

# Games and Signals

## Ling 495

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Theories of linguistic meaning have generally assumed that the speaker and the hearer can coordinate their behavior on the basis of common interest. In the real world, of course, interests rarely align perfectly; rather, our interests are often only partially aligned and sometimes are in opposition. Games of incomplete information provide an interesting framework for modeling partially aligned interests. In these games, the signaler and the receiver are not sure which game is being played, but, rather, must update their beliefs based on the signals they send and receive. These games provide an interesting model of speech acts and information transmission, one that allows us to investigate models of pragmatic behavior.

In this class, we will develop tools Game Theory, Behavioral Economics and Population Biology that will permit us to investigate, via precise models, of communicative behavior. We will analyze linguistic signaling in terms of Games of Incomplete Information and show that the resulting framework does not require perfect alignment of interests for information to flow.

We will then turn to evolutionary forces that might influence signaling behavior, in particular forces which could promote deception. We will develop a model of the evolution of signaling systems. These systems favors truth, but allow for a certain level of deception. To test our theory, we will consider criminal communication, where the agents are almost certainly not honest, but where the consequences of dishonesty can be particularly dire. Along the way, we will lay the foundations for a treatment of signaling in terms of Evolutionary Game Theory.

**Grading:** Grading in the class will be done on the basis of 4 homework assignments, two exams and class participation:

Table 1: Course Grading

Homework	40%
Exam 1	25%
Exam 2	25%
Class Participation	10%

Late homework and makeup examples will only be accepted with a doctor's note accounting for the absence.

**Readings:** Readings will be distributed via the course page; see the course schedule.

In addition, the course will make extensive use of Jupyter notebooks. We will, as part of the course, show how to construct and run these notebooks as well as how to use them in data collection. The notebooks will be distributed via Github.

**Schedule:** The schedule below is provisional and does not account for Fall Break, Thanksgiving Break and classes devoted to exams; these will add 2 weeks to the schedule below (thus summing to 14 weeks).

#### Week 1

Class overview: Language as a common good

Garrett Hardin (1968). "The tragedy of the commons." *Science*, 162:3859, pp.1243-1248.

John Maynard Smith and David Harper (2003). *Animal Signals*, Oxford Series in Ecology and Evolution. Oxford University Press. (excerpt)

#### Week 2

Overview of standard pragmatics

##### Lecture 1

Speech Acts and Conversational Maxims

Nicholas Allott (2017) Conversational Implicature. *Oxford Research Encyclopedia of Linguistics*. (online)

John Austin (1975). How to do things with words. Harvard University Press. (excerpt)

Mitchell Green (2016). Speech Acts. *Oxford Research Encyclopedia of Linguistics*. (online)

H. Paul Grice (1975). “Logic and Conversation”. in P. Cole and J. P. Morgan (eds). *Syntax and Semantics* 3. pp 41-58.

#### Lecture 2

Speech Acts and Conversational Maxims 2

Wendelin Reich (2011) “The cooperative nature of communicative acts.” *Journal of Pragmatics* 43. pp. 1349-1365

H.H. Clark (1996). *Using Language*. Cambridge University Press (excerpt)

Diego Gambetta (2009). *Codes of the Underworld: How Criminals Communicate*. Princeton University Press. (Introduction)

#### Week 3

Introduction to game-theoretic pragmatics

#### Lecture 3

Overview of Game Theoretic Pragmatics 1

Michael Franke (2009). *Signal to Act: Game Theory in Pragmatics*. Dissertation. University of Amsterdam. Chapter 1. pp 1-42

#### Lecture 4

Overview of Game Theoretic Pragmatics 2

Meaning and Decisions

Robin Clark (2016). Games, Meaning and Linguistic Signalling

#### Week 4

Basic Games 1: Coordination Games (Utility, Expected Utility and Equilibria)

#### Lecture 5

Coordination Games and Focality

Michael Bacharach (2006). *Beyond Individual Choice: Teams and Frames in Game Theory*. Princeton University Press. (excerpts)

Kenneth Savitsky, et al. (2011) “The closeness-communication bias: Increased egocentrism among friends versus strangers” *Journal of Experimental Social Psychology*. 47:1, pp. 269-273.

Boaz Keysar, et al. (2003) “Limits on theory of mind use in adults” *Cognition*. 89. pp. 25-41.

#### Lecture 6

Simple Equilibria and Backward Induction

Ken Binmore (2007). *Playing for Real: A Text on Game Theory*. Oxford University Press. (excerpt)

These lectures will be supplemented by Jupyter notebooks (available online).

