The Role of Pragmatic Plasticity in the Evolution of Linguistic Communication

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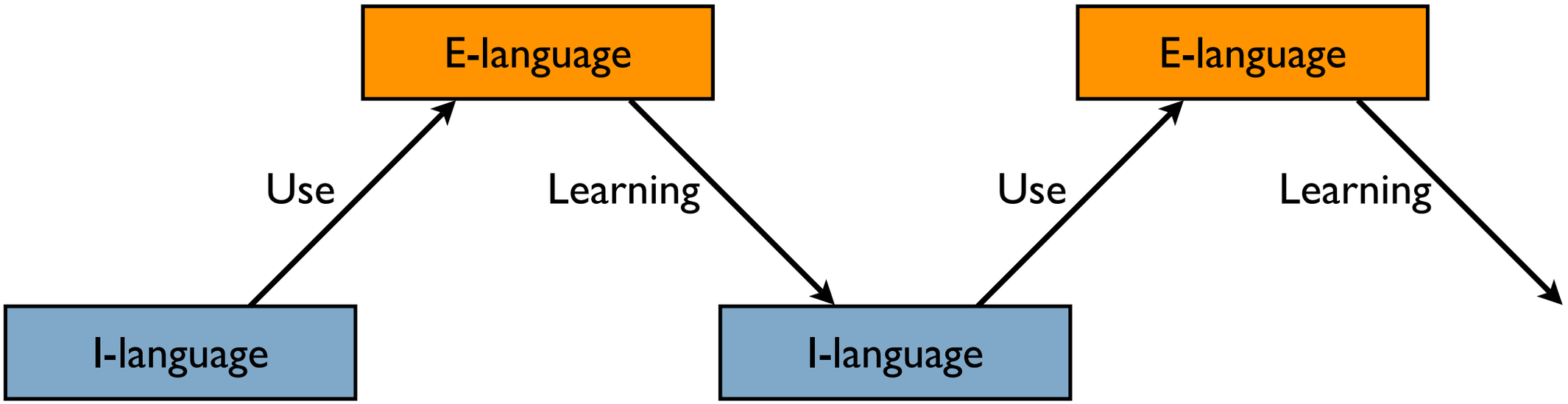
The Iterated Learning Model (ILM)

- Language evolves culturally because it is mapped from I-language to E-language (through use) and from E-language to I-language (through learning).



- common interpretation:
  <u>faithful</u> use / <u>innovative</u> (imperfect) learning

Conflicts and limitations

Conflicts

- *with models of* ***general cultural evolution***
  Tomasello's and Boyd & Richerson's emphasise the fidelity of cultural transmission as the key prerequisite for cumulative cultural evolution.

- *with models of* ***language change***
  Historical evidence shows that language acquisition is not the locus of language change.

Limitations

- *with regard to explaining the* ***emergence puzzle***
  Symbolism is usually presupposed.

- *with regard to explaining the* ***design puzzle***
  Language adapts – but to be learnable, not to its function in communication.

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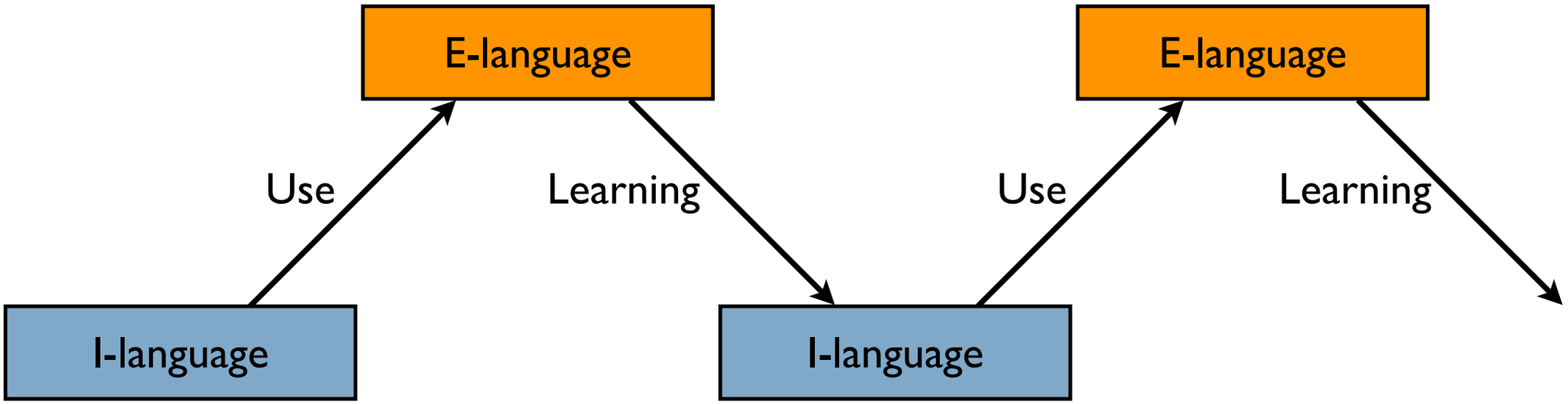

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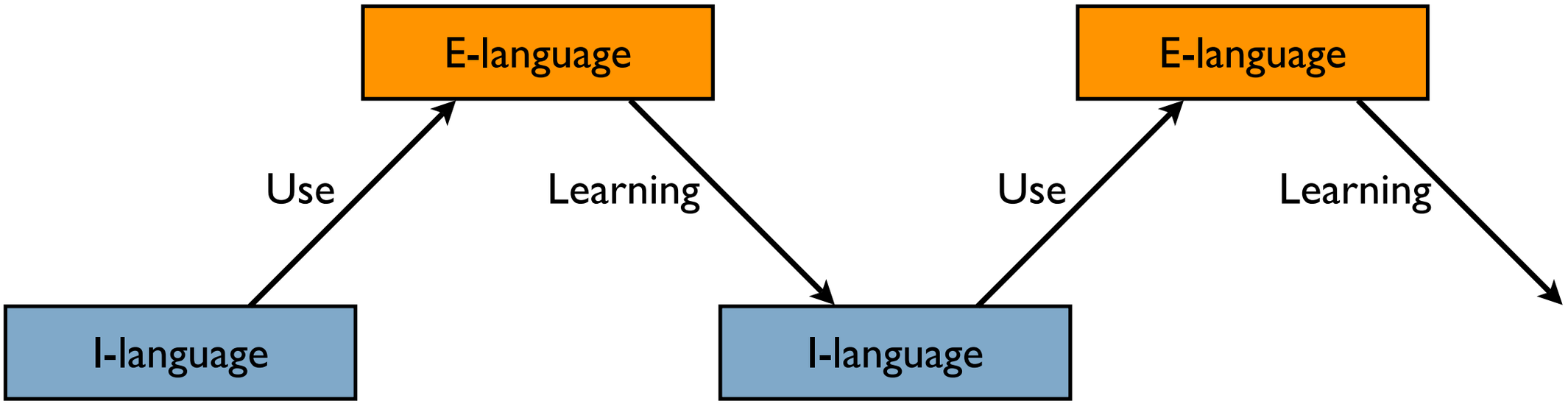

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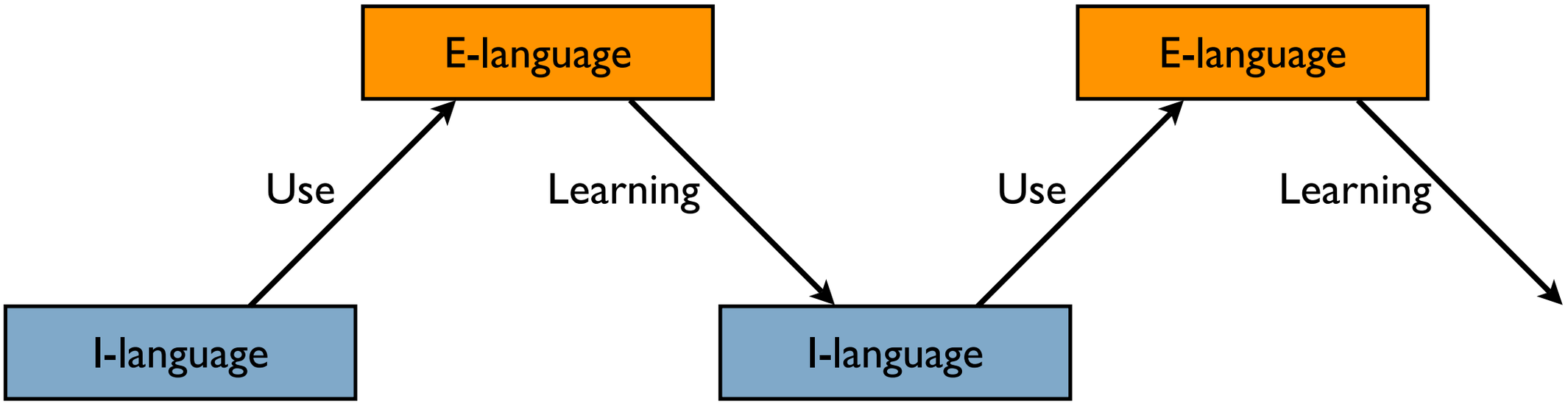

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  innovative use / faithful learning

How can we model **innovative** use?

Signal meaning v.s speaker meaning

- Most existing models cannot simulate innovative use because they only incorporate one level of meaning.

- Pragmatics distinguishes between **two types of meaning**:

  - the **signal meaning**
    the meaning that is conventionally associated with a signal

  - the **speaker meaning**
    the meaning a signal actually communicates in a specific context

- **Pragmatic plasticity**
  In specific contexts of use, speaker meanings can differ from signal meanings.

Pragmatic plasticity: under- / overspecification

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- The signal meaning can **underspecify** the speaker meaning (contain ***less*** information than the speaker meaning):

  I enjoyed reading John's book.
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speaker meaning =
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chameleon:
- is a reptile
- lives on trees
- has a long tongue
- frequently changes its appearance
- ...

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  Sally is a chameleon.
  [Sally frequently changes her appearance.]

Overspecification
speaker meaning =
signal meaning
– *ignorable* *information*

chameleon:
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✗ - lives on trees
✗ - has a long tongue
✓ - frequently changes its appearance
✗ - ...

Modelling innovative use

- **Conventional use:** speaker meaning = signal meaning
- **Innovative use:** speaker meaning ≠ signal meaning
  - → Innovative use is the product of **pragmatic plasticity**.
  - → It can be modelled as **under- and/or overspecficiation**.

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Overview

In my thesis, I have

1. developed a **mechanistic model** of the *cultural* evolution of language that acknowledges and incorporates the fact that language use exhibits ***pragmatic plasticity***

2. explored the **explanatory potential** of such a model with regard to two puzzles related to the evolution of language:

   - **the emergence puzzle**
     language has emerged from no language

   - **the design puzzle**
     language has come to exhibit the appearance of design for communication

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conceptual and computational

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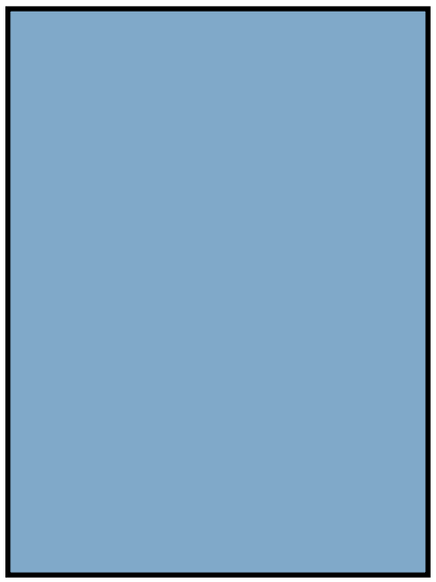
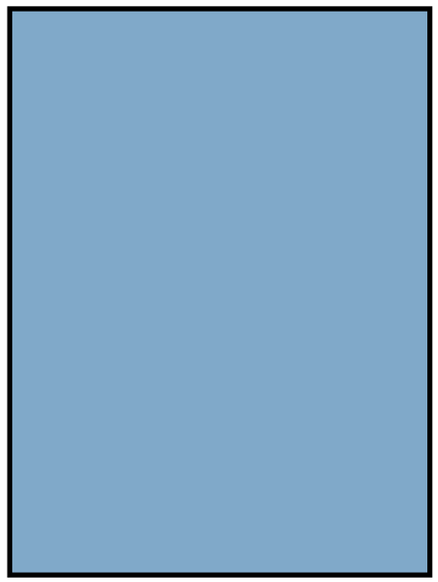


