

Automatic Detection of Deception

Atanasova M., Comita' P., Melina S., & Stoyanova M.

Abstract

The present research portrays an attempt to automatically detect deception. Specifically, the goal was to study and analyze nonverbal visual cues related to deception in order to better understand if and how a particular social signal(s) can be considered a manifestation of lying behaviour. To reach this aim, forty slices of YouTube videos, divided in experimental (denial condition) and control (truthful condition) categories, were selected and automatically analyzed by a dedicated software. The results showed that the intensity of a number of FAUs (Facial Action Units) was found to vary with the nature (true/false) of the analyzed statements.

Keywords: Automatic detection, Deception, Emotions, Non-verbal cues, Facial expressions, CERT.

Introduction

For many years, emotions expressed in the face have been successfully studied to build up and interpret a set of so called six “basic emotions”: happiness, anger, disgust, fear, sadness and surprise (Ekman, Sorenson, & Friesen, 1969). Nevertheless, detecting subtler expressions such as those of deception has been found even more difficult, especially when the detectors are human observers because cues to deception differ from person to person (Malone & DePaulo, 2001).

In the present research, the scope was to study the expressions of deception using videos, taken from YouTube, of famous people known for having lied, in order to explore the differences showed by, for instance, a sportsman in two different moments of his agonistic career: one moment in which the person was interviewed about the usage of doping (denial condition), and another moment in which the subject was admitting the usage of doping (truthful condition). Indeed, as it is well known that nonverbal cues provide a rich source of information about an individual's emotions and social intentions (Wilson & Wharton, 2006), the intention here was to understand at what degree it is possible to automatically detect such nonverbal cues related to deception; nonverbal cues have been automatically coded by means of software, with the scope of increasing the results' objectivity.

To be more specific, the addressed research question was: to what extent is it possible to automatically detect deception using facial cues?

However, prior to the explanation of the experiment, it is a good praxis to consider the theoretical framework in which previous research in this field is situated, looking at the specific relation between facial expressions and deception.

Theoretical framework

Deception

Although people's main method to detect truth is focusing on someone's speech content checking whether the different statements are consistent (Granhag & Vrij, 2005), as observed by DePaulo (1992), nonverbal communication might actually reveal more than speech (in Vrij, 2006).

In fact, studies show that, while deceiving, people leak some kind of information in their nonverbal behavior. This phenomenon, known as leakage, (Warren, Schertler & Bull, 2009) enables to study facial expressions, which, together with auditory features, are considered the best predictors for deception (DePaulo, Stone & Lassiter, 1985; Zuckerman & Driver, 1985). Leakage in facial expression can be distinguished in two categories: subtle expressions and micro-expressions. Subtle expressions occur frequently (especially in high intensity emotional displays) and should be relatively perceptible to the trained eye. Micro-expressions occur mainly when an emotion is concealed or masked; in this case, the true emotion is manifested as a micro-expression, a fleeting expression suppressed in 1/25–1/5 of a second, making it difficult to perceive with the naked eye (Porter, ten Brinke, & Wallace, 2012).

There are different reasons which underlie the importance of nonverbal communication for detecting deception. Firstly, the predominance of words in the exchange of information makes people more aware of what they utter while nonverbal behavior remains unconscious. Secondly, people communicate nonverbally even when people refrain from speech (DePaulo & Kirkendol, 1989).

According to Zuckerman, DePaulo, and Rosenthal (1981), there are three factors that could influence cues to deception thus affecting a liar's nonverbal behavior. These are emotional reactions, content complexity, and attempted behavioral control. Generally, fear, guilt and delight are the emotions associated with deception. Guilt might be associated with the fact that the individual is lying, fear might be associated with the possibility of getting caught and delight with having the opportunity to deceive someone. However, the emotions displayed depend on the context and on the personality of the individual. Different emotions lead to different nonverbal behaviors and the stronger an emotion is, the easier it is to detect deception through these factors (Ekman, 1985/2001).

