Heritage-culture images disrupt immigrants' second-language processing through triggering first-language interference

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For bicultural individuals, visual cues of a setting's cultural expectations can activate associated representations, switching the frames that guide their judgments. Research suggests that cultural cues may affect judgments through automatic priming, but has yet to investigate consequences for linguistic performance. The present studies investigate the proposal that heritage-culture cues hinder immigrants' second-language processing by priming first-language structures. For Chinese immigrants in the United States, speaking to a Chinese (vs. Caucasian) face reduced their English fluency, but at the same time increased their social comfort, effects that did not occur for a comparison group of European Americans (study 1). Similarly, exposure to iconic symbols of Chinese (vs. American) culture hindered Chinese immigrants' English fluency, when speaking about both culture-laden and culture-neutral topics (study 2). Finally, in both recognition (study 3) and naming tasks (study 4), Chinese icon priming increased accessibility of anomalous literal translations, indicating the intrusion of Chinese lexical structures into English processing. We discuss conceptual implications for the automaticity and adaptiveness of cultural priming and practical implications for immigrant acculturation and second-language learning.

bilingual | cultural psychology | cognitive activation | cross-language interference

A newly arrived graduate student from China manages to speak English smoothly to one classmate, Joe Smith, but stumbles when talking to another, Mike Liu. A visiting Taiwanese art professor lectures fluently about a slide of Grecian urns but then falters on a slide of Ming vases, struggling to recall the word "translucent." What is it about the sight of a Chinese face or a Chinese vase that can trigger dysfluency in speaking English as a second language?

Cultural psychologists increasingly study the dynamics through which people's cultural habits are situationally evoked, such as "frame switching," the shifts in judgment that bicultural individuals exhibit as they move between settings governed by different cultural norms, such as home versus the workplace. In experiments that vary whether Chinese-American biculturals are exposed to Chinese or American cultural cues (e.g., icon images such as a Dragon versus Mickey Mouse, or a Chinese versus American audience), they exhibit either Chinese or American cultural tendencies in their subsequent judgments and decisions (1, 2).

Frame-switching could reflect controlled or automatic processes. A controlled mechanism is impression management, tailoring one's judgments to the expected cultural audience. An automatic mechanism is cultural priming: cues associated with a culture set off spreading activation within one's network of knowledge related to the culture, elevating its accessibility. Past research provides some support for each account. Biculturals respond to audience cues less under higher cognitive load, consistent with effortful control (3). However, frame-switching occurs even when cues are presented and judgments and decisions are measured implicitly, consistent with automaticity (4–6).

Past frame-switching research focused on tasks for which assimilating to cues is adaptive. For example, in the Prisoner's Dilemma task, Chinese Americans switch strategies adaptively, such as cooperating more with friends under Chinese than American priming (2). However, to test the automaticity of frame-switching, it would be valuable to explore conditions under which frame-switching hurts rather than helps, because if it occurs despite the problems, this indicates that it is not easily controlled. A hair-trigger reflex for activating cultural representations in response to cues would be problematic in settings containing cultural images unreflective of the prevailing norms. For example, if Chinese symbols in a multicultural American city trigger Chinese schemas and scripts, this could hinder a Chinese immigrant's efforts to think and act according to American norms. Hence, cultural priming could be the culprit in our opening examples of how a Chinese face or a Chinese vase throws off a Chinese visitor's command of the English language.

How would cultural priming impair an immigrant's second-language processing? Mounting evidence suggests that the mental representations of the first language (L1) and second language (L2) are active simultaneously when bilinguals read or speak, sometimes creating response competition from cross-language alternatives (7–10). As automatized processes can easily interfere with deliberate processes (11), L2 processing is particularly vulnerable to the activation of L1, which is typically the dominant language, especially for recent immigrants (12–14). Assuming that L1 representations become automatically accessible in response to cues of one's heritage culture (1), then heritage-culture stimuli would trigger L1 interference with L2.

Past research on bilinguals found that cross-language interference varies as a function of foregoing linguistic activity. Bilinguals in the context of using L1 have more difficulty accessing the words of L2 (9, 15). We propose that not only the linguistic context but also the visual context of heritage-culture cues could increase the interference of L1 with L2.