Communicator



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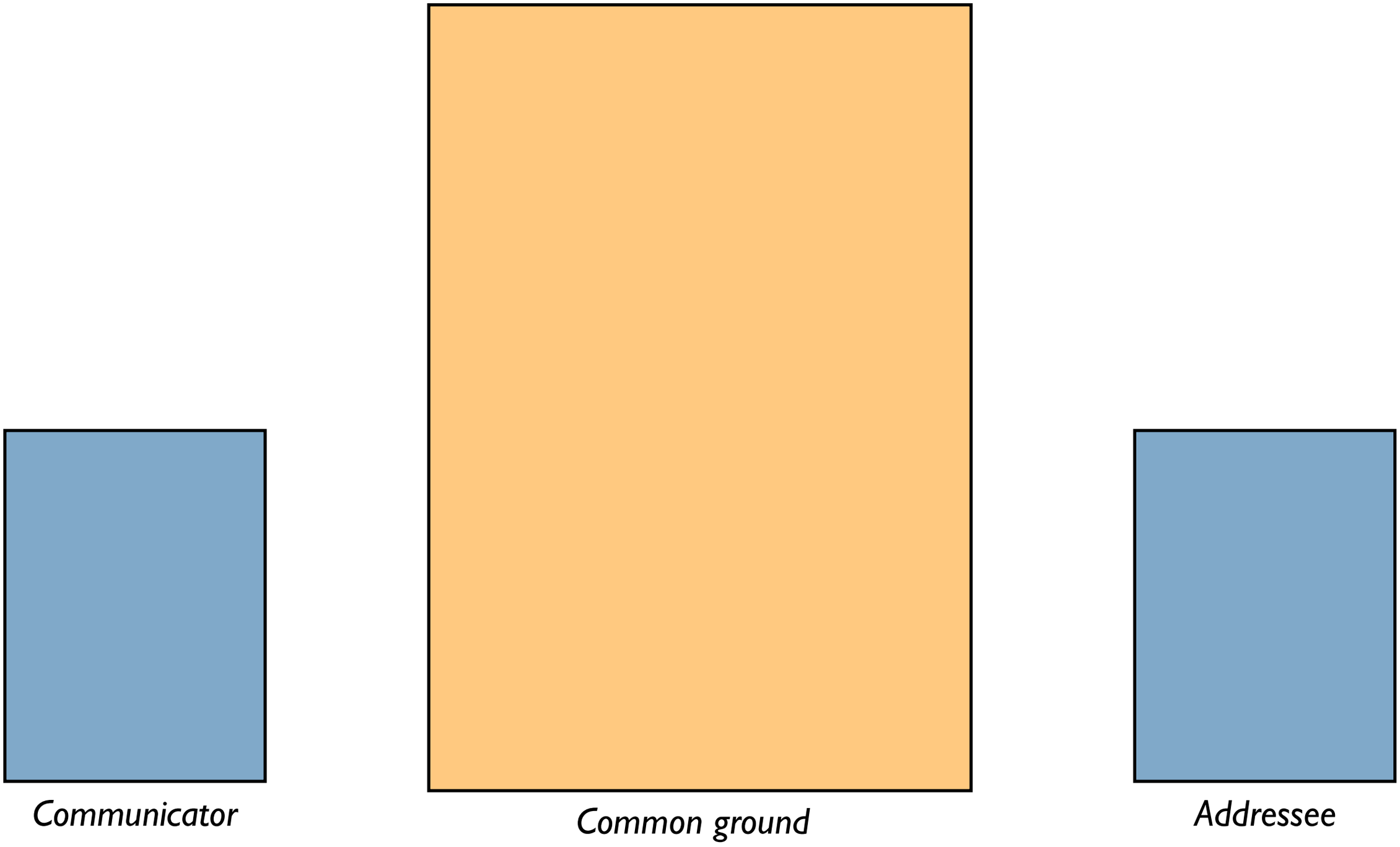

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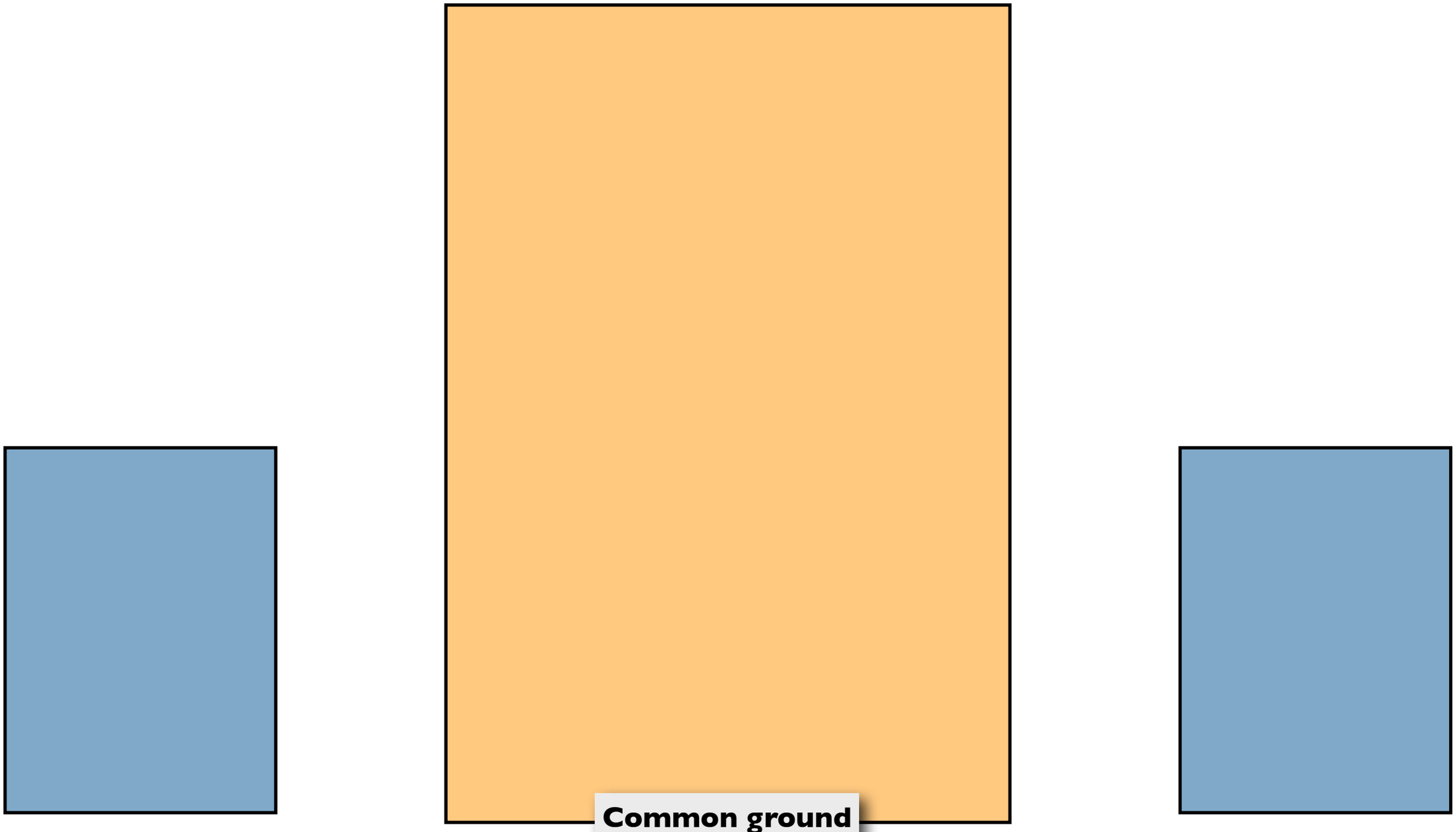

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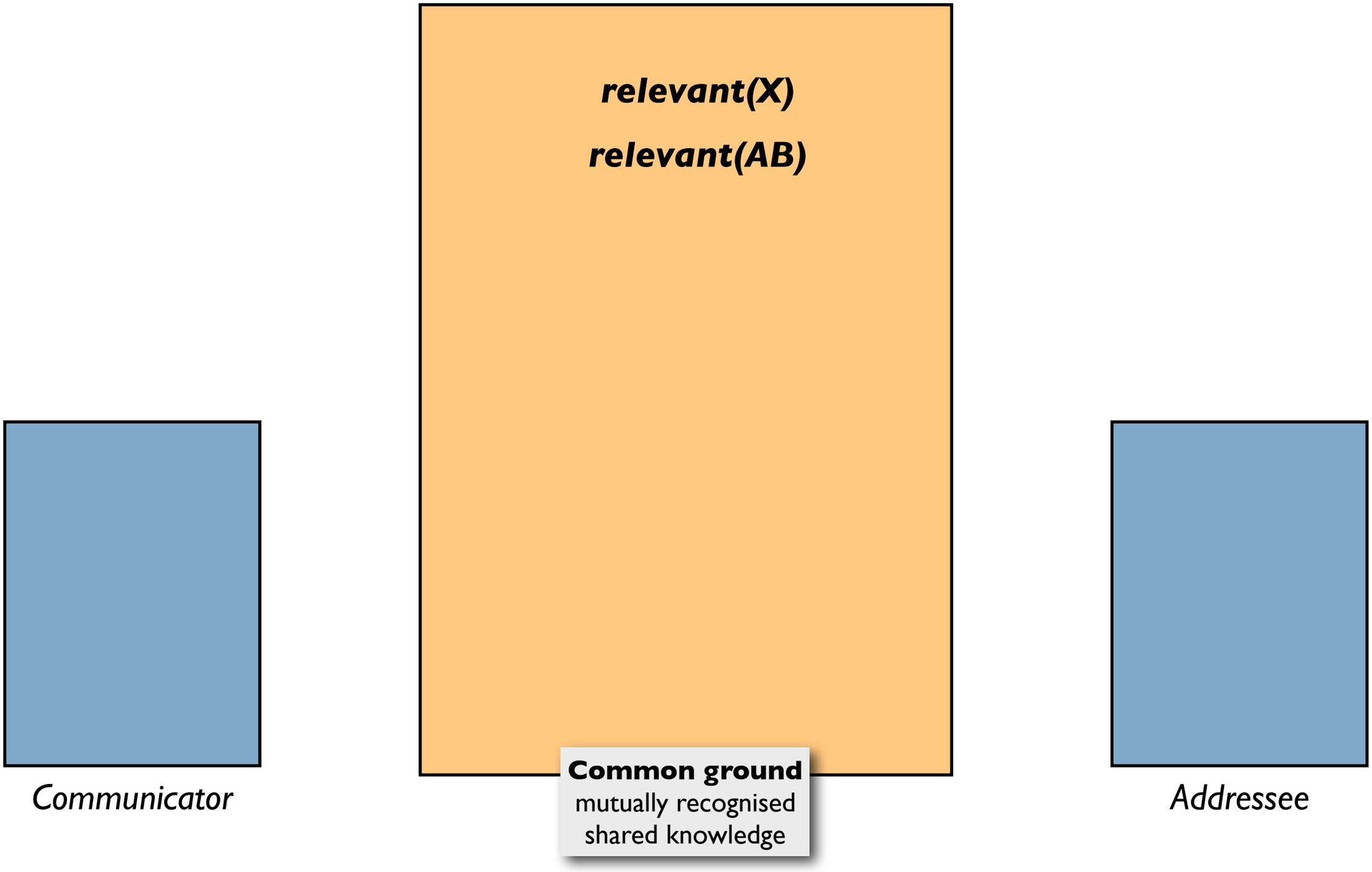

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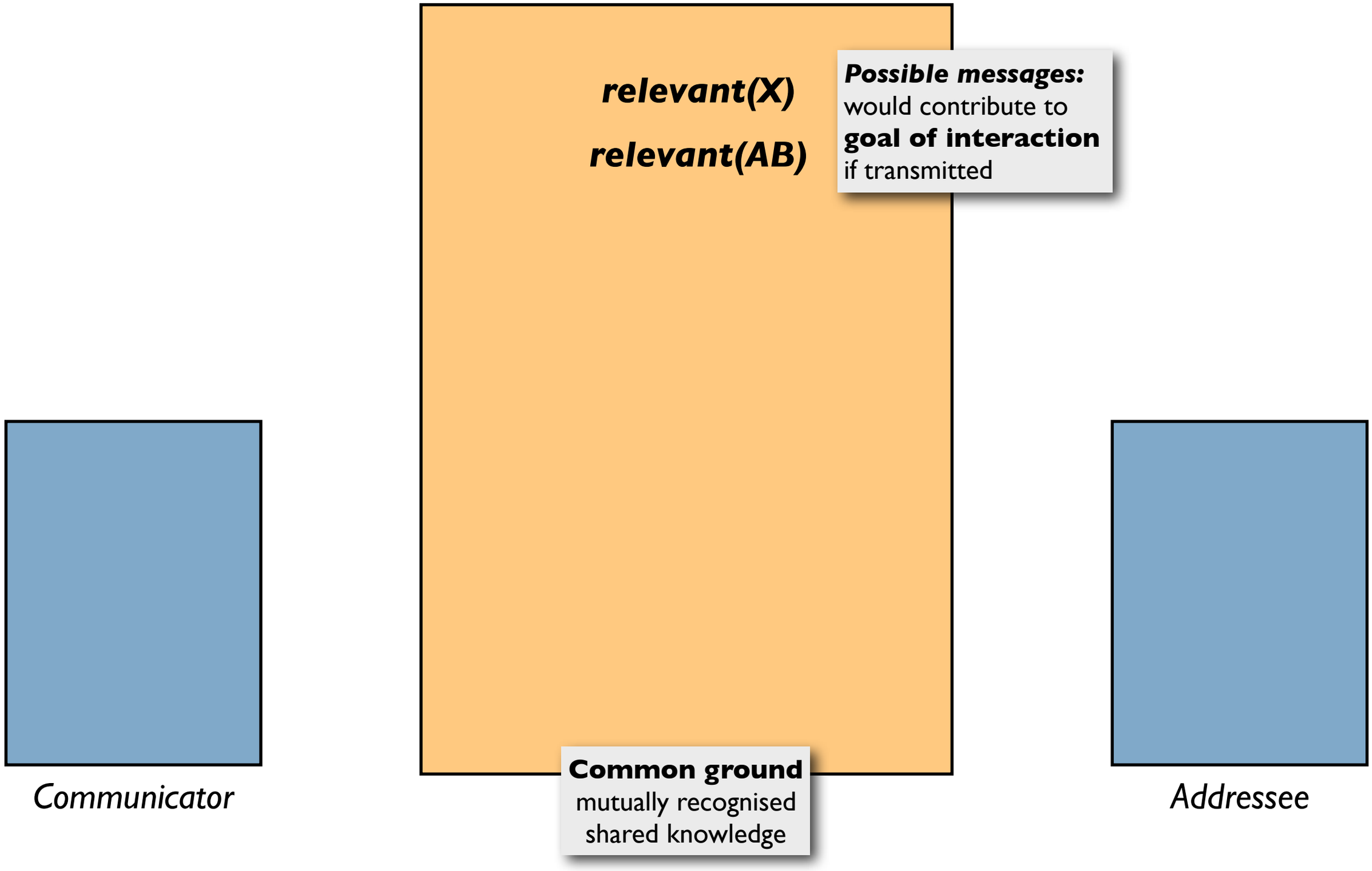

