Social Meaning, Sociolinguistic Variation and Game-Theoretic Pragmatics: Social Meaning Games

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Introduction

Topic of Classes 3 and 4

A ‘formal semantics/pragmatics’ for sociophonetic variation.

(1) (ING)

a. I’m working on my paper. [iŋ]
b. I’m workin’ on my paper. [in]

(2) /t/ release

a. We should mee[t^h]. released ‘t’
b. We should mee[t]. unreleased ‘t’

Game theory and sociolinguistics

Social Meaning Games (SMGs)

A new framework for the analysis of the social/strategic aspect of sociolinguistic variation.

- Remarks have been made (eg. Goffman (1967); Clark (2014); Dror et al. (2013)) about the potential usefulness of game theory in the analysis of the meaning of variable linguistic phenomena.
- A general framework uniting quantitative variationist sociolinguistics and game theoretic pragmatics has yet to be developed.

Sociolinguistic Variation and Probabilistic Pragmatics

A way to unification...

A formalization of the Third Wave approach to the meaning of variation (see Eckert, 2012, for a review) using signalling games with an Iterated Best Response solution concept.

- Signalling game architecture paired with an IBR solution concept and Bayesian approach to speaker/listener reasoning is an increasingly popular framework for analyzing pragmatic phenomena (Franke, 2009; Frank and Goodman, 2012; Lassiter and Goodman, 2015; Degen and Tanenhaus, 2015a; Franke and Jäger, 2016, among many many others). (See last year's ESSLLI course (Scontras & Tessler)).
- Such models have the potential for yielding a framework for unifying social meaning and with other kinds of linguistic meaning in context.

Plan

Introduction

Iterated Best Response signalling games
- Quantity implicatures

Social Meaning and sociolinguistic variation
- 'Third Wave' approach to variation

Social meaning games
- Obama style shifting across 3 contexts (Labov, 2012)

Conclusion
- Speaker agency and the social construction of identity

Appendix: Prior beliefs and sociolinguistic interpretation

Iterated Best Response Models

A family of similar approaches which formalize Gricean reasoning (Grice, 1975) (particularly quantity and quality) using signalling games and a solution concept based on iterated reasoning (Franke, 2009; Frank and Goodman, 2012; Goodman and Stuhlmüller, 2013; Lassiter and Goodman, 2015; Degen et al., 2015; Bergen et al., 2016; Franke and Jäger, 2016, among many others).

Today's presentation

Following the Rational Speech Act model (Frank and Goodman, 2012).

Quantity implicatures

(3) a. Mary ate some of the cookies.
b. $\rightsquigarrow$ Mary did not eat all of the cookies.

Reasons to think that (3-b) is not encoded into the meaning of *some*

(4) a. If you eat some of the cookies, I'll be angry.
$\not\rightsquigarrow$ If you eat some but not all of the cookies, I'll be angry.
b. Did you eat some of the cookies?
$\not\rightsquigarrow$ Did you eat some but not all of the cookies?

Variable interpretation

Scalar enrichment is variable (Sperber and Wilson, 1986; Levinson, 2000; Degen, 2015; Degen and Tanenhaus, 2015b).

- Determiner strength, partitivity and contextual aspects determine participant judgements of *some* in corpus examples.

(5) (Degen, 2015, 17)
I wish my mother had had some of those opportunities, because I think she would have really, she rea-, would have succeeded in a lot of ways, that men, that women were not able to succeed in her generation.

Signalling game (RSA-style)

An RSA-style signalling game is a tuple $\langle \{S, L\}, W, M, [\![\cdot]\!], C, Pr \rangle$:

1. S, L are the players.
2. W is a set of possible worlds.
3. M is the set of messages.
4. $[\![\cdot]\!]$ is an interpretation function assigning a set of possible worlds to each message.
5. C is the set of message costs.
6. Pr is a probability distribution over worlds representing the listener's prior beliefs before hearing a message.

Models of what?

