Article

Language Variation and Perception: Subject Pronominal Expression in Native and Non-Native Mandarin Chinese

Xinye Zhang [1,*] **, Aini Li** [2,*] **and Xiaoshi Li** [3,*]

1   Department of Linguistics, University of California, Davis, CA 95616, USA
2   Department of Linguistics and Translation, City University of Hong Kong, Hong Kong 999077, China
3   Department of Linguistics, Languages, and Cultures, Michigan State University, East Lansing, MI 48824, USA
*   Correspondence: xiyzhang@ucdavis.edu (X.Z.); ainili@cityu.edu.hk (A.L.); xli@msu.edu (X.L.)

Abstract: Subject pronoun expression (SPE) has been widely studied as a sociolinguistic variable across a range of languages. However, previous research has primarily focused on production, leaving the perception of subject pronouns largely unexplored. The perception of sociolinguistic variants not only reflects unconscious judgments towards linguistic features but also unveils the social meanings associated with these features. This study explores the perception of SPE in Mandarin by native and non-native listeners. 262 participants (185 native and 77 non-native) were recruited for Mandarin SPE perception tasks in which participants needed to rate the appropriate use of SPE in given contexts. Mixed-effects regression models reveal that native and non-native Mandarin listeners shared similar perception patterns of SPE. SPE rate serves as a significant structural constraint for both native and non-native perception. However, these two groups differ in that person of the subject and L2 experience play a key role in native perception, whereas non-native listeners demonstrated greater sensitivity to gender as a social factor. To what extent production and perception may interact is further discussed. This study contributes to the current understanding of sociolinguistics and second language acquisition by providing empirical evidence of SPE perception, adopting innovative approaches to examine variation perception, addressing the differences between native and non-native patterns of perceptual variation, and exploring the connection between variation production and perception.

Keywords: language variation; sociolinguistic evaluation and perception; subject pronominal expression; Mandarin Chinese; native and non-native differences

1. Introduction

To address the relationship between language and society, variationist study has focused on the orderly heterogeneity of particular linguistic features and their association with social meanings in language change (Labov, 1972). Recent studies delve into the semiotic system constituted by variation regarding the expression of social concerns in local communities (Eckert, 2012). For example, the variation of subject pronoun expression (SPE) has been extensively investigated across languages (Barbosa et al., 2005; Bayley et al., 2023; Cameron & Flores-Ferrán, 2004; D. G. Erker, 2012; Jia & Bayley, 2002; Kato & Duarte, 2021; Li & Bayley, 2018; Zhang, 2021). These findings suggest that various constraints including linguistic internal factors (e.g., person and number), cognitive factors (e.g., priming), discursive factors (e.g., context), and social factors (e.g., gender), significantly influence subject pronominal use (D. Erker et al., forthcoming). However, while previous studies have predominantly focused on SPE production, it remains unclear to what extent SPE use is perceived, and what roles various linguistic and social factors play in the process.

The perception and evaluation of sociolinguistic variants not only reflect unconscious judgments towards linguistic behaviors but also unveil the social meanings behind these particular features (Campbell-Kibler, 2009, 2010; Labov et al. 2011; Preston, 2013). Scholars have explored the social judgments of various phonetic variants, such as vowel variation in New York (Labov, 1966), gender-related variability in /s/ and /ʃ/ (Strand, 1999), and rhotic versus non-rhotic tokens in New York and General American dialects (Sumner & Samuel, 2009), and quotative variation in British and American English (Buchstaller, 2004). However, despite emerging studies investigating variation production by second and heritage language speakers (Bayley et al., 2022), how sociolinguistic variants are perceived and evaluated by non-native learners is underresearched. As Preston, (2013) claimed, "perception, evaluation, and production are intimately connected in language variation and change" (p. 167). This study aims to explore the sociolinguistic perception of SPE in Mandarin Chinese by both native and non-native listeners.

As defined by Campbell-Kibler's (2010), sociolinguistic perception refers to "the processes engaged when people are exposed to external stimuli, in this case, linguistic material, and extract information from it" (p. 378). During the perception, listeners also tend to associate certain social characteristics of the speaker with their linguistic behaviors (Eduwards, 1982; Preston,, 2013). In this study, we address how linguistic internal structure (e.g., SPE rate) and social characteristics of listeners (e.g., gender) affect the perception of the appropriateness of subject pronoun use in given contexts. By investigating the perception of SPE variation in native and non-native Mandarin, the study contributes to the current understanding of sociolinguistics and second language acquisition in several ways: first, it provides empirical evidence of how SPE variation is perceived regarding its usage appropriateness in both native and non-native communities; second, the approach to examining variation perception through appropriateness ratings represents an innovative methodological contribution to the field; third, the study enriches variationist research by including non-native language users, potentially revealing differences between native and non-native groups; finally, findings may shed light on the connection between production and perception in language variation and sociolinguistic competence.

2. Background

2.1. SPE Variation in Language Production

Subject personal pronoun, as shown in the linguistic examples in Table 1, stands as a widely studied sociolinguistic variable in which a subject pronoun can be variably present or absent (cf. Sentence 1 versus Sentence 2) (Labov, 1972). Traditionally, typologists and general linguists tend to categorize languages as pro-drop/non-prodrop or null-subject/non-null-subject (Dryer, 2013; Jaeggli & Safir, 2012; Rizzi, 2013). However, this dichotomous categorization may not be powerful enough to capture the continuous range of SPE rates presented in different varieties or different contexts (D. Erker et al., forthcomoing). For example, in daily conversations or sociolinguistic interviews, native speakers could use SPE with a low rate at 16.7% in Tehrani Persian and a high rate at 87.2% in Stuttgart Swabian (Adli, 2011; K. V. Beaman, 2024; D. Erker et al., forthcomoing). For Chinese specifically, the overall SPE rate ranges from 35.9% among native Mandarin speakers from Northeast China (Li et al., 2012), to 62% in heritage Cantonese in Toronto (Nagy, 2024), 65.7% in Taiwan Mandarin and California heritage Mandarin (D. Erker et al., forthcomoing; Zhang, 2021), and 69.8% among speakers from Shanghai (D. Erker et al., forthcomoing). The differences in SPE rates, as exhibited across different language varieties, may be attributed to the social characteristics of the speakers and contexts, interlocutor effects (Bell, 1984; Cai et al., 2021; Giles & Ogay, 2013; Kim & McDonough, 2008; Schilling, 2013; Wolfram, 2011), and dialectal influences, among others.

Table 1. Linguistic Examples.

Sentence 1	Sentence 2
wǒ juéde	ø juéde
我觉得	ø 觉得
'I feel like'	'ø feel like'

Studies have shown that the variation of SPE is constrained by both internal linguistic factors and external social characteristics of the interlocutors and the contexts across a wide range of languages such as Spanish, Portuguese, Persian, Swabian, Mandarin, and Cantonese (Barbosa et al., 2005; Bayley et al., 2023; Cameron & Flores-Ferrán, 2004; D. Erker et al., forthcoming; D. G. Erker, 2012; Jia & Bayley, 2002; Kato & Duarte, 2021; Li & Bayley, 2018; Zhang, 2021). In terms of linguistic structures, previous research revealed that significant factors include referential continuity, the person and number of the subject, semantic features of the verb, the tense-mood-aspect (TMA) of the verb, and clause type. For example, when the same referent has been mentioned in the same form in the preceding clause, its expression in pronoun tends to be absent (Adli, 2011; Bayley & Pease-Alvarez, 1996; Bouchard, 2018; Cameron, 1993; Flores-Ferrán, 2004; Guy, 2023; Jia & Bayley, 2002; Li & Bayley, 2018; Li et al., 2012; Shin & Otheguy, 2009; Zhang, 2021). Priming effects have also been tested in many cases (K. V. Beaman, 2024; Bouchard, 2018; Guy, 2023; Travis, 2007). Moreover, the person and number of the subject have also been found to be strong predictors of SPE variation. This holds true not only in inflectional languages like Spanish and Portuguese (Bayley & Pease-Alvarez, 1996; Cameron & Flores-Ferrán, 2004; Flores-Ferrán, 2004; Otheguy et al., 2007; Travis, 2007) but also in non-inflectional languages such as Mandarin (Jia & Bayley, 2002; Li et al., 2012; Zhang, 2021) and Cantonese (Nagy, 2024).

Compared with the crosslinguistic effects of cognitive constraints such as priming, the effects of person and number are more language-specific as linguistic internal constraints (D. Erker et al., forthcoming). For Mandarin specifically, Li et al. (2012) showed that in conversations with university teachers and students, expressed pronouns occurred significantly more frequently with singular subjects, except for second-person plural pronouns used by students or first-person plural pronouns used by teachers. This difference was explained as the pragmatic needs of the speakers according to the contexts. In heritage Mandarin by Californian undergraduates, the preference for expressed pronouns in singular subjects and first plural subjects was identified as well (Zhang, 2021). While in Toronto heritage Cantonese, pronouns were more frequently expressed in singular forms, particularly for second and third person subjects (Nagy, 2024). The higher SPE rates in singular pronouns may affect how listeners perceive the subject pronoun use regarding person and number in speech.