Telling a lie is a cognitively demanding task, especially “when the lie is not well prepared or rehearsed” (in Vrij, 2006, p. 343). As a consequence, liars tend to “make more speech hesitations (e.g., slutters) and speech errors, speak slower, pause more, and wait longer before giving an answer” (in Vrij, 2006, p. 343). As to nonverbal behavior, content complexity implies fewer hand and arm movements

(Ekman & Friesen, 1972) and gaze aversion since a direct contact in the eyes of the interlocutor may be distracting (Doherty-Sneddon, Bruce, Bonner, Longbotham, & Doyle, 2002). During deception it is possible that liars try to suppress the behavior that they believe is suspicious but they often do not succeed since the liar “must produce a credible verbal message while projecting a credible verbal-behavior simultaneously” (as cited in Vrij, 2006, p. 344).

In fact, as stated by Hocking & Leathers (1980) behavioral control results in a complex activity during which, from the one hand, the liar attempts to suppress nervousness while, from the other hand, he masks evidence of having to think hard. Simultaneously, the liar should “be able to show honest-looking behaviors and avoid dishonest looking behaviors” (as cited in Vrij, 2006, p. 343).

The absence of a fixed set of cues to detect deception makes it more difficult to detect when a person is lying. De Paulo et al. (1982) proposed a fixed set of cues involving ten visual and nine auditory features through which it should be possible to accurately recognize deceptive behavior. However, later researches by DePaulo et al. (1997), Ennis, Vrij and Chance (2008) and Vrij and Mann (2004) showed that it is not possible to delineate a fixed set of features because of individual differences in cues during deceptive situations, thus the fixed set of cues was rejected.

For an accurate detection of deception, individual and situational differences must be taken into account. Both interpersonal and intrapersonal differences must be considered since behavior varies across individuals and situations. In particular, knowing how an individual behaves in the former setting may be helpful to establish how the behavior will be affected in the latter setting (Vrij, 2006).

Also honest and dishonest demeanor bias, which depend on personal traits, play an important role since in normative behavior people can give the idea to tell the truth (honest demeanor bias) or to lie (dishonest demeanor bias). Of course, people whose normative behavior looks suspicious are in a disadvantage situation (Vrij, 2006). Even cross-cultural aspects must be taken in consideration since differences in behavior may be displayed differently across countries due to the fact that some nonverbal patterns like gaze are affected by culture and this may lead to *cross-cultural non-verbal communication errors* (Vrij, 2000). As to gaze pattern, this means that looking into the eyes of the interlocutor is considered as polite in some Western cultures while rude in others (Vrij & Winkel, 1991), so, in this case, avoiding gaze would have a different meaning which is not related to deception.

In conclusion, to make a reliable analysis of deception, it is necessary to have a comparable truth. In other words, it is necessary to make intra-individual comparisons where a true response of the same individual is compared with other responses (under investigation) uttered in the same situation (Vrij, 2006).

Method

As said before, the present study wanted to test if, and at what degree of accuracy, it is possible to automatically detect deception using nonverbal facial cues in order to reach a greater objectivity in respect of human observers.

Design

A quantitative research design was chosen for this experimental study and, in order to put it to use, one “experimental” condition and one “control” condition were created (between design). The dependent variable to manipulate was a deceptive situation, with the aim of better understanding how a particular social signal(s) can be considered a manifestation of lying behaviour. To reach this goal, the obtained data-set was analyzed looking for potential relations: measurements were statistically analyzed to determine which facial expressions were diagnostic for truthful or deceptive statements.

Material

Two different sets of videos were collected from YouTube in order to build up the necessary data-set to analyze: twenty videos for each aforementioned condition. To be more specific, each video in the experimental condition was showing just one subject in a denial situation, and each video in the control condition was showing just the equivalent same subject in a truthful situation.

