The role of pitch and speech rate as markers of deception in Italian speech

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Abstract

Speakers of all the world's languages lie. Given this, it is surprising that there has been little investigation of linguistic markers of deception in languages other than English. Here we investigated two linguistic markers of deception in native speakers of Italian: pitch and speech rate. True and false opinions were elicited in an audio-taped interview. A within subjects analysis revealed no significant difference between the average pitch of the two conditions; however, speech rate was significantly slower during deception compared with truth-telling. These results demonstrate the importance of cross-linguistic studies in research on linguistic markers of deception.

Index Terms: Deception, lies, cross-linguistic, linguistic markers of deception, Italian

1. Introduction

A meta-analysis of 206 studies revealed that humans perform near chance when making veracity judgements [1]. In an effort to increase deception detection rates researchers have turned to more objective methods such as analysis of language behaviours. Language can provide a window into the cognitive and emotional processes associated with deception. Previous research has investigated the utility of several linguistic cues to deception; however, this research has focussed primarily on speakers of English. People do not only lie in English, they lie in every language. Thus, it is important to examine linguistic markers of deception in languages other than English. Here, we examined two potential markers of deception in Italian speech: pitch and speech rate.

1.1. Cues to deception

A seminal paper proposed that deceivers unconsciously and involuntarily 'leak' cues to deception [2]. While Ekman and Friesen [2] originally proposed the leakage hypothesis in relation to physical behaviours such as facial expressions and hand and leg movements, Zuckerman, DePaulo and Rosenthal [3] extended this to vocal behaviour.

The leakage hypothesis was further expanded upon via the four-factor theory [3] which proposed that the emergence of specific cues to deception is moderated by four factors: arousal, emotion, cognitive load and behavioural control. Deceivers are thought to experience increased arousal when lying. This then leads to certain autonomic behaviours associated with arousal such as increased pitch or speech disturbances which act as cues to deception. The emotion experienced by the deceiver is closely linked to that of arousal in that autonomic behaviours can also be elicited by emotions that often accompany deception, such as guilt or anxiety. The third factor proposed by Zuckerman and colleagues [3] is based on the premise that lying is a complex task and therefore the cognitive load required to lie is greater than that required to tell the truth. The deceiver must formulate a lie and then retain the fabricated details in their memory. Finally, the leakage of cues can be attributed to attempts on behalf of the deceiver to control their own behaviour. Too much control could result in telling cues such as flat affect.

1.2. Cross-linguistic research

Despite the fact that lying occurs in all of the world's languages, few studies have examined how linguistic cues to deception manifest in speakers of a language other than English. Previous studies of deception cues in other world languages have mostly focused on verbal content cues or nonverbal behaviours [e.g., 4]. As such, there is a distinct lack of research into the reliability of linguistic markers of deception in languages other than English. In Australia, Italian is the second most commonly spoken language after English [5], so it was considered an appropriate language for the current study. Moreover, as the dataset used by Villar and colleagues was useful in determining cross-linguistic *lexical* markers of deception [6] (e.g., regarding the use of pronouns) we used it here to examine cross-linguistic *speech* markers of deception.

1.3. Current study

The two linguistic variables chosen for the current study were pitch and speech rate. While pitch has emerged as having a robust relationship with deception in research conducted with native speakers of English, the results of investigations into changes in speech rate in the presence of deception are equivocal. Each of these variables is outlined in detail below.

1.3.1. Pitch

Pitch refers to the perceptual correlate of fundamental frequency (F0). F0 is measured in Hertz (Hz) and as the F0 of a signal increases, so the pitch is perceived to increase. The average F0 for an adult male is between 100 and 150 Hz and for an adult female between 175 and 250 Hz [7]. F0 can be measured using computerised acoustic analysis programs, such as Praat [8].

Pitch has been examined extensively in the deception literature. Contrary to the findings of Sporer and Schwandt's [9] meta-analysis, some studies have reported perceived pitch to be lower in the deceptive speech condition when compared to truth-telling [e.g., 10]. The majority of studies, however, support Sporer and Schwandt's results in that pitch is generally observed to be higher during deception compared to truth-telling. Increased pitch has been associated with lying via both acoustic and perceptual measures [11].