Week 5

Basic Games 2

Lecture 7

Mixed equilibria and conflicting interest

Ken Binmore (2007). *Playing for Real: A Text on Game Theory*. Oxford University Press. (excerpt)

Lecture 8

Methods of computing mixed equilibria These lectures will be supplemented by Jupyter notebooks

Week 6

Basic Games 3

Lecture 9

Divergent Interest: The Prisoner's Dilemma

Lecture 10

Zero-sum Games, Dominated Strategies and Iterated Dominance

Excerpts from: Ken Binmore (2007). *Playing for Real: A Text on Game Theory*. Oxford University Press. (excerpt)

In addition to extensive Jupyter notebooks

Week 7

Populations and Evolution

Lecture 11

Hawks & Doves (The Game(s))

Richard McElreath & Robert Boyd (2007). *Mathematical Models of Social Evolution: A Guide for the Perplexed*. University of Chicago Press. Chapter 4: Reciprocity. pp. 123-172.

Lecture 12

Hawks & Doves (The Dynamics)

Richard McElreath & Robert Boyd (2007). *Mathematical Models of Social Evolution: A Guide for the Perplexed*. University of Chicago Press. Chapter 4: Reciprocity. pp. 123-172.

These lectures will be heavily supplemented with Jupyter notebooks

Week 8

Bayesian Updates and Games of Incomplete Information

Lecture 13

Information and Probability

Brian Skyrms (2010). *Signals: Evolution, Learning, and Information*. Oxford University Press. Chapter 3: Information. pp. 33-47.

Ken Binmore (2007). *Playing for Real: A Text on Game Theory*. Oxford University Press. Chapter 13: Keeping up to Date. pp 383-406

#### Lecture 14

##### Games of Incomplete Information and Signaling 1

Ken Binmore (2007). *Playing for Real: A Text on Game Theory*. Oxford University Press. Chapter 14: Seeking Refinement. pp. 401-430.

These lectures will be heavily supplemented with Jupyter notebooks

#### Week 9

##### Games of Incomplete Information

#### Lecture 15

##### Games of Incomplete Information and Signaling 2

Ken Binmore (2007). *Playing for Real: A Text on Game Theory*. Oxford University Press. Chapter 15: Knowing What to Believe. pp. 431-458.

#### Lecture 16

##### More Games of Incomplete Information

Steven Tadelis (2013) *Game Theory: An Introduction*. Princeton University Press. Chapter 15: Sequential Rationality with Incomplete Information

These lectures will be heavily supplemented with Jupyter notebooks

#### Week 10

#### Lecture 17

##### More Games of Incomplete Information

Steven Tadelis (2013) *Game Theory: An Introduction*. Princeton University Press. Chapter 16: Signaling Games

#### Lecture 18

##### An Application to Language Change

Christopher Ahern and Robin Clark (2017). Conflict, cheap talk, and Jespersen's cycle. *Semantics and Pragmatics*. online and open source

These lectures will be heavily supplemented with Jupyter notebooks

#### Week 11

##### Costly Signaling

#### Lecture 13

##### Costly Signaling

A. Zahavi (1975). "Mate selection—a selection for a handicap". *Journal of Theoretical Biology*, 53:1. pp. 205-214.

A. Zahavi (1993). "The fallacy of conventional signalling". *Philosophical Transactions: Biological Sciences*. 340:1292. pp. 227-230

Jonathan Grose (2011). Modeling the fall and rise of the handicap principle. *Biology and Philosophy*, 26(5), pp. 677-696.

Lecture 14

Costly Signals and Criminal Codes

Diego Gambetta (2009). *Codes of the Underworld: How Criminals Communicate*. Princeton University Press. Part I: Costly Signals

Week 12

Costly signaling, deception and evolution

Lecture 15

Deception as an evolutionary principle Robert Trivers (2011). *The Folly of Fools: The Logic of Deceit and Self-Deception in Human Life*. Basic Books. (excerpt)

Ernst Fehr and Simon Gächter (2002). Altruistic punishment in humans. *Nature*, 415. pp. 137-140.

Lecture 16

(Non-)Altruistic Punishment, Truth and Agent-Based Modeling

E. A. Tibbetts and J. Dale (2004) "A socially enforced signal of quality in a paper wasp." *Nature*. 432. pp 218-222.

Robin Clark and Steven O. Kimbrough (2017). Social structure, opportunistic punishment and the evolution of honest signaling. (in submission).