We tested this hypothesis in four experiments with United States-based students from China, varying the visual cues and linguistic tasks used. In study 1 participants addressed a simulated conversation partner whose picture showed either a Chinese or Caucasian face. We predicted that the Chinese face would hinder English fluency, contrasting with the prediction from intergroup anxiety theory that Chinese would experience more dysfluency addressing the outgroup Caucasian face. Study 2 replicated this result without using faces or a conversation task, exposing participants to Chinese or American icon images during two description tasks. Studies 3 and 4 probed the intrusion of primed Chinese linguistic structures into English in recognition and naming tasks, respectively; Chinese priming was expected to increase accessibility

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of Chinese lexical structures, which we could observe with anomalous literal translations from Chinese to English.

Study 1

We used facial characteristics to prime culture (16, 17). The setting was a computer-mediated conversation session with a fellow student, an American undergraduate. Our Chinese foreign student participants saw their interlocutor's photograph (varied as Chinese or Caucasian) (Fig. S1), listened to his prerecorded speech on two campus life topics in a standard American accent (constant across conditions), and then spoke in English into a microphone about each topic based on their own experience. Their speech on each topic was coded for fluency in two ways: a listener's holistic fluency impression from the whole speech, and an objective count of words per minute, after standard pruning of extraneous words (repetitions, self-corrections, and so forth).

Results. Baseline proficiency was assessed by a speech sample produced before the priming manipulation, and it did not differ by condition (Chinese vs. Caucasian face) in the listener's impression of proficiency, $t(40) = -1.02$, $P = 0.31$, or objective speech rate, $t(40) = -1.52$, $P = 0.14$. Fluency impressions for the two postpriming conversation topics were submitted to a factorial (prime: Chinese vs. Caucasian face) with a repeated measure (topic: 1 vs. 2). As a covariate, baseline proficiency impression predicted fluency impressions, $F(1, 39) = 52.19$, $P < 0.001$. As predicted, prime also predicted fluency impressions, $F(1, 39) = 4.12$, $P = .049$, in that they were lower in the Chinese face condition (M = 4.76, SE = 0.10) than the Caucasian face condition (M = 5.04, SE = 0.09) (Fig. 1).

In a parallel analysis, objective speech rate for the two postpriming conversation topics showed an effect of the corresponding baseline measure, $F(1, 39) = 18.83$, $P < 0.001$, as well as the predicted effect of prime, $F(1, 39) = 5.77$, $P = 0.02$, indicating that the flow of words was slower to the Chinese face (M = 98.77, SE = 3.30) than the Caucasian face (M = 110.87, SE = 3.14) (Fig. 1).

An alternative account could be raised in terms of expectancy violation (18). Perhaps the speech characteristics of the pictured interlocutor (e.g., standard American accent) were atypical of Chinese Americans. If so, surprise may have caused dysfluency in the Chinese face condition. If this were true, a comparison group of European American participants should exhibit the same dysfluency effect. To test this prediction, a European American sample was run through the same procedure. Again, we coded a baseline speech sample, which did not differ by condition in proficiency impression, $t(43) = -0.41$, $P = 0.69$, or speech rate, $t(43) = 0.49$, $P = 0.63$. Both baseline measures predicted corresponding fluency scores on the two topics: $F(1, 42) = 31.59$, $P < 0.001$ (impression measure), $F(1, 42) = 43.13$, $P < 0.001$ (speech rate measure). However, prime had no effect, $F(1, 42) = 0.09$, $P = 0.76$ (impression measure), $F(1, 42) = 1.67$, $P = 0.20$ (speech rate measure), weighing against the expectancy violation account.

Consistent with previous research on intergroup bias (19), Chinese participants reported more positive expectations about their interlocutor in the Chinese face (M = 6.05, SE = 0.14) than the Caucasian face condition (M = 5.18, SE = 0.29), $t(40) = 2.70$, $P = 0.01$. European American participants showed no such difference, $t(43) = -0.57$, $P = 0.57$.