When measuring the F0 of speech, a range of approaches may be taken [7]. The majority of deception research has examined mean, range and variance of fundamental frequency in connected speech using a within subjects design to compare truthful versus deceptive speech [e.g., 11, 12, 13]. Some studies have removed silent segments before analysis [e.g., 12], although most do not provide detail regarding speech sample editing. Looking outside the deception literature, many studies that have measured average, range or variation of F0

do not appear to edit the speech samples prior to analysis [e.g., 14, 15]. As such, the current study did not alter the speech samples. Mean F0 of the entire utterance is frequently reported in the deception literature [e.g., 11, 13], therefore this method was selected for the current study.

1.3.2. Speech rate

Speech rate refers to the speed with which someone speaks. It can be measured in a variety of units per second such as words, syllables and phonemes. There is a high degree of variation in the speech rate of individuals within languages [16]; however, the average articulation rate of spontaneous Italian speech has been estimated at 4.9 syllables and 3.4 words per second [17].

In the deception literature, speech rate is typically measured in either words or syllables per second by counting the number of words or syllables in a speech sample and dividing this by the acoustic length (in seconds) of the sample [e.g., 11, 18-22]. A measure of words per second is less labour intensive and therefore more practical than others mentioned (i.e., phonemes).

There are inconsistencies in the literature regarding the relationship between speech rate and deception. Sporer and Schwandt [9] reported a non significant increase in speech rate during deception compared to truth-telling. This is evident in the results of a few studies [21, 23]; none of which were statistically significant. In other studies, speech rate has been shown to decrease significantly in deceptive speech when compared to truthful speech [22, 24, 25]. It has also been observed that a slower speech rate tends to be more often taken as a cue to deception rather than increased speech rate [11, 20, 26]. The link between decreased speech rate and deception has been attributed to increased cognitive load [22].

In the current study speech rate was compared in a within subjects design where all of the participants speak the same language. This is important due to variability in speech rate across individuals. Speech rate was calculated by dividing the total number of words by the acoustic duration (in sec) of the entire utterance.

1.4. Summary

Previous research has investigated the utility of several linguistic cues to deception. While some of these appear to have rather robust relationships with deception, the effects of lying on other variables remain equivocal. Of these potential deception markers, pitch and speech rate were selected for the current study. Although pitch and speech rate have been identified in the research as markers of deception in the speech of native speakers of English [9], the utility of these markers is yet to be determined in a language other than English.

Drawing on previous research conducted on English speakers it was hypothesised that pitch would be higher in deceptive speech compared to truthful speech. In relation to the variable of speech rate, due to inconsistencies in the findings of previous studies, the direction and significance of change during deception compared with truth was an open empirical question.

2. Method

2.1. Participants

The participants were 19 native speakers of Italian (12 females and seven males) with a mean age of 56.1 years (*SE* = 3.36). These participants were born in Italy and received their entire education in Italy. They were recruited in Sydney, Australia through advertisements in a local Italian newspaper, flyers posted at Italian community organisations and through word of mouth (all written in Italian). Level of education ranged from primary school to university.

2.2. Procedure

A false opinion paradigm was employed [as per procedure described by 27]. Recruitment materials referred to the study as an investigation of communication skills relating to social issues in order to avoid attracting participants with a particular interest in deception. Each participant took part in an individual session of approximately 30 minutes conducted by a researcher who was a native speaker of Italian. All materials and consent forms were provided in Italian. The entire session was conducted in Italian.

Participants completed a questionnaire to determine their opinions on various social issues. These social issues included; smoking in public, capital punishment, legalisation of marijuana, legalisation of abortion, same-sex marriage, sex offender registry, church versus state and the blood-alcohol limit.

Participants were asked to rate how strongly they agreed or disagreed with each social issue (*'1' = completely disagree, '7' = completely agree)* as well as how strongly they felt about the issue (*'1' = No feelings, '7' = Very strong feelings)*. Two issues were then selected per subject, where possible these were topics about which the participants reported strong opinions (i.e. provided a rating of either '1' or '7') and strong feelings (i.e. provided a rating of '7').

