Delegation as a signal: implicit communication with full cooperation

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Research question

Research agenda

Communication, common as it is, is **imperfect**, both due to strategic incentives and language constraints.

- strategic frictions: lying, babbling, hiding information etc.
- language frictions: (lack of) common language, vague vocabulary, language complexity, limited attention, tacit knowledge etc.

Question
How do language frictions influence strategic behavior?

“Indecisiveness”

Photo by UW Health @Flickr, speech bubbles added with phrase.it

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Model

One-slide summary

Principal (patient)–agent (doctor) model with communication:

- **perfectly aligned preferences** $u(t, x, a) = a(x - t)$ where x is health, $a \in \{0, 1\}$ is action,$t \in [0, 1]$ is patient's type;
- **two-sided** private information
  - $x \sim U[0, 1]$ is observed by the doctor
  - $t \sim g(t)$ is observed by the patient
  - both x and t *hard to communicate!*
- patient may acquire **private signal** about x at cost $c > 0$
  - signal is binary, with $P(s = 1|x)$ being S-shaped
  - neither acqusition nor signal observable by the doctor
- patient either **chooses treatment** or **delegates to doctor**
- upon delegation, doctor chooses the treatment

Main result
Signaling through delegation

Doctor's action choice is **non-monotone in health**

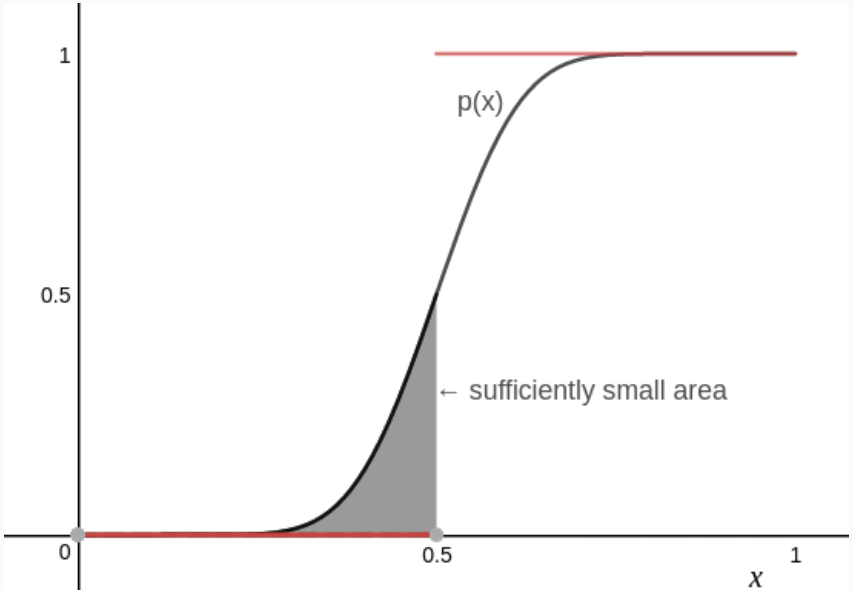
Communication

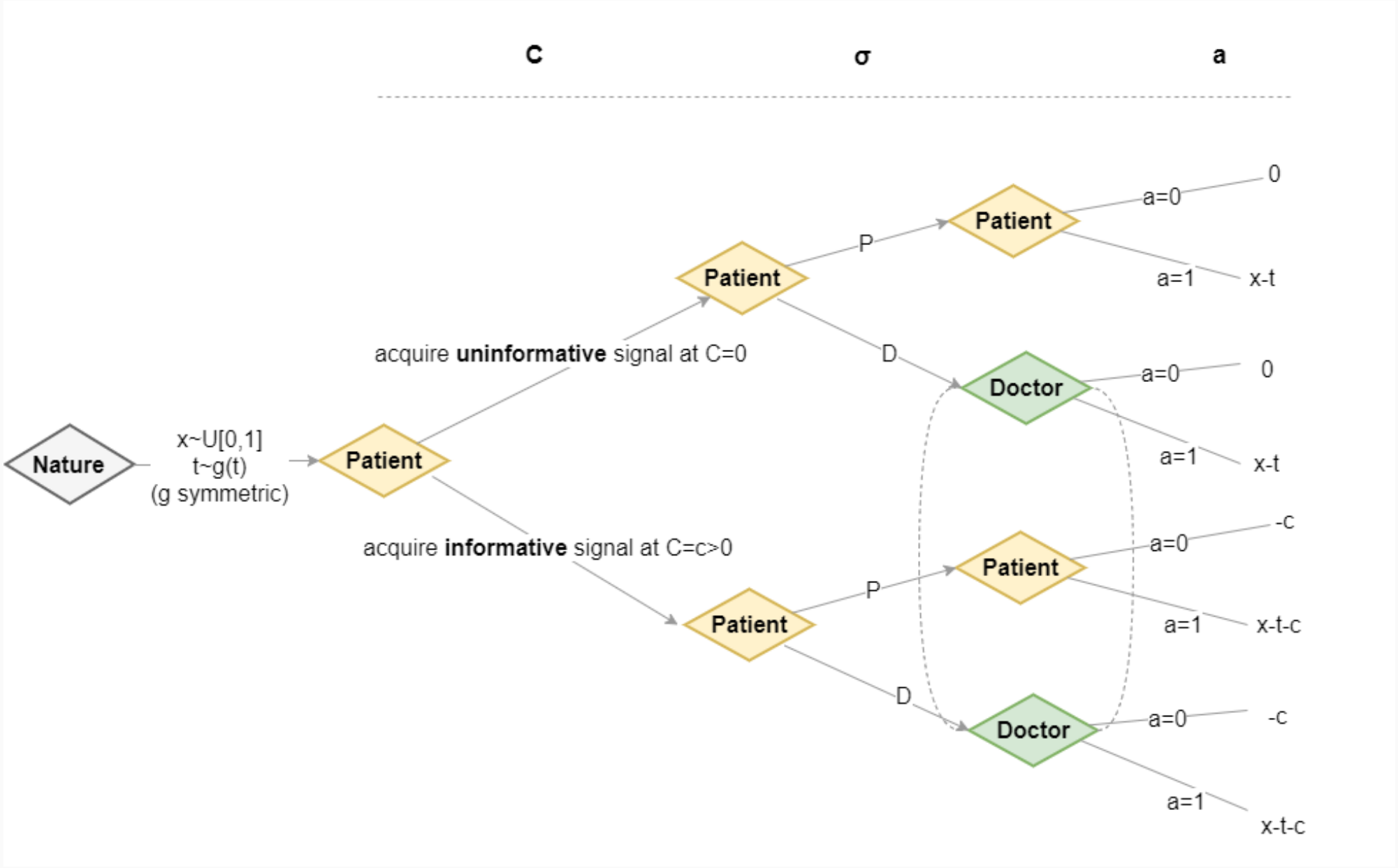
Friction 1: t is patient's **tacit knowledge** and **cannot** be expressed in language.

Friction 2: information about x **can** be acquired, but is **imperfect and costly**.

- translating medical knowledge is hard
- time/mental cost (effort)
- signal s about x is binary

