IDENTIFYING DECEPTIVE SPEECH ACROSS CULTURES

Julia Hirschberg
THE TRUSTEES OF COLUMBIA UNIVERSITY IN THE CITY OF NEW YORK
116TH AND BDWY
NEW YORK, NY 10027

07/27/2016
Final Report

Air Force Research Laboratory
AF Office Of Scientific Research (AFOSR)/RTA2

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to the Department of Defense, Executive Service Directorate (0704-0188). Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.
PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ORGANIZATION.

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
25-06-2016	Final Report	15-09-2011 to 14-05-2016

4. TITLE AND SUBTITLE

IDENTIFYING DECEPTIVE SPEECH ACROSS CULTURES

5a. CONTRACT NUMBER

5b. GRANT NUMBER
FA9550-11-1-0120

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Hirschberg, Julia Bell

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

TRUSTEES OF COLUMBIA UNIVERSITY IN THE
CITY OF NEW YORK
SPONSORED PROJECTS ADMINISTRATION

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

USAF, AFRL DUNS 143574726
AF OFFICE OF SCIENTIFIC RESEARCH
875 NORTH RANDOLPH STREET, RM 3112
ARLINGTON VA 22203

10. SPONSOR/MONITOR'S ACRONYM(S)
AFOSR/PKR3

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

DISTRIBUTION A: Distribution approved for public release.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

We have completed our collection of deceptive and non-deceptive speech recorded from interviews between native speaker of Mandarin and of English instructed to answer truthfully or to lie about 24 biographical questions. Subjects were rewarded or penalized financially for their ability to lie (interviewee) or to distinguish truth from lie (interviewer); each subject acted both roles. At 125h (174 subjects), this is by far the largest cleanly recorded speech corpus of its kind. From this data, we find that ability to lie is significantly correlated with ability to detect deception. We also find significant correlations of deception ability with personality factors (extraversion, conscientiousness). Using acoustic-prosodic features, gender, ethnicity and personality information our machine learning experiments can classify truth vs. lie in our data with 65% accuracy; we expect better results when we include lexical features. Surprisingly, using only 3-4m of norming data collected from each subject before the truth/lie interviews, and including lexical and acoustic-prosodic features, together with gender, ethnicity and personality scores we are able to predict ability

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Benjamin Knott
					19b. TELEPHONE NUMBER *(Include area code)* 703-696-1142

Reset

Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39.18
Adobe Professional 7.0

DISTRIBUTION A: Distribution approved for public release.

INSTRUCTIONS FOR COMPLETING SF 298

1. REPORT DATE. Full publication date, including day, month, if available. Must cite at least the year and be Year 2000 compliant, e.g. 30-06-1998; xx-06-1998; xx-xx-1998.

2. REPORT TYPE. State the type of report, such as final, technical, interim, memorandum, master's thesis, progress, quarterly, research, special, group study, etc.

3. DATES COVERED. Indicate the time during which the work was performed and the report was written, e.g., Jun 1997 - Jun 1998; 1-10 Jun 1996; May - Nov 1998; Nov 1998.

4. TITLE. Enter title and subtitle with volume number and part number, if applicable. On classified documents, enter the title classification in parentheses.

5a. CONTRACT NUMBER. Enter all contract numbers as they appear in the report, e.g. F33615-86-C-5169.

5b. GRANT NUMBER. Enter all grant numbers as they appear in the report, e.g. AFOSR-82-1234.

5c. PROGRAM ELEMENT NUMBER. Enter all program element numbers as they appear in the report, e.g. 61101A.

5d. PROJECT NUMBER. Enter all project numbers as they appear in the report, e.g. 1F665702D1257; ILIR.

5e. TASK NUMBER. Enter all task numbers as they appear in the report, e.g. 05; RF0330201; T4112.

5f. WORK UNIT NUMBER. Enter all work unit numbers as they appear in the report, e.g. 001; AFAPL30480105.

6. AUTHOR(S). Enter name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. The form of entry is the last name, first name, middle initial, and additional qualifiers separated by commas, e.g. Smith, Richard, J, Jr.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES). Self-explanatory.

8. PERFORMING ORGANIZATION REPORT NUMBER. Enter all unique alphanumeric report numbers assigned by the performing organization, e.g. BRL-1234; AFWL-TR-85-4017-Vol-21-PT-2.

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES). Enter the name and address of the organization(s) financially responsible for and monitoring the work.

10. SPONSOR/MONITOR'S ACRONYM(S). Enter, if available, e.g. BRL, ARDEC, NADC.

11. SPONSOR/MONITOR'S REPORT NUMBER(S). Enter report number as assigned by the sponsoring/ monitoring agency, if available, e.g. BRL-TR-829; -215.

