**Foreignness or processing fluency? On understanding the negative bias towards foreign-accented speakers.**

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Abstract

It is not clear to what extent the negative bias towards foreign-accented speakers originates from social categorisation (in/out-group categorisation) and from processing fluency (ease to process information). It has been argued that accent first induces a social identity effect and that processing fluency later modifies the impact of this effect. Using ERPs, the pre-registered study tested this hypothesis looking at the effect of social categorisation and processing fluency on sentence comprehension. Truth evaluation and the ERP data (N400) did not show significant differences across native and foreign speakers. Debriefing scores on social factors (e.g., *Status*) were lower for the foreign speaker, and an exploratory analysis revealed a larger P200 (related to acoustic features) for the native than for the foreign speaker. Hence, foreign speakers are not necessarily perceived as less credible, but accent negatively affects the evaluation of the speaker on social factors.

Keynotes: Foreign-accented speech, processing fluency, ERPs, sentence comprehension, social status.

The European Union is composed of 28 member states and comprises 24 official languages. Hence, in meetings, the majority of the representatives do not communicate in their native language, and most likely speak with a foreign accent (thereafter, ‘accent’). It is known, however, that people who speak with an accent are usually judged as less trustworthy, less educated, less intelligent and less competent than native speakers (Dewaele & McCloskey, 2015; Fraser & Kelly, 2012; Fuertes, Gottdiener, Martin, Gilbert, & Giles, 2012; Giles & Watson, 2013; Gluszek & Dovidio, 2010; Lev-Ari & Keysar, 2010; Lippi-Green, 1997), and that accented messages can influence choices (e.g., consumers' choices; Livingston, Schilpzand, & Erez, 2017; Wang, Arndt, Singh, Biernat, & Liu, 2013). Political meetings are just an example of situations in which speaking with an accent can have important consequences; this bias also leads to discrimination in everyday life (Hosoda & Stone-Romero, 2010; Huang, Frideger, & Pearce, 2013; Kalin & Rayko, 1980; Roessel, Schoel, Zimmermann, & Stahlberg, 2017). What is not clear, though, is the origin of this bias. Accent is a social cue that immediately reveals the speaker’s identity, including geographical, ethnic and social background (Bestelmeyer, Belin, & Ladd, 2014; Dehghani, Khooshabeh, Nazarian, & Gratch, 2015; Mai & Hoffmann, 2014; Pietraszewski & Schwartz, 2014), but the foreign accent bias has also been attributed to linguistic fluency, the fact that accented speakers are harder to understand (Dragojevic & Giles, 2016; Lev-Ari & Keysar, 2010). Thus, accent conveys information about both the speaker’s indexical properties and about the linguistic properties of speech (Levi & Pisoni, 2007; Mai & Hoffmann, 2014). The current study investigates to what extent the negative bias towards accented speakers originates from the speaker’s identity (*foreignness*) and from the difficulty to process the way they speak (*processing fluency1*).

**Does *foreignness* lead to negative bias?**  
Studies that have investigated the impact of accent on people’s behaviour have reached varied conclusions. Pietraszewski and Schwartz (2014) demonstrated that people categorise others according to their accent, but that this categorisation is not based on general acoustic-differences, low-level sound differences, differences in familiarity or ease-of-processing. Instead, they claim that accent is the basis of spontaneous and implicit social categorization, which leads to a negative bias towards people who are from a different category as one’s own. They reached these conclusions by using the memory confusion paradigm, a well-known paradigm from social psychology that allows measuring implicit and spontaneous social categorization. They did not focus on specific features of accent (e.g., speech rate, phoneme pronunciation), but rather on global accent, which comprises prosody along with the repertoire of sound units and their combinations (Major, 2001). This study is in line with previous ones showing that accent (foreign or dialectal) generates an immediate classification of the speaker as an in-group or out-group member (Berger, Rosenholtz, & Zelditch, 1980; Ryan, 1983). This own-accent bias occurs early in life. For example, Kinzler and colleagues (Kinzler, Dupoux, & Spelke, 2007) showed that infants and children prefer to look at a person who previously spoke their language with a native accent rather than with a foreign accent. They also showed that, when presented with photographs of children’s faces paired with voices in either American- or French-accented English, infants and children were more likely to choose the native-accented speaker than the foreign-accented speaker as a friend. The authors suggest that these preferences, that cannot be associated to activation of stereotypes at that age, may later develop into the negative bias towards social groups that are not one’s own group.

This social classification has been argued to be automatic, non-conscious, to involve positive affect, and to result in favouritism towards the in-group member (Bestelmeyer et al., 2014; Dovidio & Gaertner, 1993). People identify themselves with an in-group member, and since people prefer to be part of a successful group, they tend to attribute a positive image to an in-group member. Consequently, people tend to trust an in-group member more than an out-group member, and messages delivered by an in-group member tend to be more persuasive (Mcgarty, Haslam, Hutchinson, & Turner, 1994; Yuki, Maddux, Brewer, & Takemura, 2005). Thus, the negative bias towards accented speakers was first attributed to social categorisation, which reflects the ‘*foreignness*’ of the speaker.

**Does *processing fluency* lead to negative bias?**

Other studies investigating the impact of accent on people’s behaviour, suggest that processing fluency generates the negative bias. Lev-Ari and Keysar (2010) investigated the impact of accent on trust. They had native speakers of English listen to speakers with either a native or a foreign accent saying trivia statements like ‘Ants don’t sleep’ and asked them to rate the veracity of the statements on a 14 cm line. Foreign-accented speakers had a mild or heavy accent, as assessed by native speakers who rated each speaker’s accent on a line from ‘extremely easy’ to ‘extremely difficult’ to understand. The authors observed that people judged the statements as less true when said by a foreign-accented speaker. Crucially, this effect could not be attributed to stereotypes against foreigners because participants were explicitly told speakers were reciting statements provided by the experimenter. Also, this effect disappeared for speakers with a mild accent when participants were made aware that the difficulty of processing accented speech could impact their judgement of credibility. The authors concluded that since accented speech is harder to understand than native speech (Cristia et al., 2012; Floccia, Butler, Goslin, & Ellis, 2009; Munro & Derwing, 1995), processing fluency is reduced; however, instead of perceiving the statements as more difficult to understand, people perceive them as less truthful, and as a result, they consider foreign-accented speakers as less credible. This is consistent with the claim that processing fluency, or the ease/difficulty to process information in general, affects cognitive processes and influences judgements (Alter & Oppenheimer, 2009).

Two recent studies directly tested the role of processing fluency on language attitudes towards native and foreign-accented speech. Dragojevic and colleagues (Dragojevic & Giles, 2016; Dragojevic, Giles, Beck, & Tatum, 2017) argued that processing fluency can impact affect, which, consequently, has an impact on language attitudes. Indeed, if processing fluency is reduced and cognitive resources are highly taxed, it generates negative affect; on the other hand, if speech information can easily be decoded, or people get better at decoding the information (rewarding progress), it generates positive affect. As a result, this positive/negative affect triggered by processing fluency determines how the speaker is perceived. The authors manipulated processing fluency in quiet or noisy conditions (using background white noise) while participants listened to stories spoken in a standard American accent or a Punjabi accent. After listening to the recordings, participants indicated on a 7-point scale their affective state (i.e., negative: annoyed, irritated, frustrated; positive: interested, happy, enthusiastic), as well as their impressions in relation to the speakers’ status (i.e., intelligent, educated, smart, competent, successful) and solidarity (i.e., friendly, nice, pleasant, honest, sociable). Participants attributed lower status (and lower solidarity only in Experiment 1) to the foreign-accented compared to the native speaker. In contrast to quieter conditions, noisier conditions provoked reduced processing fluency and more negative affective reaction for both speakers. These results suggest that the difficulty associated with processing speech and the negative feeling generated by the effort required to process speech lead to a negative perception of the speaker. The authors concluded that both processing fluency and affect have an effect on language attitudes. Similar to Lev-Ari and Keysar (2010), they claim that the negative bias towards foreign-accented speaker comes from the simple fact that accented speakers are harder to understand (see also, Dovidio & Gluszek, 2012).