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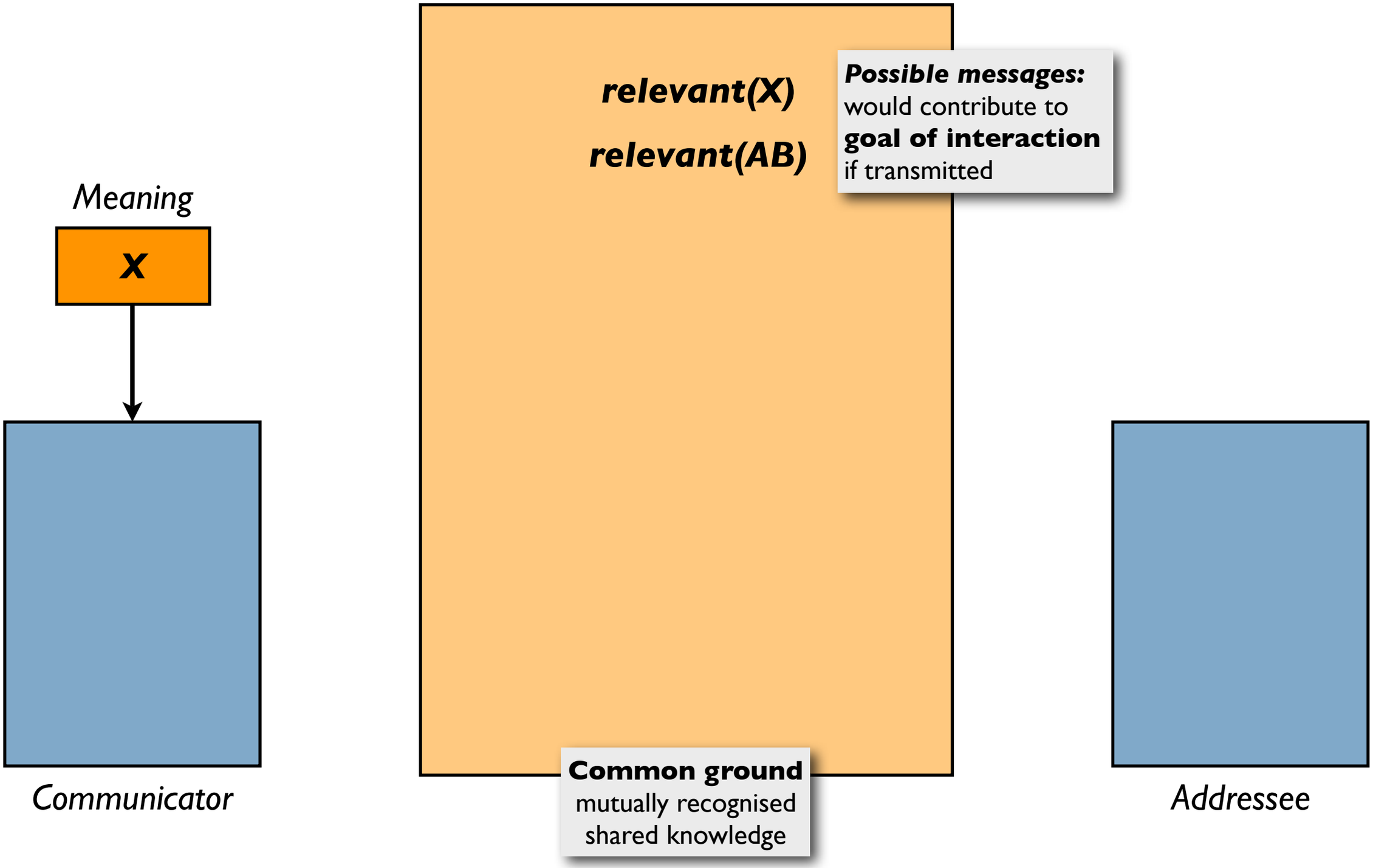

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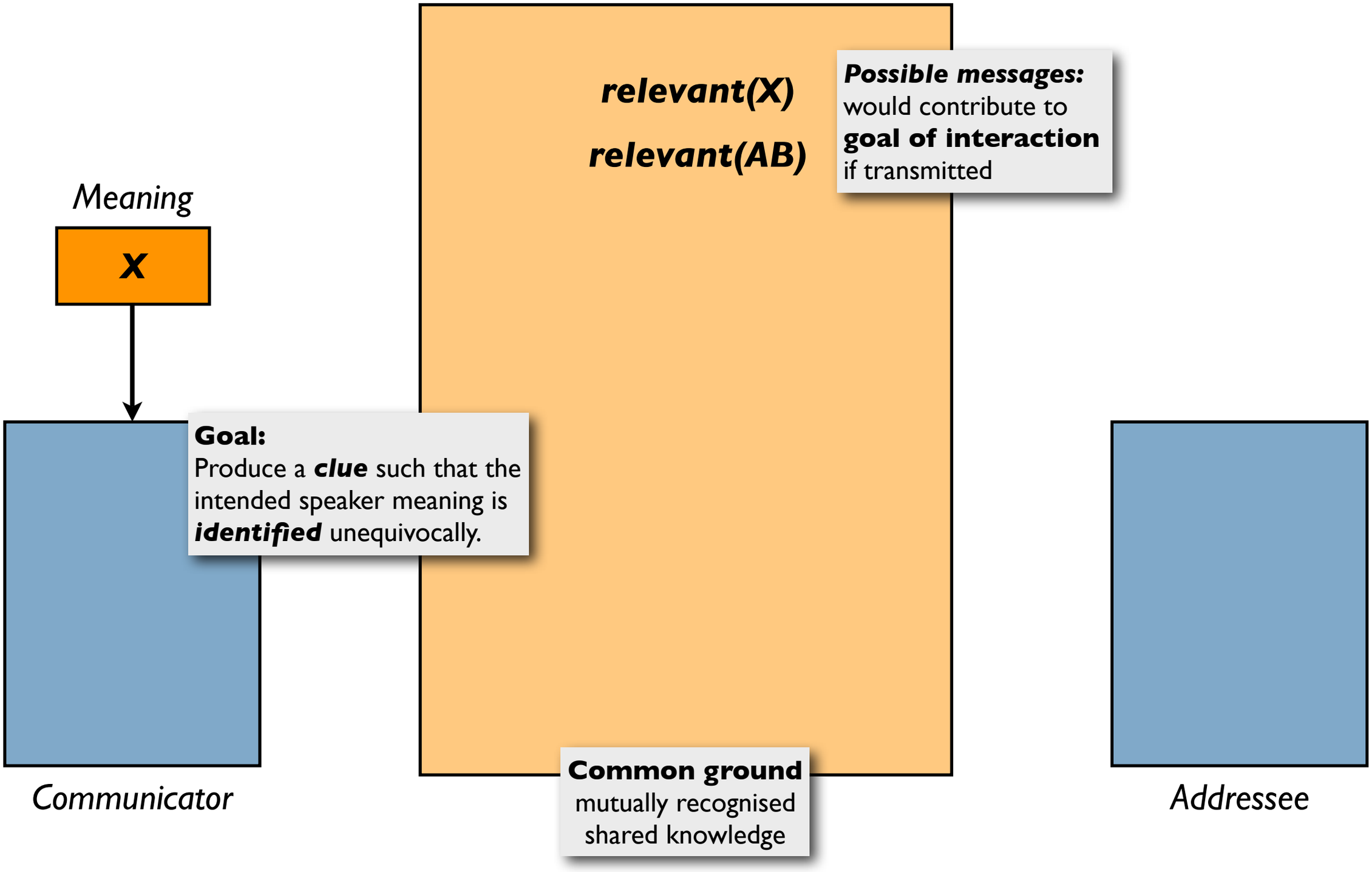

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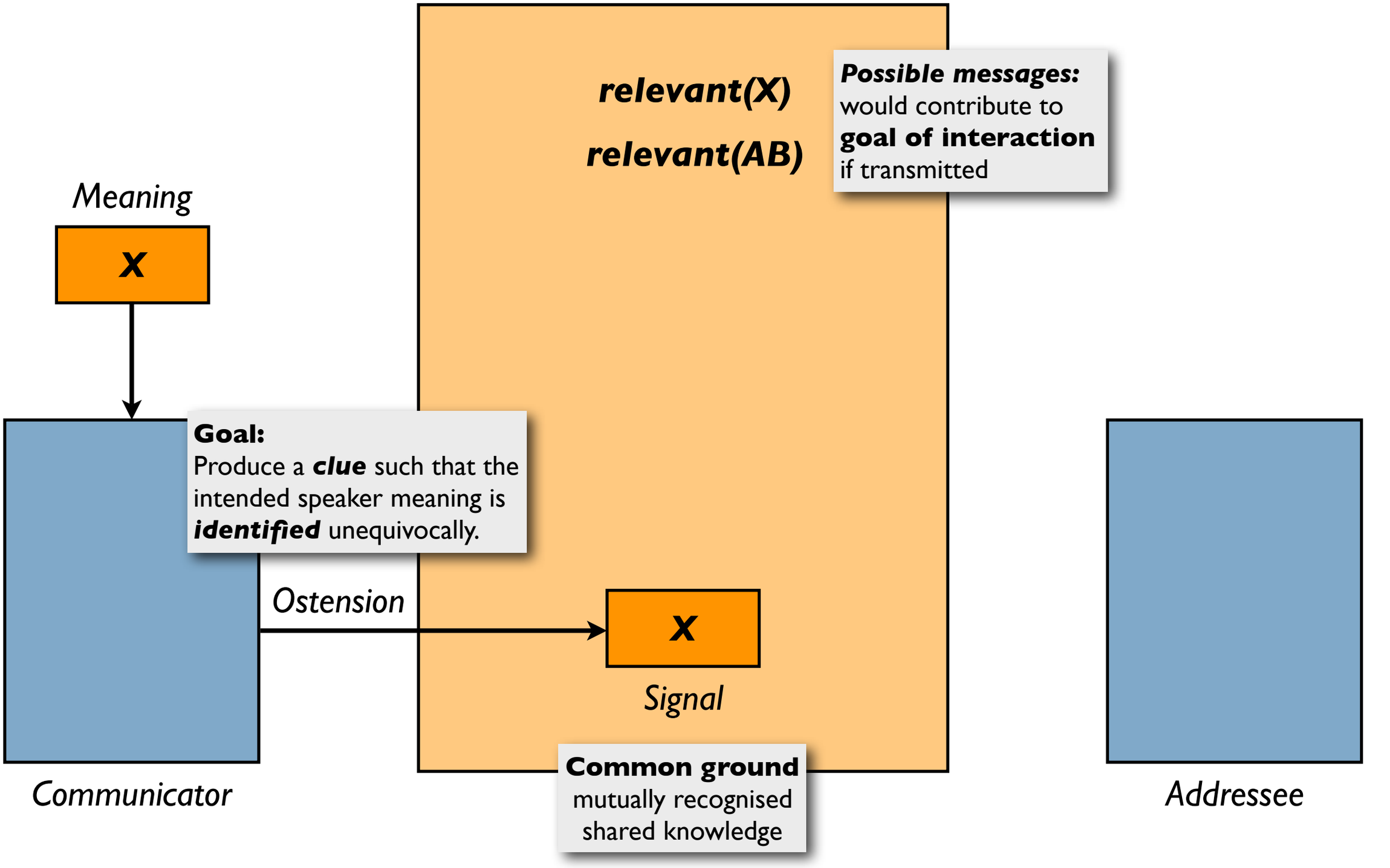

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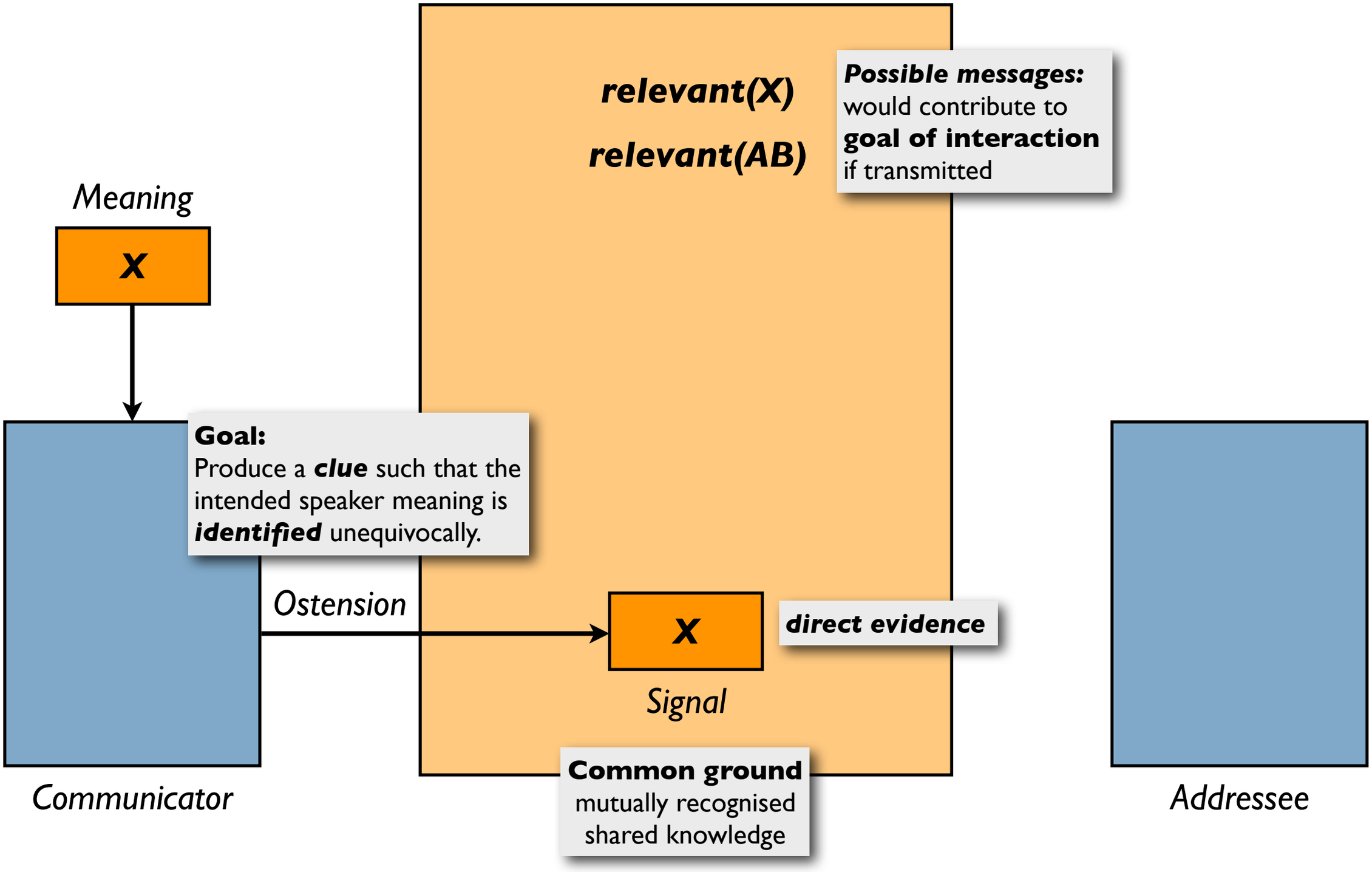