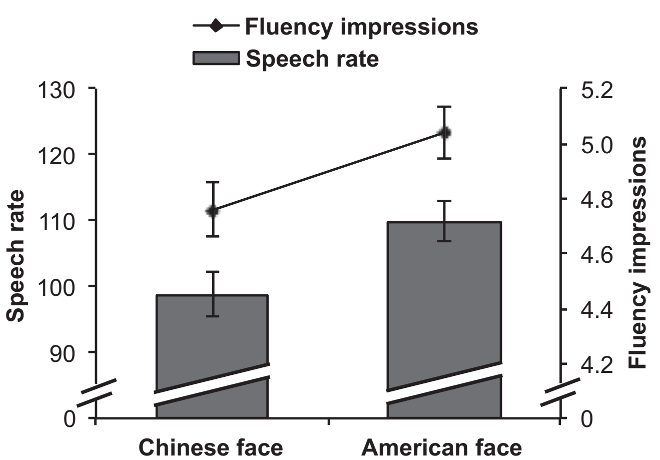

Fig. 1. Effects of face primes on fluency impressions and speech rate (study 1, Chinese participants). Error bars represent SEs.

Study 1 Discussion. Overall, a Chinese face disrupts the English fluency of Chinese foreign students, even though it elicits more positive social expectations. Although outgroup interactions can induce intergroup anxiety and resulting dysfluency (20), any such effect was more than offset by the dysfluency created by the ingroup Chinese face through the process of cultural priming.

Study 2

An alternative account for the dysfluency effect in study 1 is that Chinese immigrants may feel more motivated or obliged to speak English clearly to a Caucasian listener, who might not otherwise understand or accept them, than to a Chinese listener. Study 2 eliminated this audience-design account (21) by testing our hypothesis in a nonconversational context with no salient audience. Instead of faces, our Chinese participants viewed five icons of Chinese culture (e.g., Great Wall) or American culture (e.g., Mount Rushmore) (Fig. S2), which they rated as equal in familiarity, $t(21) = 0.29$, $P = 0.77$. Then they were asked to describe in English these culture-laden images (task 1) and subsequently to narrate stories from several culture-neutral images (task 2) (Fig. S3). We coded baseline proficiency and speech fluency with the same procedures as in study 1.

Results. Baseline proficiency did not differ by condition (Chinese vs. American icons) in proficiency impression, $t(21) = -0.61$, $P = 0.55$, or objective speech rate, $t(21) = 0.46$, $P = 0.65$. Fluency impressions for cultural-icon descriptions were submitted to a factorial (prime: Chinese vs. American icons) with a repeated measure (icons: 1–5). As a covariate, baseline proficiency impression had a marginally significant effect on fluency impressions, $F(1, 20) = 3.94$, $P = 0.06$. More importantly, prime had a main effect on fluency impressions, $F(1, 20) = 8.88$, $P = 0.007$, lower in the Chinese-icon condition (M = 5.15, SE = 0.18) than the American-icon condition (M = 5.91, SE = 0.17). Parallel analyses on fluency impressions for descriptions of culture-neutral images yielded no effect of baseline proficiency impression, $F(1, 20) = 1.81$, $P = 0.19$, but a main effect of prime, $F(1, 20) = 6.87$, $P = 0.02$, as fluency impressions were again lower in the Chinese-icon condition (M = 5.20, SE = 0.22) than the American-icon condition ($M = 5.98$, $SE = 0.21$) (Fig. 2).

Consistent with these results, speech rate for cultural-icon descriptions was predicted by the corresponding baseline measure, $F(1, 20) = 12.02$, $P = 0.002$, and more importantly, by prime, $F(1, 20) = 5.14$, $P = 0.03$, as the flow of words was slower in the Chinese-icon condition (M = 75.06, SE = 3.32) than the American-icon condition (M = 85.51, SE = 3.18). Similarly, speech rate for descriptions of culture-neutral images was predicted by the same baseline measure, $F(1, 20) = 10.73$, $P = 0.004$, and by prime, $F(1, 20) = 4.98$, $P = 0.04$, as the flow of words was again slower in the Chinese-icon condition (M = 77.05, SE = 4.68) than the American-icon condition (M = 91.56, SE = 4.48) (Fig. 2).

Study 2 Discussion. In sum, Chinese immigrants are hindered in speaking English by exposure to icon images of Chinese culture; this effect showed in their verbal descriptions of both culture-laden