**Could both *foreignness* and *processing fluency* contribute to negative bias?**  
It is not clear to what extent *foreignness* and *processing fluency* each contribute to the negative bias towards accented speakers. Note that stereotypes associated to a specific accent may also play a role, but will not be further discussed here because the current study does not directly address this question (but see Mai & Hoffmann, 2014; Roessel, Schoel, Zimmermann, & Stahlberg, 2017). While the theory that accent triggers an automatic social categorisation has received vast empirical evidence (Giles & Watson, 2013), the role of processing fluency has not been addressed as often, and results are not always consistent. For example, using the same paradigm as Lev-Ari and Keysar (2010), Souza and Markman (2013) failed to find an effect of accent on trust (see also Hanzlíková & Skarnitzl, 2017 and Podlipský, Šimáčková, & Petráž, 2016 for a partial effect of accent on trust; but Baus, McAleer, Marcoux, Belin, & Costa, 2019; Frances, Costa, & Baus, 2018 and Stocker, 2017 for no differences between regional or foreign-accented speakers and native speakers). Mai and Hoffmann (2014) put forward the possibility that the bias may originate from both *foreignness* and *processing fluency*. They argue that accent induces a social identity effect (immediate categorisation of the speaker as out-group member) and that *processing fluency* later modifies (reinforces or counteracts) the impact of the social identity effect during communication. They claim that *processing fluency* is a process secondary to the social identity effect, which is consistent with the idea that disfluency increases out-group status (Gluszek & Dovidio, 2010; Pearson & Dovidio, 2014). The current study tested this hypothesis by putting participants in a situation similar to that they experience when listening to politicians speaking with a foreign accent (which conveys both *foreignness* and *processing fluency*) or when their statements are reported by a translator (which conveys *foreignness* only). Using such a design allows to directly apply theory to a concrete everyday situation. Concretely, to investigate the origin of the negative bias towards foreign speakers, we examined neural responses to native and foreign-accented speech using event-related brain potentials (ERPs). We also looked at truth evaluation of sentences with the intention to reproduce results from previous behavioural studies (Lev-Ari & Keysar, 2010). Participants’ brain activity was recorded using ERPs while they listened to the sentences. This technique allows observing the nature and timing of cognitive processes taking place in response to (linguistic) stimuli. Using ERPs provides a more sensitive measure than behavioural data only, as previous studies looking at accent (Foucart, Santamaría-García, & Hartsuiker, 2019), social status (Santamaría-García, 2014) and trust (Boudreau, McCubbins, & Coulson, 2009) reported equivalent behavioural responses across conditions but dissociable ERP responses.

**Sentence comprehension in foreign-accented speech: evidence from ERPs**

Most ERP studies looking at foreign-accented speech processing have focused on the N400 component (Goslin, Duffy, & Floccia, 2012; Romero-Rivas, Martin, & Costa, 2015; Song & Iverson, 2018; but see Grey & van Hell, 2017; Hanulíková, van Alphen, van Goch, & Weber, 2012)**,** a negative ERP component that peaks at around 400 ms after stimulus onset and is known to reflect sensitivity to semantic processing and integration (Kutas & Federmeier, 2011; Kutas & Hillyard, 1980). The few results available do not converge. In response to semantically correct sentences, while Goslin et al. (Goslin et al., 2012) found reduced N400 amplitude for foreign-accented speech compared to native speech, Song and Iverson (2018) found the reverse pattern. Romero-Rivas et al. (2015) initially found a more negative N400 for foreign-accented speech compared to native speech, but this difference disappeared across the experiment. No clear explanation has been provided to account for the discrepancy across the results. Still, what is important to retain from these results is that lexico-semantic processing can be influenced by foreign-accented speech. However, these studies were not designed to disentangle whether this influence is due to the difficulty to process accented speech (*processing fluency*) or to speaker’s identity (*foreignness*).

It is, however, an important issue since ERP studies have shown that the speaker’s characteristics such as speaker’s identity (Foucart et al., 2015; Van Berkum, van den Brink, Tesink, Kos, & Hagoort, 2008) or speaker’s social category (Foucart et al., 2019; Santamaría-García, 2014) influence sentence comprehension. For instance, Foucart et al. (2019) recently investigated the impact of a short exposure to foreign accent on subsequent written sentence comprehension (hence, no spoken language was involved during ERP recording). Participants listened to sentences and evaluated their veracity. Sentences contained true and known information, unknown information (e.g., ‘Ants don’t sleep’, where participants can only rely on the speaker’s knowledge to evaluate the veracity of the statement) and world knowledge violations, as in the current study. To ensure the social status of native and non-native speakers was equal, prior to data collection, their social status was set by means of a 2-minute video (the only time accent was heard in the whole experiment). Behavioural responses did not reveal differences across sentences. Sentences containing unknown information triggered different N400 amplitudes depending on the speakers’ social status and accent. Moreover, speakers’ social status and accent also seemed to affect the visual perception of the speaker, as reflected by differences in the amplitude of early negative ERP component (similar to that observed for other race faces) in reaction to the presentation of the speaker’s photo. The results suggest that, despite having an equivalent social status, foreign-accented speakers seem to be considered different from native speakers, and information coming from foreigners does not seem to be processed similarly. Here, we further investigate how accent influences sentence comprehension, and what may be the cause, i.e. *processing fluency* or *foreignness*.

**The current study**

In the current study we tested to what extent *foreignness* (speaker’s social identity) generates the negative bias towards accented speakers, and whether *processing fluency* (ease to process speech) modulates this bias. Using ERPs, we investigated the difference in the processing of sentences spoken by a native speaker or by foreign speakers. We presented general knowledge statements spoken in Dutch with 1) a native accent (thereafter, ‘Native candidate’), 2) a foreign accent (thereafter, ‘Foreign candidate’) or 3) a native speaker reporting the statements of a foreign speaker (thereafter, ‘Reported candidate’). Importantly, the foreign-accented speaker (2) conveyed both the factors *foreignness* and *processing fluency*, whereas the reported speaker (3) conveyed only the factor *foreignness*. To render the experiment credible, participants were told the speakers were candidates that had been pre-selected to be representative at a Junior Professional Event organised in Brussels. Only one of these three candidates would be elected to represent all the junior professionals during the event. It was explained to the participants that the event was open to candidates from various countries with the condition that they were residents of Belgium, and spoke one of Belgium official languages (but the experiment only included Dutch language). We pretended that the pre-selected candidates were asked to briefly introduce themselves and then were asked to answer trivia questions about diverse topics to evaluate their level of general knowledge.

Thus, participants were first introduced to each candidate; they saw their photo and heard a short audio introduction. Then they heard sentences accompanied with the photo of the candidate who had said it. Importantly, both foreign candidates introduced themselves in Dutch to show participants that both could speak their language equally well. To justify the statements of one of the candidates being reported by a native speaker (thereafter ‘the Reporter’), we pretended the candidate could not be present on the day of the recordings thus the statements she provided were recorded by someone from the event organisation. See Supplementary Materials for full instructions. After the presentation of each sentence, participants were asked to assess its veracity. This truth evaluation task intended to replicate Lev-Ari and Keysar’s (2010) behavioural study, and the critical condition was Unknown sentences (see example (b) below). According to their findings, we expected sentences uttered by the foreign-accented speaker to be assessed as less true than sentences uttered by the native speaker. Note that these authors attributed these results to processing fluency. If *foreignness* also influences truth evaluation, sentences associated with the reported candidate should also be assessed as less true.

The sentences contained (a) true (and known) information, (b) unknown (but true) information or (c) information violating world knowledge, along with the photo of the candidate who had said the sentence.

1. One of the colours of the French flag is blue.
2. One of the colours of the Gabonese flag is green.
3. One of the colours of the French flag is green.

These sentences allow observing whether information coming from native or foreign speakers is accepted in a similar manner. Overall (but see specific predictions for each sentence type below), our predictions were as follows. If only *foreignness* triggers a negative bias, differences should be observed between the native condition and the two foreign conditions indiscernibly. However, if *processing fluency* modulates the bias, we should observe differences between the two foreign conditions. If the difficulty to process information due to *processing fluency* re-enforces *foreignness* (Mai & Hoffmann, 2014), larger differences should be observed between the Native candidate and the Foreign candidate than between the Native candidate and the Reported candidate. However, while the factor *foreignness* stayed constant across the experiment, the factor *processing fluency* may vary across the experiment. Indeed, participants may first experience negative affect in response to difficulty to process speech, but may then adapt to the speaker’s accent (Bradlow & Bent, 2008; Romero-Rivas, Martin, & Costa, 2015; but see, Floccia et al., 2009), which should lead to larger differences between the Native candidate and the Reported candidate than between the Native candidate and the Foreign candidate (in line with Dragojevic and colleagues’ (2016; 2017) reasoning about rewarding progress). One other possible case is that *foreignness* is cancelled out when the foreign candidate’s statements are reported by a native speaker. In this case, no differences should be observed between the Native candidate and the Reported candidate. Note that, as mentioned above, a few ERP studies have shown that speaker’s identity affects sentence comprehension (Foucart et al., 2015, 2019; Santamaría-García, 2014; Van Berkum et al., 2008), but, to our knowledge, none has shown how the identity of the author of the statement (in case of reported speech) affects sentence comprehension. Although it is not the main focus of the current study, the results will be informative regarding processing of reported speech.

Following the ERP literature about foreign-accented speech, we expected different neural patterns across speakers. The N400 was used as an index of sentence acceptability. However, since differences in later time-windows have also been reported when comparing native and foreign-accented speakers (Foucart et al., 2019; Romero-Rivas et al., 2015), we also looked at later effects to detect potential re-analysis processes (Tanner, Grey, & van Hell, 2017; Van Petten & Luka, 2012). Below we expose the predictions for each sentence type.