If we are modelling listener behaviour (Interpretation):

- *Pr* represents L's beliefs.

If we are modelling speaker behaviour (Production):

- *Pr* represents S's hypothesis concerning L's prior beliefs.

If we are modelling interaction (Evolution):

- *Pr* represents L's prior beliefs and is usually common knowledge.

The scenario

S and L baked three cookies, and then, while L was out, Mary stopped by and possibly ate some of them. Suppose that L calls the house and wants to know how many of the cookies Mary ate. What should S say and how should L understand what S says to them?

Possible World	Description
w_0	Mary ate 0 cookies
w_1	Mary ate 1 cookie
w_2	Mary ate 2 cookies
w_3	Mary ate 3 cookies

Table: Universe (W) in cookie example

Messages

Short name	message	$[\![\text{message}]\!]$
NONE	Mary ate none of the cookies	$\{w_0\}$
SOME	Mary ate some of the cookies	$\{w_1, w_2, w_3\}$
ALL	Mary ate all of the cookies	$\{w_3\}$

Table: Messages in cookie example

Prior beliefs

Suppose L has no prior expectations about how many cookies Mary ate.

- *Pr* is uniform over the set of possible worlds.

w_0	w_1	w_2	w_3
0.25	0.25	0.25	0.25

Table: L has uniform prior beliefs (Pr(w)).

Formalization of Quality Maxim

When they hears a message m, L restricts their attention to the worlds in which m is true.

- L conditions on $[\![m]\!]$: intersection followed by renormalization of the measure.

Message	w_0	w_1	w_2	w_3
NONE	1	0	0	0
ALL	0	0	0	1
SOME	0	$0.\dot{3}$	$0.\dot{3}$	$0.\dot{3}$

Table: L's beliefs immediately after hearing m (Pr(w|m)).

Formalization of Quantity Maxim

Coordination (i.e. communication) occurs because speakers try to say the most informative statement possible. And listeners know this.

- Informativity is encoded as part of speaker's utility function (U_S).
- (Frank and Goodman, 2012, et seq.): The informativity of m is its negative surprisal (positive natural log probability (Shannon, 1948)) of the prior conditioned on the truth of the message.

(6) $$U_S(m, w) = ln(Pr(w|m)) - C(m)$$

Costs as linguistic factors

Costs can encode grammatical/psychological constraints on utterances (length, markedness etc.).

- We will ignore $C(m)$ in this quick demonstration.

Speaker Utility

Message	w_0	w_1	w_2	w_3
NONE	0	$-\infty$	$-\infty$	$-\infty$
ALL	$-\infty$	$-\infty$	$-\infty$	0
SOME	$-\infty$	-0.108	-0.108	-0.108

Table: S's utility for m for communicating w (U_S(w, m)).

If we are in w_2 (two of three cookies eaten):

(7) a. $U_S(w_2, \text{SOME}) = ln(0.\dot{3}) = -0.1081748095$
b. $U_S(w_2, \text{NONE}) = ln(0) = -\infty$
c. $U_S(w_2, \text{ALL}) = ln(0) = -\infty$

Predicting linguistic production

Hypothesis: Agents are approximately rational

1. Rationality: They are trying to maximize utility.
2. Approximately: They may not always pick the optimal action.
   - Computation can be impeded by time/resource constraints.

To account for variability in action selection:

Soft-Max Choice (Luce, 1959; Sutton and Barto, 1998)

For a world w, a message m and a value α (the temperature).

$$P_S(m|w) = \frac{exp(\alpha \times U_S(w,m))}{\sum_{m' \in M} exp(\alpha \times U_S(w,m'))}$$

- α introduces some non-determinacy into the model.

Quantitative predictions for language use

When $\alpha = \infty$, S picks the message with the highest utility 100% of the time. Anything lower will predict some variability.

- When modelling actual quantitative studies, the value for α that best fits the observed data can be estimated (as in Goodman and Stuhlmüller, 2013; Franke and Degen, 2016).