12. DISTRIBUTION/AVAILABILITY STATEMENT. Use agency-mandated availability statements to indicate the public availability or distribution limitations of the report. If additional limitations/ restrictions or special markings are indicated, follow agency authorization procedures, e.g. RD/FRD, PROPIN, ITAR, etc. Include copyright information.

13. SUPPLEMENTARY NOTES. Enter information not included elsewhere such as: prepared in cooperation with; translation of; report supersedes; old edition number, etc.

14. ABSTRACT. A brief (approximately 200 words) factual summary of the most significant information.

15. SUBJECT TERMS. Key words or phrases identifying major concepts in the report.

16. SECURITY CLASSIFICATION. Enter security classification in accordance with security classification regulations, e.g. U, C, S, etc. If this form contains classified information, stamp classification level on the top and bottom of this page.

17. LIMITATION OF ABSTRACT. This block must be completed to assign a distribution limitation to the abstract. Enter UU (Unclassified Unlimited) or SAR (Same as Report). An entry in this block is necessary if the abstract is to be limited.

Final Report: "IDENTIFYING DECEPTIVE SPEECH ACROSS CULTURES"
PI: Julia Hirschberg, 6/25/2016

We have completed our collection of deceptive and non-deceptive speech recorded from interviews between native speaker of Mandarin and of English and are currently completing the use of this data to produce classifiers that can automatically distinguish truth from lie using speech features, gender, ethnicity, and personality inventory information.

Experimental Design: Subjects were brought into the lab, given a demographic survey to assess age, ethnicity, and years of English study. They were then asked to answer 24 biographical questions (e.g. "What is your mother's occupation?", "Who was the last person you were in a physical fight with?") truthfully. We then chose 12 of these questions and asked them to prepare a false answer, which we checked to make sure this was different enough from the truth. Subjects were then interviewed individually in a sound booth to obtain "norming" speech data, pre-interview. We also administered the NEO-FFI Five Factor Personality inventory to each. Subjects then entered the booth again, where they took turns interviewing one another about the biographical questionnaire. They were separated in the booth by a curtain. Interviewers were asked to judge truth of lie for each of the 24 questions, also writing down their confidence in their judgment. Interviewees were asked to indicate for each statement they made in the interview whether that statement contained any false information or not by pressing a key on the keyboard in front of them. Subjects were rewarded or penalized financially for their ability to lie (interviewee) or to distinguish truth from lie (interviewer). At 125h (174 subjects), this is by far the largest cleanly recorded speech corpus of its kind.

Statistical Correlations and Classification Results: From analyzing the speech data we have collected, we find that ability to lie is significantly correlated with ability to detect deception $(r(280) = 0.12, p = 0.05)$; this holds across all subjects but is strongest for females $(r(140) = 0.24, p = 0.005)$. We also find significant correlations of deception ability with personality factors (e.g. extraversion is negatively correlated for English males, $r(70) = -0.24, p = 0.04$ and there is a tendency for conscientiousness also to be negatively correlated for English females while extraversion tends to be positively correlated for Mandarin females).

Using acoustic-prosodic features (e.g. pitch, intensity, speaking rate, voice quality), gender, ethnicity and personality information, our machine learning experiments can classify truth vs. lie in our data with 65% accuracy; we expect even better results when we include lexical features. Surprisingly, using only 3-4m of norming data collected from each subject before the truth/lie interviews, and including lexical and acoustic-prosodic features, together with gender, ethnicity and personality scores we are able to predict ability to detect deception with 65% accuracy over a majority class baseline of 59.9%.

We have also found significant differences in interviewers' ability to judge truth vs. lie depending upon whether the questions asked were yes/no (e.g. "Have you ever been in trouble with the police?" vs. open-ended (e.g. "What is the last movie you saw that you really hated?")

or were sensitive (e.g. "Who ended your last romantic relationship?") vs. non-sensitive (e.g. "Do you own an e-reader of any kind?"), with yes/no questions and sensitive questions easier for interviewers to judge correctly. Finally, we have also found that the 3-4m of norming data we collected even before the interviews began can be used to identify gender, ethnicity, and personality factors – as well as ability to deceive -- with considerable accuracy. We have also found important differences relating to gender and ethnicity, of interviewer and interviewee, with respect to ability to deceive successfully and with respect to the type of questions interviewers find easier to judge correctly.

1.

1. Report Type

Final Report

Primary Contact E-mail
Contact email if there is a problem with the report.

julia@cs.columbia.edu

Primary Contact Phone Number
Contact phone number if there is a problem with the report

212-939-7114

Organization / Institution name

Columbia University

Grant/Contract Title
The full title of the funded effort.

FA9550-11-1-0120 IDENTIFYING DECEPTIVE SPEECH ACROSS CULTURES

Grant/Contract Number
AFOSR assigned control number. It must begin with "FA9550" or "F49620" or "FA2386".