True sentences (a). True sentences served to test the prediction that if information coming from a foreign speaker is not accepted as easily as when coming from a native speaker, sentence comprehension should be more difficult, even when the information is true and known (Foucart et al., 2015, 2019; Goslin et al., 2012; Romero-Rivas et al., 2015; Santamaría-García, 2014; Van Berkum et al., 2008). Given the discrepancy in the literature, it is difficult to anticipate the direction of the N400 component (more negative or more positive for foreign than native candidates). What can be predicted though is that if *processing fluency* affects processing of true sentences, differences should be observed between the Native speaker and the Foreign candidate but not between the Native candidate and the Reported candidate. On the other hand, if *foreignness* affects processing of true sentences, differences should be observed between the Native candidate and the two foreign candidates indistinctively. Finally, if both *processing fluency* and *foreignness* affect processing, larger differences should be observed between the Native candidate and the Foreign candidate than between the Native candidate and the Reported candidate. Independently of the direction of the effects, the results will add up to the literature of accented speech comprehension.

Unknown sentences (b). Unknown sentences were the critical condition, since they allowed testing the prediction that accent affects trust, and consequently, sentence comprehension. Indeed, given that information contained in these sentences is unknown, if participants evaluate the statement as true, it would indicate that they trust the speaker’s knowledge. The Unknown sentences are comparable to the trivia statements used in Lev-Ari and Keysar’s (2010), as their participants did not know whether the fact was true or not (their participants reported knowing for sure the veracity of only 6% of the statements, and familiarity with the statements did not affect the main effect of accent). Hence, with this condition, we intended to reproduce previous behavioural results (which reflect decisional processes), and we investigated the impact of accent on trust at neural levels (which reflect automatic processes). Note that in a previous study, Foucart et al. (2019) showed differences for this type of sentences (in written modality) between native and foreign-accented speaker at the neural level, but did not observe differences at the behavioural level. Since, to our knowledge, no ERP studies have looked at processing of unknown information in accented speech (in listening modality), we cannot derive our predictions from previous studies. However, if *foreignness* makes accepting new information from the speaker more difficult, a larger N400 should be observed for both foreign candidates compared to the Native candidate. If *processing fluency* makes it more difficult, differences between the two foreign conditions should be observed. As stated above, if *processing fluency* re-enforces *foreignness* (Mai & Hoffmann, 2014), a larger N400 should be observed for the Foreign candidate than for the Native candidate (the Reported candidate showing similar effect as the Native candidate or falling in-between the two candidates). If, on the other hand, participants adapt to the accent (Bradlow & Bent, 2008; Romero-Rivas, Martin, & Costa, 2015; but see, Floccia et al., 2009), the N400 component for the Foreign candidate should fall in-between that observed for the other two candidates.

World knowledge violations (c). World knowledge violations tested whether information that is false and known is processed similarly independently of the speaker, and whether accent affects integration of world knowledge during sentence comprehension (Hagoort, Hald, Bastiaansen, & Petersson, 2004). No studies have looked at world knowledge integration in foreign-accented speech until now, so it is difficult to make clear predictions. However, in view of Foucart et al.’s (2019) study looking at the impact of accent on subsequent sentence comprehension (in written modality), we expected no differences across the three candidates in the N400 time-window, but differences in a later time-window may emerge, reflecting extra processing cost when a native speaker (in-group member) makes an erroneous statement.

The experiment ended with a debriefing session in which participants were asked to vote for the candidate they would like to see as a representative at the Junior Professional Event. Similarly as in Dragojevic and Giles’ (2016) study, they also answered questions about their affect, their impression of the candidates and the candidates’ accent. The debriefing served to 1) investigate whether native and foreign speakers are evaluated differently (negative bias), 2) to check for comprehensibility of the accents (Trofimovich & Isaacs, 2012) and 3) to check whether these factors modulate sentence comprehension, and if they do, whether modulation is similar for native and foreign speakers (we looked at the correlations between these factors and the magnitude of the N400 effect, the main measure of the current study). Moreover, comparing the accent ratings allows checking whether the foreignness of the ‘reported speaker’ was maintained throughout the experiment; if, in response to the question ‘How strong was the speaker’s accent’, the percentage attributed to the reported speaker and the native speaker are not significantly different, it will be an indication that foreignness was not maintained.

METHODS

Data and stimulus materials will be made publicly available in a free online repository (upon publication).

The experiment consisted of four phases (Figure 1). In the first phase (Introduction phase), we set the context of the experiment (the Junior Professional Event). Participants were introduced to the three candidates who gave a brief description of themselves. Candidates were equally successful in terms of professional, social, and personal achievements (scripts available in Supplementary Materials). No data were collected during this phase. In the second phase (Listening phase, Figure 1A), participants’ brain activity was recorded as they listened to sentences containing true information, unknown information or world knowledge violations. At the end of each sentence, they had to assess the veracity of the statement on a sliding scale (from ‘definitely false’ to ‘definitely true’, results collected in percentages). In the third phase (Memory phase, Figure 1B), a memory test was included to ensure participants were paying attention to the photo of the speakers during the listening phase. This was indeed a crucial point since the foreignness of the ‘reported speaker’ could only be identified via the photo, not speech. Participants were visually presented with the sentences they had listened to during the listening phase. After each sentence, the photos of the three candidates were displayed and participants had to indicate who had said the sentence during the listening phase by pressing the number corresponding to the candidate (only behavioural answers were collected in this phase). Finally, in a debriefing phase, participants were asked to vote for their preferred candidate and answered questions related to the candidates’ personality and accent.

Participants:

Based on a statistical power analysis to estimate the required sample size (GPower 3.1; Faul, Erdfelder, Lang, & Buchner, 2007)2 (see also footnotes 4 and 5), we tested 33 participants. They were Dutch native speakers (22 females, mean age: 23.4 years, SD: 4.2), recruited from the university participant pool with the condition that they had been exposed to Dutch from birth from both parents and had grown up in the Flemish part of Belgium (for the accent), were right handed, had normal or corrected-to-normal vision, and reported no neural or auditory disorders. Given that listeners’ familiarity with other languages and accents has been shown to be an influential factor in accented speech comprehension (Grey & van Hell, 2017; Porretta, Tremblay, & Bolger, 2017; Porretta, Tucker, & Järvikivi, 2016; Witteman, Weber, & McQueen, 2013), we controlled for homogeneity in participants’ use of foreign/accented languages with their relatives and friends in a language background questionnaire administered at the end of the experiment. Participants all knew English and had learnt French at school (see Table 1 for details) and 17 of them had some basic knowledge of a third language but used it less than 5% in their everyday life. In the pre-registration phase, we had set the condition that participants who used a foreign language (any language apart from their native language, Dutch) over 50% of the time daily would be excluded from analyses, none of them reached that number. This condition of exclusion was set to avoid having participants who regularly used one (or more foreign languages), which may have an effect on the perception of foreign speakers, as previously reported. Before the experiment, all participants signed a consent form after receiving oral and written information about the procedure and experiment. They received 25 Euros for their participation. The study had been approved by the ethical committee of the Faculty of Psychology and Educational Sciences of Ghent University (Number 2016/68) for the research project entitled 'The impact of foreign accent on social interaction and cognitive processes'.

Table 1. Participants’ familiarity with other languages than their native language, Dutch (standard deviations are reported into parentheses). Daily use refers to the average percentage of time the language is used daily with family, with friends, when reading, when watching TV. Self-rating refers to the average of self-estimation of proficiency for oral/written comprehension/production.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Age of acquisition in years | Daily use of language in % | Time spent in a country where the language is spoken (in months) | Self-rating proficiency (1=low proficient, 7= native-like) |
| English | 11 (2.9) | 25 (12.8) | 4.9 (4.8) | 5.2 (0.7) |
| French | 9.6 (1.6) | 5.1 (5.6) | 4.2 (3.7) | 3.8 (0.9) |

Materials:

The same sentences as in Foucart et al. (2019) were used. The materials consisted of 180 triplets in Dutch containing a sentence with known information (‘True sentences’), a sentence with unknown information (‘Unknown sentences’) and a sentence violating world knowledge (‘World Knowledge sentences’). The knowledge of the information contained in the three sentence conditions was checked in a previous study by the same authors (Foucart et al., 2019) in a pre-test in which 12 Dutch native speakers were presented with one of the three lists; for each sentence, they had to assess the statement as ‘definitely true’, ‘maybe true’, ‘maybe false’, ‘definitely false’ or ‘don’t know’. True sentences were assessed as true at 79% (‘maybe true’ and ‘definitely true’ combined), Unknown sentences were assessed as unknown (‘I don’t know’) at 49%, and World Knowledge sentences were assessed as false at 79% (‘maybe false’ and ‘definitely false’ combined). Due to the constraints compelled by the nature of the information contained in the sentences (true vs. unknown), sentence context and/or critical words could not always be exactly similar as it is usually required in language studies looking at effect of sentence types. However, the main interest of the proposed study is the effect of Speaker, therefore, what is relevant is that the difference between sentences similarly applies to the different speaker conditions. Nevertheless, based on SUBTLEX (van Heuven, Mandera, Keuleers, & Brysbaert, 2014), we matched word frequency of the critical words in the three sentence types (True, mean: 88.7 per million, SD: 239; Unknown, mean: 73 per million, SD: 212; World knowledge, mean: 73 per million, SD: 213, *F*(2, 358) = 1.48, *p*=.23, =.008). The duration of the sentence and the duration of the critical word for each sentence type were both shorter for True sentences than for the other two types of sentences (True, mean: 2743 ms, SD: 722 ms; Unknown, mean: 2860 ms, SD: 715 ms; World knowledge, mean: 2790 ms, SD: 733 ms, *F*(2, 358), 10.99, *p*<.001, =.057, for sentence duration; True, mean: 552 ms, SD: 170 ms; Unknown, mean: 579 ms, SD: 187 ms; World knowledge, mean: 579 ms, SD: 181 ms, *F*(2, 358) = 3.56, *p*=.03, =.019, for word duration). Crucially though, this difference in duration did not differ for the speaker condition (interaction Sentence type x Speaker: *p*=.44 for sentence duration; *p*=.66 for word duration). The sentences of the triplet have the same structure and the critical word is in final position (see examples in Table 2 and Supplementary Materials for a complete list of sentences). The 180 triplets were divided into three lists of 180 sentences with 60 sentences in each condition (True, Unknown and World Knowledge); each sentence was seen only once in each list, in only one of the conditions. In each list, each candidate said 20 True sentences, 20 Unknown sentences, and 20 World Knowledge sentences. Each sentence was associated with the different candidates across lists.

Table 2. English translation of examples of experimental triplets. The critical word is underlined.

|  |  |
| --- | --- |
| Conditions | Sentence |
| True sentences | 1. The last football world cup took place in Russia. 2. The waffle was first invented in Belgium. 3. Usually the number of strings of a guitar is six. 4. The colour of the tongue of a dog is pink. |
| Unknown sentences | 1. The first football world cup took place in Uruguay. 2. The saxophone was first invented in Belgium. 3. Usually the number of strings of a harp is forty-six. 4. The colour of the tongue of a giraffe is black. |
| World knowledge sentences | 1. The last football world cup took place in Uruguay. 2. The waffle was first invented in Mexico. 3. Usually the number of strings of a guitar is forty-six. 4. The colour of the tongue of a dog is black. |

**Candidates**

Participants were introduced to three candidates. One had a native (Belgian) Dutch accent (i.e., ‘Native candidate’), one spoke Dutch with a foreign accent (i.e., ‘Foreign candidate’) and one spoke Dutch with an accent in the Introduction phase but then had her statements reported by a reporter (i.e., ‘Reported candidate’). Four female speakers did the audio recordings in Dutch. Two were Dutch native speakers from Belgium, and two were non-native speakers with advanced level of Dutch (one from Italy and one from Czech Republic). They also recorded a pre-written script to introduce themselves, giving a brief description of personal, work, and academic achievements (see Supplementary Materials). Scripts were written so that all candidates came across as equally successful, and were counter-balanced3. Speakers were all Caucasian and of similar age. To avoid any preference bias across candidates, the photos of all candidates were counter-balanced across participants, and so were the voices. In other words, one participant heard the voice of a native speaker playing the role of the Native candidate, and another participant heard the same voice playing the role of the Reporter. Similarly, one participant heard one of the non-native speakers speaking Dutch with a foreign accent (Foreign candidate), and another participant saw the photo of the same candidate but with the Reporter’s voice (Reported candidate). The voices of the two recorded foreign speakers were also counter-balanced to avoid idiosyncratic effects on the Foreign speaker; half of the participants heard the voice of one of the two foreign speakers (e.g., the Italian native speaker), and the other half, the other’s (e.g., the Czech native speaker).

**Procedure**

*Introduction phase*.

Participants were first introduced to three candidates. They saw the photo of each candidate and heard a short text in Dutch.

*Listening phase*

Participants were sitting comfortably in front of a computer screen in a softly lit sound proof room. Instructions were given visually as well as verbally. Participants’ EEG data were recorded as they listened to sentences. They were instructed to minimize blinking and eye movements when the fixation cross was red. To ensure they paid attention to the candidate’s photo, they were explicitly told they would perform a ‘who said the sentence’ memory task after the listening phase. After a four-sentence practice, participants were presented with one of the three lists, randomised for each participant. Each trial started with a fixation cross (2000 ms) and the presentation of the candidate’s photo (2000 ms). Then a black fixation cross was displayed below the photo (1000 ms) and turned red when the auditory sentence started. The photo stayed on the screen during the whole sentence (see Materials for average sentence duration). Finally, a sliding scale was displayed (1000ms after critical word onset), and participants had to respond by clicking on the scale with the mouse (‘definitely false’, ‘don’t know’, ‘definitely true, results collected in percentages). The choice of a sliding scale (and not a 1 to 5 scale, for example) was to use a scale as close as the 14 cm line used in Lev-Ari and Keysar (2010) and get more sensitivity in the assessment of statement veracity. They were asked to respond as fast as possible (Figure 1A). They had up to 7 seconds to respond. The listening phase was divided by one break (dividing block 1 and block 2) and lasted for about 30 min.

*Memory task*

After the listening phase, participants were presented with the 180 sentences they had heard along with the photos of the three candidates, and participants had to indicate who had said the sentence during the listening phase by pressing the number corresponding to the candidate. The order of the photos was counterbalanced across participants.

*Debriefing*

At the end of the session, participants answered 54 questions (18 for each candidate) to give their impression of the speakers in relation to social and linguistic factors. As in Dragojevic and Giles’s (2016) study, we asked questions regarding social factors, such as *affect* (i.e., negative: annoyed, irritated, frustrated; positive: interested, happy, enthusiastic), the speakers’ *status* (i.e., intelligent, educated, smart, competent, successful) and *solidarity* (i.e., friendly, nice, pleasant, honest, sociable). Regarding linguistic factors, we asked about *accent* (‘how strong was the speaker’s accent?’) and *comprehension* (‘How difficult was it to understand the speaker?’) (Trofimovich & Isaacs, 2012). The full list of questions is available in Supplementary Materials. Questions were presented along with the photo of each candidate, in a random order, and answers were provided using a sliding scale from 0% to 100%. The final question was presented with the photo of the three speakers and participants had to indicate which of the three candidates should be the representative at the Junior Professional Event. Whenever one of these factors showed significant differences between the speakers, we calculated the correlation between the percentage attributed to the speakers for this (these) factor(s) and the magnitude of the N400 effect (i.e., difference of the means for True vs. Unknown sentences, and for True vs. World Knowledge sentences). This calculation allowed us to examine how the perception of the speaker modulates sentence comprehension and if it does, whether it does so similarly for native and foreign speakers, and which factor(s) drive(s) the bias usually observed against foreign-accented speaker.

Finally, as their last task (to avoid experimental bias) participants had to fill in a questionnaire about their own language background (use of foreign language, etc).

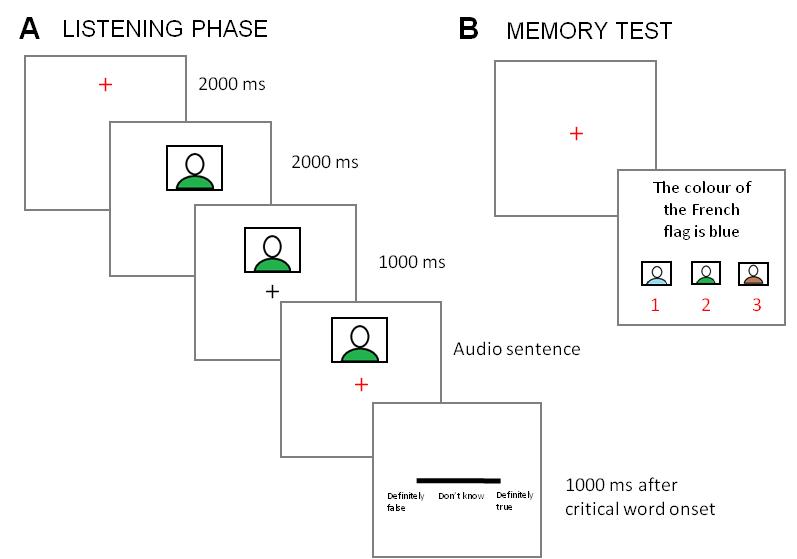
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Figure 1. Representation of the different experimental phases. Panel A: Listening phase, panel B: Memory test. Real faces have been replaced by cartoon faces here for anonymity.