Besides linguistic structures, the social characteristics of the speakers also significantly affect the expression of subject pronouns. One of the widely explored social constraints is speakers' gender. As many have shown that female speakers often prefer the use of "standard" or non-socially stigmatized variants in speech than their male counterparts, the preference for explicit expression of subject pronouns by women was also found in many speech communities such as Santo Domingo Spanish (Alfaraz, 2015), Swabian (K. Beaman, 2025), Northeast Mandarin (Li et al., 2012), and Toronto heritage Cantonese (Nagy, 2024). Interestingly, in a Spanish-English bilingual community, it was found that females lead men in the increasing use of pronouns in Spanish as a heritage language (Shin & Otheguy, 2013). Overall, it seems that compared with men, women are more sensitive to the use of SPE and prefer explicit expressions in their narratives.

Another social characteristic that contributes greatly to SPE variation in speech production is nativeness. In many cases, heritage and foreign language learners differ from

native speakers in variation patterns as they often lack full exposure to various contexts where different variants are used (Bayley et al., 2022). In addition, the extent to which non-native speakers are able to demonstrate native-like sociolinguistic competence or native-like variation usage patterns depends on many other background factors such as language proficiency, age of acquisition, learning path, language domain, or inaccessibility of variable use in different contexts (Bayley, 2005; Bayley et al., 2022; Dewaele, 2008b; Regan, 2010; Tse, 2022). Therefore, it is not surprising to see that heritage speakers may not be as sensitive as native speakers in the use of some particular features, and foreign learners often need to achieve an intermediate or higher proficiency to establish a better sense of what is appropriate and what is not. For example, Linford et al. (2018) found that the more contact L2 learners had with native speakers while studying abroad, the more their SPE patterns approximated the native norms in Spanish. Among heritage speakers of Spanish in New York City, Shin and Otheguy (2009) revealed that second-generation Latinos were less sensitive to the constraint of referential continuity for SPE variation than newcomers. For Mandarin specifically, Li (2014) showed that overall, high-intermediate and advanced L2 learners demonstrated substantial mastery of subject pronoun use; however, their awareness of variation constraints required further development. Moreover, other social factors including L1, gender, context, and proficiency significantly affected L2 learners' SPE patterns as well. For heritage learners, Zhang (2021) revealed that students who moved to the United States around age four or five demonstrated more native-live subject pronoun use than their US-born peers. In sum, SPE variation is more structurally constrained in speech, but its usage patterns differ among native, heritage, and L2 speakers.

2.2. Perception and Evaluation of Sociolinguistic Variables

Language perception has drawn significant attention, especially in recent decades. Campbell-Kibler (2010) explored key areas of sociolinguistic perception, focusing on how language is socially and affectively evaluated, how social information is derived from speech, and how linguistic comprehension is shaped by the social information available to listeners. In essence, sociolinguistic perception involves listeners relying on their linguistic and social knowledge to interpret language and form judgments. It has been observed that sociolinguistic variation affects perception by creating patterns that listeners must interpret, even if they are unaware of them (Campbell-Kibler, 2010). In other words, even when listeners are unaware of certain linguistic patterns, their perceptions are unconsciously shaped by these patterns, whether through their own or others' language production.

Since perception and production interact, investigating listeners' perception patterns is as crucial as studying speakers' production patterns to understand the sociolinguistic phenomenon of language use. Additionally, in second language acquisition, sociolinguistic perception is as essential as sociolinguistic production for documenting learners' development of sociolinguistic competence (Chappell & Kanwit, 2022; Escalante, 2018). As mentioned, the optional use of subject pronoun is an important feature of Mandarin, and production studies by native speakers show variation in SPE rates. One of the aims of this study is to explore whether speakers' perception patterns of SPE use and the factors involved align with the production patterns documented in previous studies. Since this is the first perception study on SPE use in Mandarin, there are no prior studies to draw upon directly. Therefore, this section briefly reviews perception studies of other sociolinguistic variables conducted with native speakers and L2 learners in other languages.

What is pertinent to the current study is the strand of perception studies that focused on sensitivity to certain linguistic varieties. For example, in examining how vowel shifts in different regions of the U.S. affect speakers' production and perception and the relationship between these two aspects, Fridland and Kendall (2012) found that regional affiliation

and individual participation in the linguistic variety were the two main predictors of the perceptual patterns. As they put it, "perception appears to depend both on what you yourself produce (i.e., as an individual speaker) and who you are more generally (i.e., as a member of a specific community) (p. 792)". Labov et al. (2011) also found that speakers' own production patterns align with their perception patterns: listeners in South Carolina demonstrated greater acceptance of the non-standard use of /ɪŋ/, corresponding to their greater use of it in formal spontaneous speech. Strong links between production and perception were also found by Fridland et al. (2004) in their examination of listeners' sensitivity to subtle phonetic changes based on Southern Vowel Shift and Northern Cities Shift (e.g., Eckert, 2000; Evans, 2001; Fridland, 1999, 2003; Labov, 2001). Another example is Sumner and Samuel (2009), in which priming effects were shown on Long Islanders and outsiders by their own practiced language variety of postvocalic /r/. Clopper and Pisoni (2004) found that listeners' experience with or exposure to different language varieties also influenced their ability to identify where a speaker was from. L. B. Schmidt (2015) found that short-term travel and media exposure from regions where the target variant is used were not significant predictors of variable identification, whereas reported social contacts were. This suggests that live interactions have a stronger influence on language perception development.

In addition, gender has been shown to constrain sociolinguistic perception. Labov et al. (2011) found that females generally had less tolerance for non-standard /ɪŋ/ usage at moderate frequencies. Warren et al. (2007) showed in perception experiments on the "near" and "square" diphthong merger in Australia that females identified more with Australian norms compared to men. Speaker gender also influences speech perception, and even listeners' beliefs about a speaker's gender, or how typically male or female they sound, can affect their perceptions, too (Strand, 1999).

Language learning experience influences listeners' speech perception abilities as well. For example, Qin et al. (2024) found that native speakers of two Korean varieties who had L2 Mandarin learning experience were better at discriminating contour-level tone contrasts than those without such experience. L2 Mandarin proficiency significantly affected this ability, supporting the role of L2 in speech perception. Qin and Jongman (2016) demonstrated that English learners of Mandarin perceived Cantonese tones differently due to their L1 and L2 experiences, and L2 experience influenced L3 tone perception when the lexical tones of L2 and L3 were similar. Furthermore, Marian et al. (2018) demonstrated that second language learning experience enhances cognitive processes, with bilinguals better at integrating visual and audio cues in speech perception.

Proficiency level in a second language and linguistic training experiences also play significant roles in developing sociolinguistic perceptual competence. L. B. Schmidt (2011) cautiously suggested that while proficiency contributes, exposure to dialectal features and linguistic training play crucial roles. In her study, advanced learners who reported more study-abroad experiences and linguistic training outperformed less experienced learners in identifying target features. Escalante (2018) found that English learners of Spanish with higher proficiency levels were better at perceiving aspirated coda /s/ as legitimate during a one-year stay in coastal Ecuador. She further observed that novice speakers, even with similar exposure, were significantly less adept at perceiving /s/ than intermediate speakers, emphasizing the importance of proficiency. Proficiency is confounded by heritage speaker status. Escalante (2018) discovered that when the two heritage speakers in her study were included in the analysis, proficiency did not reach statistical significance. Conversely, when these heritage speakers were excluded, proficiency became significant. She attributed this discrepancy to the diversity within heritage populations, emphasizing that the ability to perceive aspirated /s/ may be more closely tied to heritage speakers' home dialects. Thus,

heritage speaker status alone does not constrain sociolinguistic perceptual development but interacts with other factors, such as proficiency and language experience.

3. The Current Study

This study investigates sociolinguistic perception of SPE use in Mandarin Chinese by both native and non-native speakers, focusing on how the perception of SPE use appropriateness is influenced by linguistic and social constraints. Appropriateness, different from grammaticality and acceptability, derives from a speaker's pragmatic knowledge and sociolinguistic competence (Bardovi-Harlig, 2013; Dewaele, 2008a; Fairclough, 2014; Kasper & Rose, 2002; R. Schmidt, 1990). As a crucial part of sociolinguistic competence, appropriateness judgment addresses to what extent the use of sociolinguistic variables is appropriate in different contexts (Geeslin et al., 2018; Regan & Bayley, 2004; Van Compernolle & Williams, 2012). Specifically, the current study aims to answer the following research questions.

1. Are there any differences between perceptions of SPE appropriateness by native and non-native participants of Mandarin Chinese? If so, what are they?
2. How do linguistic structures and social factors affect the perception of SPE appropriateness by native and non-native Mandarin Chinese listeners?