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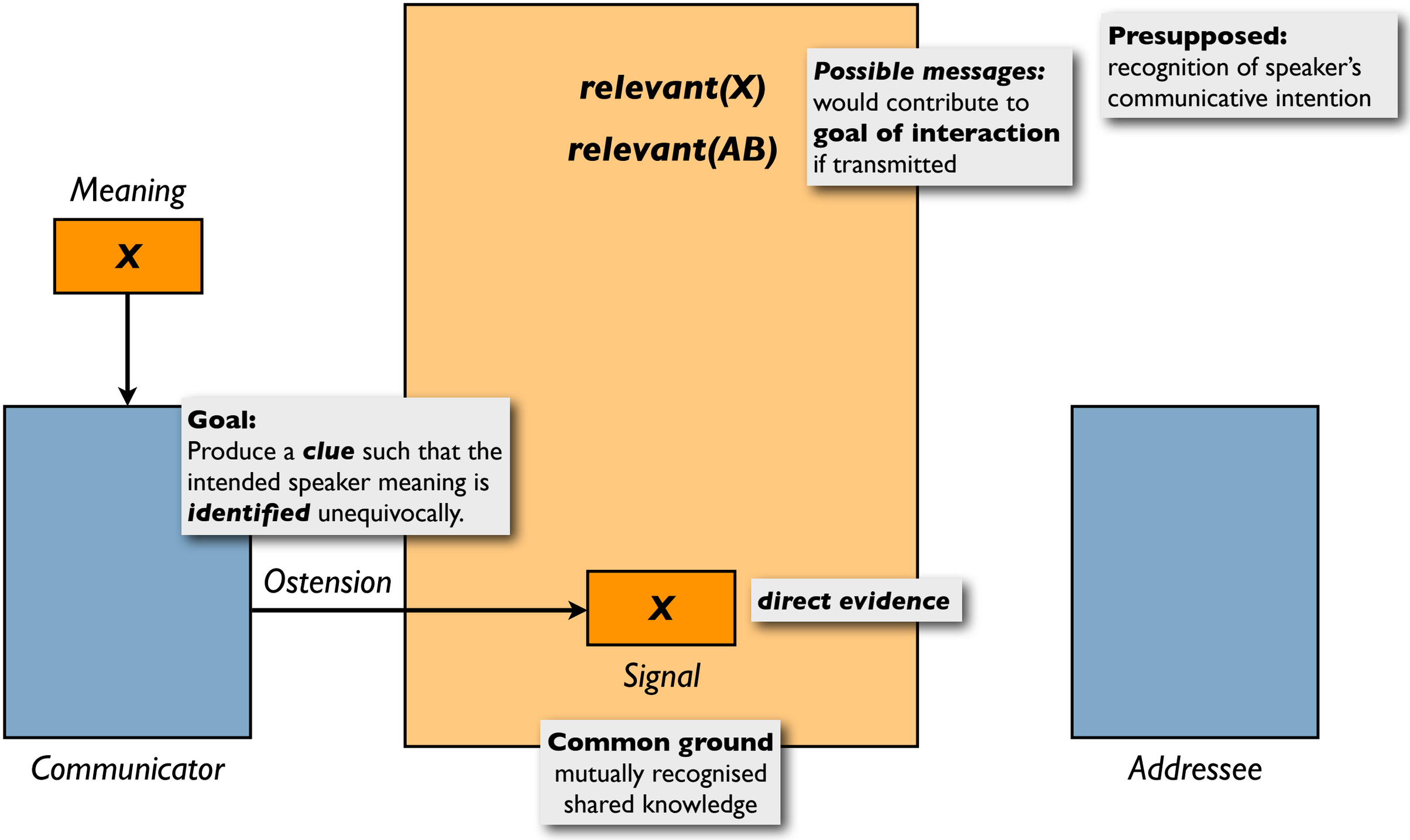

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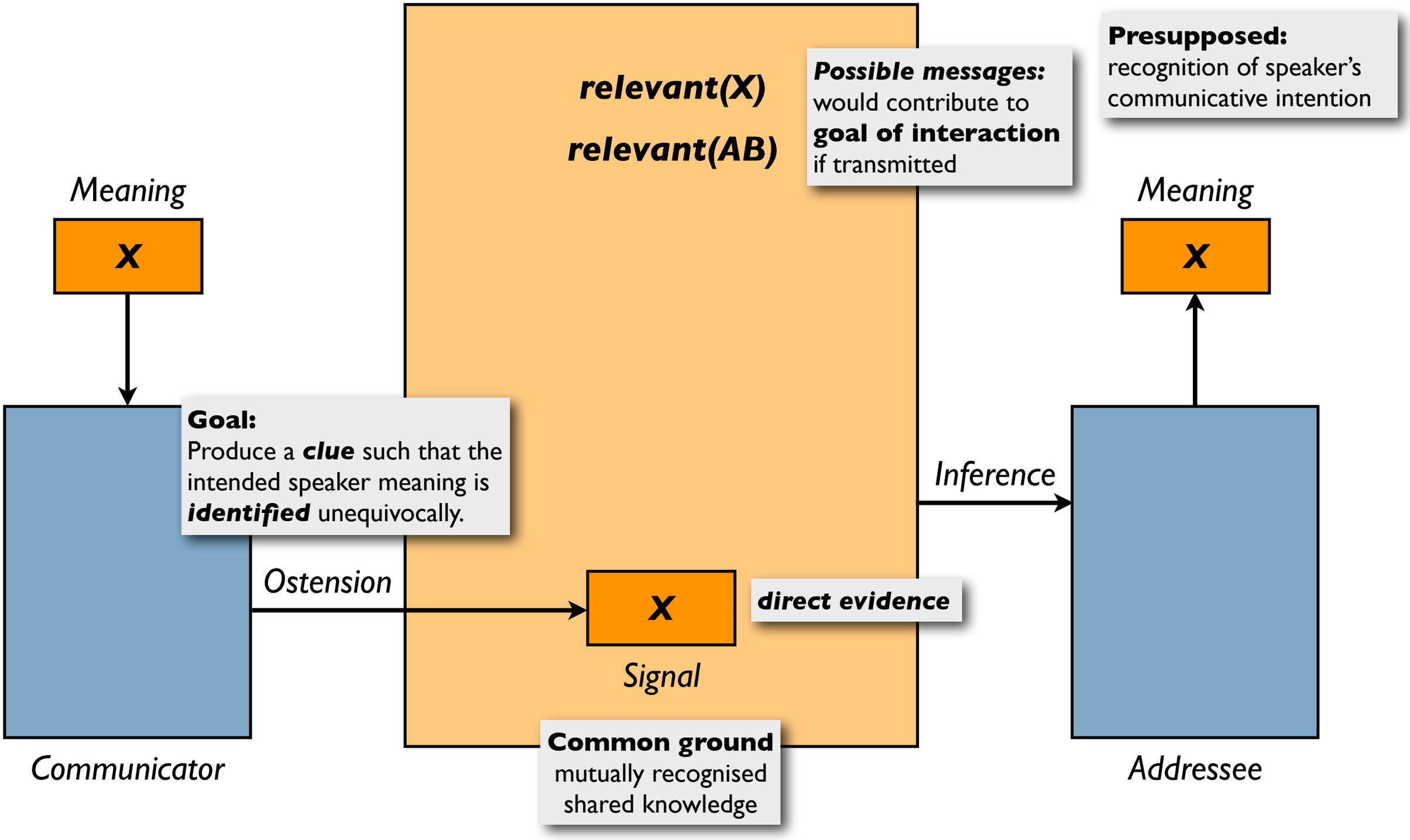

Modelling ostensive-inferential communication (1)

Signal meaning (***X***)
fully specifies
speaker meaning (***X***)

Meaning

X

Goal:
Produce a ***clue*** such that the intended speaker meaning is ***identified*** unequivocally.

Ostension

relevant(X)

relevant(AB)

Possible messages:
would contribute to
goal of interaction
if transmitted

X

direct evidence

Signal

Common ground
mutually recognised
shared knowledge

Presupposed:
recognition of speaker's
communicative intention

Meaning

X

Inference

Communicator

Addressee

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X→X

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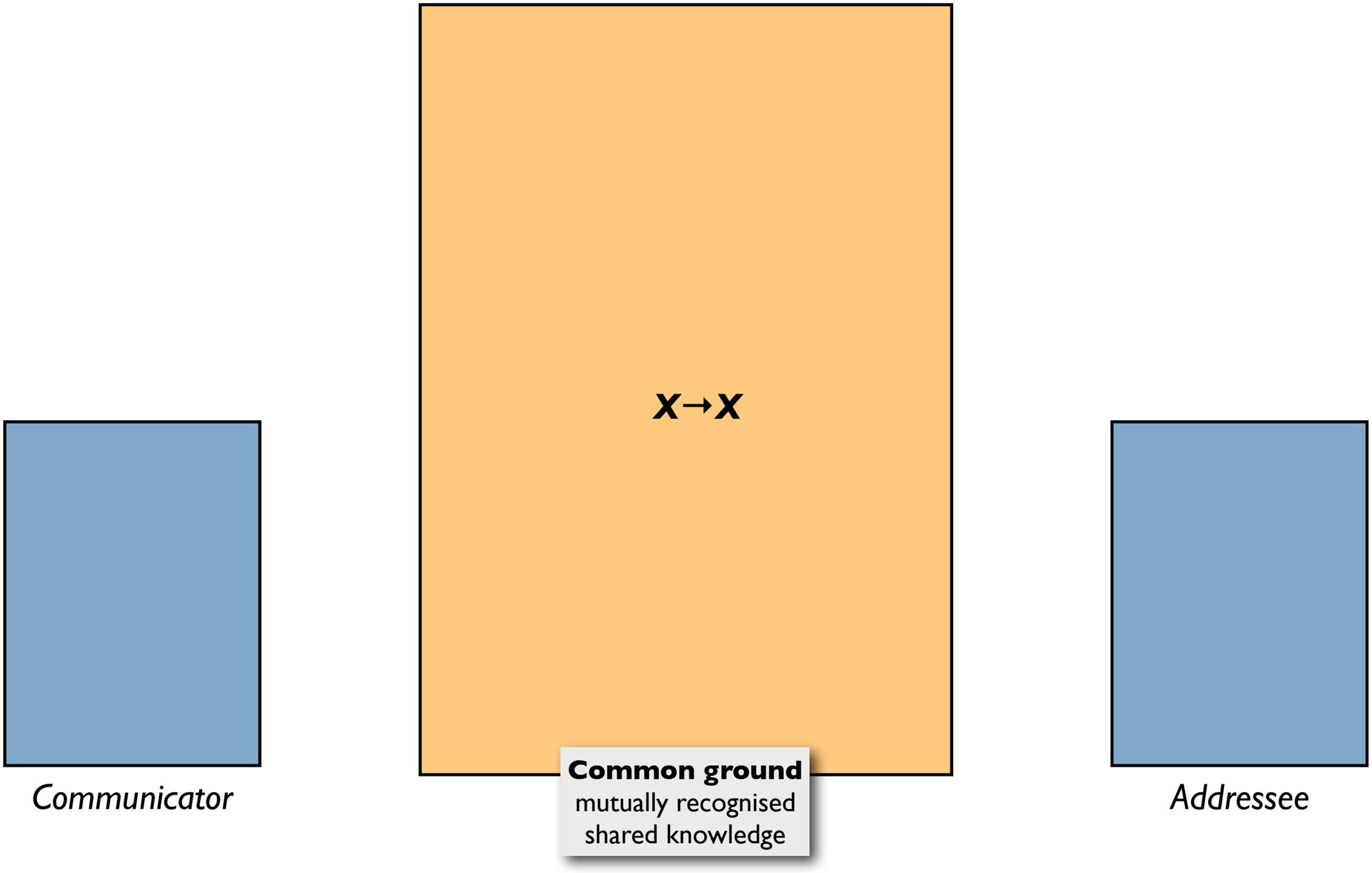