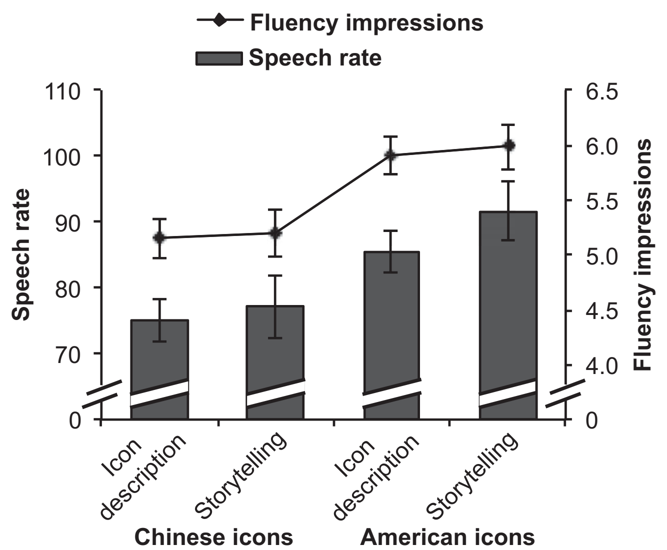

Fig. 2. Effects of icon primes on fluency impressions and speech rate on culture-icon description and storytelling tasks (study 2). Error bars represent SEs.

and culture-neutral items. Neither the expectancy violation nor audience design accounts can explain these effects, as priming was implemented through images rather than an audience.

Study 3

Although studies 1 and 2 found that visual primes of Chinese culture hinder English processing, they did not directly reveal the intrusion of Chinese linguistic structures into English processing. Our final studies aimed to do that. Of the many kinds of linguistic structures (e.g., syntactical, lexical, phonological) that may interfere to affect L2 processing, evidence for lexical structures is most straightforward to test. One way that L1 can get in the way of L2 is through anomalous literal translations (22). Our procedure showed pictures of objects (Fig. S4) that have Chinese compound names that are not mirrored in the structure of their English names (e.g., the literal translation of the Chinese name for pistachios is "happy nuts"). We used a recognition task to evaluate the accessibility of the literal translations from L1 (23, 24). We tested, for example, that a picture of pistachios would evoke the name "happy nuts" in the minds of Chinese immigrant participants more after they had been primed with Chinese icons.

Studies 1 and 2 were also unclear about whether the dysfluency effect was more about Chinese primes hindering English processing or American primes improving it, so we included control conditions without cultural primes, as well as Chinese and American conditions that each used the same icon primes as in study 2 (Fig. S2). Moreover, in addition to the literal-translation recognition trials to test effects of Chinese priming, English-name recognition trials were included to test facilitatory effects of American priming. As these two types of trials were presented in different order to test separate effects of Chinese and American priming, a matched control condition was included for each priming condition (Chinese vs. Control-Chinese, American vs. Control-American). Finally, Chinese-name recognition trials were also included and presented last.

Results. Recognition accuracy rates were 0.87, 0.88, and 0.97 for literal-translation, English-name, and Chinese-name recognition trials, respectively. None of the three types of trials differed in recognition accuracy between Chinese and Control-Chinese conditions, all $t(42) < 1.32$, all $P > 0.19$, or between American and Control-American conditions, all $t(38) < 1.28$, all $P > 0.21$.

To test the hypothesized effect of Chinese priming on accessibility of Chinese linguistic structures in English processing, we submitted the recognition latency scores on the literal-translation trials to a one-way ANCOVA (condition: Chinese vs. Control-Chinese). Two baseline measures were used as covariates: a general indicator of English proficiency provided by self-report before the priming manipulation, and a task-specific recognition latency measure obtained from the Chinese-name trials. Given the rarity of cross-language intrusion into L1 (13, 25), the latter measure should reflect participants' baseline latency in our recognition task with minimal influence of cultural primes. Indeed, the latency scores on the Chinese-name trials did not differ by condition, $F(3, 80) = 0.44$, $P = 0.73$, nor did self-report proficiency, $F(3, 80) = 0.49$, $P = 0.69$.

As covariates, Chinese-name recognition latency predicted literal-translation recognition latency, $F(1, 40) = 20.74$, $P < 0.001$, whereas self-report proficiency did not, $F(1, 40) = 0.06$, $P = 0.81$. As expected, Chinese primes had a main effect on literal-translation recognition latency, $F(1, 40) = 5.63$, $P = 0.02$, evidenced by faster recognition of literal-translation names in the Chinese condition (M = 7.16, SE = 0.04) than the Control-Chinese condition (M = 7.31, SE = 0.04) (Fig. 3). Parallel analyses showed that literal-translation recognition latency did not differ between American and Control-American conditions, $F(1, 36) = 0.18$, $P = 0.67$.