3.1. Method

3.1.1. Materials

Following previous sociolinguistic perception frameworks (Campbell-Kibler, 2009; Labov et al., 2011), we developed a sociolinguistic survey with 22 SPE perception tasks, each task representing a unique context in which a subject pronoun may be used. In each task, there were eight sequential clauses that described everyday events the subject may experience. This aimed to simulate the spontaneous speech nature of sociolinguistic interviews as investigated in previous research on SPE production. As shown in Table 2, each clause contained a position where a subject pronoun may be expressed or unexpressed. To contextualize the referent, the SPE in the first clause was always present. However, the remaining SPE positions may be either filled or empty, resulting in three different overall SPE rates: (1) Low (SPE rate = 12.5%): only the first SPE was present, whereas the rest were all absent; (2) Mid (SPE rate = 50%): the first and three additional SPEs were expressed, and others were unexpressed; and (3) High (SPE rate = 100%): all SPE positions were filled with the same pronoun. In this way, the SPE variation was categorized quantitatively and systematically as other sociolinguistic variables (e.g., /ŋ/ vs. /n/) as tested in previous studies (Campbell-Kibler, 2009; Labov et al., 2011).

Given the grammatical person and number properties of subject pronoun in Mandarin, six types of SPE were included during stimuli creation: first, second, and third person in both singular and plural forms. Namely, the six Mandarin personal pronouns were first person singular "wǒ 我", second person singular "nǐ 你", third person singular "tā 她/他", first person plural "wǒmen 我们", second person plural "nǐmen 你们", and third person plural "tāmen 他们". Each pronoun was presented with three different SPE rates. For third person singular pronoun which serves as the most common subject in casual narratives, stimuli also demonstrated different positions where the pronoun could be inserted. All clauses were declarative sentences, and no embedded structures were involved. The subject in each clause remained the same to avoid referential switch. The verbs used in these clauses were activity or psychological verbs that frequently occurred in narratives. To ensure the audio quality across different stimuli, the narration was generated using two AI voices: a female and a male (Chinese AI voices resource: https://www.text-to-speech.cn/,

accessed on 20 March 2024). In total, 22 audios were constructed as the critical stimuli for our perception tasks (see Appendix A Table A1 for details).

Table 2. Critical stimuli.

Clause	Content
Clause (1)	(SPE) zǎoshang bā diǎn qǐchuáng. [1]
	(SPE) 早上八点起床。
	(SPE) got up at 8 am.
Clause (2)	(SPE) chīguò zǎocān.
	(SPE) 吃过早餐。
	(SPE) had breakfast.
Clause (3)	(SPE) jiù qù gōngsī shàngbān.
	(SPE) 就去公司上班。
	(SPE) just went to work.
Clause (4)	(SPE) kāile sān gè huì.
	(SPE) 开了三个会。
	(SPE) had three meetings.
Clause (5)	(SPE) xiěle hěnduō wéndàng.
	(SPE) 写了很多文档。
	(SPE) wrote a lot of files.
Clause (6)	(SPE) juédé yǒudiǎn kùn.
	(SPE) 觉得有点困。
	(SPE) felt a little sleepy.
Clause (7)	(SPE) hēle yībēi kāfēi.
	(SPE) 喝了一杯咖啡。
	(SPE) had a cup of coffee.
Clause (8)	(SPE) yòu gěi kèhù dǎle liǎng gè diànhuà.
	(SPE) 又给客户打了两个电话。
	(SPE) and made two calls to the clients.

[1] For each clause, the first line presents Pinyin, the second line presents Chinese characters, while the third line presents English gloss. SPE in parentheses indicates where a pronoun can be expressed or absent.

3.1.2. Participants

Two groups of participants were recruited: native Mandarin listeners and non-native Mandarin listeners. All these participants were approached through multiple channels, including snowball sampling, Emails, social media (i.e., Wechat), and recruiting platforms (i.e., Prolific). Participation was voluntary and compensated with a $15 gift card.

Native speakers of Mandarin who had been living in Mandarin-speaking countries before 18 years old were identified as eligible native participants. In total, 185 native participants including 112 women and 73 men aged between 18 and 76. Eligible non-native participants were selected based on the following criteria: (1) their L1 was English; (2) they had been learning Mandarin for at least one year by the time of the recruitment; and (3) they self-identified their Mandarin proficiency as intermediate or higher. To ensure the non-native participants had sufficient knowledge about Mandarin pronouns and their referents, three reading comprehension questions were posed before the perception task (see Appendix A Table A2 for details). Only participants who answered all comprehension questions correctly were selected. In the end, 107 participants were recruited. With incomplete and ineligible participants excluded, there were 77 non-native participants with intermediate and advanced Mandarin proficiency levels, including 36 women and 41 men aged between 18 and 61.

Based on the information reported by the participants, including their age of acquisition, Mandarin learning methods, and Mandarin learning duration, non-natives were further categorized as (1) *Foreign learners* who had acquired English as their L1 and started

to learn Mandarin as a foreign language at least after ten years old, (2) *Heritage learners* who had been exposed to Mandarin at home and learned Mandarin from their family members, and (3) *Multilingual learners* who grew up in areas such as Guangzhou, Hong Kong, Singapore or Malaysia where several languages were often used together in daily life. The demographic information of participants recruited can be further found below in Table 3.

Table 3. Summary of participants.

Group	Gender	Age	Total
Native	60.54% female	18–76	185
Non-native (total)	46.75% female	18–61	77
Foreign (non-native)	44.44% female	18–51	19
Heritage (non-native)	53.57% female	18–49	28
Multilingual (non-native)	56.67% female	19–61	30

3.1.3. Procedure

A pilot study had been conducted in advance to validate the design of the perception tasks. In total, 13 native participants were recruited via personal connections, including nine females and four males aged between 24 to 50. Participants were asked to complete the whole survey and provide feedback. Although the pilot data could not be sufficient enough to run well-powered regression models, descriptive statistics still demonstrated a significant difference in the appropriateness ratings of stimuli with different SPE rates. Specifically, the lowest portion (61.46%) of average and higher ratings were given to stimuli with a high rate of SPE (100%) while the highest portion (99.47%) of average and higher ratings were given to stimuli with a low rate of SPE (12.5%). Based on this, the survey was slightly modified for data collection instruments, technical setup, and protocol implementation before its formal launch. Pilot data were not included in the following analysis.

In the sociolinguistic survey, the participants were first asked to read and sign the consent form if they agreed to take part. Note that non-native participants needed to complete the reading comprehension questions before they started the perception tasks. After this, all the participants were given the context of the narration and were instructed to listen to each audio and evaluate how appropriate it sounded in the given context on a 5-point Likert scale. Specifically, based on the participants' sociolinguistic competence, they selected the appropriateness level of the narration: "very appropriate" for narration that perfectly aligned with the context and communication norms; "average" for narration that might sound fine but contain some communication mismatches; and "not appropriately at all" for narration that did not align with the context and communication norms in every detail. The order of the tasks in the survey had been randomized. To better contextualize the perception task, participants were additionally informed that the narration they would hear was part of a conversation between friends. Due to the signal-to-noise distinction, working memory constraints, and individual differences during speech processing, participants had the freedom to play the audios as many times as needed. After the tasks, both native and non-native participants reported their demographic information. Non-native participants also provided information about their age of acquisition, Mandarin-learning duration, and how they learned Mandarin (i.e., Mandarin-learning method). An illustration on the workflow of the perception tasks can be found in Table 4.

Table 4. Perception task example.

Subsections	Content
Instruction [1]	The following recording is a conversation between friends. They are all native Mandarin speakers. They have known each other for a long time and are familiar with each other. They are talking about some personal issues. The context is relaxed and casual. Please listen to the recording and answer the question. The recording can be played repeatedly if necessary.
Audio stimulus [2]	"He got up at 8 am. had breakfast. just went to work. had three meetings. wrote a lot of files. felt a little sleepy. had a cup of coffee. and made two calls to the clients."
Perception question	In this context, how appropriate do you think these sentences are? (1) not appropriate at all (2) not so appropriate (3) average (4) somewhat appropriate (5) very appropriate

[1] English translation was provided for instructions in non-native survey. [2] All audios were recorded in Mandarin.

4. Analysis and Results

To address our research questions, we conducted three major analyses using mixed-effects linear regression, which accounts for clustered or repeated data such as participants and trials by modeling group-level variability (random effects) and overall trends (fixed effects) while overcoming issues brought about through unbalanced designs, missing data and individual differences. The first analysis included both native and non-native data, exploring the linguistic and social constraints on SPE perception and to what extent nativeness may affect this. To further examine the differences between native and non-native perception, our second analysis explored various factors that might influence native perception of Mandarin SPE, followed by a third analysis investigating factors affecting non-native SPE perception. Explanations of dependent and independent variables can be found in Table 5.

Table 5. Variables in statistical models.