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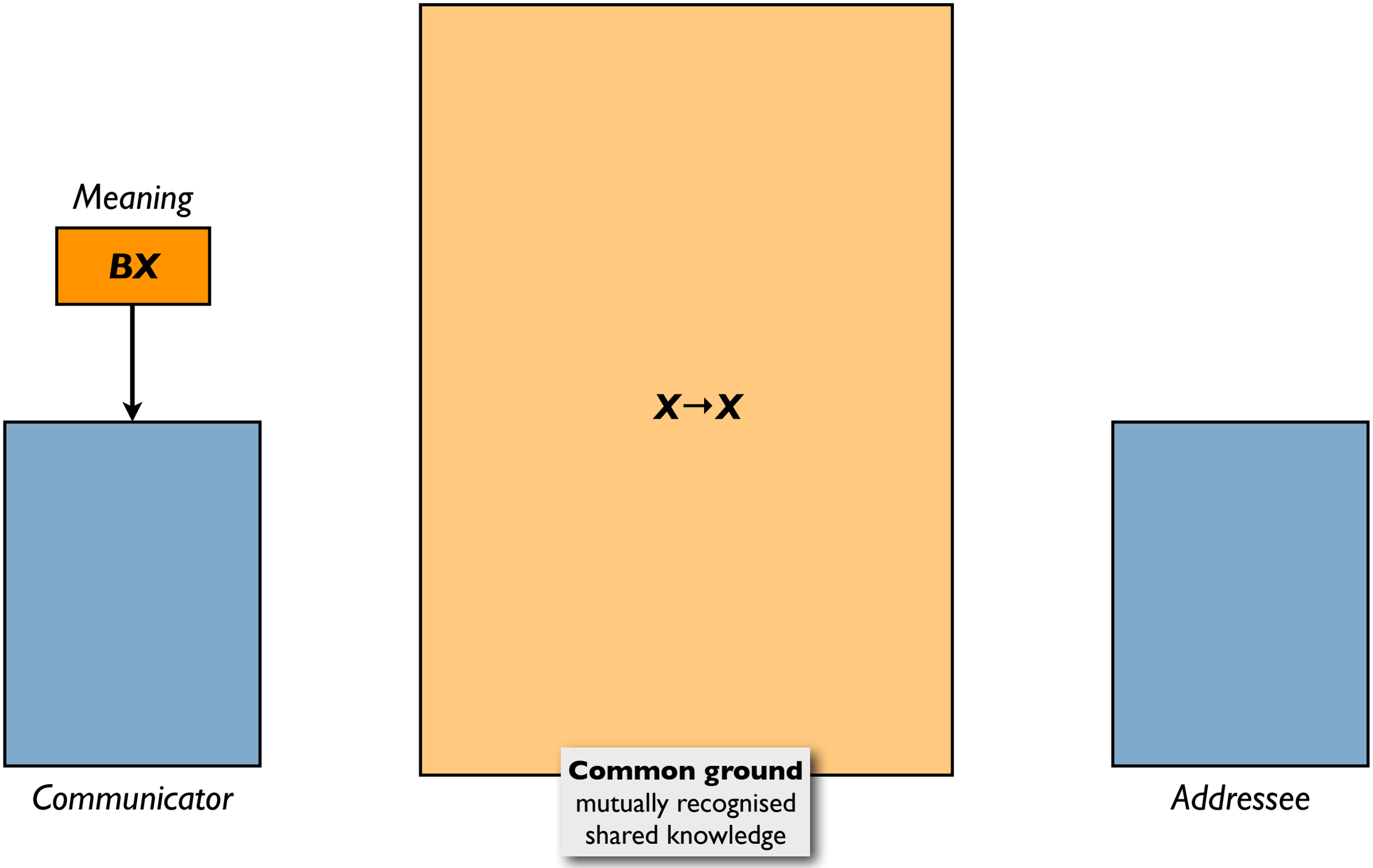

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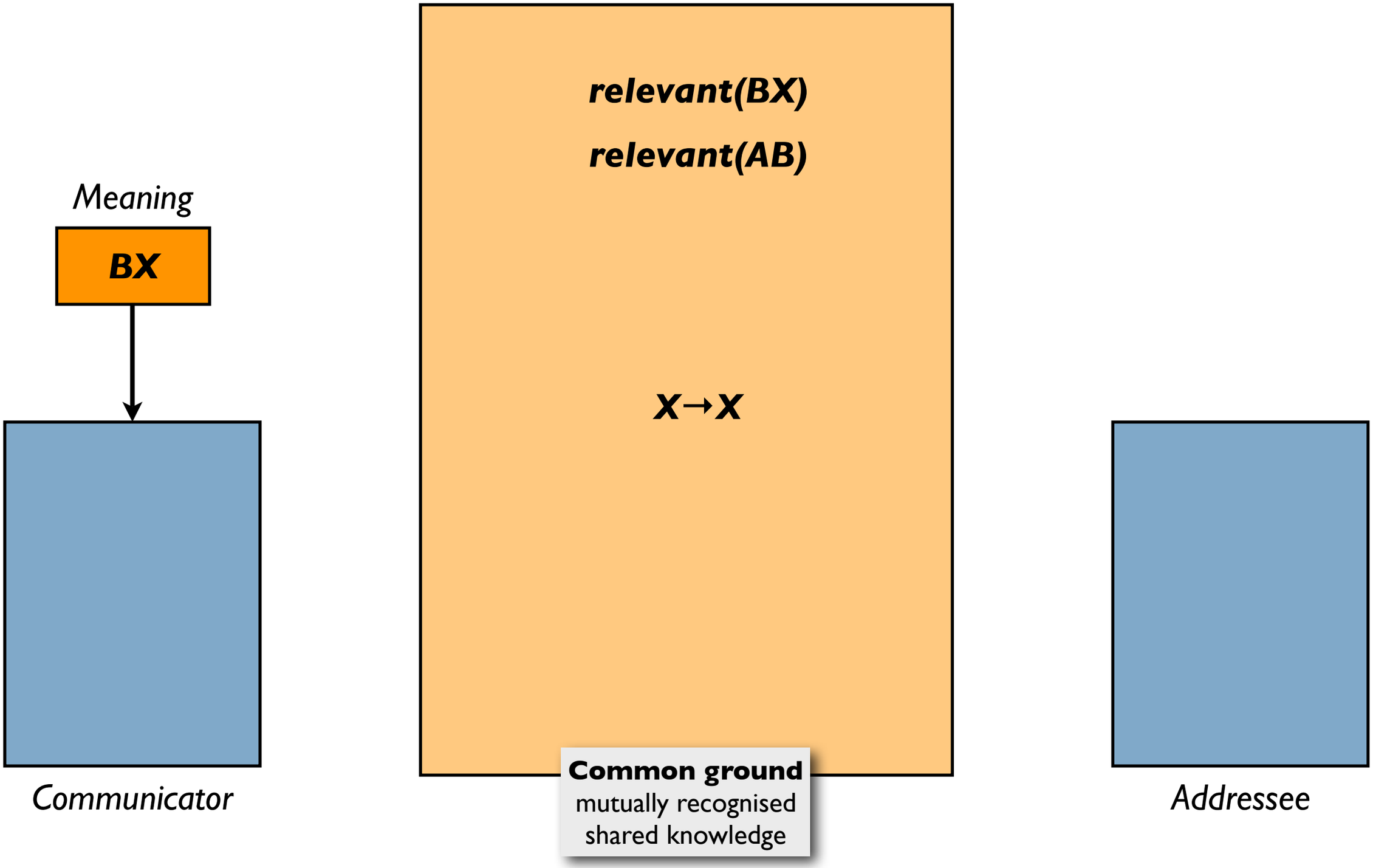

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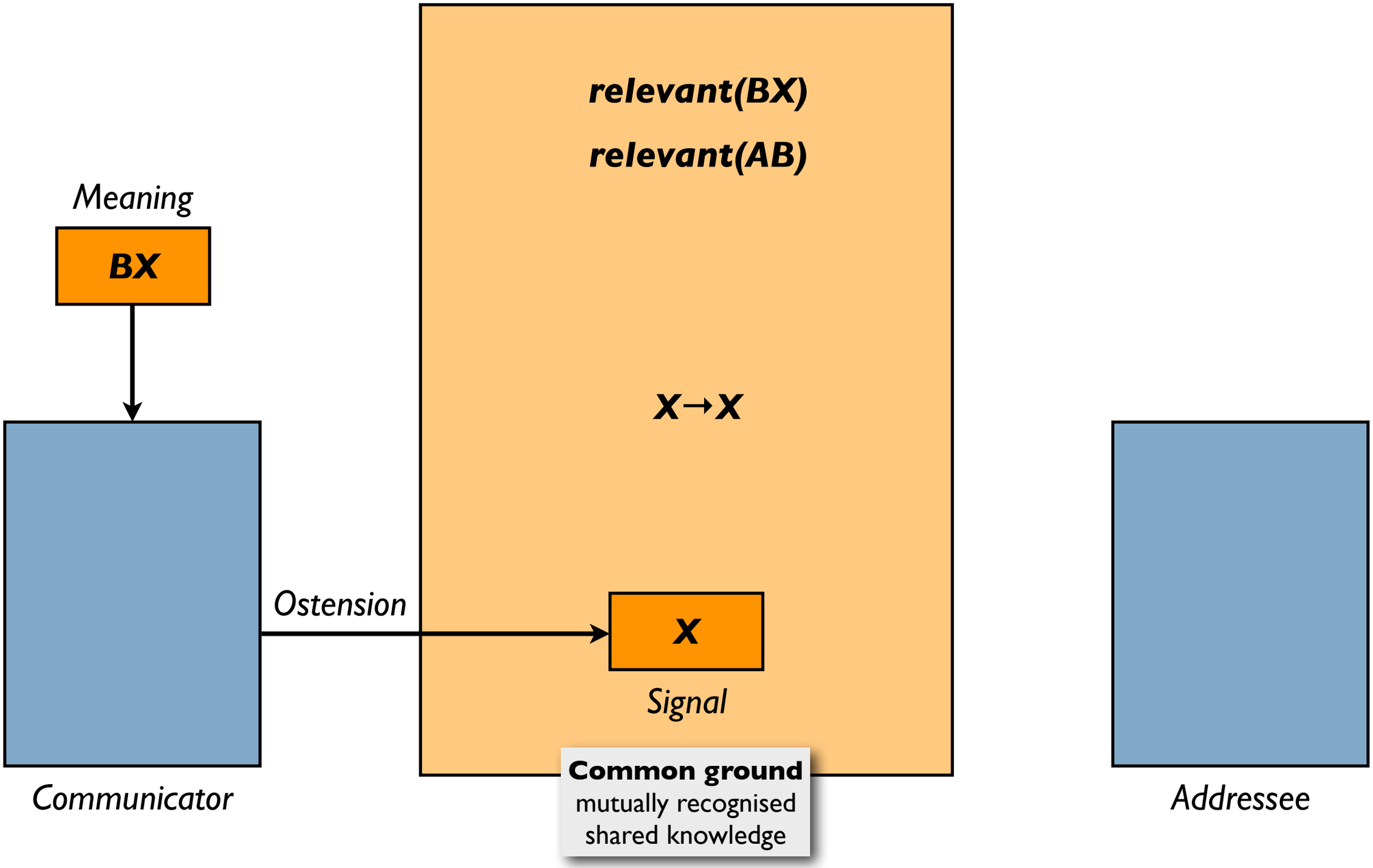

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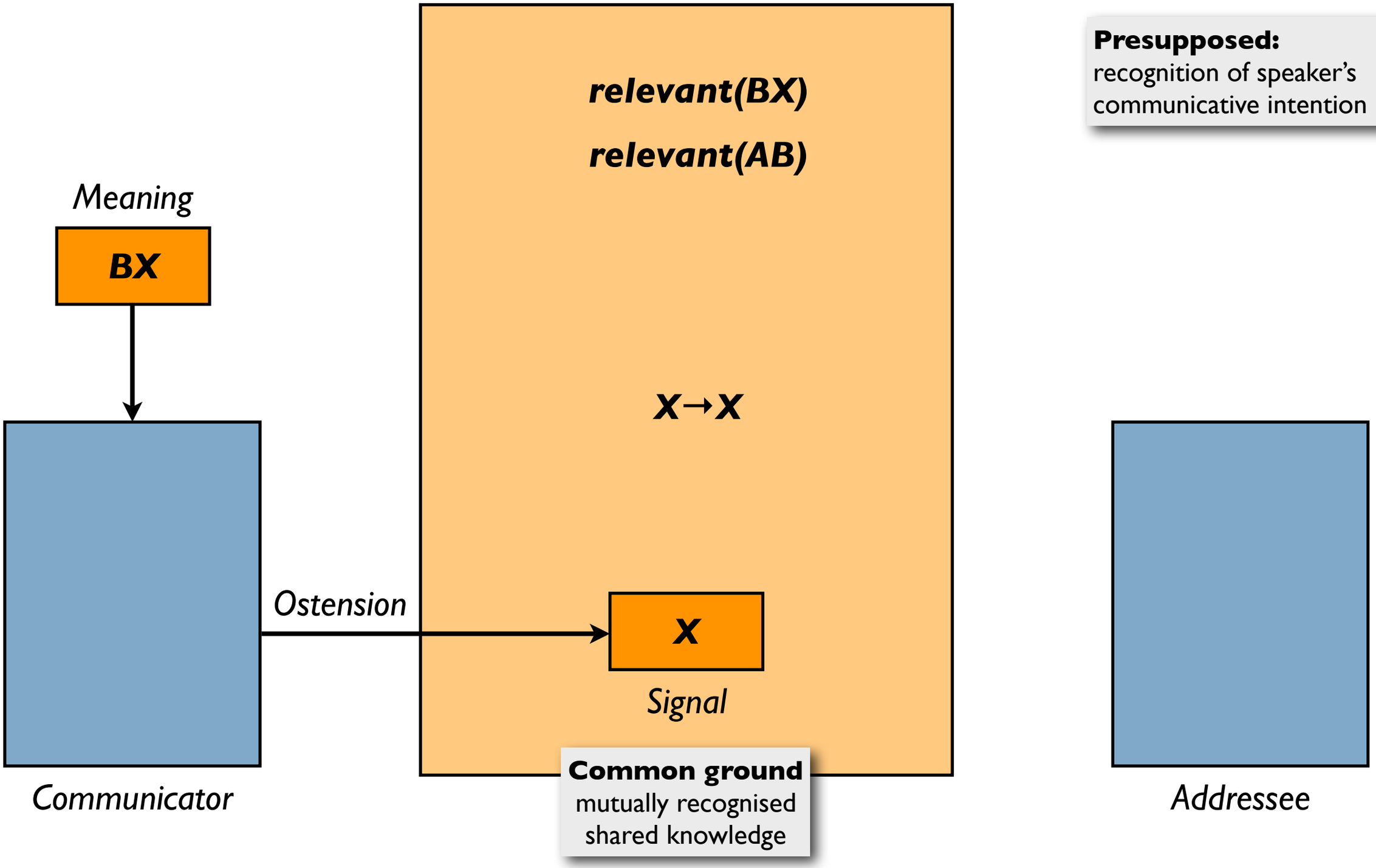