To test the nonpredicted facilitatory effect of American primes, we submitted the latency scores on the English-name trials to a one-way ANCOVA (condition: American vs. Control-American). As covariates, Chinese-name recognition latency predicted English-name recognition latency, $F(1, 36) = 8.97$, $P = 0.005$, whereas self-report proficiency did not, $F(1, 36) = 2.52$, $P = 0.12$. American primes did not affect English-name recognition latency, $F(1, 36) = 0.51$, $P = 0.48$. Parallel analyses showed no effect of Chinese primes either, $F(1, 40) = 2.64$, $P = 0.11$.

Study 3 Discussion. Importantly, study 3 results indicate that exposure to Chinese icons heightened the accessibility of Chinese lexical structures for Chinese immigrants engaged in an English language task. To rule out the alternative account that the effects from previous studies came from facilitatory effects of American primes, we tested the Chinese prime effect relative to a control condition. We also tested for an effect of American primes fostering English fluency and found none. Overall, these findings are consistent with the dysfluency effects in prior studies reflecting inhibitory influence of Chinese primes—but not facilitatory influence of American primes—on Chinese immigrants' English processing.

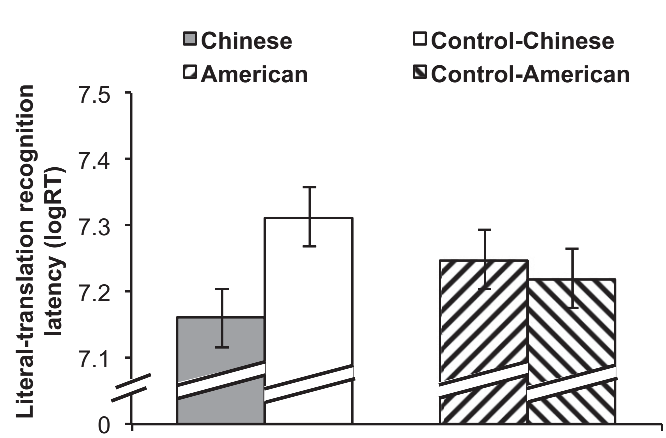

Fig. 3. Effects of icon primes on literal-translation recognition latency (study 3). Error bars represent SEs.

Study 4

Using the same cultural icon primes as in studies 2 and 3 (Fig. S2), study 4 tested the intrusion of Chinese lexical structures into English processing in an object-naming task. Naming tasks are widely used to test cross-language interference because when searching for a name, structures from L1 and L2 compete for selection (26, 27). As in study 3, we presented pictured objects that have Chinese compound names that are not mirrored in the structure of their English names. If Chinese primes heighten not only accessibility of Chinese lexical structures but also their selection in English production, then we may see increased use of literal translations in the object-naming task.

Results. In a task of naming five pictured objects (Fig. S4), Chinese participants produced an average of 0.81 proper English names (SE = 0.11) and 0.92 literal-translation-from-Chinese names (SE = 0.10). Mean production rates per object were 0.16 and 0.18 for English names and literal translations, respectively. These rates were lower than the recognition accuracy rates in study 3, as recall in a second language is much more challenging than recognition.

Baseline proficiency was assessed by an impression measure based on a speech sample produced before the priming manipulation, and it did not differ by condition (American vs. Chinese), $t(83) = -0.10$, $P = 0.92$. We submitted the binary variable indicating literal-translation production (0: no, 1: yes) to a hierarchical linear modeling, with naming trials nested within participants. At the participant level, baseline proficiency was included as a covariate and prime as a predictor. There was no effect of baseline proficiency on literal-translation production, $t(82) = 1.38$, $P = 0.17$. However, prime predicted literal-translation production, $t(82) = 2.80$, $P = 0.007$, as more literal translations were produced under Chinese (M = 0.24, SE = 0.03) than American priming (M = 0.13, SE = 0.03) (Fig. 4). Parallel analyses were performed on the binary variable indicating English-name production (0: no, 1: yes), yielding an effect of baseline proficiency, $t(82) = 2.20$, $P = 0.03$, but no effect of prime, $t(82) = -0.60$, $P = 0.55$.

Study 4 Discussion. Extending study 3 findings, study 4 show fuller evidence for the intrusion of Chinese lexical structures into immigrants' English processing as a function of priming with visual cues of Chinese culture. There was no effect of priming on English-name production, suggesting again no facilitatory effect of American primes on English processing.