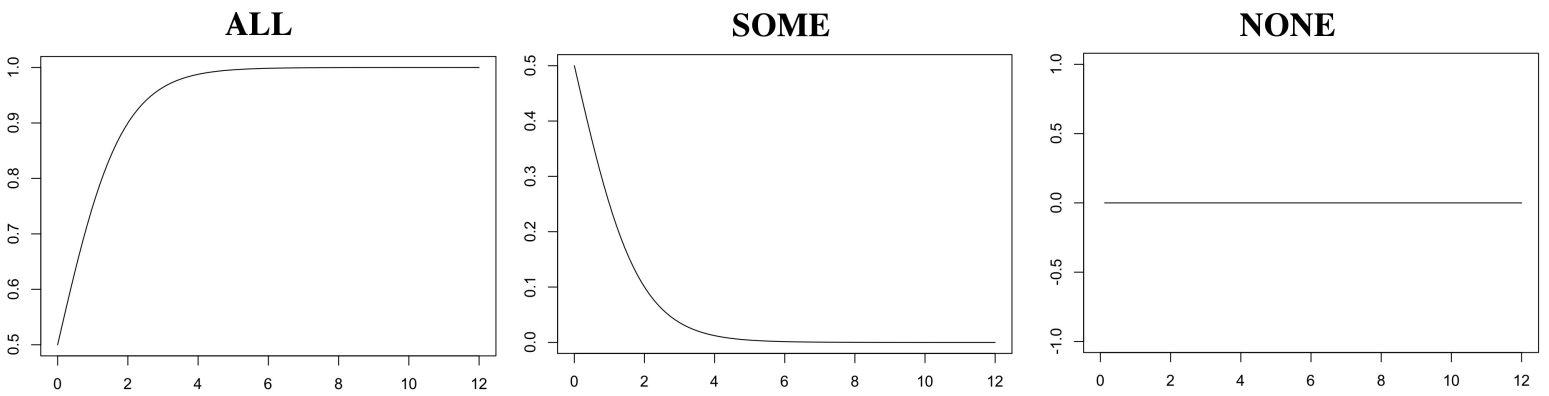


Figure: Predictions for ALL, SOME, NONE communicating w_3, by α

Quantitative Predictions for Language Use

Message	w_0	w_1	w_2	w_3
NONE	1	0	0	0
ALL	0	0	0	0.99
SOME	0	1	1	0.01
Prediction	Cat. NONE	Cat. SOME	Cat. SOME	Favored ALL

Table: S's predicted use of m, given w with $\alpha = 10$ ($P_S(m|w)$).

Fundamental Interpretation Rule: Bayesian inference

Humans draw a conclusion B after having observed event A ($P(B|A)$) through combining:

1. How likely they think A is to indicate B (P(A|B)).
2. How likely they thought B was to begin with (Pr(B)).

Bayes rule

$$P(B_i|A) = \frac{Pr(B_i) \times P(A|B_i)}{\sum_{j=1}^{|B|} Pr(B_j) \times P(A|B_j)} \tag{8}$$

$$P(B|A) \propto Pr(B) \times P(A|B) \tag{9}$$

Quantitative Predictions for Language Interpretation

Interpretation as Bayesian Inference

$$P_L(w|m) = \frac{Pr(w) \times P_S(m|w)}{\sum_{w'} Pr(m|w') \times P_S(m|w')}$$

Message	w_0	w_1	w_2	w_3	PREDICTION
NONE	1	0	0	0	Categorical w_0
ALL	0	0	0	1	Categorical w_3
SOME	0	0.498	0.498	0.005	Favoured w_1, w_2

Table: L's predicted interpretation of w, given m ($P_L(w|m)$).

Heavily Weighted Priors

Suppose that L knows that Mary usually likes to have two cookies for her dessert.

w_0	w_1	w_2	w_3
0.1	0.1	0.7	0.1

Table: L's priors heavily weighted on w_2.

Prior beliefs influence interpretation

L's interpretation probabilities change.