Variable	Definition	Level
Appropriteness [1]	Listerner's responses to the perception tasks for the appropriate use of SPE. Responses were numericalized.	−2 (not appropriate at all), −1 (not so appropriate), 0 (average), 1 (some appropriate), 2 (very appropriate)
SPE rate	A tertiary categorical variable that refers to SPE rate at different levels.	Low (12.5%), Mid (50%), and High (100%)
Person	A tertiary categorical variable that captures the different grammatical person properties in Mandarin subject pronouns.	1st, 2nd, and 3rd
Number	A binary categorical variable that stands for the number properties of subject pronouns in Mandarin.	Singular, Plural
Voice gender	A binary categorical variable that indicates the gender of the speaker's voice.	Female voice, Male voice
Nativeness	A binary categorical variable that distinguishes native and non-native Mandarin listeners.	Native, Non-native
Listener gender	A binary categorical variable that represents the gender of listeners.	Female, Male

Table 5. *Cont.*

Variable	Definition	Level
Listener age	A continuous variable that represents the age of participants	Numeral
L2 experience	A binary categorical variable that represents whether the participant also has had the experience of learning a second language.	No, Yes
Age of acquisition	A continuous variable that refers to the age at which participants began learning Mandarin as a second language.	Numeral
Mandarin-learning duration	A continuous variable that represents the duration for which participants have learned Mandarin as a second language.	Numeral
Mandarin-learning method	A tertiary categorical variable that indicates how non-native speakers learned Mandarin as a second language.	Foreign, Heritage, and Multilingual

[1] Appropriateness was set as the dependent variable in each model, while all the other variables were independent variables in different models.

All the statistical analyses were conducted using the R statistical environment version 4.4.1 (R Core Team, 2024). Plots were created using `ggplot` version 3.5.1 (Wickham, 2011), and mixed-effects regression models were configured using `lme4` version 1.1-35.5 (Bates, 2014). Participants' appropriateness ratings were numericalized from −2 to 2 corresponding to the Likert scales from "not appropriate at all" to "very appropriate" in the perception tasks.

4.1. The Overall Patterns: Native vs. Non-Native

This section presents the main analysis examining the overall patterns of native and non-native SPE perceptions, focusing on critical linguistic and social factors that have been found to influence SPE variation in speech production, such as SPE rate, subject person and number, and gender (Bayley & Pease-Alvarez, 1996; Cameron, 1993; Flores-Ferrán, 2004; Li et al., 2012; Nagy, 2024; Shin & Otheguy, 2013; Zhang, 2021).

Figure 1 shows the differences between native and non-native participants when person and SPE rate are taken into consideration. As can be seen, when the use of SPE increases in the stimuli, the ratings decrease, regardless of whether the listener acquired Mandarin natively or not. In addition, listeners had similar ratings toward stimuli with low or mid SPE rate. Figure 2 shows a similar pattern focusing on the influence of number. Figure 3 presents the result of listener gender and voice gender.

Model One was configured to predict participants' appropriateness ratings, with Nativeness, SPE rate, Person, Number, Participant gender, and Voice gender as fixed effects. Two three-way interactions were included: SPE rate, Nativeness, and Person, as well as SPE rate, Nativeness, and Number. Person and Number as well as Participant gender and Voice gender were included as two two-way interactions. SPE rate by participant was included as a random slope and stimuli was included as a random intercept. All the categorical predictors were sum-coded, allowing for each level to be compared with the grand mean. Model output, as shown below in Table 6, revealed a significant effect of SPE rate. That is, overall, stimuli with low (12.5%) and mid (50%) rates of SPE were rated as more appropriate ($\beta = 0.25$, $p < 0.001$ for low SPE rate and $\beta = 0.15$, $p < 0.01$ for mid SPE rate). There is also a main effect of Nativeness: Native participants tended to give

lower ratings in general ($\beta = -0.02$, $p < 0.001$). No significant main effects were found for Person, Number, Participant gender or Voice gender. However, the interaction between Participant gender and Voice gender turned out to be significant ($\beta = -0.02$, $p = 0.01$), suggesting that female participants were inclined to rate stimuli read in a female voice less appropriate. In addition, the three-way interaction between Person, SPE rate and Nativeness was significant: When stimuli with low SPE rate contained the second person pronoun, native participants tended to give them lower ratings ($\beta = -0.06$, $p = 0.01$). But for stimuli with mid SPE rate, native participants would rate them more appropriate when the stimuli had a second person pronoun ($\beta = 0.05$, $p = 0.02$).
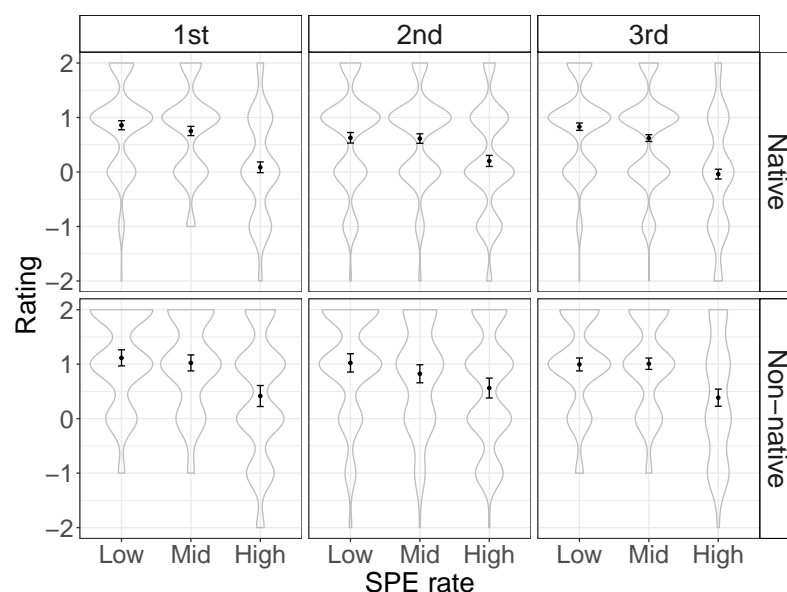
Figure 1. Overall SPE appropriateness perception (Model One): person, SPE rate, and nativeness.
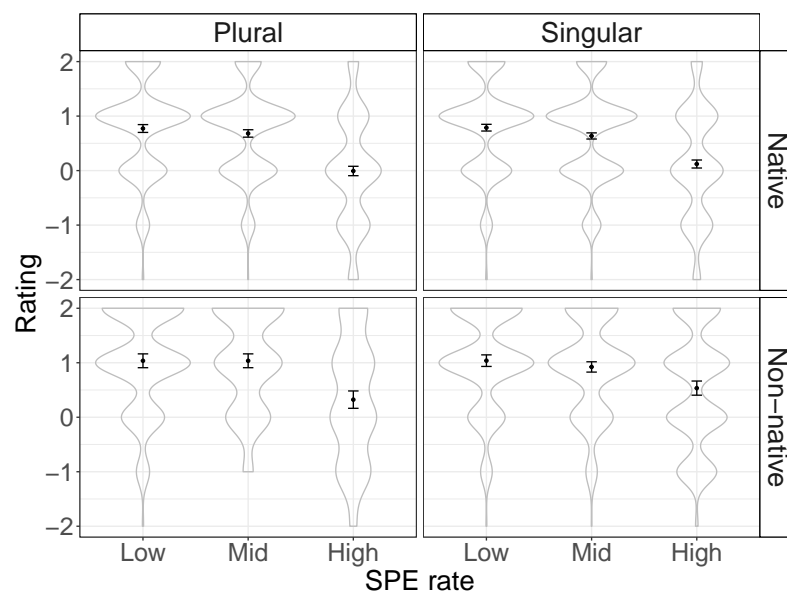
Figure 2. Overall SPE appropriateness perception: number, SPE rate, and nativeness.
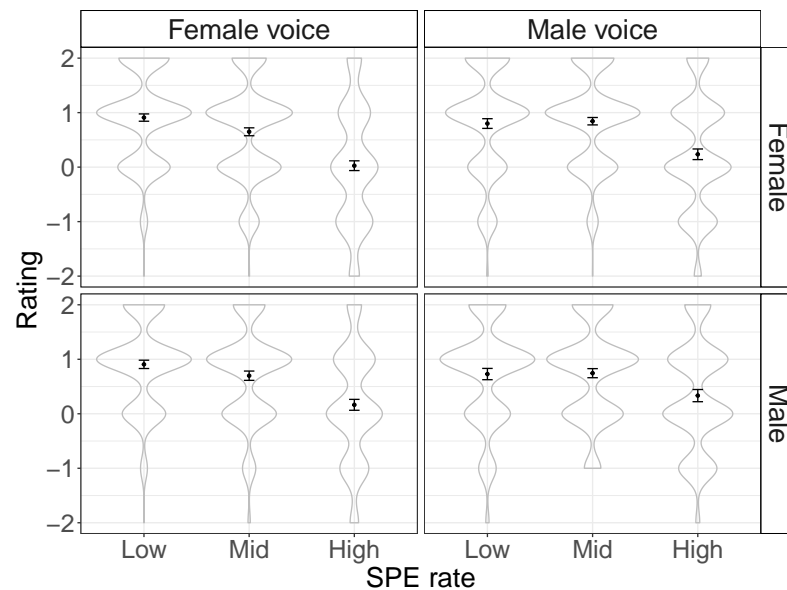
Figure 3. Overall SPE appropriateness perception: voice gender, SPE rate, and listener gender.