The total length of each video was greatly different due to its non-laboratorial (not controlled) nature and, then, it has been necessary to make a selection of the perceived more deceptive part in each experimental video, and the same for the more truthful part in each control video. Thus, the videos have been cropped using Windows Movie Maker and, in order to be scientifically correct, for both conditions, one thin slice of exactly 10 seconds for each video was made, for a total of 40 slices.

Having the slices, the first step towards facial-expression analysis is face detection; the next step is to extract behavioral cues displayed by people. Those cues include video signals that convey the information about the behaviour of the detected person. They are the actual source from which socially relevant behavioral cues are extracted (Vinciarelli, & al., 2009). Consequently, the thin slices of the present experiment were analyzed using CERT (Computer Expression Recognition Toolbox - a facial recognition system that can detect basic emotions by analyzing facial muscle such as eyebrow or mouth movements and comparing this to a model).

Mean results were generated for specific Action Units tested by CERT and imported into SPSS (a software package used for statistical analysis). Action Units are important in a Non Verbal Communication analysis because are considered to be the smallest visually discernable facial movements and, being independent of interpretation, they can be used for recognition of basic emotions (Vinciarelli, & al., 2009).

Results

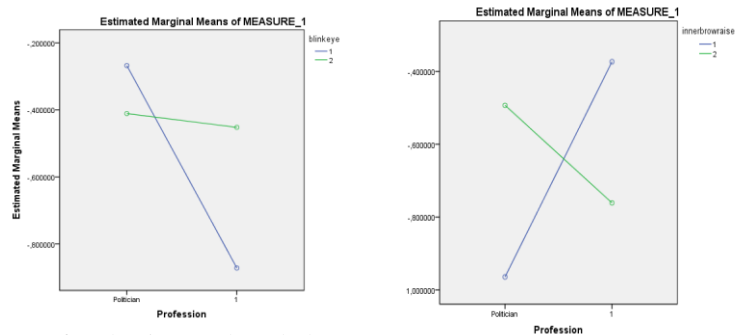
In order to analyze the results obtained, two types of statistical analysis were performed, paired t-test and Repeated Measures ANOVA. In this section only the significant results will be discussed and of course a few of the surprising results. Despite the claim of facial expressions are not reliable to detect deception, it appears that when participants were saying the truth, participants' lip corner ($M= 2.39, SD= .46$) were depressed significantly more than when they were lying ($M= 2.27, SD= .05, p= .04$). Furthermore, when people were being truthful they were pressing their lips tighter ($M=1.19, SD=.05$) than when they were untruthful ($M=1.03, SD=.038, p=.05$). As far as the pressing of the lips is concerned, participants were found to press their lips significantly less when they were admitting the wrongdoing ($M= -.04, SD= .07$) in comparison to when they were denying ($M=-.07, SD=.04, p=.05$). Another facial feature which differed in whether the truth was being said or a lie was the jaw drop. When people were saying the truth, they were articulating more ($M=.89, SD=.40$) than when they were lying ($M= .64, SD=.37, p=.04$). When the basic emotions were analyzed, a surprising result was obtained for joy. According to CERT, the participants were more joyful when they were denying ($M=.03, SD= .04$) in comparison to when they were truthful ($M=.02, SD=.01, p=.05$). Unfortunately, no significant differences were observed for the other basic emotions analyzed.

Nevertheless, since there were 10 videos which captured incidents with politicians and 10 of people from completely different fields of professions such as athletes, for the researchers was interesting to investigate whether and what kind of differences the profession would make (politician/ no politician). A Repeated Measures ANOVA showed significant interaction between profession and eye blinking ($F(1, 18) = 4.804, p=.04$) where politicians were found to blink significantly less when they were denying ($M= -.41, SD=.65$) in comparison to non-politicians ($M= -.45, SD=.36$). The same trend was observed when they were admitting the wrong doing ($M=-.27, SD=.44$) and when non-politicians were admitting ($M=-.87, SD=.71$). Another facial feature which was found to have significant interaction with profession was inner brow raise ($F(1, 18) = 5.350, p=.03$) where politician were raising their inner brows more often when they were telling the truth ($M= -.96, SD=.49$) than non-politicians ($M=-.37, SD=.50$). However, the opposite was observed when the people were denying. Politicians were found to raise their inner brows less ($M= -.49, SD=1.01$) compared to non-politicians in denying situation ($M=-.76, SD= .78$). Furthermore no interaction but main effect was found for joy ($F(1,18)= 27.463, p<.001$). Lip corner depressor was another feature which seemed to have no interaction but a main effect when profession is concerned ($F(1, 18) = 545.519, p<.001$). The same occurs for lip tighter, there is no interaction between profession but there is a significant main effect ($F(1, 18) = 146.710, p<.001$). Finally, the level of jaw dropping was also a