$p(x) = \mathbb{P}(s = 1|x)$ is symmetric around midpoint, S-shaped




C
σ
a
Nature
x~U[0,1]
t~g(t)
(g symmetric)
Patient
acquire **uninformative** signal at C=0
acquire **informative** signal at C=c>0
Patient
Patient
P
D
Patient
Doctor
a=0
a=1
0
x-t
0
x-t
Patient
Patient
P
D
Patient
Doctor
a=0
a=1
-c
x-t-c
-c
x-t-c

Literature

- delegation (Dessein (2002), Li and Suen (2004); Alonso and Matouschek (2008))
  - Garfagnini, Ottaviani, Sørensen (2014)
  - ...but I have endogenous info acquisition choice
- signaling (Spence (1973))
  - ... but here it happens 'incidentally'
- costly information/communication (Austen-Smith (1994); Hedlund (2015); Eso and Szentes (2007); Gentzkow and Kamenica (2014)

Simple case

Perfectly informative binary signal

Simple signal structure: $s = 1$ for $x > 1/2$ and $s = 0$ otherwise. Assume $g(t) = U[0, 1]$ and $c < \frac{1}{36}$.

In the **unique equlibrium**:

- patient
  - invests in a signal whenever $t \in \left[\frac{1}{4}, \frac{3}{4}\right]$.
  - for $t \in \left(\frac{5}{12}, \frac{7}{12}\right)$ retains the authority,
  - for $t \in \left[\frac{1}{4}, \frac{5}{12}\right]$ delegates for $s = 0$
  - for $t \in \left[\frac{7}{12}, \frac{3}{4}\right]$ delegates for $s = 1$
- doctor
  - chooses $a = 1$ (upon hearing delegation) if and only if $x \in \left[\frac{1}{3}, \frac{1}{2}\right] \cup \left[\frac{2}{3}, 1\right]$,
  - thus, his recommendation is **non-monotone in health**

Limit case explained

Take doctor's choice as given:

- every patient apart from extreme gets cheap information
- median types follow the signal
- at least some types prefer to delegate
- for doctor's profile as above, the delegating types are $t \in \left[\frac{1}{4}, \frac{5}{12}\right] \cup \left[\frac{7}{12}, \frac{3}{4}\right]$.

Take patient's choice as given.