**EEG recording and data analysis**

Electrophysiological data were recorded from 64 tin electrodes attached to an elastic cap (Electrocap International) distributed according to the standard International 10-20 system (Jasper, 1958) and referenced to CPz. EEG activity was amplified online using the BrainAmps DC amplifier (Brain Products GmbH, Munich, Germany) with a 0.1 Hz high-pass filter, continuously digitised at a sampling rate of 500 Hz, and re-filtered offline at 30 Hz low-pass filter (24 dB/octave roll-off). Impedances were kept below 10 kOhm. Epochs ranged from -200 ms to 1000 ms after the onset of the critical word. Artifacts were automatically rejected using the procedure implemented in Brain Analyzer 2.0 (differences in values 200 μv in 200 ms intervals, and amplitudes of +/- 100 μv), resulting in less than 2% rejection for each sentence type. One participant who had over 25% of artifact rejections was excluded from analyses. Baseline correction was performed in reference to pre-stimulus activity (-200; 0 ms) and individual averages were digitally re-referenced to the common average reference. The ERP data were quantified by calculating the mean voltage amplitudes. Based on the literature and after visual inspection of the grand means (following Keil et al.’s (2013) guidelines), analyses were conducted within the time-window 300-500 ms and 500-700 ms (Hagoort et al., 2004; Kutas & Hillyard, 1980; Tanner et al., 2017; Van Petten & Luka, 2012). Since the N400 component is usually maximal at central sites (Kutas & Federmeier, 2011; Kutas & Hillyard, 1980, 1984; Luck, 2005), we conducted the analysis for this component on a Central region (Cz, CPz, C1/C2, C3/C4, CP1/CP2, CP5/CP6). For later components, we looked at Central sites as well as Frontal sites (Fz, FCz, F1/F2, F3/F4, FC1/FC2, FC6/FC5), as re-analysis effects are usually reported in these regions (Tanner et al., 2017; Van Petten & Luka, 2012). An ANOVA was conducted with Candidate (Native, Foreign, Reported) and Sentence Type (True, Unknown and World Knowledge) factors as repeated measures. A main effect of Candidate was expected but the factor Sentence Type was included to reveal potential differences. We anticipated that if a main effect of Candidate was significant, post-hoc analyses would be conducted within each sentence condition to reveal differences between speakers or to reveal different effects of speaker within each sentence type if an interaction Candidate x Sentence type reached significance. We also planned to conduct an additional analysis including Block (first and second block) and Candidate factors as repeated measures to check for adaptation to the accent. Since previous studies have reported effects of speaker (based on accent, Romero-Rivas et al., 2015; or social status, Santamaría-García, 2014) for semantically correct sentences, we expected the effect to be more salient for True sentences, and therefore, conducted the analysis on this sentence type only. The Greenhouse-Geisser correction (Greenhouse & Geisser, 1959) was applied to all repeated measures with greater than one degree of freedom; in this case, the corrected *p* values are reported. Bonferroni correction was used for pair-wise comparison post-hoc analyses. Partial eta-squared effect sizes are reported.

*Results*

The analyses were conducted as approved during the Stage 1 phase of the pre-registration. We added one analysis in an early time-window from the onset of the sentence for the ERP data and also correlation analyses across the social and linguistic factors for the Debriefing. They are clearly identified as exploratory analyses in the section headers and the text.

**Behavioural answers**

We first tested the hypothesis that foreign speakers are perceived as less credible than native speakers4. We hypothesised that if it is true, sentences spoken by the Foreign and the Reported candidates should be assessed as less true than sentences spoken by the Native candidate. This effect should be specifically noticeable with Unknown sentences (b), when participants must rely on the candidate’s knowledge. Furthermore, if *foreignness* impacts the speaker’s credibility, ratings should be equally lower for both foreign candidates compared to those for the Native candidate. If, as argued by Lev-Ari and Keysar (2010), *processing fluency* modulates the bias, larger difference should be observed between the rates for the Native candidate and the Foreign candidate than for the rates between the Native candidate and the Reported candidate. To test this hypothesis, we conducted an ANOVA with Sentence Type and Candidate factors as repeated measures. A significant main effect of Sentence Type was found (*F*(2, 62) = 801.03, *p*<.001, =.96), confirming that the manipulation of the veracity of the information contained in the sentences worked properly. On the sliding scale (from 0% = ‘definitely false’ to 100% = ‘definitely true), True sentences obtained a rate of 77% (SD: 6), Unknown sentences of 49% (SD: 5), and World Knowledge violations of 20% (SD: 7). There was no significant main effect of Candidate but a significant interaction Candidate x Sentence Type (*F*(4, 124) = 3.73, *p*<.001, =.11). Post-hoc *t*-tests revealed that True sentences had a higher score when spoken by the Reported candidate than by the Native candidate (*p*=.02; *d*=.45) or the Foreign candidate (*p*<.001; *d*=.57). Means for each candidate are reported in Table 3. Importantly, the critical sentences that contained unknown information did not reveal differences across candidates (*p*=.33).

Table 3. Mean rates (standard deviations) in percentage for each sentence type and candidate.

|  |  |  |  |
| --- | --- | --- | --- |
|  | True sentences | Unknown sentences | World knowledge |
| Native candidate | 75% (8) | 49% (7) | 19% (9) |
| Foreign candidate | 76% (7) | 51% (8) | 23% (8) |
| Reported candidate | 79% (9) | 48% (6) | 20% (10) |

**ERP data**

We then looked at participants’ brain activity to test whether sentences spoken by native speakers and foreign speakers are processed differently. We expected to observe the main differences in the N400 time-window and possibly in a later time-window (500-700 ms). We conducted an ANOVA with Candidate and Sentence Type factors as repeated measures. Grand averages are displayed in Figure 2. In addition, three figures are available in the Supplementary Materials (Figure 2-Suppl. a, b and c), one for each Sentence Type displaying the waves corresponding to each Candidate at each site of the Central region.

300-500 ms time-window.

Analysis (means for each factor are reported in Figure 3) revealed a main effect of Sentence Type (*F*(2, 62) = 4.57, *p*<.01, =.13); the negativity was significantly larger for World Knowledge violations than for True sentences (*p*=.02), but not when compared to Unknown sentences (*p*=.06) (Bonferroni multiple comparison corrected tests). The main effect of Candidate did not reach significance (*F*(2, 62) = 1.97, *p*=.15, =.06), nor did the interaction Sentence Type x Candidate (*F*(4, 124) = 0.40, *p*=.81, =.01). The additional analysis on True sentences including Block (first and second block) and Candidate factors as repeated measures did not reveal any significant main effect or interaction.

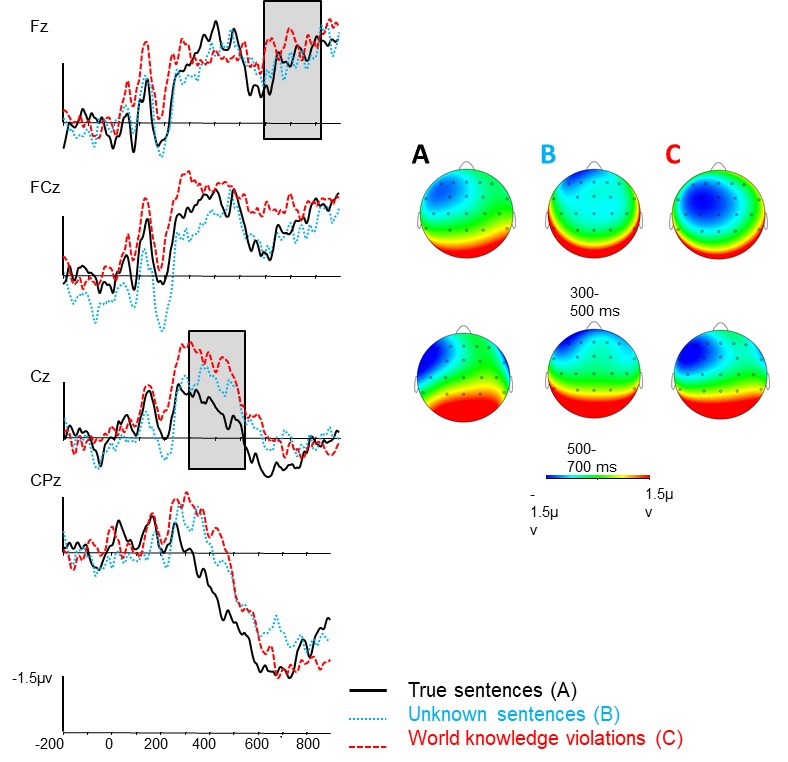
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Figure 2. Grand averages and voltage maps from the onset of the critical noun on midline sites for True sentences (black/solid line, A), Unknown sentences (blue/dotted line, B) and World Knowledge violations (red/dashed line, C). Negative is plotted up. Grey rectangles represent the analysed time-windows.

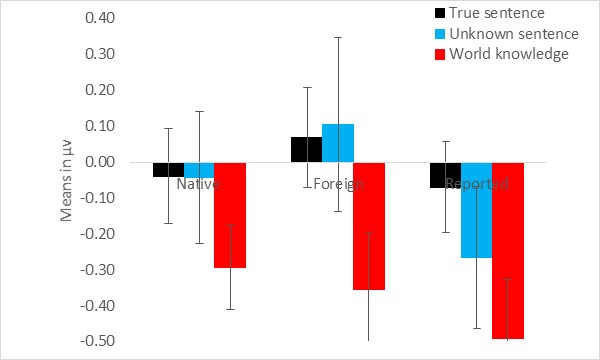


Figure 3. Means in µv for each sentence type and candidate. Error bars represent standard errors of the mean.