feature which had no interaction but a main effect on lying versus telling the truth ($F(1, 18) = 133.342, p<.001$).

The graphs below illustrate some of the interesting observations obtained during this research.

Fig. 1 Interactions between profession eye blinking and inner brow raise.



After having gathered these results, it was very surprising to see that some of the basic emotions where the researchers expected to observe significant differences between the truth and the lie conditions were not met. For instance, the researchers expected that when the subjects were telling the truth they would be significantly less angry than when they were denying. However in reality, there was no significant difference between the truth condition ($M= .08, SD= .09$) and the lying condition ($M=-.08, SD= .09, p=.09$). Additionally, fear was another emotion where differences were expected to be observed. According to the results, there was also no significant difference between the level of fear when telling the truth ($M= -2.96, SD=.32$) and when lying ($M= -2.85, SD=.35, p=.09$). Sadness was another emotion which was expected to show differences in the two conditions. However, the results demonstrate that there was no statistically significant difference when the participants were telling the truth ($M=.23, SD=.18$) and when they were denying ($M=.27, SD= .23, p=.37$). Finally, a difference was also expected in the pitch of the speakers. It would be presumed that when people tell truth their pitch would be somehow lower and significantly different from when they deny. Nevertheless, the results demonstrate no significant difference in the pitch when the participants tell the truth ($M= -.84, SD= 5.04$) and when they deny ($M= -1.51, SD= 5.02, p=.58$).

Another element where, however, the insignificance of the results did not surprise was when smiling was concerned. Since there was no difference between smile detected when the truth was being told ($M=.27, SD= 2.31$) and when the person was lying ($M=-2.32, SD=2.29, p=.46$), for the researchers this was logical. It is hard to believe that when people are publically confronted with wrong doing and their initial reaction is to lie that they would be joyful, the same would count for the opposite situation when not only do they have to admit the lie but also justify their actions.

Discussion

The results of this study have highlighted some significant outcomes. More particularly, out of the numerous action units and basic emotions that can be analyzed through CERT, there are only few that have been spotted to differentiated significantly within subjects. These are some lip and jaw movements.

On the one hand it can be speculated that the explanation of the lip results is hidden in the fact that people might be ashamed or angry of the fact that they have deceived their audience. This can be explained by the feature tight pressing of the lips. However, in general, the results show that the participants in this study tended to press their lips less when they were admitting their lies, which might be explained with finally facing their actions in a particular situation and subsequently accepting their consequences. Furthermore, the fact that the lip corner of the mouth is significantly more depressed in a situation of telling the truth can also be related to the possible situation that the participant in this study was not happy to admit a wrongdoing after already presenting a misleading statement to their audience.

On the other hand, another facial feature that showed significant differences within subject is the jaw drop movement. As the jaw is an important part of the articulation in people, it is assumed that these results show that the participants articulated more when admitting their previous behavior (i.e. when deceiving). As a result, it can be claimed that people tend to defend their behavior and wrongdoings through clearer speech and in a way that their words can be well understood by their audience.

In terms of the basic emotions, joy was the only one showing a significant result within this study. Interestingly, the participants had more joyful expressions in cases when they were deceiving their audience. It can be assumed that this might be a result of their inner joy that they were able to deceive other people and in return believe that these people trust the expressed claims.