FA9550-11-1-0120

Principal Investigator Name
The full name of the principal investigator on the grant or contract.

Julia Hirschberg

Program Manager
The AFOSR Program Manager currently assigned to the award

Benjamin A. Knott

Reporting Period Start Date

09/15/2011

Reporting Period End Date

05/14/2016

Abstract

We have completed our collection of deceptive and non-deceptive speech recorded from interviews between native speaker of Mandarin and of English instructed to answer truthfully or to lie about 24 biographical questions. Subjects were rewarded or penalized financially for their ability to lie (interviewee) or to distinguish truth from lie (interviewer); each subject acted both roles. At 125h (174 subjects), this is by far the largest cleanly recorded speech corpus of its kind. From analyzing this data, we find that ability to lie is significantly correlated with ability to detect deception. We also find significant correlations of deception ability with personality factors (extraversion, conscientiousness). Using acoustic-prosodic features, gender, ethnicity and personality information, our machine learning experiments can classify truth vs. lie in our data with 65% accuracy; we expect even better results when we include lexical features. Surprisingly, using only 3-4m of norming data collected from each subject before the truth/lie interviews, and including lexical and acoustic-prosodic features, together with gender, ethnicity and personality scores we are able to predict ability to detect deception with 65% accuracy. We have also found significant differences in interviewers' ability to judge truth vs. lie depending upon whether the questions asked were yes/no vs. open-ended or were sensitive vs. non-sensitive, with yes/no questions and sensitive questions easier for interviewers to judge correctly. We have also found that this norming data can be used to identify gender, ethnicity, and personality factors with considerable accuracy. Overall, we have also found important differences relating

to gender and ethnicity, of interviewer and interviewee, with respect to ability to deceive successfully and with respect to the type of questions interviewers find easier to judge correctly.

Distribution Statement

This is block 12 on the SF298 form.

Distribution A - Approved for Public Release

Explanation for Distribution Statement

If this is not approved for public release, please provide a short explanation. E.g., contains proprietary information.

SF298 Form

Please attach your SF298 form. A blank SF298 can be found here. Please do not password protect or secure the PDF The maximum file size for an SF298 is 50MB.

AFD-070820-035.pdf

Upload the Report Document. File must be a PDF. Please do not password protect or secure the PDF . The maximum file size for the Report Document is 50MB.

report2016.pdf

Upload a Report Document, if any. The maximum file size for the Report Document is 50MB.

Archival Publications (published) during reporting period:

2015. S. I. Levitan, M. Levine, J. Hirschberg, N. Cestero, G. Ahn, A. Rosenberg, "Individual Differences in Deception and Deception Detection," Cognitive 2015. (Best Paper Award)

2015. S. I. Levitan, G. An, M. Wang, G. Mendels, J. Hirschberg, M. Levine, A. Rosenberg, "Cross-Cultural Production and Detection of Deception from Speech," ACM Workshop on Multimodal Deception Detection, ICMI 2015.

2016. S. I. Levitan, Y. Levitan, G. An, M. Levine, R. Levitan, A. Rosenberg, J. Hirschberg, "Identifying Individual Differences in Gender, Ethnicity, and Personality from Dialogue for Deception Detection" NAACL Workshop on Computational Approaches to Deception Detection, NAACL 2016.

2016. S. I. Levitan, G. An, M. Ma, A. Rosenberg, R. Levitan and J. Hirschberg, "Combining Acoustic-Prosodic, Lexical, and Phonotactic Features for Automatic Deception Detection," Interspeech 2016.

2016. G. An, S. I. Levitan, R. Levitan, A. Rosenberg, M. Levine, J. Hirschberg, "Automatically Classifying Self-Rated Personality Scores from Speech," Interspeech 2016.

2. New discoveries, inventions, or patent disclosures:

Do you have any discoveries, inventions, or patent disclosures to report for this period?

No

Please describe and include any notable dates

Do you plan to pursue a claim for personal or organizational intellectual property?

Changes in research objectives (if any):

None.

Change in AFOSR Program Manager, if any:

Original PM: Joseph Lyons

Extensions granted or milestones slipped, if any:

NA

AFOSR LRIR Number

LRIR Title

Reporting Period

Laboratory Task Manager

Program Officer

Research Objectives

Technical Summary

Funding Summary by Cost Category (by FY, $K)

	Starting FY	FY+1	FY+2
Salary			
Equipment/Facilities			
Supplies			
Total			

Report Document

Report Document - Text Analysis

Report Document - Text Analysis

Appendix Documents

2. Thank You

E-mail user

Jun 25, 2016 14:20:50 Success: Email Sent to: julia@cs.columbia.edu