- L's probability of interpreting w_2 after SOME is now 0.87 from 0.498.

Computational resources for Bayesian pragmatics

To facilitate calculations and prediction testing, a number of computational implementations have been developed:

1. Chris Potts' implementation in python:
   `https://github.com/cgpotts/pypragmods`
2. Goodman and Tenenbaum's implementation in Church:
   `https://probmods.org/`.
   - Also comes with a textbook.
3. Goodman and Stuhlmüller's implementation in WebPPL:
   `http://dippl.org/examples/pragmatics.html`
   - Also comes with a textbook for Scontras & Tessler's 2016 ESSLLI course:
     `http://gscontras.github.io/ESSLLI-2016/`

Summary

Bayesian game-theoretic models provide a framework for:

1. Formalizing pragmatic theories (in this case Gricean pragmatics).
2. Making both qualitative and quantitative predictions about (possibly variable) language use and interpretation.
3. Capturing interactive co-construction of meaning (in this case truth-conditional).
   - The inference (10-b) arises as a product of coordination between the speaker and listener.

   (10) a. Mary ate some of the cookies.
   b. $\rightsquigarrow$ Mary didn't eat all of the cookies.

4. Capturing the contribution that speaker/listener prior beliefs make to pragmatic interpretation.

Recall from Class 1

Generalization from perception studies

Hearers make judgments about the properties that characterize speakers based on the linguistic forms that they use.

In MGT studies,

- -ing was associated with properties like *competence* and *articulateness*.
- -in' was associated with properties like *sincerity* and *friendliness*.

Generalization from production studies

Speakers strategically exploit hearer's interpretation process to communicate properties about themselves to their interlocutors.

Figure 3. President Obama's use of (ING) in three contextual styles.

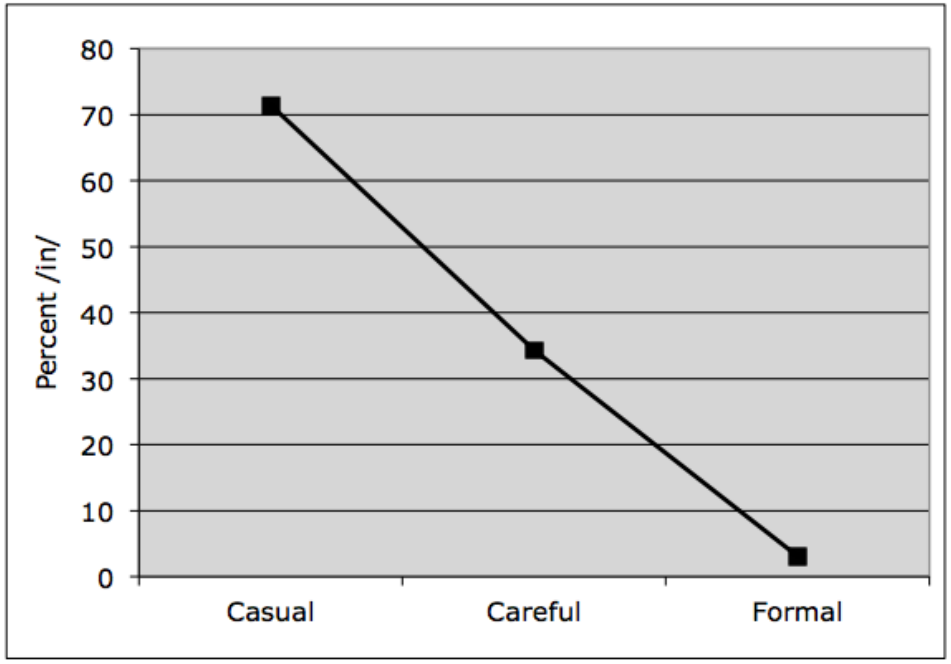


Figure: Obama's use of (ING) across contexts

What do we want in a formal model?