Participants were then informed that an audio-taped interview would be conducted in relation to some of the issues covered in the questionnaire. A Sony Digital Voice Recorder, with a frequency response of between 80Hz and 20,000Hz was used to record the interviews. The audio files were stored in uncompressed linear PCM (.wav) format. Of the two issues selected, participants were randomly assigned to lie about one of these issues and tell the truth about the other. For the truthful speech condition, participants were instructed to provide an honest account of their opinion. For the deceptive speech condition participants were instructed to provide a false representation of their true opinion with the aim to convince the interviewer they were telling the truth. Participants were also informed that the interviewer would be unaware of whether they were lying or telling the truth. Topic presentation was counterbalanced so that half the participants started the interview with a lie and half by telling the truth.

2.3. Data preparation and analysis

All interviews were transcribed by a native speaker of Italian. Audio recordings were analysed using Praat software [8] to determine the pitch and length of utterance (used to calculate speech rate). Truthful and deceptive speech samples were analysed separately for each participant. The average pitch was calculated for the entire speech sample. The female speech samples were analysed within a pitch range of 75-500 Hz and the male speech samples within a pitch range of 75-300 Hz, as per the Praat software instructions [8]. Speech rate was calculated by dividing the number of words in the entire speech sample by the duration of the sample in seconds (determined using Praat software). The word count was obtained via the transcription and included all interjections such as "erm" and "um" since recent literature has suggested

that these utterances are not filled pauses or hesitations but have a lexical status similar to other words [28]. In determining significant differences between conditions, parametric analyses were appropriate in most cases. In cases where non-parametric analyses were conducted we explain why.

3. Results

3.1. Word count

The average number of words produced in the deceptive speech condition was 189.63 (*SE* = 17.21). The average number of words in the truthful speech condition was 218.84 (*SE* = 20.27). A paired samples t-test revealed no significant difference between these means, $t(18) = 1.162$, $p = .260$ (two-tailed). The following are examples of speech used to argue for, and against, the legalisation of marijuana; "No, io non sono assolutamente d'accordo su questo perché, secondo me, essendo una droga, fa male," (*No, I am in absolute disagreement with this because, in my opinion, being a drug, it is harmful)* and "Sì, penso di sì, perché in molti casi si è visto che aiuta molto, ehm, i giovani a rilassarsi" (*Yes, I think so, because in many cases one can see that it helps, um, young people to relax).*

3.2. Length of utterance

The average length of the utterances in the deceptive speech condition was 100.20 (*SE* = 9.46), and in the truthful speech condition was 104.03 (*SE* = 9.70). A two-tailed paired samples t-test showed no significant differences between these means, $t(18) = .322$, $p = .751$.

3.3. Pitch

The average pitch of the participants in the deceptive speech condition for the entire sample was 160.88 Hz (*SE* = 7.73), and in the truthful speech condition was 160.67 Hz (*SE* = 7.19). A paired samples t-test revealed no significant difference between the means, $t(18) = .093$, $p = .927$ (two-tailed). As pitch is known to differ across females and males, additional analyses were performed. The average vocal pitch (in Hz) of female speakers was 178.14 (*SE* = 6.24) during their truthful utterances and 180.21 (*SE* = 6.50) during their deceptive utterances, while the average male vocal pitch was 130.74 (*SE* = 7.87) during their truthful utterances and 127.76 (*SE* = 8.04) during their deceptive utterances. As expected, an analysis of gender effects on pitch production, a 2 (veracity: lying vs. truth-telling) x 2 (gender: male vs. female) mixed ANOVA revealed a significant main effect of gender ($F(1,17) = 24.632$, $p < .0001$, partial $\eta^2 = .592$). However there was no significant main effect of veracity ($F(1,17) = .037$, $p = .850$, partial $\eta^2 = .002$) and no interaction between gender and veracity ($F(1,50) = 1.147$, $p = .299$, partial $\eta^2 = .063$).

3.4. Speech rate

The average speech rate (in words per second) of the participants was slower in the deceptive speech condition (*M* = 1.95, *SE* = 0.08) compared to the truthful speech condition (*M* = 2.10, *SE* = 0.07). A paired samples t-test revealed a significant difference between the means, $t(18) = 2.454$, $p = .025$ (two-tailed), with a small effect size, $r = .22$.