Table 6. Results of overall patterns: native vs. non-native perception.
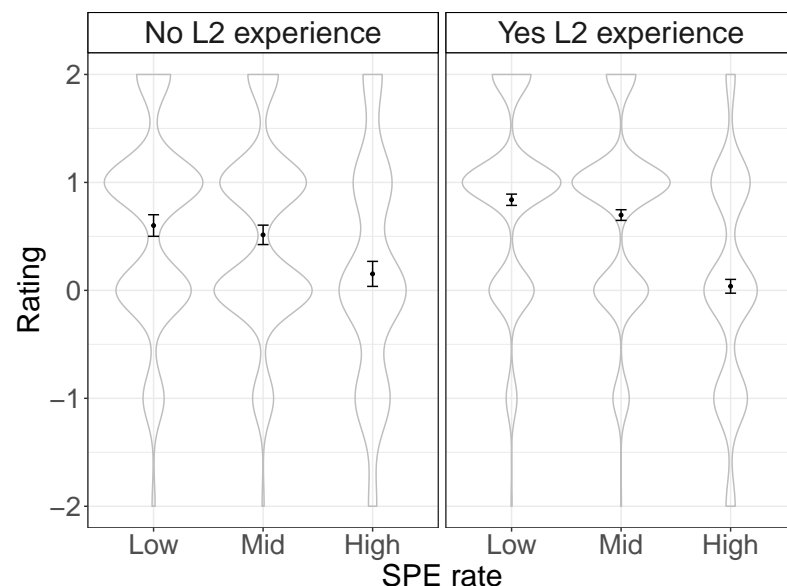
Fixed Effects	Estimate	SE	z Value	Pr (>|z|)
(Intercept)	0.66	0.05	13.24	<0.001 ***
Person (1st)	0.06	0.04	1.32	0.22
Person (2nd)	−0.03	0.05	−0.74	0.48
Number (Plural)	−0.02	0.03	−0.68	0.52
SPE rate (Low)	0.25	0.04	5.73	<0.001 ***
SPE rate (Mid)	0.15	0.04	3.62	<0.01 **
Nativeness (Native)	−0.02	0.04	−3.75	<0.001 ***
Participant gender (Female)	0.02	0.03	0.70	0.49
Voice gender (Female)	−0.03	0.04	−0.74	0.48
Person (1st): Number (Plural)	0.05	0.04	1.28	0.24
Person (2nd): Number (Plural)	−0.06	0.04	−1.48	0.18
Person (1st): SPE rate (Low)	0.05	0.06	0.81	0.44
Person (2nd): SPE rate (low)	−0.09	0.07	−1.36	0.21
Person (1st): SPE rate (Mid)	−0.02	0.08	−0.24	0.82
Person (2nd): SPE rate (Mid)	−0.03	0.09	−0.30	0.77
Person (1st): Nativeness (Native)	0.01	0.02	0.85	0.40
Person (2nd): Nativeness (Native)	−0.01	0.02	−0.32	0.75
SPE rate (Low): Nativeness (Native)	0.02	0.02	0.90	0.37
SPErate.mid: Nativeness (Native)	0.01	0.02	0.37	0.71
Number (Plural): SPE rate (Low)	0.02	0.04	0.53	0.61
Number (Plural): SPE rate (Mid)	0.05	0.04	1.24	0.25
Number (Plural): Nativeness (Native)	−0.00	0.01	−0.20	0.84
Participant gender (Female): Voice gender (Female)	−0.02	0.01	−2.46	0.01 *
Person (1st): SPE rate (Low): Nativeness (Native)	−0.01	0.02	−0.25	0.80
Person (2nd): SPE rate (Low): Nativeness (Native)	−0.06	0.02	−2.60	0.01 **
Person (1st): SPE rate (Mid): Nativeness (Native)	− 0.00	0.02	−0.02	0.98
Person (2nd): SPE rate (Mid): Nativeness (Native)	0.05	0.02	2.26	0.02 *
Number (Plural): SPE rate (Low): Nativeness (Native)	0.01	0.02	0.39	0.69
Number (Plural): SPE rate (Mid): Nativeness (Native)	−0.03	0.02	−1.74	0.08

Model configuration: Ratings ∼ SPE rate × Nativeness × Person + SPE rate × Nativeness × Number + Person × Number + Participant gender × Voice gender + (SPE rate | Participant ID) + (1|StimuliID). Note: *: Indicates a statistically significant result at the 0.05 level ($p < 0.05$); **: Indicates a statistically significant result at the 0.01 level ($p < 0.01$); ***: Indicates a statistically significant result at the 0.001 level ($p < 0.001$).

4.2. Results of Native Participants

This section further focuses on what matters the most for capturing native perception of Mandarin SPE use. Model Two was configured to predict native participants' appropriateness ratings (z-scored by participants), with SPE rate, Participant age, Participant gender, Voice gender, Person, Number and L2 experience as fixed effects. Participant gender and Voice gender were included as a two-way interaction. All the categorical variables were sum-coded. Age was centered by subtracting the age of each participant from the age of the youngest participant such that the model coefficients represent whether the older participants are different from their younger counterparts.

The model output, as can be seen in Table 7, reveals a significant main effect of *SPE rate*: Overall, native participants preferred stimuli with a low rate of SPE and tended to rate them as more appropriate ($\beta = 0.28$, $p < 0.01$). No other main effects were found except for L2 experience, which showed a significant effect. This suggests that native participants with L2 learning experience tended to give higher ratings ($\beta = 0.24$, $p = 0.01$). This is further demonstrated in Figure 4.

Figure 4. Appropriateness ratings from native speakers of Mandarin Chinese).

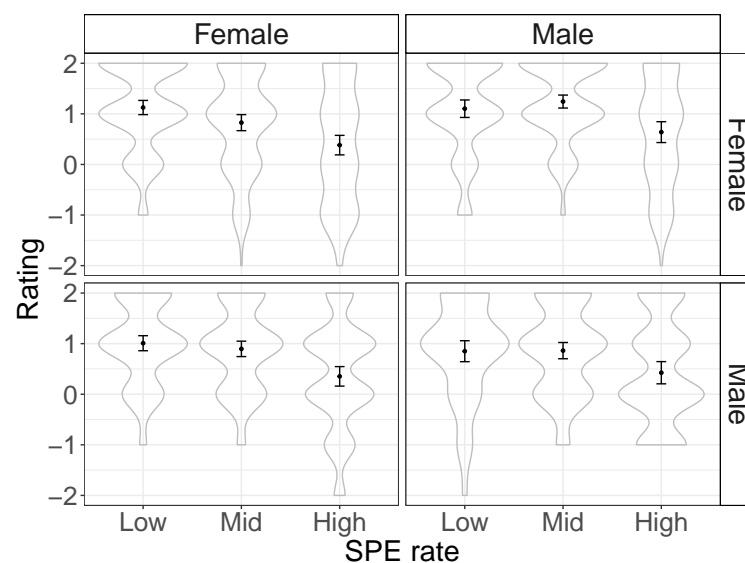**Table 7.** Model results of appropriateness perception by native participants (Model Two).

Fixed Effects	Estimate	SE	z Value	Pr (>|z|)
(Intercept)	0.35	0.1	3.35	<0.001 ***
SPE rate (Low)	0.28	0.05	5.84	<0.001 ***
SPE rate (Mid)	0.15	0.05	3.33	<0.01 **
Voice gender (Female)	−0.03	0.03	−0.94	0.36
Participant gender (Female)	−0.01	0.04	−0.31	0.75
Person (1st)	0.07	0.05	1.47	0.16
Person (2nd)	−0.03	0.05	−0.71	0.49
Number (Plural)	−0.02	0.03	−0.62	0.55
Participant age	−0.00	0.00	−0.48	0.63
L2 experience (Yes)	0.24	0.09	2.60	0.01 *
Participant gender (Female): Voice gender (Female)	−0.01	0.01	−0.66	0.51

Model configuration: Ratings $\sim$ SPE rate + Person + Number + Participant gender $\times$ Voice gender + L2 experience + (SPE rate | Participant ID) + (1|StimuliID). Note: Three-way interactions are not feasible given that the data of native speakers would not be sufficient enough to run well-powered models. Note: *: Indicates a statistically significant result at the 0.05 level ($p < 0.05$); **: Indicates a statistically significant result at the 0.01 level ($p < 0.01$); ***: Indicates a statistically significant result at the 0.001 level ($p < 0.001$).

4.3. Results of Non-Native Participants

This section focuses on the factors that may affect non-native perception of SPE variation. Model Three was conducted with SPE rate, Person, Number, Voice gender, Participant gender, Participant age, Age of L2 acquisition, Mandarin learning duration, and Mandarin learning method as the fixed effects. Again, Participant gender and Voice gender were included as a two-way interaction. The results, as can be seen in Table 8 found a significant effect of SPE rate: Non-native participants rated stimuli with the average amount of SPE (i.e., 50% SPE) as more appropriate ($\beta = 0.14$, $p < 0.01$). But other factors such as the age of acquisition and the way these participants learned Mandarin did not play a role in the statistical sense. Interestingly, there is a significant interaction between Participant gender and Voice gender that did not appear in the native model: female non-native participants were inclined to rate stimuli read in a female voice more harshly ($\beta = -0.07$, $p < 0.01$). This interaction between Participant gender and Voice gender can be further seen in Figure 5.