1. A framework that can capture the context dependent interplay between conversational participants (i.e. both the speaker and the listener). (Interactivity)
2. A model in which the speaker (tries to) choose the variant that has the best chance to construct their desired persona. (Approximate rationality)
3. A model that predicts quantitative patterns of variation/interpretation. (Variability)

Proposal

Game theoretic models have these properties.

Third Wave approach to variation

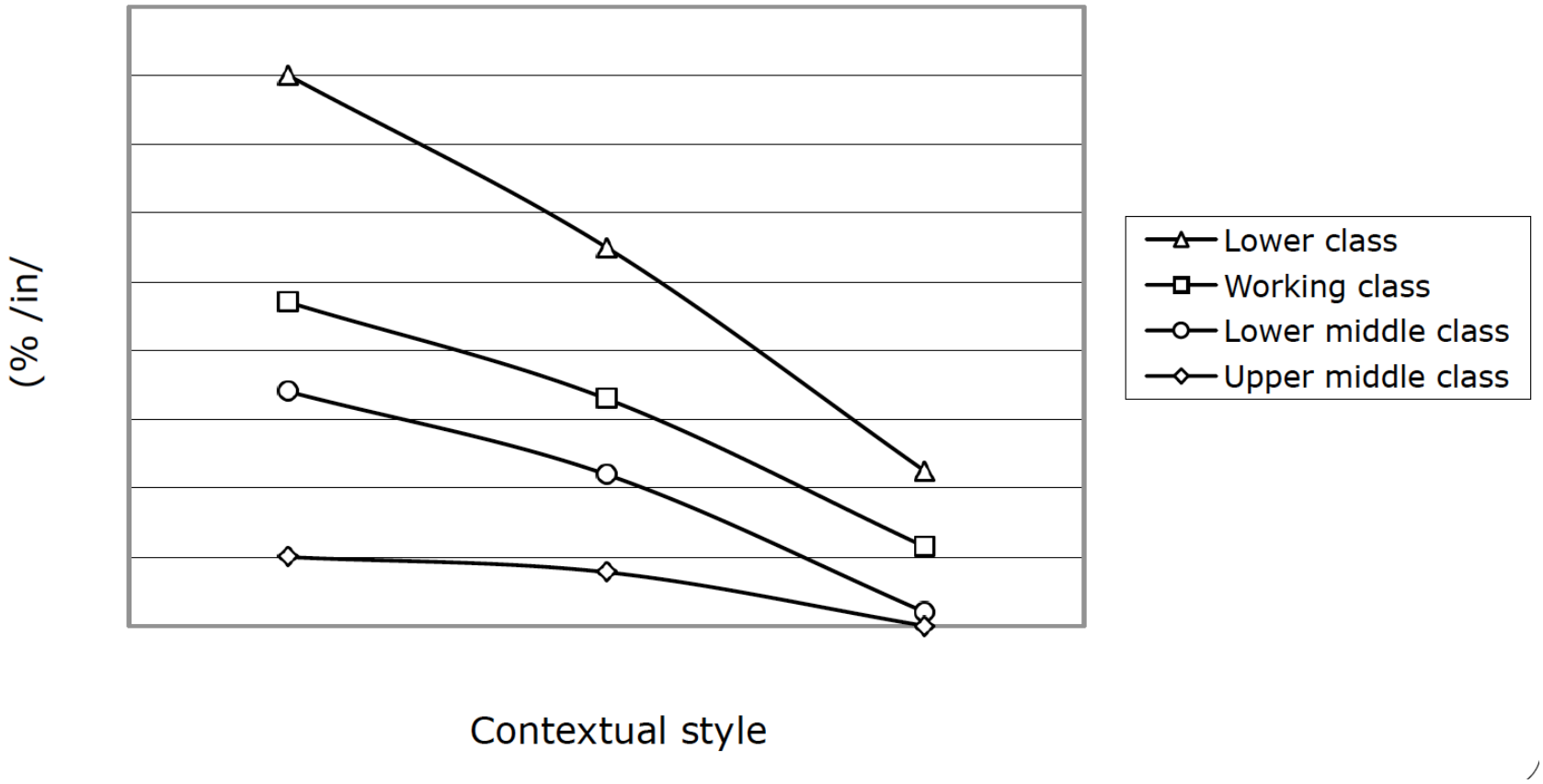
Empirical discovery from sociolinguistics

The linguistic resources speakers vary across situations **coincide** with those used to distinguish social groups (Labov, 1966, 1972; Bell, 1984; Eckert, 1989, among many others).