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Common ground
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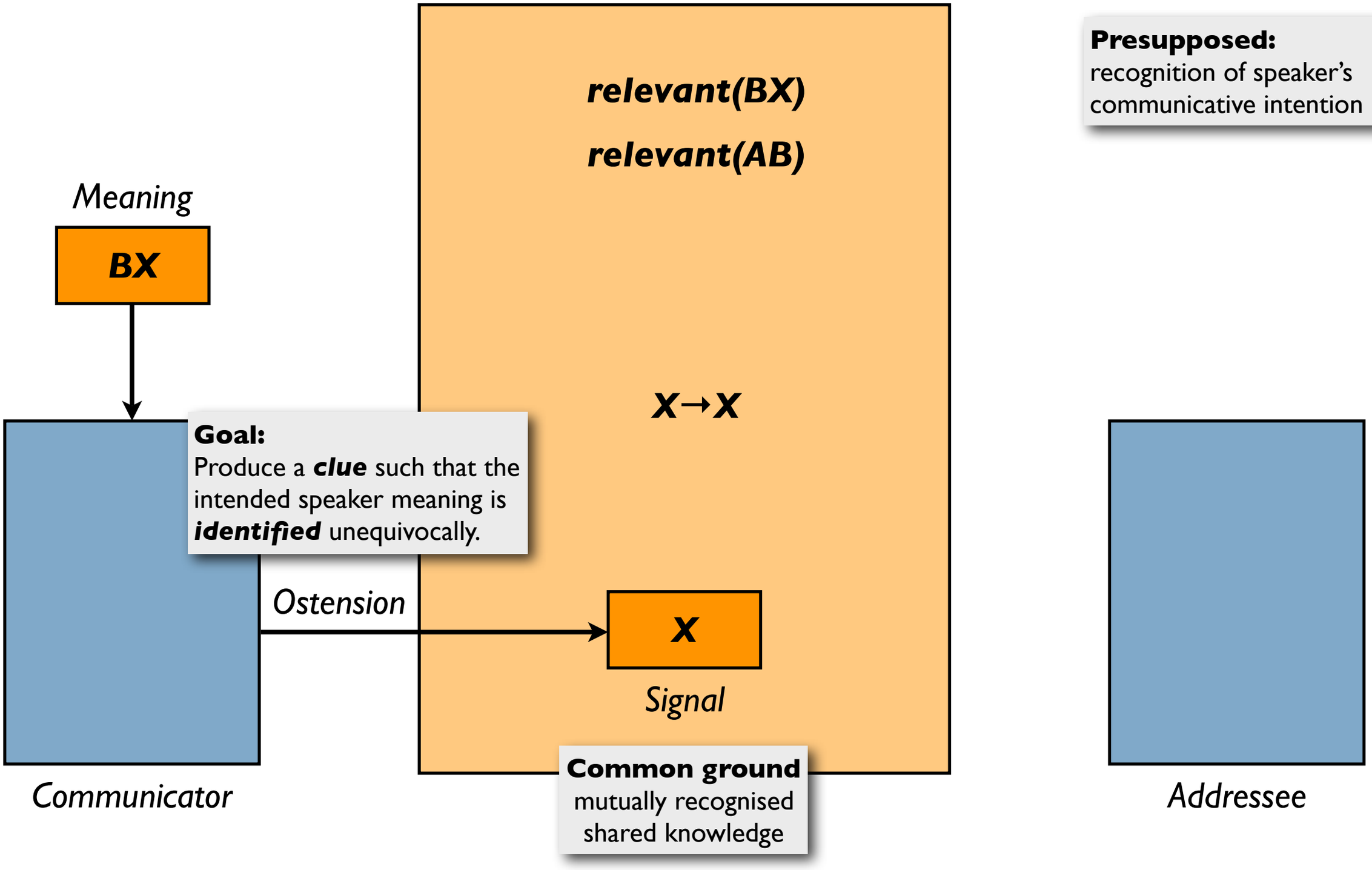

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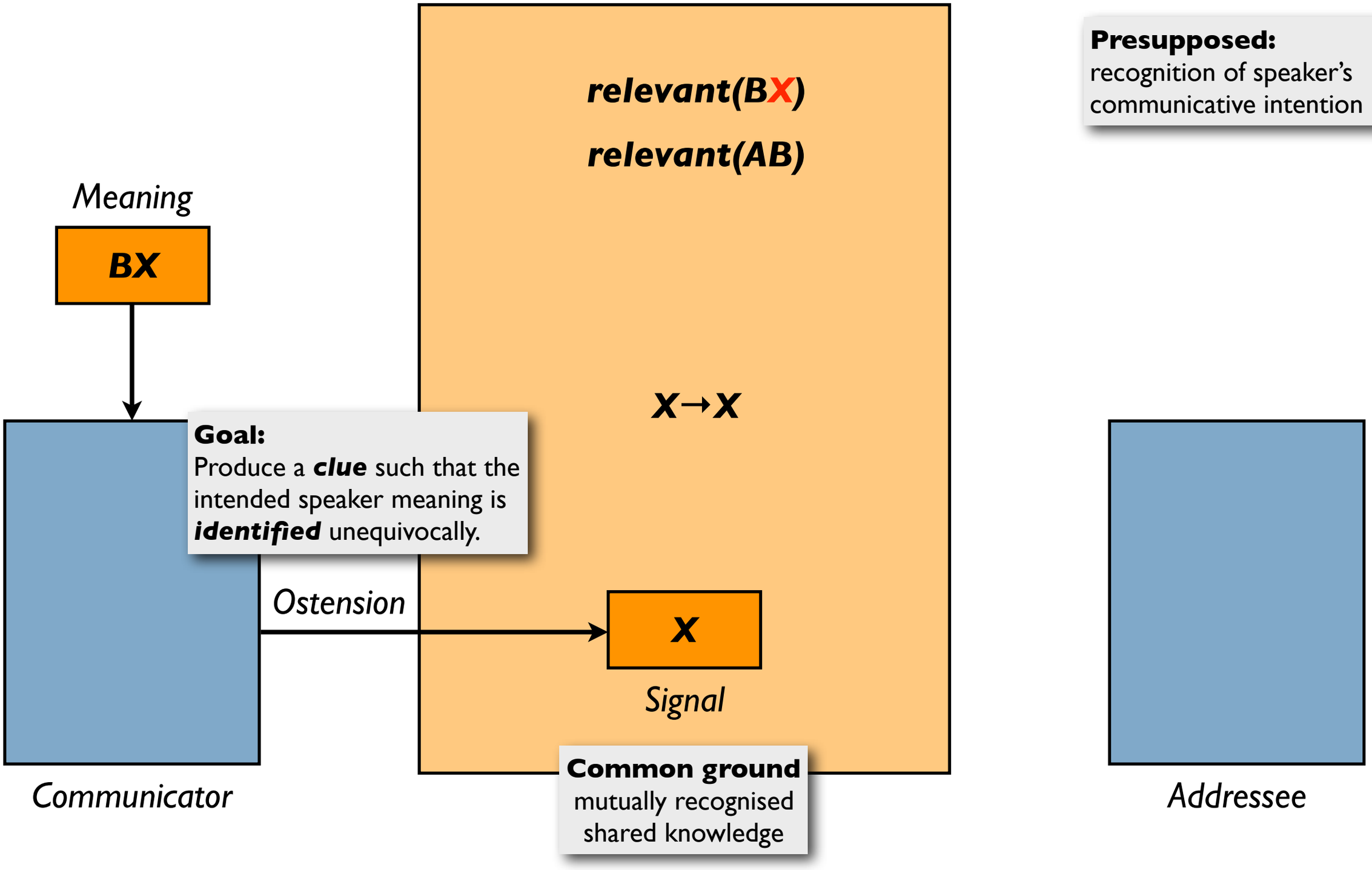

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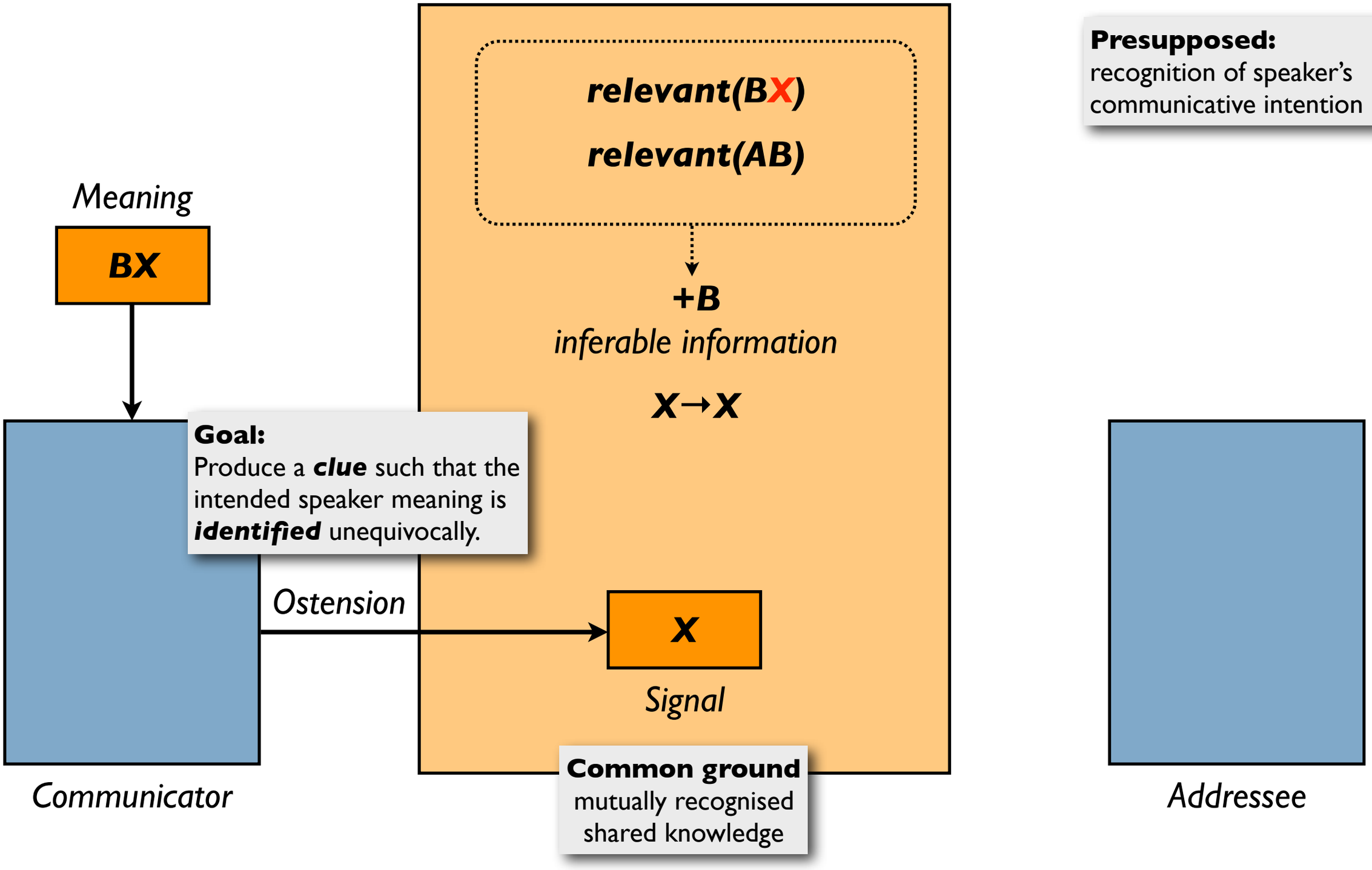

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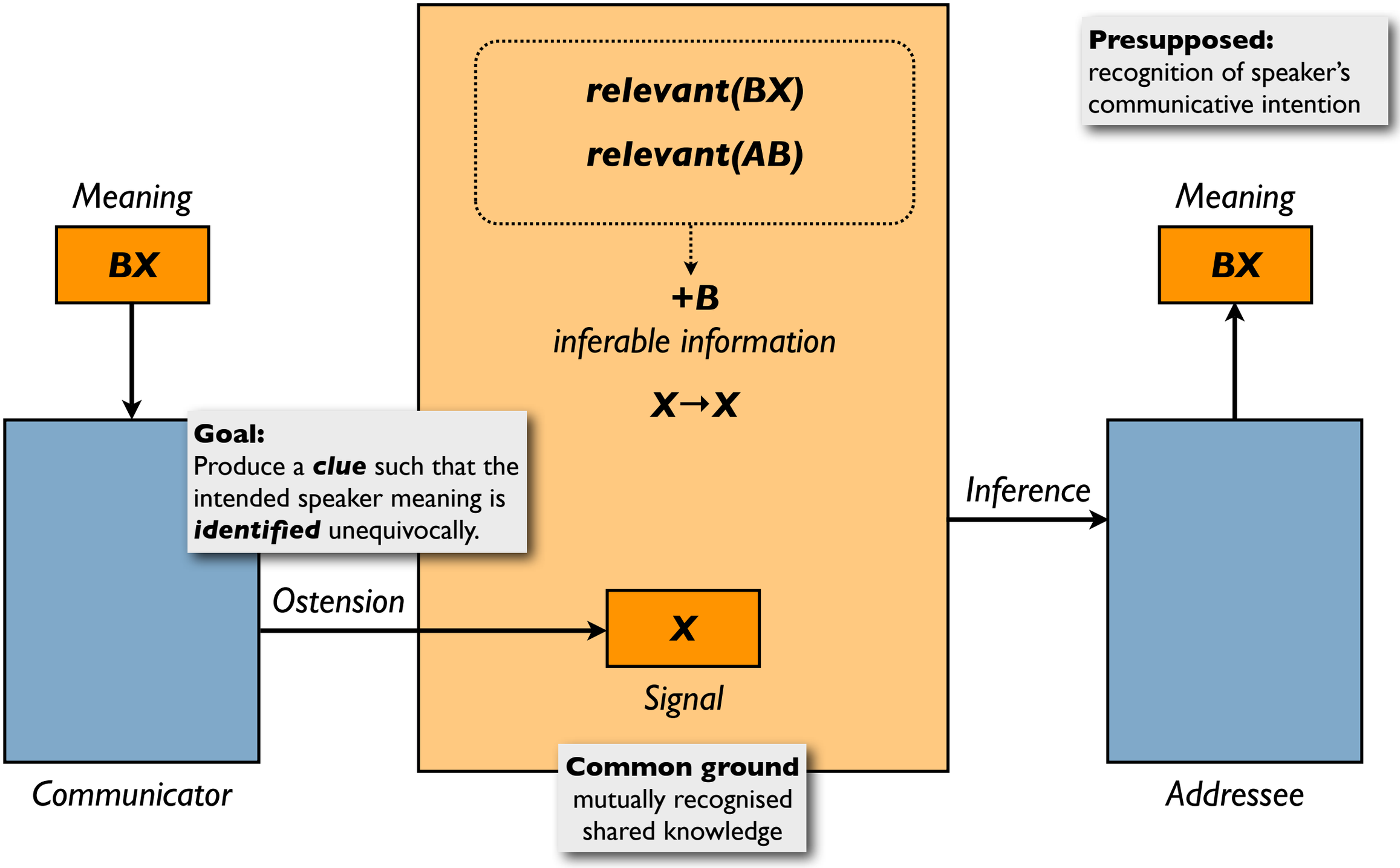