Figure 5. Appropriateness ratings from non-native speakers of Mandarin Chinese.

Table 8. Model results of appropriateness ratings of non-native speakers of Mandarin Chinese (Model Three).

Fixed Effects	Estimate	SE	z Value	Pr (>|z|)
(Intercept)	0.82	0.17	4.93	<0.001 ***
SPE rate (Low)	0.22	0.05	4.26	<0.001 ***
SPE rate (Mid)	0.14	0.05	3.07	<0.01 **
Person (1st)	0.05	0.05	1.03	0.32
Person (2nd)	−0.04	0.05	−0.77	0.46
Number (Plural)	−0.02	0.03	−0.47	0.64
Participant Age	−0.01	0.01	−0.67	0.51
Voice gender (Female)	−0.05	0.03	−1.61	0.13
Participant gender (Female)	0.07	0.07	1.09	0.28
Age of Acquisition	0.02	0.01	1.55	0.13
Mandarin-learning duration	−0.01	0.01	−0.86	0.39
Mandarin-learning method (Foreign)	−0.18	0.14	−1.31	0.20
Mandarin-learning method (Heritage)	0.21	0.12	1.75	0.00
Voice gender (Female): Participant gender (Female)	−0.07	0.02	−3.29	<0.01 **

Model configuration: Ratings ~ SPE rate + Person + Number + Participant gender × Voice gender + Participant age + Age of L2 acquisition + Mandarin-learning duration + Mandarin-learning method + (SPE rate | Participant ID) + (1| StimuliID). Note: **: Indicates a statistically significant result at the 0.01 level ($p < 0.01$); ***: Indicates a statistically significant result at the 0.001 level ($p < 0.001$).

5. Discussion

Overall, our results show that both linguistic constraints such as SPE rate and person of the subject, and social constraints including nativeness and gender significantly affect the perception of SPE variation regarding its appropriateness in Mandarin casual narratives. At the same time, when one of the linguistic structural constraints (i.e., SPE rate) appears to be more consistent in native and non-native perception patterns, other factors have different effects on these two groups. The following sections first discuss how linguistic constraints affect SPE perception, followed by the interpretation of social factors, then an illustration of how production and perception may align in SPE variation.

5.1. SPE Perception Is Sensitive to Linguistic Constraints

Our results clearly demonstrate that the two linguistic structural constraints, SPE rate and the person of the subject, which significantly reflect and condition the production of SPE, also play a vital role in SPE perception. As mentioned, SPE rate in conversational Mandarin ranges from 35.9% to 69.8% which may be affected by context, dialectal difference, and demographic characteristics of the speakers (D. Erker et al., forthcomoing; Li et al., 2012; Nagy, 2024; Zhang, 2021). When there is no switch in subject referents, the rates are even lower. For example, Li et al. (2012) showed 29.1% for Mandarin native speakers, and 23.6% for Chinese college students participants. Our perception results reveal that SPE rate also forms a core linguistic internal constraint for perceiving this variable as appropriate. Specifically, the stimuli with low (SPE rate = 12.5%) and mid (SPE rate = 50%) rates were rated significantly higher than those with high rates (SPE rate = 100%) by both native and non-native participants (see details in Tables 6–8). In other words, both native and non-native listeners find it acceptable to drop subject pronouns more than half of the time in casual conversations. However, explicitly expressing subject pronouns in every clause can sound inappropriate and may be unnecessary when there is no referential switch in speech. In variationist research, it seems that researchers have consistently prioritized conditioning factors over the frequency of variant occurrence (MacKenzie, 2020; Tagliamonte, 2013; Torres Cacoullos & Travis, 2018). However, as D. Erker et al. (forthcomoing) pointed out, within a linguistic community, individuals may exhibit divergent usage rates while maintaining comparable sensitivity to identical conditioning factors—a characteristic emblematic of coherent linguistic varieties or speech communities. Our perception results validate this hypothesis by showing that native listeners demonstrated sharp sensitivity to the appropriate use of SPE in casual contexts, even when their demographic backgrounds varied. In addition, non-native listeners with intermediate and higher Mandarin proficiency showed similar perceptions of SPE appropriateness regarding its rate. This suggests that the conditioning effect of linguistic internal structure remains strong for non-native perception.

Moreover, previous production studies have revealed that even in Mandarin, a non-inflectional language, the person and number of the subject significantly constrain SPE production (D. Erker et al., forthcomoing; Li, 2014; Li et al., 2012; Nagy, 2024; Zhang, 2021). However, our results show that only native participants were sensitive to the change of person, but not number in the pronouns. More interestingly, two opposite patterns were observed: native listeners tended to rate stimuli with second person pronouns and a low SPE rate (12.5%) as less appropriate, while they rated stimuli with second person pronouns and a mid SPE rate (50%) as more appropriate (see details in Table 7). In other words, to use second person pronouns nǐ 你 and nǐmen 你们 appropriately in casual conversations, a native speaker should express approximately half of the pronouns in their narratives, as either overusing or underusing second person pronouns could lead to a perception of inappropriate language use. Li et al. (2012) showed that the usage rate of second person pronouns in subject positions was the highest (64.1%), compared with other pronouns.

This aligns with our finding that a higher appropriateness was given to the mid-SPE rate by native listeners. Perceiving a low rate of second person pronouns as inappropriate may be attributed to the use of second person pronouns in a narrative context. Compared with "I got up at 8 a.m." or "She got up at 8 a.m.", "You got up at 8 a.m." sounds more like a direction instead of a description. Based on the data from Li et al. (2012), in casual conversations, the second person subject is mostly used when asking the other interlocutor a question or in indirect speech when narrating another person's words. A second person pronoun with multiple verbs is very rare. The ability of different personal pronouns to carry multiple clauses with absent subjects may vary. Based on their sophisticated pragmatic competence, native listeners are usually sufficiently sensitive to recognize that in conversational contexts, second person pronouns have a weaker capacity to carry too many verbs in sequential clauses. Otherwise, they might find it odd, as reflected in their ratings of such usage as inappropriate. This pattern connects to Accessibility Theory and Usage-Based Models, which all can explain how native listeners develop nuanced expectations about the use of different variants across contexts (Bybee, 2010; Mira, 2008). Nevertheless, this sensitivity to second person pronouns was not observed among non-native participants. Their lack of sensitivity to second person patterns may result from incomplete pragmatic acquisition, processing load differences, L1 transfer effects, or reliance on explicit rather than implicit knowledge, aligning with Sorace's (2011) Interface Hypothesis that predicts difficulties with syntax-discourse interface features (Sorace, 2011). Lastly, although previous production findings suggest that Mandarin speakers preferred to express more pronouns in singular forms (Li et al., 2012; Nagy, 2024; Zhang, 2021), the number of the subject pronoun did not affect the perception of SPE variation. In previous research, the effect of the person and number of the SPE in SPE production has only been explained at discourse level (Li et al., 2012) but not interpreted from the functional or pragmatical perspective. To further explore the influence of person and number in SPE variation for both production and perception, future studies may need to compare SPE use with different verbs and in different contexts.

5.2. SPE Perception Is Sensitive to Social Constraints

Various socio-demographic factors have been examined in previous SPE production studies, such as age, gender, education and occupation, language background, and language learning experience, among others, across different speech communities (Li, 2014; Li et al., 2012; Nagy, 2024; Zhang, 2021). Our results found three social constraints that are critical for SPE perception: nativeness, L2 learning experience, and gender, which is further discussed in this section.

To start with nativeness, as many have revealed, non-native language users may not be as sensitive as native users to the use of sociolinguistic variables in most cases (Escalante, 2018; Li, 2014; Nagy, 2024; Zhang, 2021). As their developmental trajectories of sociolinguistic competence differ from the native ones and their exposure to the target linguistic features is often limited, non-native speakers usually can not demonstrate native-like variation patterns in speech production. For variation perception, previous studies show that higher proficiency and rich exposure to the target features may contribute to a more native-like perception of variation (Escalante, 2018; Qin & Jongman, 2016; Qin et al., 2024; L. B. Schmidt, 2011). Aligned with these findings, the perception of SPE variation in Mandarin also demonstrates different patterns between native and non-native listeners. We found that nativeness plays an important role in SPE perception, as non-native listeners, compared to native listeners, generally gave higher ratings of SPE stimuli (cf. Table 6). This suggests that, unlike native listeners who demonstrated sharp sensitivity to the inappropriate overuse of subject pronouns, non-native listeners were more tolerant of

pronoun use in general. Furthermore, non-native listeners were also less sensitive to the inappropriate use of second person pronouns in casual conversations compared to their native counterparts.