Variation as social practice (Eckert, 2000, 2008, 2012)

TW pursues unified treatment of social stratification and style shifting as interactive rational language use.

Two empirical phenomena or one?



Labov, W. (1966). *The Social Stratification of English in New York City*. CFAL.

TW in a nutshell. . .

- Variants are related to abstract mental representations (meanings) which mediate the relationship between language and personae (identity/social types) (Ochs, 1992, 1993; Silverstein, 1979, 2003; Eckert, 2008, among many others).
- These abstract mental representations are made up of sets of properties, stances or other concepts/ideas that are to be attributed to the speaker (indexical fields (Eckert, 2008)).
- Speakers use these linguistic resources to (attempt to) construct the persona that will be the most useful to them in their context-specific goals. interactivity/rationality
  - The properties indexed by -ing are more useful to Obama in a formal setting than in an informal setting.

Stratification in TW (Eckert, 2000, 2008, 2012)

Speakers of different social groups (gender, class, age etc.) have very different experiences and live very different lives.

- As such, speakers value different properties in objects and people (see also Bourdieu and Passeron, 1970; Bourdieu, 1979; Lamont, 1992, 2009, among many others).
- Personae/identities that may be useful/desirable to individuals of certain social groups may be less so to individuals of other social groups.
- Linguistic expressions with social meanings that can be used to construct these personae are predicted be more useful to individuals of certain social groups than to others.
    - The properties indexed by -ing are more useful to upper middle class speakers (being interviewed by a researcher) than to working class speakers.

Social meaning games (Burnett, 2017b)

1. The speaker (S) has a persona (an identity/social type) that they wish to communicate to the listener (L).
   (Where does the persona come from?)
2. S chooses a variant with which to signal their persona to L.
3. Variants are related to indexical fields (sets of properties).
4. L chooses a persona to attribute to S based on their prior beliefs about S and the variants' indexical field.

Social Meaning Game

- S and L are the players.
- $\mathbb{P} = \{p_1, \ldots, p_n\}$ is a finite set of properties.
- $>$ is a relation on $\mathbb{P}$ that encodes antonymy.

Example: Obama across 3 contexts

$\mathbb{P}$ = {competent, incompetent, friendly, aloof}

(11) a. competent $>$ incompetent
b. friendly $>$ aloof

- The universe could be enriched with additional ideological structure...

Personae

Third Wave Variation Theory focuses on how variants combine together (styles), which construct particular social types (personae) (see Podesva, 2004; Eckert, 2008; Zhang, 2008, among many others).

- Possible personae are collections of properties that *go together*.

The personae are the set of largest consistent sets of properties.

Persona	Nickname
{competent, friendly}	'cool guy/gal'
{competent, aloof}	'stern leader'
{incompetent, friendly}	'doofus'
{incomptent, aloof}	'arrogant asshole'

Table: Universe in Obama example

Messages

- $M = \{m_1, \ldots, m_n\}$ is the set of messages (i.e. variants) that S can pick from.

Today's Example

M = {-ing, -in'}

Indexation and Indexical Fields

In Third Wave variation theory, individual variants have meaning that goes beyond their truth conditional meaning.

- Variants index sets of properties, called their indexical field (Eckert, 2008).

Variant	Eckert field
-ing	{competent, aloof}
-in'	{incompetent, friendly}

Eckert-Montague Fields

- In the spirit of Montague (1973), we can also look at indexical fields through the personae that they have the potential to construct.

