compared with the paradigm studied by White et al. (2009), the RMW paradigm was implicit. In our experiment, two words were presented sequentially to participants. The first word was a status noun (RMWs or urban workers) and the second word was an adjective (positive or negative). The participants’ task was to classify the adjective as either positive or negative. Although the prime stimulus did not connect directly with the task, it still activated a participant’s stereotypes of RMWs. We found that stereotypes affected the N400 amplitude, even though in the implicit paradigm experiment.

In our research, we did not find significant differences in RT both between RP and RN conditions and between RN and UN conditions. Similarly, differences in the N400 amplitudes of RP with RN and of RN with UN were also not significant. One complication that could interfere with our results would be an atypical stereotype about RMWs. A possible source of such a stereotype may be a result of recent positive propaganda in the mainstream media concerning rural migrant. This propaganda has changed, to a certain extent, the public bias to have a more favorable view of RMWs. However, the dominating stereotype of RMWs is still largely negative as the results of our experiment have shown.

Taken together, our findings suggested that target words are easier for subjects to identify due to the congruence of the target words with the primed stereotypes, which are retrieved from their long-term memories. The significantly larger N400 amplitude elicited by RP word pairs compared with UP word pairs showed that the stereotype of RMWs was still negative relative to urban workers despite efforts in the media to portray RMWs in a positive light.

Although the problem we studied concerned a special type of prejudice in China, our findings concerning the N400, which reflected stereotypes and were elicited by an implicit association task, may have implications for future studies on other kinds of stereotypes using the same or a similar association paradigm. The N400 amplitudes elicited in the semantic association paradigm, as a reference measure of stereotype and prejudice, may be supported by more studies in the future.

4. Experimental procedures

4.1. Participants

Sixteen healthy right-handed young adults (half male and half female) aged 19–26 years (mean = 22.5) provided written consent to participate in this experiment. All the participants were Zhejiang University students and had possessed permanent city resident cards (Hukou) since middle school. Their native language was Mandarin Chinese. Participants were screened for a history of neurological and psychiatric disorders, substance abuse, and current psychotropic medications. Additionally, all the participants claimed to have unprejudiced attitudes towards RMWs.

4.2. Materials

The stimuli consisted of 400 word pairs (10 nouns × 40 adjectives) divided randomly into 8 blocks. The first word (Stimulus 1, the prime stimulus) was a status noun selected from one of two social groups, i.e., the group “RMWs” or the group “urban workers.” The group for “RMWs” consisted of five status nouns (the Chinese terms for migrant blue-collar, migrant seasonal laborer, male migrant worker, female migrant worker, and migrant manual laborer) and the group “urban workers” was also composed of five status nouns (the Chinese terms for white-collar, business clerk, corporate staff, senior business manager, and civil servant). The second word (Stimulus 2, the target stimulus) was an adjective (positive or negative).

To construct a set of second stimulus words, we started with 60 adjectives from Chinese dictionaries (half positive and half negative). Sixteen students (half from the countryside and half from the cities, and the 16 raters were different from the 16 EEG participants) rated the 60 adjectives for their suitability to describe the social groups “RMWs” and “urban workers,” respectively. If the stereotype about one of the two groups was negative, the rated results for the negative adjectives were taken into account to select the negative words. The same method was used for selecting positive words. Based on the results of these ratings, 40 adjectives (20 positive, 20 negative) were chosen as target stimuli. The negative adjectives included the Chinese

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1. All the participants were asked to complete a simple questionnaire that was created by another researcher.
terms for dirty, conservative, humble, clumsy, slow, short-sighted, grubby, lazy, mean, vague, extreme, vacillating, narrow-minded, stingy, slack, stupid, inferior, insensitive, and barbaric. The positive adjectives consisted of the Chinese terms for calm, intelligent, decent, dignified, noble, sensitive, wise, outstanding, smart, stylish, stable, elegant, gentle, righteous, sturdy, confident, civilized, polite, and tidy. Table 3 shows the selected Chinese adjectives.

The 400 stimuli for prime-target pairs were divided into four conditions: rural migrant worker-positive adjective, rural migrant worker-negative adjective, urban worker-positive adjective, and urban worker-negative adjective. Each Chinese word was made into a picture and digitized at 228×172 pixels. Stimuli were presented sequentially in the center of a computer screen with a visual angle of 2.58°×2.4°.

4.3. Procedure

Each participant was seated in a chair 1 m from a computer monitor. The experimenter informed participants that they would see a series of word pairs and that their task would be to categorize the second word as positive or negative as quickly as possible. Participants were told that an erroneous “negative” response on a rural migrant worker-positive trial was indicative of rural migrant worker bias. The 400 stimulus pairs in entire experiment were randomly distributed into 8 blocks with 50 trials each. The 50 word pairs in each block were presented randomly. Each trial began with a pattern mask (500 ms), followed by the prime (1000 ms) and then the target (500 ms). Each participant was asked to give his/her response within 1500 ms after the target word onset. The interval between the end of the previous Stimulus 2 and the onset of the following Stimulus 1 was 1.5 s (see Fig. 4). Each participant rested for 3 min before the next block began. Stimuli and recording triggers were presented using STIM 2 software (Stim2, Neurosoft Labs, Inc., Sterling, USA).

In the trials, the prime consisted of a noun (either “rural migrant worker” or “urban worker”) and the target consisted of either a positive adjective or a negative adjective (e.g., intelligent, lazy).

4.4. Electroencephalography (EEG) recording and analysis

An electroencephalogram (band pass 0.05–100 Hz, sampling rate 500 Hz) in conjunction with a Neurosan Synamp2 amplifier (Scan4.3.1, Neurosoft Labs, Inc., Sterling, USA) recorded continuously using an electrode cap with 64 AG/AGCl electrodes mounted according to the extended international 10–20 systems and referenced to digital, linked mastoids. Vertical and horizontal electroencephalograms were also recorded. When electrode impedance was maintained below 5 kΩ, the experiment could start. Electroencephalogram recordings were segmented for the epoch from 100 ms before the onset of appearance of the target word on the video monitor to 800 ms after this onset with the first 100 ms pre-targets as a baseline. Electroencephalogram artifacts were corrected using the method proposed by Semlitsch et al. Trails contained by amplifier clipping, wherein bursts of electromyography activity and peak-to-peak deflection exceeding ±80 μV were excluded. The EEG recording for each recording site for every participant was averaged separately within each of the experimental conditions. Then the averaged ERPs were digitally filtered with a low pass filter at 30 Hz (24 dB/Octave).

![Fig. 4 – Schematic of the adjective classification task.](image-url)
Acknowledgments

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