500-700 ms time-window

The main effects of Sentence Type (Frontal sites: *F*(2, 62) = 0.32, *p*=.72, =.01; Central sites: *F*(2, 62) = 1.52, *p*=.23, =.05) and Candidate (Frontal sites: *F*(2, 62) = 0.54, *p*=.58, =.02; Central sites: *F*(2, 62) = 1.25, *p*=.29, =.04) did not reach significance, nor did the interaction Sentence Type x Candidate (Frontal sites: *F*(4, 124) = 0.96, *p*=.43, =.03; Central sites: *F*(4, 124) = 0.49, *p*=.74, =.01).

**Exploratory analysis (not pre-registered)**

To further check for adaptation to foreign accent, we conducted another analysis that was not originally planned; based on Romero-Rivas et al. (2015), we analysed the P200 component (150-300 ms time-window) on the first word of the sentence (see Figure 4). The amplitude of this component, which has previously been taken as an indication of the ease to extract acoustic features used for phonological and phonetic processing (De Diego Balaguer, Toro, Rodriguez-Fornells, & Bachoud-Lévi, 2007; Reinke, He, Wang, & Alain, 2003), seems to be reduced in degraded (Strauß, Kotz, & Obleser, 2013) and foreign-accented speech (Romero-Rivas et al., 2015) compared to normal or native speech5. We conducted a three-way ANOVA on True sentences with Region (Frontal and Central), Block and Candidate factors as repeated measures, which revealed significant main effects of Candidate (*F*(2, 62) = 4.81, *p*<.01, =.13), Region (*F*(1, 31) = 14.17, *p*<.001, =.31) and Block (*F*(1, 31) = 5.53, *p=*.02, =.15), but no interaction between Candidate and other factors. These results show that the P200 was larger at central sites than at frontal sites and in the second block than in the first block for all the speakers, which is consistent with previous findings and with the fact that speech (for all speakers) becomes easier to process across the experiment. Interestingly, the P200 was significantly larger for the Native candidate than for the Foreign candidate (*p*<.001), and the Reported candidate was not significantly different from either the Native (*p*=.42) or the Foreign candidate (*p*=.34) (multiple comparison corrected tests).

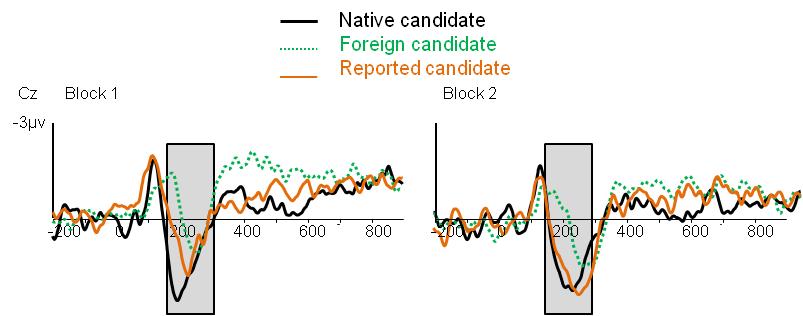


Figure 4. Grand averages from the onset of the sentence on Cz for Native candidate (black/solid line), Foreign candidate (green/dotted line) and Reported candidate (orange/light grey) for the first and second blocks. Negative is plotted up. Grey rectangles represent the analysed time-window.

**Memory task**

To test whether participants were paying attention to the speakers’ photo, we looked at the overall accuracy rates. Scores indicate that they answered above chance level (33%, see Table 4). Moreover, to check for potential differences across speakers and sentences types, we conducted an ANOVA on the accuracy rates with Sentence Type and Candidate factors as repeated measures. Neither of the main effects reached significance (*F*(2, 62) = 0.19, *p*=.83, =.01 and *F*(2, 62) = 0.56, *p*=.57, =.02, respectively), nor did the interaction (*F*(4, 124) = 2, 27, *p*=.06, =.07).

Table 4. Mean accuracy rates (standard deviations) in percentage to the memory task for each sentence type and candidate.

|  |  |  |  |
| --- | --- | --- | --- |
|  | True sentences | Unknown sentences | World knowledge |
| Native candidate | 44% (22) | 49% (19) | 53% (15) |
| Foreign candidate | 53% (17) | 47% (14) | 47% (14) |
| Reported candidate | 47% (16) | 49% (17) | 44% (21) |

**Debriefing**

We conducted ANOVAs to compare the scores for the three candidates for the factors *Affect*, *Status*, *Solidarity, Accent* and *Comprehension*, individually (the distribution of the scores is available in Figure 5 in the Supplementary Materials). Scores for each factor were obtained by calculating the average score of the questions related to this factor (e.g., for the factor *Status* we calculated the average score across the 5 questions: ‘How intelligent/educated/smart/competent/successful did you find this speaker?). For the factor *Affect*, we averaged the score across the questions related to positive affect and negative affect (we previously reversed the scores for negative affect so that 100% was the maximum positive value). We put forward that if scores were significantly different for the Native candidate and the two foreign candidates, it would suggest that *foreignness* impacts the perception of the speaker. On the other hand, if only one of the foreign candidates was significantly different from the Native speaker, it would suggest that *processing fluency* affects the perception of the speaker, either in favour (adaptation of the accent reduces *foreignness;* Dragojevic and Giles, 2016) or in disfavour (*processing fluency* re-enforces *foreignness;* Mai & Hoffmann, 2014) of the speaker.

Scores for each factor and candidate are displayed in Figure 6 and post-hoc (*t*-tests) *p*-values and effect size (*d*) are reported in Table 5. The analyses showed a significant main effect of Candidate for *Affect* (*F*(2, 64) = 15.24, *p*<.001, =.32), *Status* (*F*(2, 64) = 4. 01, *p*=.02, =.11), *Solidarity* (*F*(2, 64) = 4.98, *p*<.001, =.13), *Accent* (*F*(2, 64) = 40.88, *p*<.001, =.56) and *Comprehension* (*F*(2, 64) = 93.86, *p*<.001, =.74). Post-hoc analyses revealed that scores for the social factors (*Affect, Status* and *Solidarity*)were significantly lower for the Foreign candidate than for the other two candidates. Scores for the linguistic factors (*Accent* and *Comprehension*) were significantly different for the Native candidate and the two foreign candidates, as participants assessed accent as stronger and comprehension as more difficult in relation to foreign candidates (note that these results suggest that the foreignness of the ‘reported speaker’ was maintained throughout the experiment). However, scores between the two foreign speakers were also significantly different.

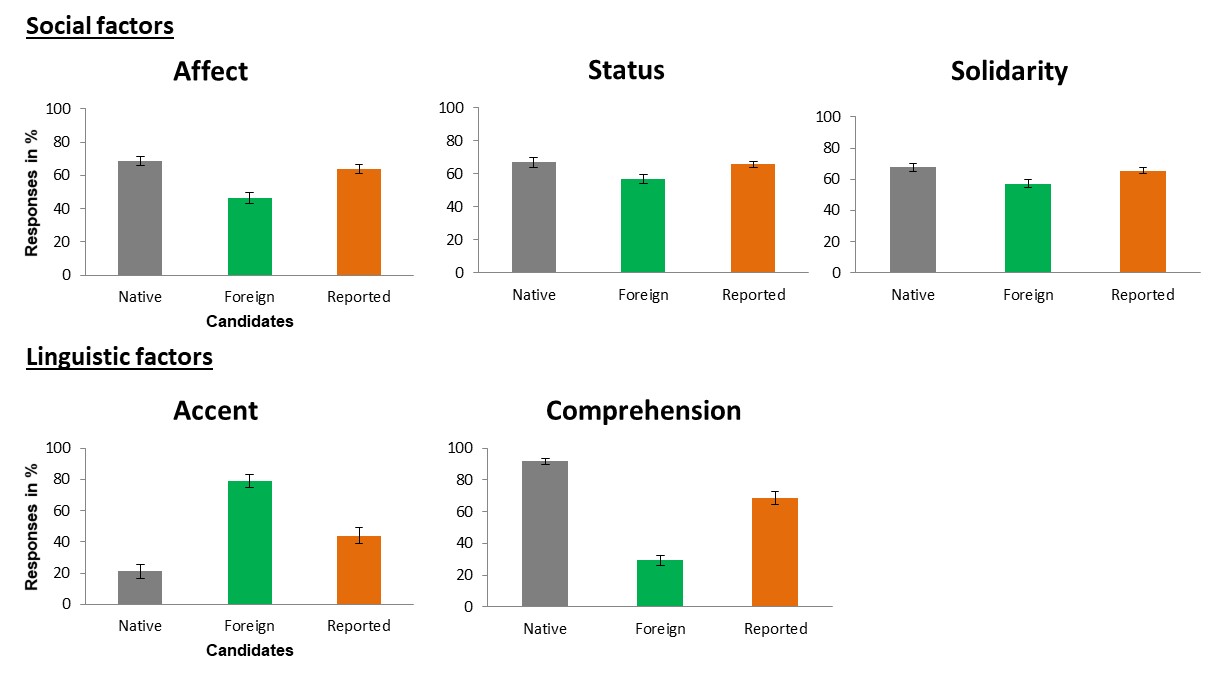
Figure 6. Scores in percentage for candidate and each factor (social factors: *Affect, Status, Solidarity*; linguistic factors: *Accent, Comprehension*). Error bars represent standard errors of the mean.