- upon delegation, the doctor anticipates $t \in \left[\frac{1}{4}, \frac{5}{12}\right] \cup \left[\frac{7}{12}, \frac{3}{4}\right]$
- *but* he also know x! Suppose $x > 1/2$
- the signal *must have been* $s = 1$
- the delegation *must have come from* $t \in \left[\frac{7}{12}, \frac{3}{4}\right]$
- on average $E(t|delegation, x) = 2/3$
- if $x < 2/3$, doctor recommends $a = 0$; otherwise $a = 1$

General model

Idea

Generalize the simple result for a general class of (well behaved) $g(t)$, $p(x)$ and some range of cost c. Assume $g(t)$ is arbitrary (symmetric with full support) and $p(x)$ is S-shaped.

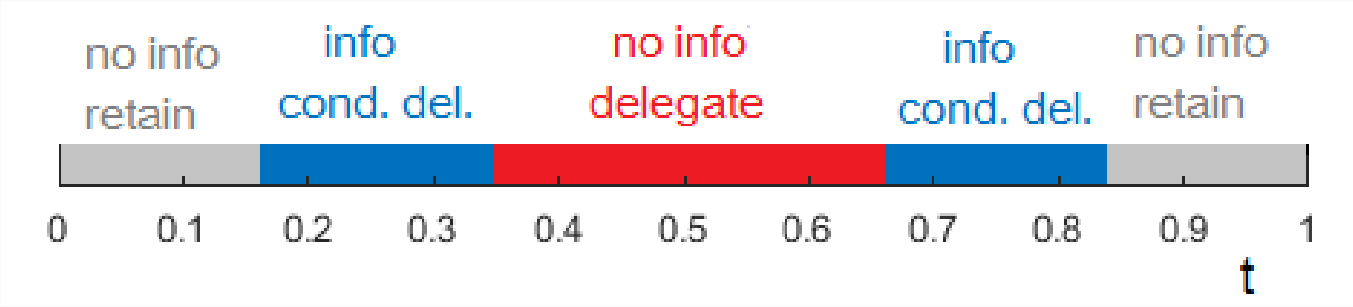
Main message:

- there are a few types of equlibria
  - patient's strategy varies with cost
  - doctor's strategy varies with his posterior, which is influenced by signal's informativeness
- cheaper information acquisition and 'steeper' signals lead to non-monotonicity of the doctor's action profile
- more expensive or less informative signal lead to "naive" (also, prior) action profile

Patient's choice

Delegation & investment when information is very cheap ($c < \psi$)

...and a bit more expensive ($\psi < c < \phi$)



ψ and ϕ depend (non-trivially) on $p(x)$,$g(t)$

Doctor's belief

Doctor, upon delegation

- anticipates what values of (s, t) led to delegation
- knows $x \Rightarrow$ knows "most likely" s
- separates types who delegate for $s = 1$ from those who delegate for $s = 0$
- knows "most likely" range of t
- adjusts his action by choosing $a = 1$ if $x - E(t|D, x) > 0$
- choice (sometimes) is *non-monotone* in x!

Doctor's choice

Denote by $\tilde{\tau}$ the average type satisfying {t<1/2$\wedge t$delegates}. If $p'(\frac{1}{2}) > 1/(1 - 2t\tilde{a}u$ the doctor's choice in eq follow non-monotone pattern

$$a^D(x) = \begin{cases} 1 & \text{for x}\in \left[\bar{x}, \frac{1}{2}\right] \cup [1 - \underline{x}, 1], \\ 0 & \text{otherwise,} \end{cases} \quad \text{for some } \bar{x} < \frac{1}{2}$$

Otherwise, the doctor's action profile in equilibrium coincides with the "naive" one:

$$a^D(x) = \begin{cases} 1 & \text{for } x \in \left[\frac{1}{2}, 1\right], \\ 0 & \text{otherwise.} \end{cases}$$

Main theorem

There exists a Perfect Bayesian Equilibrium of the game with implicit signaling of type through delegation. In such an equilibrium, the patient's strategy is symmetric around $t = \frac{1}{2}$, while the doctor's strategy may be non-monotone in health state.

The patient choices depend on c, and the doctor's choices depend on $p(x), g(t)$ in a way described in the previous slides.

Is it unique?
Not proven, but I believe so!

Summary

Model of costly communication vs. delegation with **no conflict of interest** and severe language frictions.

- tacit knowledge
- imperfect technology of acquiring information

Result: There exists an equilibrium with ”cues”, in which:

- doctor uses observed delegation *and* knowledge about x to **correctly guess the range of** t
- thus, **delegation** becomes an imperfect **signal** about the nonverbalizable type
- (for some family of signals) the action profile becomes **non-monotone** in state of the world

Thank you!

Source: Warner Bros, Looney Tunes. Available on-line: http://animationanomaly.com