Variant	Eckert field	Eckert-Montague field
-ing	{competent, aloof}	{comp., aloof}, {comp., friend.}, {incomp., aloof}
-in'	{incompetent, friendly}	{incomp., friend}, {comp., friend}, {incomp., aloof}

Table: Messages in Obama example

Obama at the BBQ

Suppose Obama wants to be perceived as the cool guy at the barbecue.

- He wants to construct the {competent, friendly} persona.

Listener prior beliefs

Obama at the BBQ

Obama is worried about coming off as too aloof (since he is the president).

stern leader	cool guy	asshole	doofus
{comp, aloof}	{comp, friend}	{incomp, aloof}	{incomp, friend}
0.30	0.20	0.30	0.20

Table: Obama worries about seeming aloof.

Contribution of Indexical Fields

When they hear a variant, L focuses their attention to the personae in the (Eckert-Montague) fields.

- L conditions on $[\![m]\!]$: intersection followed by renormalization of the measure.

	stern leader	cool guy	asshole	doofus
m	{comp, aloof}	{comp, frien}	{incomp, aloof}	{incomp, frien}
-ing	0.375	0.25	0.375	0
-in'	0	0.286	0.428	0.286

Table: L's beliefs immediately after hearing m (Pr(P|m)).

Speaker Utility as Informativity - Costs

(12) $U_S(m, P) = ln(Pr(P|m)) - Cost(m)$ RSA utility function

In a nutshell

1. The speaker tries to give the listener the most information possible about their persona.
2. The listener assumes that the speaker is (un)intentionally giving them the most information possible about S's persona.

Costs as linguistic conditioning

Message Costs

Costs can encode grammatical/psychological constraints on utterances.

- (ING) is conditioned by grammatical category and other abstract properties of morphological structure (Labov, 1966; Houston, 1985; Tamminga, 2014).
- Mathematical connections between game-theoretic syntax/semantics and OT syntax/semantics (also Linear OT, Harmonic Grammar).
- Since this requires more complicated message representations, we ignore costs here.

Obama at the BBQ (predictions)

- We obtain the speaker's probability distribution over variants through the Soft-max choice rule (based on U_S and α).

Suppose $\alpha = 6$.

- P_{Obama}(-ing| {competent, friendly}) $\approx$ 0.31.
- P_{Obama}(-in'| {competent, friendly}) $\approx$ 0.69.

Obama after the BBQ

Suppose Obama is worried about coming off as incompetent when answering questions after the BBQ.

stern leader {comp, aloof}	cool guy/gal {comp, friend}	asshole {incomp, aloof}	doofus {incomp, friend}
0.20	0.20	0.30	0.30

Table: Obama worries about seeming incompetent.

Obama after the BBQ (predictions)

Suppose $\alpha = 6$.

- P_{Obama}(-ing| {competent, friendly}) ≈ 0.69.
- P_{Obama}(-in'| {competent, friendly}) ≈ 0.31.

Obama in front of Congress

Suppose Obama wants to be perceived as the stern leader in front of Congress.

- He wants to construct the {competent, aloof} persona.

Predictions

- P_{Obama}(-ing| {competent, aloof}) = 1.
- P_{Obama}(-in'| {competent, aloof}) = 0.

Summary

Bayesian game-theoretic models provide a framework for:

1. Formalizing sociolinguistic theories (in this case Third Wave variation theory (Eckert, 2000, 2008, 2012)).
2. Making both qualitative and quantitative predictions about (possibly variable) language use and interpretation.
3. Capturing interactive co-construction of meaning (in this case social).
   - The inference (13-b) arises as a product of coordination between the speaker and listener.

   (13) a. I have been work[in] on my paper.
   b. $\rightsquigarrow$ The speaker is friendly.

4. Capturing the contribution that speaker/listener prior beliefs make to social interpretation.

Where do personae come from?

In classic signalling games, S's type is determined by 'Nature'.