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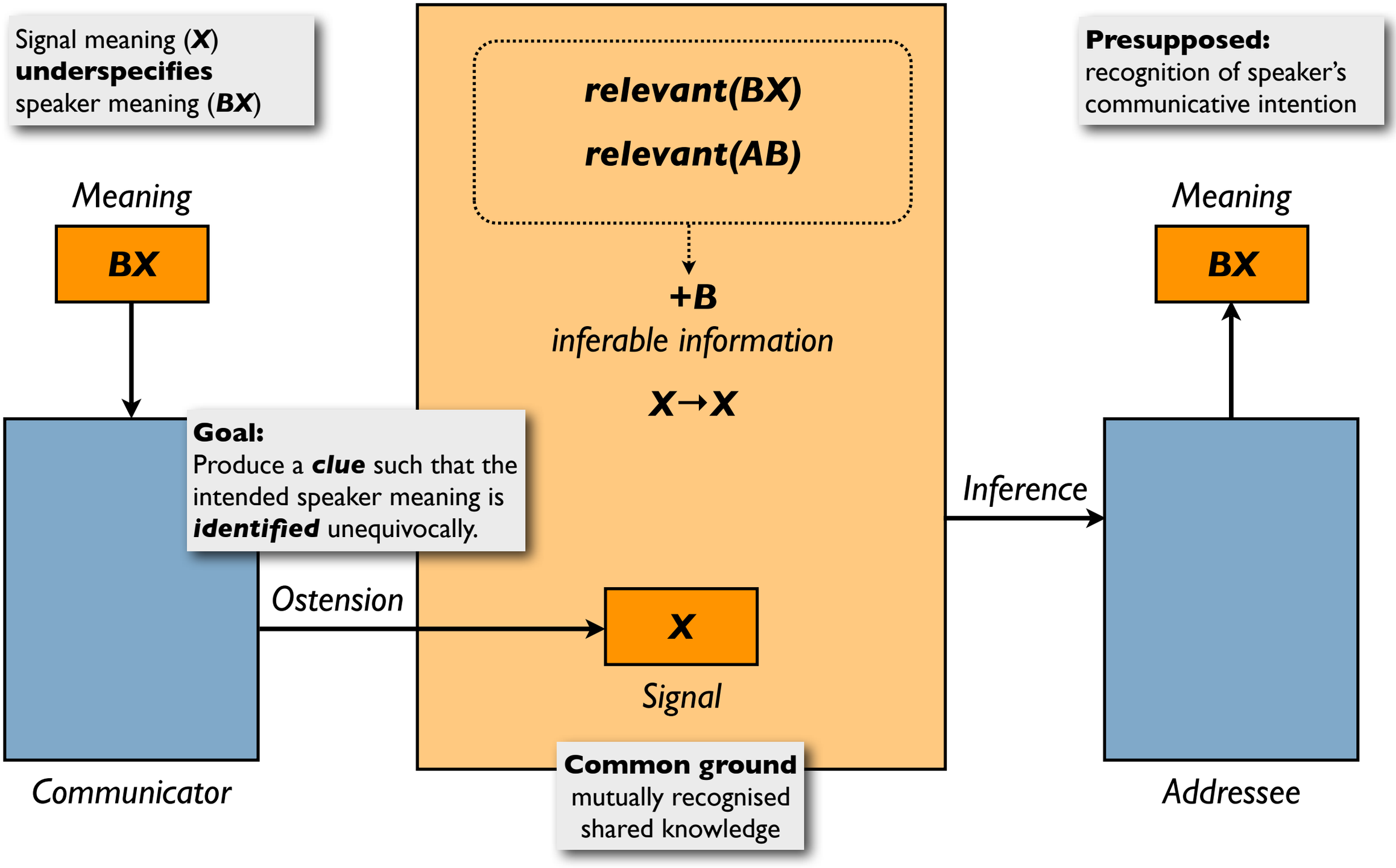

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Communicator

Ostension

relevant(BX)

relevant(AB)

+B

inferable information

X→X

X→BX

X

Signal

Common ground
mutually recognised shared knowledge

Presupposed:
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Meaning

BX

Inference

Addressee

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iconic convention

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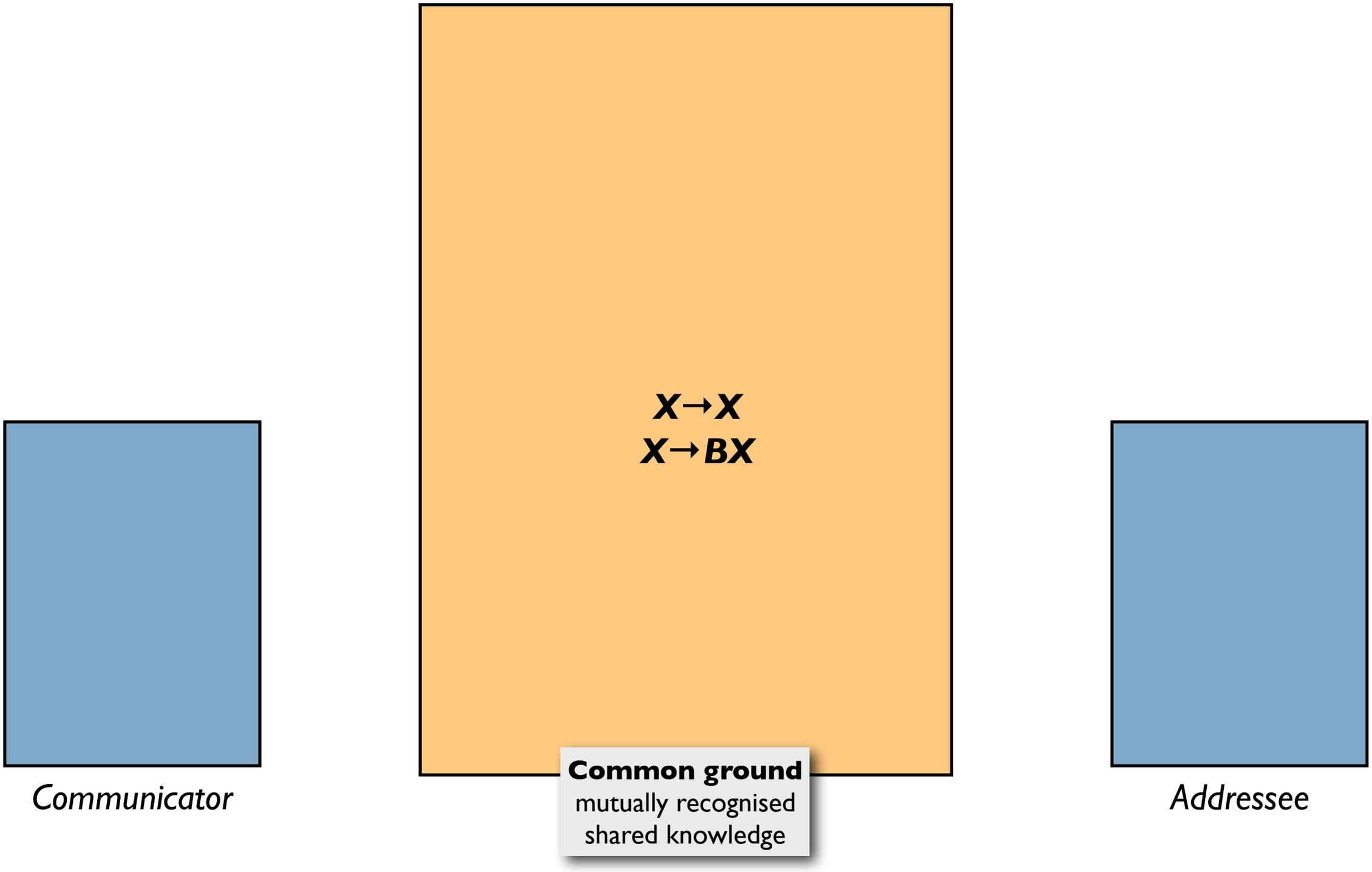

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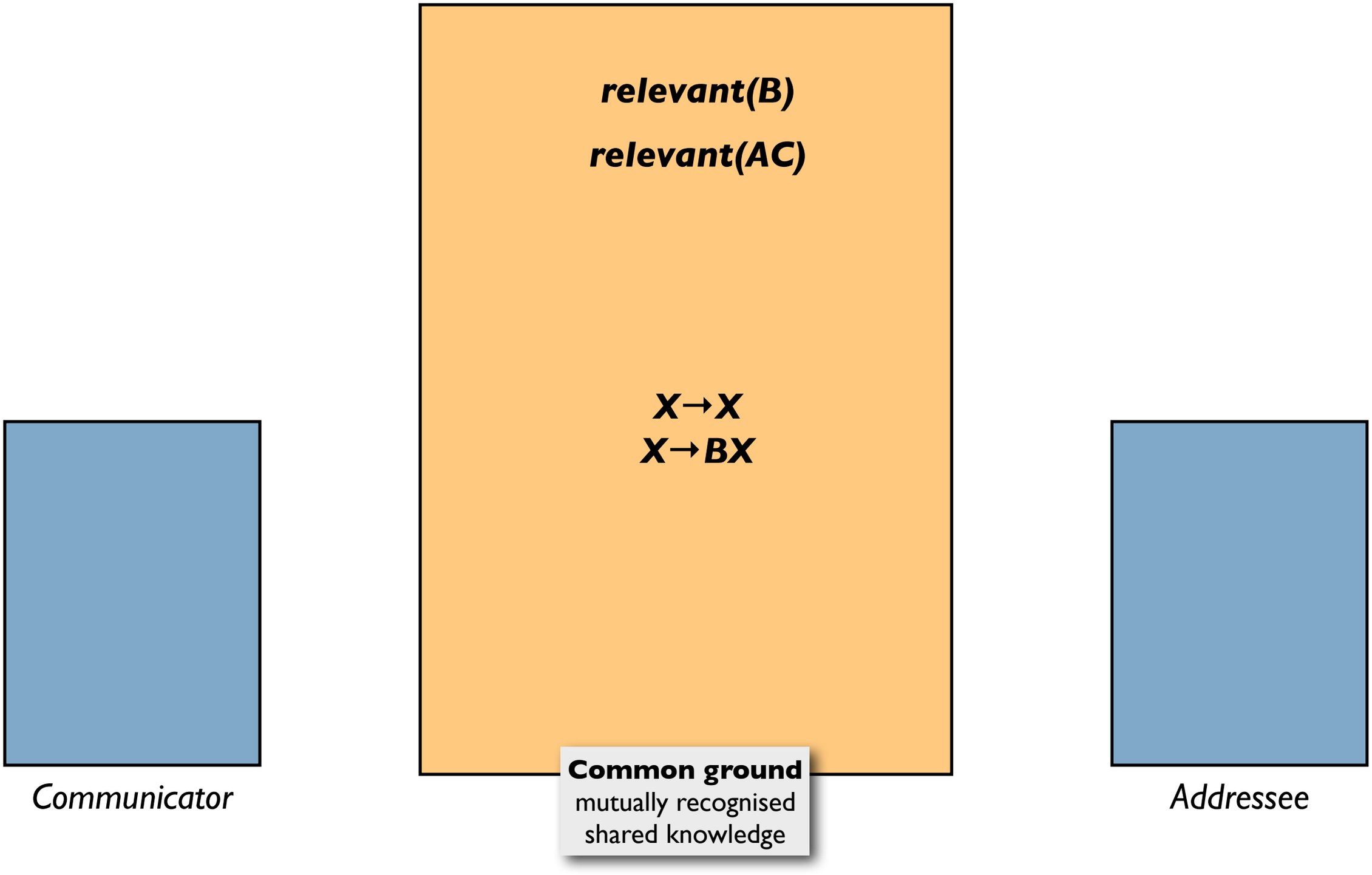