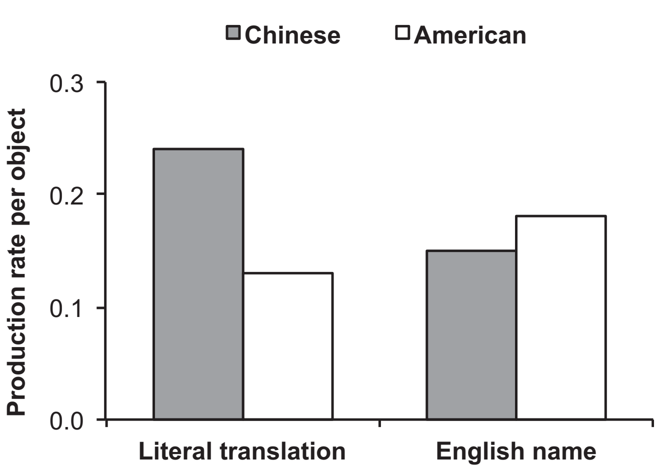

Fig. 4. Effects of icon primes on production rate for literal translations and English names (study 4).

General Discussion

The present studies found consistent evidence that immigrants' second-language processing can be disrupted by heritage-culture priming. Focusing on recent Chinese immigrants to the United States, we first tested that L2 fluency would be disrupted by exposure to cues of Chinese culture, such as a Chinese face (study 1) or iconic Chinese symbols (study 2). Alternative explanations, such as interaction anxiety, expectation violation, and audience design were ruled out. Then we tested that priming with such visual cues produces the intrusion of Chinese linguistic structures into English processing, evidenced by increased accessibility (speeded recognition) of Chinese-to-English literal translations (study 3) and increased use of these literal translations in an object-naming task (study 4). Although Chinese priming had these effects, American priming did not affect English processing, consistent with the interpretation of the fluency effects as reflecting the intrusion of the primed Chinese language into English processing.

This research contributes distinctive evidence that visual cues of heritage culture can affect people through a priming mechanism. Although past studies show that cultural images shift biculturals' judgments and decisions, we provide original evidence for the theorized automaticity of cultural priming, as the effects of priming occur despite its interference with fluent performance in English (28). Whereas past cultural priming studies have used language as a cultural prime (1, 29, 30), or measured linguistic category choices and memories indicative of cultural schemas (6), the present studies are unprecedented in looking at language as a performance that can be disrupted by cultural priming.

Furthermore, the results contribute to the literature on how bilinguals manage their two languages. Cross-language interference has been studied as arising from inherent linguistic structures and from the linguistic context of a task (7, 31). Here we found that visual cues, such as faces and symbolic icons, also affect cross-language interference. This finding raises the question of what other features of one's visual environment are salient triggers of the mother tongue and whether cues in other modalities (e.g., distinctive sounds, smells, and kinesthetic patterns) may also prime culturally associated languages.

Our findings speak to the intergroup literature as well. In study 1, Chinese participants exhibited in-group favoritism by reporting more positive expectations about a Chinese than a Caucasian interlocutor (32). However, unlike in studies showing greater verbal dysfluencies (in L1) during cross-group interactions (20), Chinese participants were more dysfluent (in L2) during same-group interactions. This finding suggests that dysfluency in L1 and L2 may be affected by different aspects of an interaction, although more research is needed to sort this out.

Our results raise new questions for several applied literatures. Immigrants who settle in ethnic enclaves acculturate more slowly (33). Moreover, immigrants to culturally mixed neighborhoods report experiences of distraction and confusion (34). These phenomena may arise in part from the priming of heritage-culture schemas and scripts that compete with newly learned host-culture schemas and scripts. For immigrants or expatriates, a visual environment with heritage-culture cues may have mixed effects, bolstering mood and felt connectedness yet hindering the process of learning the host culture.

Research on second-language learning has attributed advantages of study-abroad programs to linguistic contexts. Americans taking a Spanish course in the United States showed lower Spanish proficiency and greater accessibility of English words than a group taking the same course of Spanish in Spain (35). Although the linguistic context outside of class no doubt contributed to the United States group's higher L1 accessibility, the cues in the visual environment may have also mattered: the everyday environment of the United States group was saturated with cues to American culture, which heightened L1 accessibility. In sum, L2 learning may depend on the extent to which courses are culturally immersive and not just linguistically immersive.