However, as Tables 7 and 8 show, none of the social constraints of interest reached statistical significance except for L2 experience among native listeners and gender among non-native listeners. In particular, native listeners with L2 experience tended to rate SPE stimuli higher for the appropriate use of pronouns overall compared with those who had no L2 experience. It is possible that the experience of learning a non-native language made these participants more tolerant of the unexpected use of a particular linguistic feature. As Jaeger and Weatherholtz (Jaeger & Weatherholtz, 2016) illustrated, the processing of sociolinguistic variables, as well as other forms of linguistic information, is based on listeners' previous language experience and their expectations about the occurrence of a particular feature. Through exposure to various variables, listeners construct and maintain their internal linguistic models that shape these expectations. When unexpected input occurs, such as the overuse of subject pronouns, listeners would identify it as a surprisal that carries informative messages about the speech. Native listeners with L2 learning experience have learned how to adjust information that comes with surprisals into their linguistic models and would tend to be more flexible with changes in the environment, which makes them more tolerant of unexpected variable use. While for native listeners who had not been exposed to surprisals after their mastery of the native language, unexpected language use would be more difficult to adjust and tends to be perceived as "inappropriate". From the perspective of linguistic flexibility and cross-linguistic influence, native listeners with L2 experience may develop enhanced metalinguistic awareness that allows them to shape a more flexible understanding of how SPE variants can be deployed in different languages and this flexibility can be translated into greater acceptance of variation in their L1 (Jarvis & Pavlenko, 2008; Rothman & Cabrelli Amaro, 2010; Sorace & Filiaci, 2006). However, for non-native listeners whose linguistic models were usually established on limited inputs, it is not surprising to see that they demonstrated sensitivity to some of the salient linguistic constraints (i.e., SPE rate) but not others (i.e., person of the subject).

Apart from nativeness and L2 learning experience, both listener gender and voice gender turned out to be important social constraints conditioning SPE perception. To elaborate, female listeners were inclined to give lower appropriateness ratings to audio stimuli read in a female voice. But this gender effect was only observed in the non-native data, but not in the native data. As many production studies have illustrated, female speakers are often more sensitive to language change and prefer the prestigious forms for variable use (K. Becker et al., 2022; Coates, 2015; Eckert, 1989; Hall et al., 2021; Holmes, 1997; Labov et al., 2011; Lakoff, 1973). In the case of SPE, it has been found that female speakers prefer to express pronouns more frequently in their speech (Li et al., 2012). When it comes to perception, female listeners were found to be less tolerant of non-standard variable use and tended to demonstrate more negative reactions to deviations from overt linguistic norms (Labov et al., 2011). Based on these findings, the effect of listener gender and voice gender interaction in the non-native model reveals that compared with their male counterparts, female listeners were more rigorous in their appropriateness ratings for female-read stimuli because they may expect a female speaker could represent a more explicit language expression. According to the Speech Accommodation Theory, listeners allocate more attention to speakers sharing their social identity characteristics (Giles & Ogay, 2013). Female listeners may benefit from gender-based perceptual advantages and in-group identification processes that optimize linguistic processing resources. This sensitivity could also represent a compensatory strategy for linguistic insecurity in L2 contexts, where gender serves as a stable identity anchor. In addition, Social Network Theory suggests

that women's typically greater interaction with other women may additionally contribute to enhanced perceptual templates for female voices (Drager, 2010; Labov, 2001; Trudgill, 2000). However, this gender interaction effect was not observed in the native model, which may suggest that the association between explicit language expression and female roles is not involved in the native perception of SPE variation. Namely, native listeners did not expect a female speaker and a male speaker to demonstrate different gender patterns in SPE variation. It is possible that in native listeners' sociolinguistic competence, SPE variation is not associated with any gender-related meaning.

5.3. On Production-Perception Relationships

As revealed, language production and perception are deeply intertwined with each other not only for general language processing but also for the interpretation of social meanings behind linguistic variables in both native language development and L2 acquisition (Campbell-Kibler, 2010; Pickering & Garrod, 2013; Sakai & Moorman, 2018). To further illustrate how production and perception may align for SPE variation, this section compares the conditioning factors of SPE production as identified in previous studies and the significant constraints of SPE perception as found in the current study (see details in Table 9). Based on the aspects tested, the following discussion focuses on the potential connections between production and perception with respect to two linguistic constraints—SPE rate and person and number of the subject—and two social constraints—gender and language learning experience.

Table 9. Summary of SPE constraints in production and perception [1].

Constraint Group	Production	Perception
Linguistic	SPE rate	tested [2]
	Person and number	tested
	Referential continuity	controlled (same)
	Semantic feature of the verb	controlled (activity verbs and psychological verbs)
	TMA of the verb	controlled (past tense)
	Clause type	controlled (declarative)
Social	Gender	tested
	Language learning experience	tested
	Context	controlled (casual and narrative)
	Proficiency	controlled (intermediate and/or higher)

[1] Significant constraints as revealed in previous studies. [2] Tested or controlled in the current study.

According to previous production studies, the average occurrence rate of Mandarin subject pronouns by native speakers in sociolinguistic interviews ranges between 35.9% to 69.8% (D. Erker et al., forthcoming; Li et al., 2012). Li (2014) demonstrated that high-intermediate and advanced L2 learners (L1 = English, Japanese, Korean, Russian) overall used subject pronouns at a rate of 59.4% which is significantly higher than the native SPE rate of 35.9% examined in the same community (Li et al., 2012). When there is no switch of subject referents, the rates are even lower. Li (2014) showed 46.3% SPE use for learners and 23.6% for native speaker peers. Regarding perception, the results of Mandarin SPE perception show that, overall, native and non-native listeners across different age and gender groups generally agreed that subject pronouns can be explicitly expressed at a low (12.5%) or a mid (50%) rate, but the overuse of subject pronouns in every clause (100%) sounds inappropriate in casual narratives. In separate analyses, native listeners rated low SPE rate as more appropriate, whereas non-native listeners found a mid SPE rate more

appropriate. Combining these two patterns, it appears that production and perception roughly align in terms of SPE occurrence frequency. As the Production-Distribution-Comprehension account (MacDonald, 2013) explains, language users follow implicit biases to reduce cognitive burdens for speech production, which over time shapes the statistical patterns of their internal models of linguistic inputs. With these patterns, language users form and adapt predictions for language comprehension. This suggests that comprehension in which perception stands as a core part is fundamentally linked to production-driven statistics rather than being determined by innate features of the comprehension system. For language variation and change, Janson (1983) pointed out that "for an individual in a situation of change, perception seems to lag behind production" because "it is easier to change the way one speaks than it is to adjust a well-established listening behavior" (pp. 31–32). If Mandarin SPE is in the process of on-going change, then the difference of its appropriateness between production and perception may be attributed to the lag between these two. Although this does not form an ideal comparison of production and perception data, it seems that when non-native listeners reached intermediate or higher proficiency, they were able to identify the appropriate rate of SPE, but it was still challenging to use the same variable at a native-like rate. This echoes previous statements about variation perception and production in second language acquisition that the relationship between perception and production could be time-lagged and asymptotic—"perception would guide production at a later stage" and "production would improve only once perception has reached a high level of accuracy" (Nagle, 2018, p. 234).

Another significant linguistic constraint of SPE production is person and number. In both native and non-native research, findings showed that subject pronouns tended to be expressed more in singular forms (Li, 2014; Li et al., 2012; Nagy, 2024; Zhang, 2021). The effects of person in SPE production, however, are not consistent across different studies. On the other hand, native perception data demonstrates sensitivity to person (i.e., 2nd person pronouns) but not number. This mismatch between production and perception patterns may be unfolded in two ways. First, compared with SPE rate which serves as a structural constraint of the variable in both production and perception, person and number seem less powerful for its conditioning effect on variation. Second, the effects of person and number may be activated differently in production and perception. Namely, number serves as an important feature in SPE production while person carries some core signals for SPE perception.

As one of the key social characteristics, gender differentiation of the variation patterns can reveal part of the indexicality of the linguistic variable in some cases (K. Becker et al., 2022; Coates, 2015; Eckert, 1989; Hall et al., 2021; Holmes, 1997; Lakoff, 1973). For Mandarin SPE variation, gender has been found to be a social constraint of SPE production in some but not all Chinese varieties (D. Erker et al., forthcoming; Jia & Bayley, 2002; Li, 2014; Li et al., 2012; Nagy, 2024; Zhang, 2021). However, our perception results did not reveal any gender effect among native listeners. From the perspective of language variation and change, it seems that men and women differ not only in speech production but also in how they perceive linguistic patterns (Meyerhoff, 2014; Wodak & Benke, 2017). For production specifically, Labov (1990) pointed out that "in stable sociolinguistic stratification, men use a higher frequency of nonstandard forms than women" (p. 210). However, the "standard" use of SPE in Mandarin does not necessarily require the explicit expression of pronouns, and to what extent pronouns are expected to be present depends on other conditions as discussed above. It seems that in casual speech, native female speakers preferred to use more subject pronouns to be explicit. This echoes previous claims that women often prioritize interpersonal communication and explicitness. On the other hand, the effect of gender interaction has not been activated in the native perception of SPE variation,

which may suggest that native listeners have been accustomed to a range of linguistic variation within the speech community, and they may not assign any social meaning to pronoun use differences between genders. For non-native Chinese varieties, while previous studies have shown that gender does not appear to be a strong social constraint for SPE in non-native Chinese varieties (Nagy, 2024; Zhang, 2021), our perception results show that non-native listeners, especially females, were sensitive to the female voice. When working on a perception task read by a female voice, non-native female listeners might apply stricter standards of appropriateness, influenced by stereotypes or expectations about how women "should" speak (Holmes, 1997; Lakoff, 1973; Meyerhoff, 2014). In addition, it is also possible that the SPE variation in their native languages may carry some gender-related implications which could be transferred to their perception of Mandarin variables.