Furthermore, this study has also been focused on differentiating the nonverbal behavior of politicians and non-politicians. In general, this difference has been assumed because by definition politicians are public figures and trained public speakers. On the other hand, non-political participants in this study vary from sportsmen to media magnates. On the contrary to the politicians, it is assumed that most of these figures do not have such an in-depth training in public speaking as politicians. This assumption has been supported by the results in eye blinking and inner brow raise. Politicians have shown a significantly less eye blinking in both situations of deceptions and admitting. This can be explained by their confidence in their statements. On the other hand, eye blinking could be recognized as a sign of a nervous tick which in both cases can be related to non-political figures due to the fact that they on the spot in situations where they do not feel comfortable in. Last but not least, there have been significant results in the raise of the inner brow of politicians both in times of deception and confession. These public figures have drastically raised their

inner brow more than non-politicians in cases when they were confessing. Moreover, they have done it less when denying a wrongdoing. It can be speculated that this phenomenon is a result of the fact that the raise of this feature could be related to the act of persuasion and convincing.

To summarize, some of the results in this study have not been proven to be significant. However, there are some features in human faces that have been recognized to confirm significant results in a deceiving and truthful setting. As a result, it can be claimed that the results of this study clearly demonstrate that nonverbal visual cues related to deception can be automatically detected via the software CERT.

Limitations

There are several limitations that have to be taken into account when evaluating the outcomes of this study. First, the focus will be on limitations related to the methodology of this paper and subsequently a couple of limitations will be highlighted in the context of the analysis of the results.

Arranging an experiment on a topic such as deception for a short period of time could be considered as a limitation by itself. However, more importantly it should be highlighted that the outcomes of this study have been based on only 40 videos, ten seconds each. Moreover, this fact could be one of the reasons why the results did not show many significant outcomes.

On the other hand, all videos were downloaded from the public website YouTube. As a result, the quality of all video parts can be questioned. There are some videos recorded based on face-to-face interviews between a reporter and a politician/non-politician. However, there are also videos recorded from a specific angle of a conference room, for example, which does not allow the viewer to see the facial expressions of the subject clearly.

Last but not least, CERT is a newly developed software. This means that some errors in the analysis were expected. Unfortunately there were some videos where the subject's face was not recognized by the program. However, these cases were not taken out of the results, due to the fact that this lack of recognition was present only for some parts of particular videos. Moreover, CERT is programmed to analyze only one face at a time. However, some of the examined clips include more than one face in the focus of the video. Subsequently, for a short period of time CERT has also included the analysis of the non-subject face in its final outcome on which the statistics have been based.

In terms of analysis, two main limitations have to be taken into account. First, it should be acknowledged that each person is an individual. As such, each individual may vary in terms of facial expressions, including their "neutral face". The fact that there is no "standard neutral face" may explain the results in different action unit movements. As mentioned earlier in the theoretical frame, this could also be the reason why scholars cannot agree on a certain set of action units which can be related to recognizing deception.

On the other hand, cross-cultural differences have to be taken into account. The sample cases used in this study are not based on public figures from the same nationality (e.g. American). The results have been based on the analysis of facial expressions of people from different cultural backgrounds – e.g. Italian, French, North American. As mentioned earlier in the theoretical background, the culture may play a role in the behavior of a person. That is why it can be considered that the significant differences in this study's results might be biased by culture.

Conclusion

The aim of this study was to objectively analyze nonverbal visual cues in order to understand which social signals can be considered to manifest deception. After conducting an experiment with the CERT software, based on 40 video clips, the claim that it is possible to automatically detect deception using facial cues has been supported.

As discussed earlier in the paper, spotting specific nonverbal features that correspond to the nonverbal behavior of people when trying to deceive has always been a struggle for scholars. The results of this study however show that academic research in nonverbal communication is moving forward to more innovative and objective ways of researching that case. Using software programs like CERT allow researchers to run tests and subsequently analyze in detail the facial expressions in people.

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