The effects of cultural priming on linguistic performance may go beyond fluency (studies 1 and 2). Heritage-culture priming may affect second-language speakers' pitch, prosody, and linguistic content. Similarly, although we focused on the intrusion of lexical structures in recognition and naming tasks (studies 3 and 4), procedural knowledge related to other linguistic and paralinguistic dimensions may also intrude. For example, Chinese immigrants trying to adhere to American norms of speaking assertively, making direct eye contact, and promoting their own accomplishments in a job interview might find it difficult to enact these behaviors with a Chinese-looking interviewer or in an office decorated with Chinese paintings. Future studies that address interference effects of cultural priming beyond linguistic fluency would elucidate the scope of this phenomenon.

How broad a population is vulnerable to cross-language intrusion induced by cultural priming? Worldwide, biculturals outnumber monolinguals (36). Our analysis refers to the most prevalent subtype of bilinguals: coordinate bilinguals who learn their languages in separate contexts, such that their L1 is strongly associated with their heritage culture, whereas their L2 is not. Compound biculturals, who learn their two languages simultaneously, should be less susceptible to cultural-priming–induced intrusion. Our studies focused on immigrants, who make up about 10% of the American population and over 20% in some other countries (37). Although the phenomenon is not unique to immigrants, immigrants who are still learning the language of the host culture are prototypical coordinate bilinguals and serve well to test the hypothesized process.

In this transnational era, immigrants often return to their heritage cultures. Do they risk having their L2 intrude into their L1 processing when exposed to cues of their host culture? The literature on cross-language interference finds less intrusion of L2 into L1, reflecting the more automatic and encapsulated nature of L1 processing (13, 14). However, L2 intrusion is an empirical question. For longstanding immigrants, L1 may become less automatic and more effortful, so they should be more vulnerable to this reverse intrusion than recent immigrants. Finally, cultural priming is not the only process through which L2 intrudes in L1. Bilinguals may use L2 within L1 and vice versa to talk about specific domains (e.g., types of food or technical topics) for which they lack a vocabulary in one of their languages. Anthropologists and sociolinguists have described many forms of cross-language switching exhibited by immigrants and other bilingual biculturals that warrant attention from a cultural psychology perspective (38).

Methods

Study 1. Forty-two Chinese students (20 males) from a northeastern United States university participated in a study of communication in English. They had lived in the United States for 11 mo on average. A comparison group comprised 45 European American students (18 males) from the same university. We have written informed consent from all study participants. Our studies are approved by Columbia University IRB (human subject study protocol #AAAD2827).

Participants were randomly assigned to two conditions (prime: Chinese vs. Caucasian face). The participants were seated in front of a computer equipped with a headphone and a microphone that recorded their verbal responses. After participants verbally delivered a 1-min self-introduction, they learned about Michael Lee, ostensibly their partner for a computer-mediated communication task. Participants viewed either a Chinese or Caucasian face photo of Michael Lee (Fig. S1) while listening to the same audio recordings of him talking about two campus-life topics in a standard American accent. After listening to Michael Lee talking about each topic, participants spoke about this topic in English for 1 min. When finished, participants reported their expected enjoyment in working with Michael Lee.

Fluency impressions. A hypothesis and condition-naïve coder listened to the recordings of participants' self-introduction given before the priming manipulation and assessed their baseline proficiency (1 *not proficient at all*, 7 *very proficient*). The coder also listened to the recordings of their speech on each topic delivered after the priming manipulation and rated their fluency on three dimensions (39, 40): speed (1 *very slow*, 7 *very fast*), pauses (1 *no pause*, 7 *a lot of pauses*), and truncation (1 *no truncation*, 7 *a lot of truncation*). The three dimensions were averaged into an impression measure of fluency. As a reliability check, a second coder who independently coded 20% of the recordings showed high agreement, intraclass correlation coefficient = 0.78, $P < 0.001$.

Speech rate. All recordings were transcribed verbatim. A speech-rate measure was developed by counting how many "pruned words" were produced per minute, excluding self-corrected words, repetitions, false starts, nonlexical filled pauses, and asides (41, 42). This measure was correlated with the impression measure of fluency, $r = 0.64$, $P < 0.001$, consistent with previous evidence on reliability of listener-based impressions of fluency (43).

Study 2. Participants were 23 Chinese students (9 males) from the same university. They had lived in the United States for 14 mo on average. Participants were randomly assigned to two conditions (prime: Chinese vs. American icons).