Lastly, language learning experience forms a crucial social influence on sociolinguistic competence development. Many studies have illustrated that intensive contact with local communities where the target sociolinguistic variable is frequently adopted could positively facilitate the acquisition of the native patterns of the variable (Escalante & Wright, 2022; Geeslin & Garrett, 2018; Linford et al., 2018; Regan, 1998; Terry, 2017). For SPE variation, previous production studies of native communities mainly focused on other social factors (e.g., age and gender) while rarely examining if L2 experience may affect speakers' use of subject pronouns. But in non-native communities, the exploration of language learning experience varies according to the backgrounds of the speakers. For example, Li (2014) revealed that L2 learners' L1 backgrounds, length of residency in China, and their Mandarin proficiency all significantly affected their SPE variation patterns. For California heritage Mandarin, Zhang (2021) showed that heritage learners who had early exposure to the native communities demonstrated more native-live SPE patterns compared with their US-born peers. Nevertheless, Nagy (2024) did not identify cross-generational differences in heritage Cantonese for SPE variation, which suggests that although the language environment had been changed and language learning experience was different, the first and second generations of heritage speakers still maintained their native SPE patterns. Taking these findings of SPE production into consideration, it is surprising to see the effect of L2 experience reached significance in the native model, but other related factors such as age of acquisition, Mandarin learning duration, and Mandarin learning method showed no effect in the non-native model. As explained, native listeners with L2 experience may be more flexible in adjusting their expectations of surprisals in speech, therefore they tend to be more tolerant of different speech patterns than their counterparts with no L2 experience. For non-native perception patterns, it is possible that when listeners had reached intermediate or higher proficiency, the potential effects of other background factors were not powerful enough in the model to be observed. In other words, when non-native listeners have obtained relatively complete sociolinguistic knowledge of the variable, how they acquired the language will no longer affect their perception of the language use in context.

6. Conclusions

As the first attempt to explore SPE perception in Mandarin, this study examines how linguistic structures such as SPE rate and the person and number of the subject, and social factors including gender and nativeness affect the perception of SPE variation regarding its appropriateness. Results show that SPE rate serves as a core and consistent linguistic constraint in both native and non-native models—low (12.5%) and mid (50%) rates were rated as appropriate SPE use while the overuse of pronouns (100%) was perceived as inappropriate. This suggests that regardless of their language backgrounds, listeners found it was contextually appropriate to have absent subject pronouns in casual narrative, but

the explicit expression of pronouns should not appear in every clause. However, listeners demonstrated different patterns for other conditioning factors. Native listeners tended to be more sensitive to the use of second person pronouns and L2 experience positively affected their ratings for SPE appropriateness. Non-native listeners did not demonstrate any sensitivity to person, but females held higher standards for the use of pronouns by females. Overall, SPE production and perception roughly align in SPE rate, but not in any other conditioning factors. The mismatch between SPE production and perception may be attributed to the lag in language variation and change (if any) and the potential differences in the social meanings behind the variable.

These findings yield some significant implications for second language pedagogy and sociolinguistic theory. First, the demonstrated consensus among native and non-native listeners regarding appropriate SPE rates suggests that instructional approaches should incorporate explicit teaching of pronoun optionality with frequency awareness rather than merely presenting binary options. The differential sensitivity patterns—with native listeners attending to second-person pronouns and L2 experience positively affecting appropriateness ratings, while non-native females demonstrated heightened evaluative standards for female voice—illuminate the complex interplay of linguistic and social factors in perception. The notable production-perception asymmetry, wherein alignment occurs only in rate but not other conditioning factors, contributes to theoretical frameworks addressing the relationship between production and perception in language variation. This asymmetry potentially reflects temporal lags in language change processes and differential social indexicalities attached to grammatical features. These insights advocate for more nuanced pedagogical approaches incorporating person-specific instruction, gender-aware language teaching, and explicit attention to sociopragmatic variation, while simultaneously supporting sociolinguistic theories regarding cross-linguistic influence in perception and the multifaceted social meanings embedded in seemingly straightforward grammatical features.

On the other hand, based on these findings, the connection between sociolinguistic competence and variation perception can be further unfolded in several ways. On one hand, sociolinguistic competence and variation perception function in a reciprocal relationship whereby enhanced perceptual awareness of linguistic variables in different contexts facilitates appropriate language deployment. On the other hand, developed competence simultaneously refines one's capacity to detect and interpret socially meaningful variation. This bidirectional process manifests developmentally as individuals acquire increasingly sophisticated repertoires through socialization and interaction with diverse speech communities, ultimately enabling them to recognize the social meanings of the variants, navigate the relevant dynamics, and signal group membership. The interconnection between sociolinguistic competence and variation perception can form a continuous feedback mechanism that shapes language acquisition, accommodation strategies, and communicative efficacy across varying contexts.

Due to the limitations of the current study, some questions remain unanswered and call for future research. First, not all significant linguistic constraints as identified in SPE production have been tested. The potential influence of other constraints such as referential continuity, semantic features of the verb, and verbal TMA is still unknown. Second, we only tested SPE variation in casual narratives while leaving other contexts unexplored. As mentioned, the use of subject pronouns varies in contexts in production, so SPE perception likely varies in different contexts. Third, the extent to which the backgrounds of non-native listeners would affect their variation perception requires further exploration. For example, how would proficiency and L1 influence non-native perception of variation? Additionally, the connection between variation production and perception needs to be further illustrated

by examining how an individual's sociolinguistic perception could be affected by their own variable production patterns. Moreover, additional approaches such as follow-up interviews can be involved to answer other questions about the potential social meanings behind the perception results: for example, how is the overuse or underuse of SPE socially and affectively evaluated? Are there any socially prestigious or stigmatized norms in SPE variation? Lastly, the experimental context of the perception tasks, which presented the speech in audio only likely heightened participants' metalinguistic awareness, making SPE patterns more salient than they would be in natural conversation where multiple communicative demands and contextual factors would moderate perceptions.

Appendix A

Table A1. Audio stimuli for SPE perception.

Audio	Person/Number	SPE Rate	Context	Speaker Gender
Audio 1	3SG	low	Casual	F
Audio 2	3SG	low	Casual	M
Audio 3	3SG	middle [1]	Casual	F
Audio 4	3SG	middle	Casual	M
Audio 5	3SG	middle	Casual	F
Audio 6	3SG	high	Casual	M
Audio 7	3SG	high	Casual	F
Audio 8	1SG	low	Casual	F
Audio 9	1SG	middle	Casual	M
Audio 10	1SG	high	Casual	F
Audio 11	2SG	low	Casual	M
Audio 12	2SG	middle	Casual	F
Audio 13	2SG	high	Casual	M
Audio 14	1PL	low	Casual	F

Table A1. *Cont.*

Audio	Person/Number	SPE Rate	Context	Speaker Gender
Audio 15	1PL	middle	Casual	M
Audio 16	1PL	high	Casual	F
Audio 17	2PL	low	Casual	M
Audio 18	2PL	middle	Casual	F
Audio 19	2PL	high	Casual	M
Audio 20	3PL	low	Casual	F
Audio 21	3PL	middle	Casual	M
Audio 22	3PL	high	Casual	F

[1] For audios 3, 4, 5, the four pronouns were inserted in different positions: pronouns were positioned in the first four clauses in Audio 3; pronouns were positioned in the 1st, 3rd, 5th, and 7th clauses in Audio 4; and pronouns were positioned in the last clauses in Audio 4. For the rest Audio stimuli with middle SPE rate, pronouns were all positioned in the 1st, 3rd, 5th, and 7th clauses.

Table A2. Reading comprehension question example for non-native participants.

Subsection	Content
Instruction [1]	Please listen to the following audio and answer the question.
Audio [2]	"Zhangsan got up before dawn. He went out immediately. He ran to the registration place. (SPE) was tired. (SPE) saw a chair by the garden. He sat down to rest."
Question	Who saw the chair by the garden?
Choices	A. I B. you C. Zhangsan D. a friend of Zhangsan
Expected answer	C. Zhangsan

[1] English translations were provided for instructions. [2] All audios were recorded by the same AI voices in Mandarin.

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