4. Discussion

We set out to determine whether linguistic markers of deception that have been observed in native speakers of English would also occur in the deceptive speech of native speakers of Italian. Specifically, we examined the possibility of differences in pitch and speech rate between truthful and deceptive Italian speech. Each of these variables has been identified in the literature as reliably linked to deception in English speech [9, 25].

Comparison of the mean pitch across truthful and deceptive conditions revealed no significant difference. We did find a significant difference between the average speech rate for the two conditions. Speech rate was significantly slower in the deceptive speech condition compared to the truthful speech condition.

4.1. Pitch

Previous studies have identified the utility of pitch as an indicator of deception in studies of English. Why is it that we found no effects of pitch in the deceptive speech of Italian speakers? If we refer back to the four factor theory [3] it is possible that any potential increase in pitch due to increased arousal may be negated by deceivers' attempts to control their behaviour. According to studies investigating beliefs about cues to deception, increased pitch is among a set of perceived cues the general public believe to be associated with lying [e.g., 29, 30, 31]. It is possible that (at least some of) the subjects in our study may have been aware that increased pitch is a potential deception cue and consequently they consciously controlled this behaviour. On the other hand, a recent study aimed at examining similar beliefs about pitch found that participants who believed pitch would increase during deception were more likely to exhibit this behaviour when lying [32]. Therefore, while behavioural control may account for our pitch results, the results of the aforementioned study [32] suggest that this is an unlikely explanation. Further research into the effect of beliefs on behaviour during deception is required to clarify this.

It is possible that we did not see the difference in pitch that we expected due to the manner in which the lies were elicited in our study. Sporer and Schwandt's [9] meta-analysis analysed data as a function of lie content. Pitch was found to be significantly higher during deception when participants lied about 'facts and feelings'; however, no significant results were found when the lie was related to 'facts only'. This supports the assumption that deceivers are more likely to experience increased arousal and therefore use increased pitch when lying about a topic that elicits strong emotions. Although we did select topics about which participants felt strongly our paradigm may not have elicited emotions that were strong enough to be accompanied by pitch changes. However, it is important to note that our paradigm was effective in eliciting differences in speech rate in deceptive versus truthful Italian speech. Thus, it is conceivable that there is a genuine difference in the way speakers of English moderate pitch (consciously or otherwise) during deception in comparison with speakers of Italian.

4.2. Speech rate

There are inconsistencies in the literature with regard to whether a speaker will use a faster or slower rate of speech when lying compared to when telling the truth. One of our aims in conducting this study was to add to the existing body

of research regarding the relationship between deception and speech rate. Our results are in line with several studies that have found speech rate to be significantly slower during deceptive speech [22, 24, 25]. Sporer and Schwandt [9] proposed that the increased cognitive load experienced during deception is due to increased demands on working memory. In other words, when a pre-existing schema or script is not available, which is the case during lying, the formulation of novel ideas is required. This increases the load on the working memory, leaving less capacity available for speech production, which in turn causes the deceiver to speak more slowly as they attempt to manage the increased load [22].

4.3. Future Research

Given that much of the world's population is now bilingual or multilingual, it would be interesting to investigate whether an individual's use of deception cues varies according to which language they are speaking. While all the participants in our study were native speakers of Italian, born and educated in Italy, they were currently residing in Australia. It is likely that some participants were bilingual. However, we think it unlikely that bilingual status would have a systematic impact upon truth-telling and lies in a native language in a way that could explain our results. Still, it would be interesting for future research to compare linguistic markers of deception in bilingual speakers by examining truth and lies in each language that the participant speaks.

4.4. Conclusion

People do not only lie in English, they lie in every language. Yet, very little research has examined linguistic markers of deception in languages other than English. In a first for deception research this study investigated the effects of veracity on pitch and response latency in the speech of native speakers of Italian. We observed that changes in speech rate are associated with deception in the speech of native speakers of Italian. While we have speculated about why we did not find corresponding changes in pitch in deceptive Italian speech, more research is required before any firm conclusions can be drawn.

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