Participants first gave a self-introduction speech as in study 1 to provide measures of baseline proficiency. Then they performed two tasks on computer. The first task showed five icon images of Chinese or American culture (Fig. S2), and participants described each icon in spoken English for 1 min. Then, with thumbnails of these icons still visible in the top margin of the computer screen, participants completed a storytelling task, making up a story explaining each of four culture-neutral images in the center of the computer screen (Fig. S3). Finally, participants indicated prior familiarity with the five cultural icons (1 *not familiar at all*, 7 *very familiar*). A holistic impression measure and an objective speech rate measure of fluency were developed as in study 1. These two measures were again correlated, $r = 0.42$, $P < 0.001$.

Study 3. Participants were 84 Chinese students (35 males) from the same university; they had lived in the United States for 3 mo on average. The participants were randomly assigned to four conditions, including two priming conditions (Chinese, American) and two control conditions that each matched in block order with a priming condition (Control-Chinese, Control-American).

After reporting their English proficiency (1 *not proficient at all*, 5 *very proficient*), participants in the priming conditions wrote about the same five Chinese or American icons as in study 2 (Fig. S2), and participants in the control conditions wrote about five geometric figures (44). Then participants completed three blocks of name-recognition trials: literal translations (27 trials), English names (27 trials), and Chinese names (54 trials). Each trial presented a pictured object (Fig. S4) for 2 s, followed by a target word/phrase. In a literal-translation trial, participants judged whether the target English phrase identifies the pictured object. In an English-name (Chinese-name) trial, participants judged whether the target word is the correct English (Chinese) name of the pictured object. The literal-translation trials presented different objects from the English-name trials, and the Chinese-name trials presented all of the objects from the literal-translation and English-name trials. Each block included twice as many distractor trials that required a "no" response as trials that required a "yes" response. Reaction times on accurately judged trials were transformed into natural logarithms (45).

Our primary goal was to test the Chinese priming effect on recognition latency for the literal-translation trials. We were also interested in whether American priming would facilitate recognition for the English-name trials. The Chinese-name trials were included as a baseline measure of recognition latency. To minimize order effects, each priming condition, as well as its

Table 1. Coding examples for the object-naming task (study 4)

Naming task	Object 1	Object 2	Object 3	Object 4	Object 5
English name	Q-tips; Cotton swabs	Lollipop	Pistachios	Frisbee	Bulldozer
Literal translation	Cotton sticks; Cotton bars	Stick candy; Sugar with stick	Happy nuts; Happy fruits	Flying plate; Flying dish	Earth-pushing machine

matched control condition, presented the most relevant block of trials first: Chinese and Control-Chinese conditions presented the literal-translation trials first, followed by English-name trials; American and Control-American conditions presented English-name trials first, followed by literal-translation trials. Chinese-name trials were presented last in all conditions.

To assess Chinese lexical intrusion in English following Chinese primes, we submitted the latency scores on the literal-translation trials to a 2 (prime: Chinese vs. Control-Chinese) factorial, with self-report proficiency and baseline recognition latency as covariates. Similar analyses were performed to detect the effect of American primes on literal-translation recognition latency (prime: American vs. Control-American). We further tested the effect of American priming on English processing by submitting the latency scores on the English-name trials to a 2 (prime: American vs. Control-American) factorial with the same two covariates. Similar analyses were performed to detect the effect of Chinese primes on English-name recognition latency (prime: Chinese vs. Control-Chinese).

Study 4. Participants were 85 Chinese students (32 males) from the same university. They had lived in the United States for 4 mo on average. Participants were randomly assigned to two conditions (prime: Chinese vs. American icons).

Like studies 1 and 2, participants first gave a self-introduction speech that was later coded into an impression measure of baseline proficiency. When finished, they viewed the same five Chinese or American icons as in studies 2 and 3 (Fig. S2). Then, with thumbnails of these icons visible in the top margin of the computer screen, participants completed an object-naming task. They were shown five pictured objects in consecutive order (Fig. S4) and for each were asked to say in English what it was to a person who could not see the picture. The five objects were chosen from a pilot set based on two criteria: they evoked the most convergent literal translations from Chinese, and their English names were recognizable to Chinese participants but not easy to recall (Table 1). Verbal responses for the object-naming task were coded into two indicators: literal-translation production (0: no, 1: yes) and English-name production (0: no, 1: yes).

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