Table 5. Post-hoc (*t*-test) *p*-values and effect sizes (*d*) of the significant main effect of Candidate (Native, Foreign, Reported) for each factor individually (*Affect, Status, Solidarity, Accent, Comprehension*).

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Affect | | Status | | Solidarity | | Accent | | Comprehension | |
|  | *p* | *d* | *p* | *d* | *p* | *d* | *p* | *d* | *p* | *d* |
| Native vs. Foreign | .001 | .81 | .05 | .36 | .02 | .44 | .001 | 1.5 | .001 | 2.65 |
| Native vs. Reported | .20 | .23 | .69 | .07 | .49 | .12 | .001 | .60 | .001 | .88 |
| Foreign vs. Reported | .001 | .79 | .001 | .53 | .01 | .47 | .001 | .98 | .001 | 1.34 |

Since factors showed scores significantly different across candidates, we calculated the correlation between the percentage attributed to the speakers for each factor and the magnitude of the N400 effect (i.e., difference of the means for True vs. Unknown sentences, and for True vs. World Knowledge sentences)6. This calculation was conducted to examine whether the perception of the speaker modulates sentence comprehension, and which factor(s) drive(s) the bias usually observed against foreign-accented speaker. None of the factors significantly correlated with the magnitude of the N400 component. When asked to vote for the candidate they would like to see as a representative at the Junior Professional Event, participants did not significantly vote for one candidate over the others (Native candidate: 11 votes, Foreign candidate: 12 votes, Reported candidate: 9 votes; χ2=0.43, df=2, *p*=.80).

**Exploratory measure on the Debriefing (not pre-registered)**

In light of a new study (Dragojevic, 2019) and previous work (Dragojevic & Giles, 2016; Dragojevic et al., 2017) from Dragojevic and colleagues showing the significant impact of processing fluency and affect on the perception of the speaker, we conducted an additional analysis that was not planned in Stage 1 of the pre-registration. We computed the correlations across the social and linguistic factors (reported in Table 6). *Comprehension* correlated with social factors; the higher the score for *Comprehension*, the higher the score for *Affect* and *Solidarity* for the three speakers. *Comprehension* correlated with *Status* only for the foreign speakers. *Accent* correlated with *Affect* and *Solidarity* only for the Reported candidate. Subsequently, *Affect* correlated with *Status* and *Solidarity* for all the speakers; the higher the score for *Affect*, the higher the score for the other two factors.

Table 6. Details of the correlation analyses between linguistic factors (*Accent* and *Comprehension*) and social factors (*Affect, Status* and *Solidarity*). The coefficient of correlation, *t-* and *p-*values are reported. Significant values are in bold.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Native candidate | | | Foreign candidate | | | Reported candidate | | |
|  | *r* | *t* | *p* | *r* | *t* | *p* | *r* | *t* | *p* |
| *Accent* in relation to *Affect, Status* and *Solidarity* | | | | | | | | | |
| *Affect* | -0.06 | -0.35 | .72 | -0.05 | -0.27 | .79 | -0.39 | -2.34 | **.03** |
| *Status* | -0.16 | -0.92 | .36 | 0.09 | 0.52 | .60 | -0.25 | -1.45 | .16 |
| *Solidarity* | -0.95 | -0.53 | .60 | 0.09 | 0.51 | .61 | -0.37 | -2.24 | **.03** |
| *Comprehension* in relation to *Affect, Status* and *Solidarity* | | | | | | | | | |
| *Affect* | 0.50 | 3.23 | .**002** | 0.71 | 5.65 | **.001** | 0.80 | 7.39 | **.001** |
| *Status* | 0.27 | 1.55 | .13 | 0.51 | 3.30 | **.002** | 0.58 | 3.99 | **.001** |
| *Solidarity* | 0.57 | 3.89 | **.001** | 0.49 | 3.15 | **.003** | 0.72 | 5.73 | **.001** |
| *Affect* in relation to *Status* and *Solidarity* | | | | | | | | | |
| *Status* | 0.73 | 5.95 | **.001** | 0.65 | 4.82 | **.001** | 0.56 | 3.82 | **.001** |
| *Solidarity* | 0.77 | 6.66 | **.001** | 0.76 | 6.59 | **.001** | 0.75 | 6.28 | **.001** |

**Visual perception of the candidate**

Finally, as an extra measure not directly relevant for the main purpose of the current study, we tested whether *foreignness* and *processing fluency* affect the visual perception of the candidate. Based on Foucart et al. (2019), we ran an ANOVA with the factors Region (Frontal and Central sites) and Candidate as repeated measures within a 180-300 ms time-window. We expected to observe an ERP deflection more negative for the Foreign and Reported candidate than for the Native candidate, as that usually observed across social groups and races (Amodio, Bartholow, & Ito, 2014). The analysis revealed no significant differences across the three candidates. More research is needed to investigate whether foreign accent affects the visual perception of the speaker.

**Discussion**

The study investigated to what extent the negative bias towards accented speakers originates from the speaker’s identity (*foreignness*) and from the difficulty to process the way they speak (*processing fluency*). More precisely, we tested Mai and Hoffmann’s (2014) theory that the bias may originate from both *foreignness* and *processing fluency*, in that *processing fluency* may be a process secondary to the social identity effect. We tested this hypothesis by putting participants in a situation similar to that they experience when listening to politicians speaking with a foreign accent (which conveys both *foreignness* and *processing fluency*) or when their statements are reported by a translator (which conveys *foreignness* only). The main measures were the behavioural and neural responses to sentences spoken in native and foreign-accented speech that contained true, false or unknown information. We also used a debriefing to investigate whether native and foreign speakers are evaluated differently (negative bias) on social and linguistic factors.

Pre-registered results.

In the behavioural answers, we were particularly interested in the evaluation of sentences that contained unknown information, when participants had to rely on the speaker’s knowledge. Results revealed that the truth evaluation was independent of the speaker. The absence of significant differences across speakers suggests that neither *foreignness* nor *processing fluency* affected truth evaluation. In other words, foreign speakers were not perceived as less credible than native speakers. Our results depart from Lev-Ari and Keysar’s (2010) who found that trivia statements spoken by foreign-accented speakers are rated as less true than those spoken by native speakers. These authors advanced that because foreign-accented speech reduces processing fluency, speakers come across as less credible. However, given that these results were not reproduced (Baus et al., 2019; Frances et al., 2018 (regional accent); Souza & Markman, 2013; Stocker, 2017) or only partially (Hanzlíková & Skarnitzl, 2017; Podlipský et al., 2016), the impact of foreign-accented speech on credibility cannot be generalised, and further research should investigate under which conditions it occurs. Note that, surprisingly, True sentences had a higher score when spoken by the Reported candidate than by the Native candidate or the Foreign candidate. We did not have a hypothesis for this type of sentence, nor do we have a clear interpretation of this result.

The pre-registered ERP data showed no significant differences across speakers at neural level in the N400 time-window, which implies that neither *foreignness* nor *processing fluency* impacted lexico-semantic processing. Nevertheless, the interpretation of the results is interesting for the language literature. First, even though it was not the main interest of the study, the ERP data bring information regarding processing of world knowledge violations, which, to our knowledge, have not yet been investigated in foreign-accented speech with ERPs. The results suggest that processing did not differ systematically, independently of the speaker’s accent. Moreover, remember that previous studies investigating foreign-accented speech processing have reported conflicting results in response to *semantically correct* sentences7. While Goslin et al. (2012) found reduced N400 amplitude for foreign-accented speech compared to native speech, Song and Iverson (Song & Iverson, 2018) found the reverse pattern. Romero-Rivas et al. (Romero-Rivas et al., 2015) initially found a more negative N400 for foreign-accented speech compared to native speech, but this difference disappeared across the experiment. We found no difference across speakers in the N400 time-window on the critical word for True sentences, not even at the beginning of the experiment, suggesting that lexico-semantic processing was not affected by accent. However, our results cannot be generalised given the different results reported in the literature. We propose tentative explanations to account for these differences.