> *Game theorists like to think of the states of a signaling game as initial chance moves by a third player, called Nature, who selects any state $t \in T$ with probability $Pr(t)$, without any strategic concern of her own (cf. Harsanyi 1967, 1968a,b). In a signaling game, Nature reveals her choice to only the sender, but not the receiver. (Franke, 2009, 129)*

This doesn't seem quite right for identity construction...

Truth conditional meaning vs social meaning

We have reason to believe that propositional communication and persona/identity construction are different.

Propositional communication is reportative

S observes a fact about the external world and then tries to report it to L.

- S's type exists independently of both S's preferences and S's linguistic action reporting it.
- Nature metaphor is appropriate.

Speaker agency

Identity construction is performative

Aspects of S's identity are constructed (in part) through S's linguistic action.

- (Butler, 1990, 34): "There is no gender identity behind the expressions of gender; that identity is performatively constituted by the very "expressions" that are said to be its results."

Proposal (Burnett, 2017a)

S's type should be should be chosen by human nature.

Next class. . .

Incorporating speaker agency into the model

- What determines the persona that S will chose in a given context? (Social theory)
- Extending SMGs with speaker agency.
- A speaker-agency model for social stratification.

Contribution of listener beliefs (specific)

Observation

Which property attributions a particular variant will trigger often depends on which other properties the listener believes hold of the speaker.

- Podesva et al. (2015) found significant relationships between articulateness and released /t/ with Edwards and Rice, but only with these two speakers.
- Flapping made only Nancy Pelosi sound more friendly and sincere.
- In Campbell-Kibler (2007), only Jason was heard as gay when he said *-ing*.

Contribution of listener beliefs (general)

Levon (2014): A MGT study of the interpretation of styles involving high/low pitch (and other variables) in the speech of British men.

- Levon also had participants fill out the Male Role Attitudes survey (MRAS: Pleck et al. 1994).
  - Agreement with statements corresponding to aspects of male gender norms.
  - $\uparrow$ MRAS $\Rightarrow$ $\uparrow$ homophobia, church attendance, promiscuity etc. (in other studies).

Pertinent result

- Listeners scoring high on the MRAS attributed more incompetent and less masculine personae to speakers using high pitch.
- Listeners scoring low on the MRAS attributed more incompetent personae to speakers using high pitch (no difference in masculinity).

Effects of prior beliefs (Levon, 2014)

Differences in interpretation of high pitch ([+pitch]) and low pitch ([-pitch]) depending on stereotypes.

- For conservatives, high pitch triggers interpretations of incompetence and non-masculinity.
- For progressives, high pitch triggers only interpretations of incompetence.

(14) SMG (based on (Burnett and Levon, 2016))

a. $\mathbb{P} = \{$competent, incompetent, masculine, non-masculine$\}$

b. [[+pitch]] = {incompetent}

c. [[-pitch]] = {competent}

Different prior beliefs

Progressives have no prior associations between competence and masculinity.

{comp, masc}	{comp, non-masc}	{incomp, masc}	{incomp, non-masc}
0.25	0.25	0.25	0.25

Table: Progressives prior beliefs($Pr_P(\mathrm{P})$).

Conservatives believe that incompetence is immasculating (Burnett and Levon, 2016).

{comp, masc}	{comp, non-masc}	{incomp, masc}	{incomp, non-masc}
0.25	0.25	0.05	0.45

Table: Conservatives prior beliefs($Pr_C(\mathrm{P})$).

Predictions for interpretations

m	{comp, masc}	{comp, n-masc}	{incomp, masc}	{incomp, n-masc}
-pitch	0.5	0.5	0	0
+pitch	0	0	0.5	0.5

Table: Progressives' predicted interpretation of P given m ($P_L(\text{P}|\text{m})$).

m	{comp, masc}	{comp, n-masc}	{incomp, masc}	{incomp, n-masc}
-pitch	0.5	0.5	0	0
+pitch	0	0	0.1	0.9

Table: Conservatives' predicted interpretation of P given m ($P_L(\text{P}|\text{m})$).

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