First, the absence of adaptation (reflected in Romero et al.’s study by an initial larger N400 component for foreign-accented speech than for native speech that gradually reduced across the experiment) may not necessarily mean that adaptation did not occur. Indeed, Romero et al.’s participants listened to various foreign-accented speakers, whereas here, we only used one speaker per accent. It is possible that our participants adapted to the accent after listening to only a few sentences (Bradlow & Bent, 2008. but see, Floccia et al., 2009), and hence, the modulation of the N400 at early stages of the experiment may have been invisible when looking at the entire block (and looking at only the first few sentences would not give enough power). Moreover, the difference of results between our study and Song and Iverson’s (2018) and Goslin et al.’s (2012) may be explained by the cloze probability of the sentences. Goslin et al. found a reduced N400 for foreign-accented sentences with low close probability; Song and Iverson found a larger N400 for high than low predictability sentences. Although we did not manipulate cloze probability in our study, it cannot be discarded that predictability may have affected semantic processing in foreign-accented speech in our experiment (see Romero-Rivas, Martin, & Costa, 2016, for a reduction of anticipatory mechanisms in foreign-accented speech). These explanations are speculative as they cannot be confirmed by our results, and the difference of results across studies looking at sentence processing and foreign accent may have various origins, such as ‘auditory-phonetic processing, linguistic knowledge, and attention’, as mentioned by Song and Iverson. Overall, the pre-registered hypotheses for the behavioural and ERP data were not confirmed, as they did not show any significant differences between native and foreign candidates.

Exploratory results.

To discard the possibility that the absence of difference between sentences spoken in a native accent or a foreign accent be due to the fact that participants did not perceive any difference between the accents, we conducted an exploratory analysis that was not pre-registered. At the beginning of the sentence, we observed a reduction of an early component (P200) for the Foreign candidate compared to the Native candidate, like in Romero-Rivas et al. (2015). This result suggests that *processing fluency* renders more complex the extraction of acoustic features used for phonological and phonetic processing. The P200 for the Reported candidate was not significantly different from either that reported for the Native or for the Foreign candidate. Although no clear conclusion should be drawn from a null result, this observation implies that even though a native speaker recited the sentences originally uttered by the Reported candidate, her speech was not processed differently from the Foreign candidate’s (but neither from the Native candidate’s). Thus, it seems that *foreignness* is a factor from the speaker’s identity that might affect early processes of speech processing (extraction of acoustic features). This is in line with previous studies showing that the speaker’s indexical properties affect semantic processing (Foucart et al., 2015, 2019; Santamaría-García, 2014; Van Berkum et al., 2008). Examining the effect of foreign accent on phonological/phonetic processing was not originally planned in this study, but given that, to our knowledge, no ERP studies have investigated reported speech processing, this observation (even though it should be considered with caution) is a starting point to further study the effect of the identity of the person who utters the message versus the identity of the person who reports it on speech processing.

The debriefing scores showed that *Affect* was significantly lower for the Foreign candidate than for the other two candidates, which is in line with Dragojevic and colleagues’ claim that *processing fluency* impacts *Affect* (Dragojevic, 2019; Dragojevic & Giles, 2016; Dragojevic et al., 2017). This idea was reinforced by the fact that the easier *processing fluency* (as reflected by the score for *Comprehension*), the higher the score for social factors (*Affect, Status and Solidarity*), as revealed by exploratory correlations across social and linguistic factors (not pre-registered). While the correlation with *Comprehension* was true for all the candidates for *Affect* and *Solidarity*, it was only true for the two foreign speakers regarding *Status*. Like Dragojevic and colleagues, we also observed that the negative effect of *processing fluency* on *Affect* impacted other social factors; indeed the lower the score for *Affect*, the lower the score for *Status* and *Solidarity* for all the speakers. These results support the argument that when *processing fluency* is reduced and cognitive resources are highly taxed, negative affect is generated (compared to easily decoded speech information, which generates positive affect), and as a result, this negative affect determines how the speaker is perceived. The pre-registered correlation between the percentage attributed to the speakers for each factor and the magnitude of the N400 effect was not significant, suggesting that the perception of the speaker did not modulate sentence comprehension.

Overall, although the pre-registered behavioural and the ERP data in the N400 time-window did not show significant differences across speakers, the results of the debriefing and the exploratory analysis on the phonological/phonetic perception of the speaker converge with the hypothesis that both *foreignness* and *processing fluency* play a role in the negative bias towards foreign-accented speakers. In various measures, when the data provided strong support for the differences between the Foreign candidate and the Native candidate, data for the Reported candidate were not significantly different from neither candidates, which suggests that although participants listened to native speech, the (foreign) identity of the speaker who had originally uttered the sentences was also processed. Hence, although we cannot draw strong conclusions from this null result, our findings go in the direction of Mai and Hoffmann’s (2014) proposal that accent induces a social identity effect (immediate categorisation of the speaker as out-group member) that is later reinforced by *processing fluency*, which is consistent with the idea that disfluency increases out-group status (Gluszek & Dovidio, 2010; Pearson & Dovidio, 2014).

To conclude, this study shows that foreign speakers are not necessarily perceived as less credible (as previously reported), but that accent negatively affects the evaluation of the speaker on social factors (e.g., *Affect, Status* and *Solidarity*). We did not find an impact of accent on semantic processing, but given that other studies did, more research should be conducted to better understand foreign-accented speech processing. The findings suggest that although the difficulty to understand accented speech reinforces the negative bias towards foreign speakers, the simple fact of the speaker being an out-group member also seems to have an impact to a lesser extent. Thus, independently of whether they speak with a foreign accent or whether they have their statements translated, foreign politicians may still be perceived more negatively than natives. The awareness of this bias might lead to reduced discrimination towards foreign speakers in our multilingual society.

**Footnotes**

1- Throughout the paper, we refer to ‘processing fluency’ as the ease with which information is processed (Alter & Oppenheimer, 2009). As in previous studies, we expect accent to affect processing fluency (Dragojevic & Giles 2016; Dovidio & Gluszek, 2012; Frances, Costa, & Baus, 2018; Lev-Ari & Keysar, 2010; Mai & Hoffmann, 2014; Podlipský, Šimáčková, & Petráž, 2016; Roessel, Schoel, Zimmermann, & Stahlberg, 2017; Souza & Markman, 2013; Stocker, 2017). Here, processing fluency is not an indicator of the speaker’s proficiency at semantic or syntactic level, but an indicator of the ease to process the speaker’s global accent, which comprises prosody along with the repertoire of sound units and their combinations (Major, 2001).

2- We performed a statistical power analysis to estimate the required sample size, based on data from a study we previously conducted with the same materials (Foucart et al., 2019). The study included 20 participants, three Sentence Types (True, Unknown and World Knowledge violation sentences) and three different speaker conditions. Therefore, the experiment was similar to the proposed one, with the exception that sentences were written, not spoken (only the speakers’ photo were manipulated). In the power analysis, we focused on the main effect of Candidate. The partial eta squared in this study was 0.18. With an alpha = .05 and power = 0.95, the anticipated sample size required to obtain a significant main effect of Candidate with this effect size is approximately N = 21.

3- To ensure there was no difference across candidates, we pre-tested the written version of the texts on 7 people who did not take part in the experiment and were unaware of its aim. We asked them to evaluate three different features of each speaker (i.e., friendliness, success at work, level of education) by indicating from 1 (not at all) to 10 (very much) a) how friendly the candidate seemed, b) how successful she looked in her work, and c) how educated she seemed. The overall ratings tended to be slightly lower for Silvia (mean: 7, SD: 2) than for Heleen (mean: 7.7, SD: 1) and Sofia (mean: 7.8, SD: 2) (F(1, 2), 3.59, p=.06, =.37), but there was no interaction between the candidate and the features (F(1, 4), 1.16, p=.35, =.16).

4- There was no previous data/study with enough information to conduct a power analysis to estimate the required sample size for the behavioural task, the closest one would be Lev-Ari and Keysar’s (2010), but the correlation in the paired t-tests was not included, therefore, it was not possible to calculate an effect size from this study. With a sample size of 32 (as estimated in the power analyses for the other measures), we should be able to detect with an 80% power any effect equal to or bigger, that corresponds to a partial eta square of ~0.065 that is classified as medium effect size (Miles & Shevlin, 2001).

5- The P200 has received various interpretations in the literature, however, since our study manipulated similar experimental conditions (e.g., correct sentences spoken in native or foreign accent) as in Romero-Rivas et al. (2015), we opted to adopt the interpretation they proposed to facilitate comparison across studies.

6- We performed a statistical power analysis to estimate the required sample size based on the preliminary data from another study we conducted with the same materials. The study included 17 participants. With an alpha = .05 and power = 0.95, the anticipated sample size required to obtain a significant correlation with this effect size was approximately N = 32.

7- Studies such as Hanulikova et al.’s (2012) and Grey and Van Hell’s (2017) also investigated the impact of foreign accent on semantic processing taking the N400 as marker, but since they used semantic violations, our results are not directly comparable

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**Supporting Information**

Additional Supporting Information may be found in the online version of this article at the publisher’s website:

**AppendixS1**. Cover story and instructions provided to participants.

**AppendixS2**. Dutch version and translation into English of the speakers’ introduction script.

**AppendixS3**. The 180 triplets in Dutch used in the listening phase.

**AppendixS4**. Questions asked during the debriefing phase.

**AppendixS5**. Figure 2-Supp. a, b and c

**AppendixS6**. Figure 5