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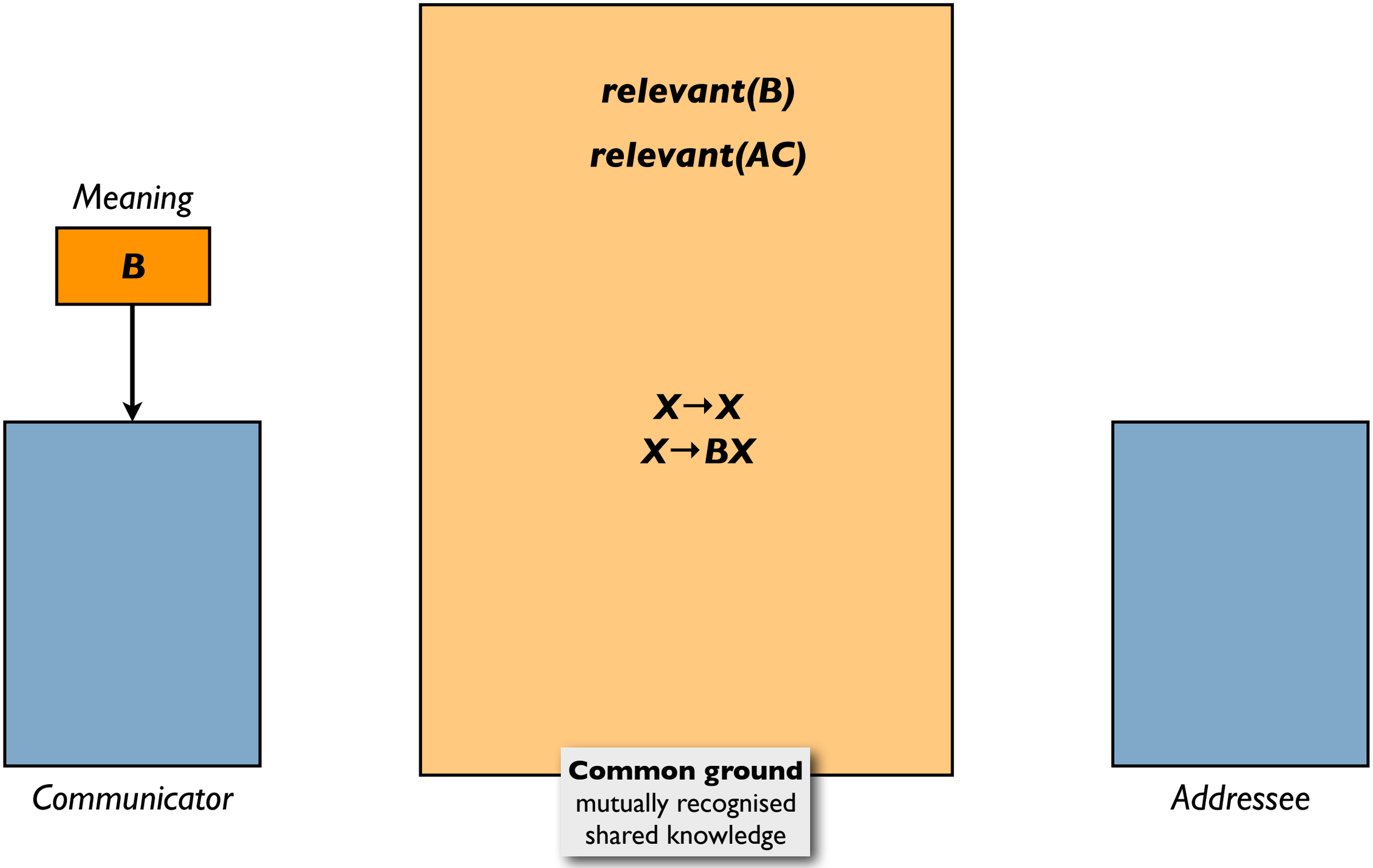

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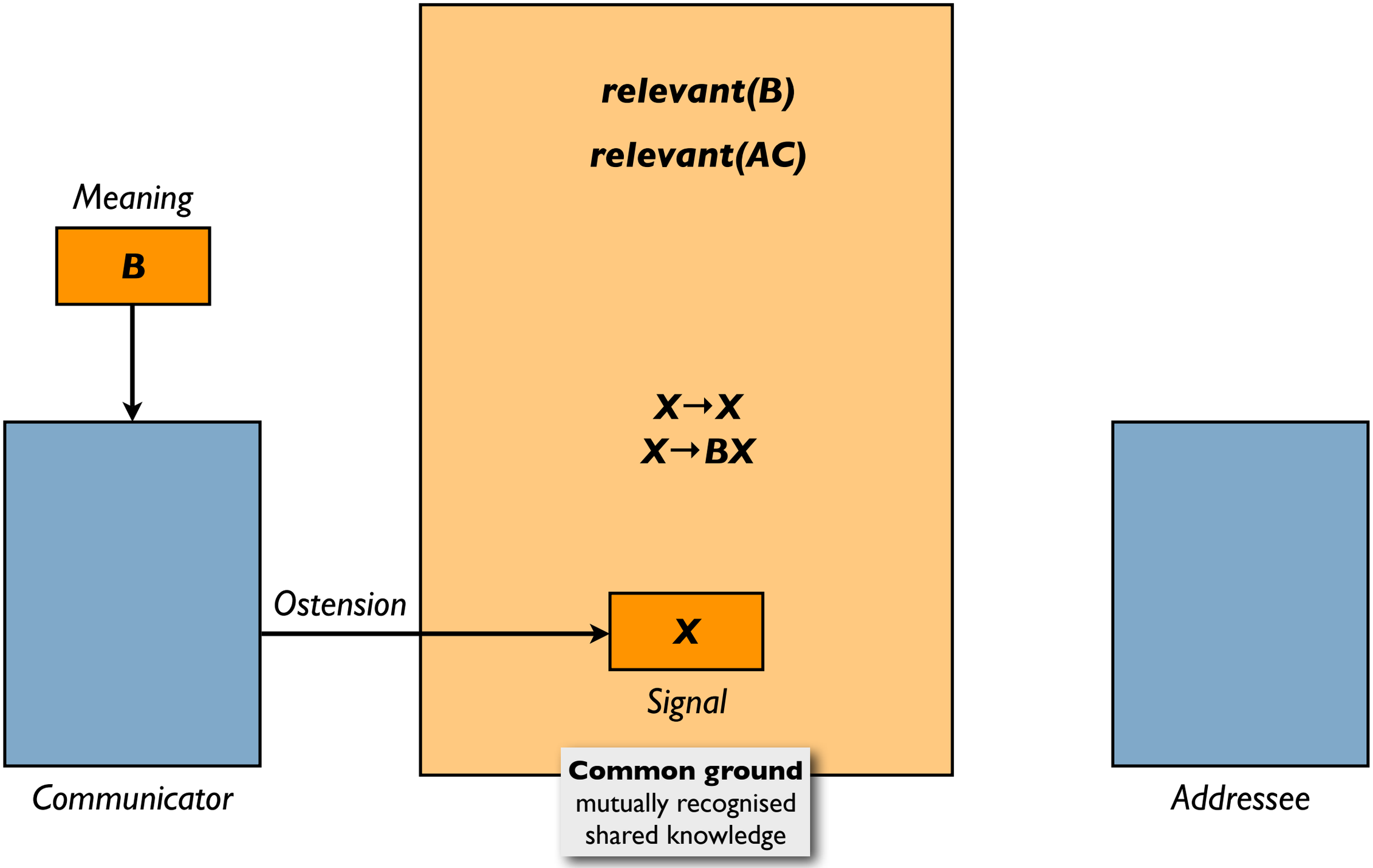

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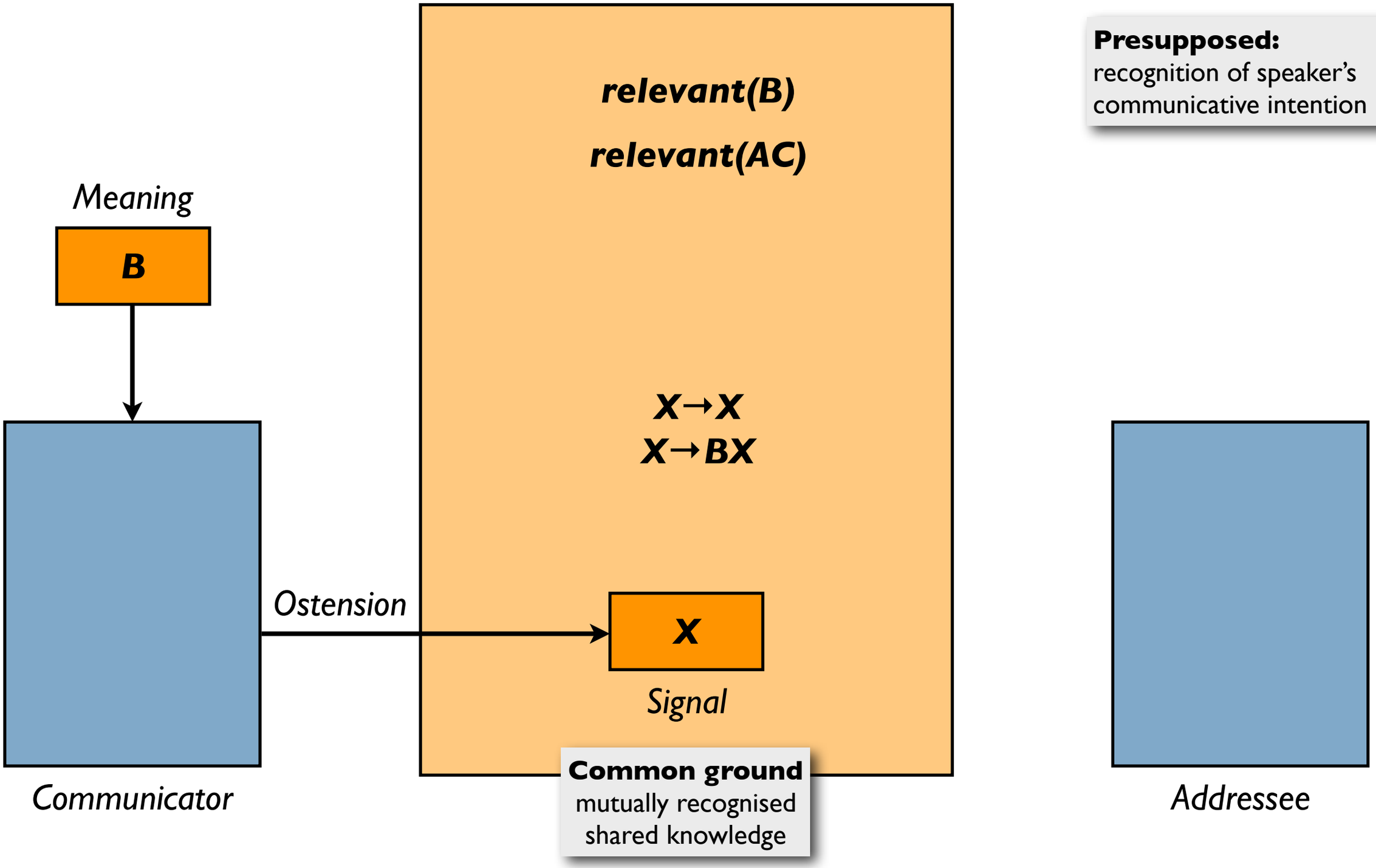

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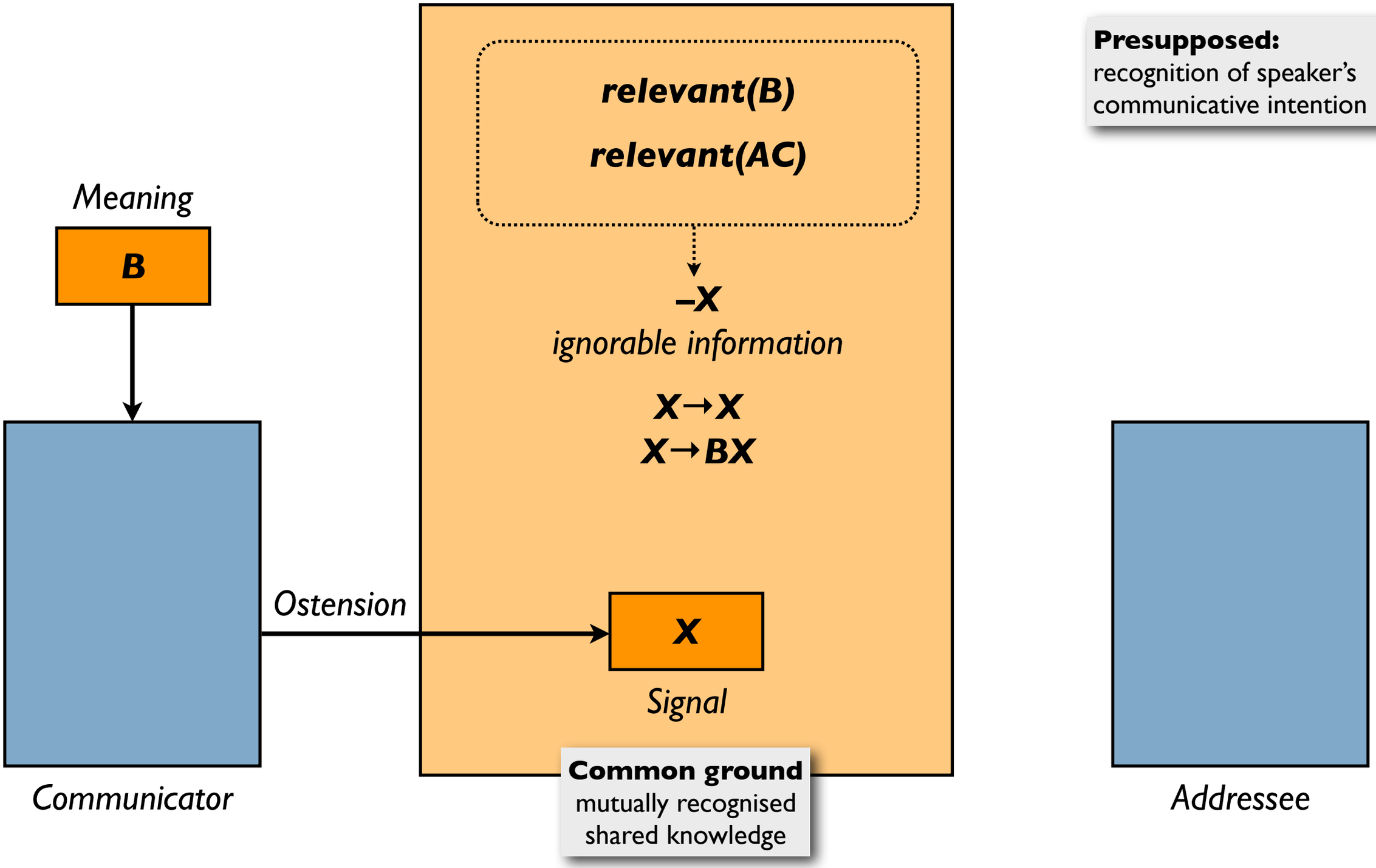

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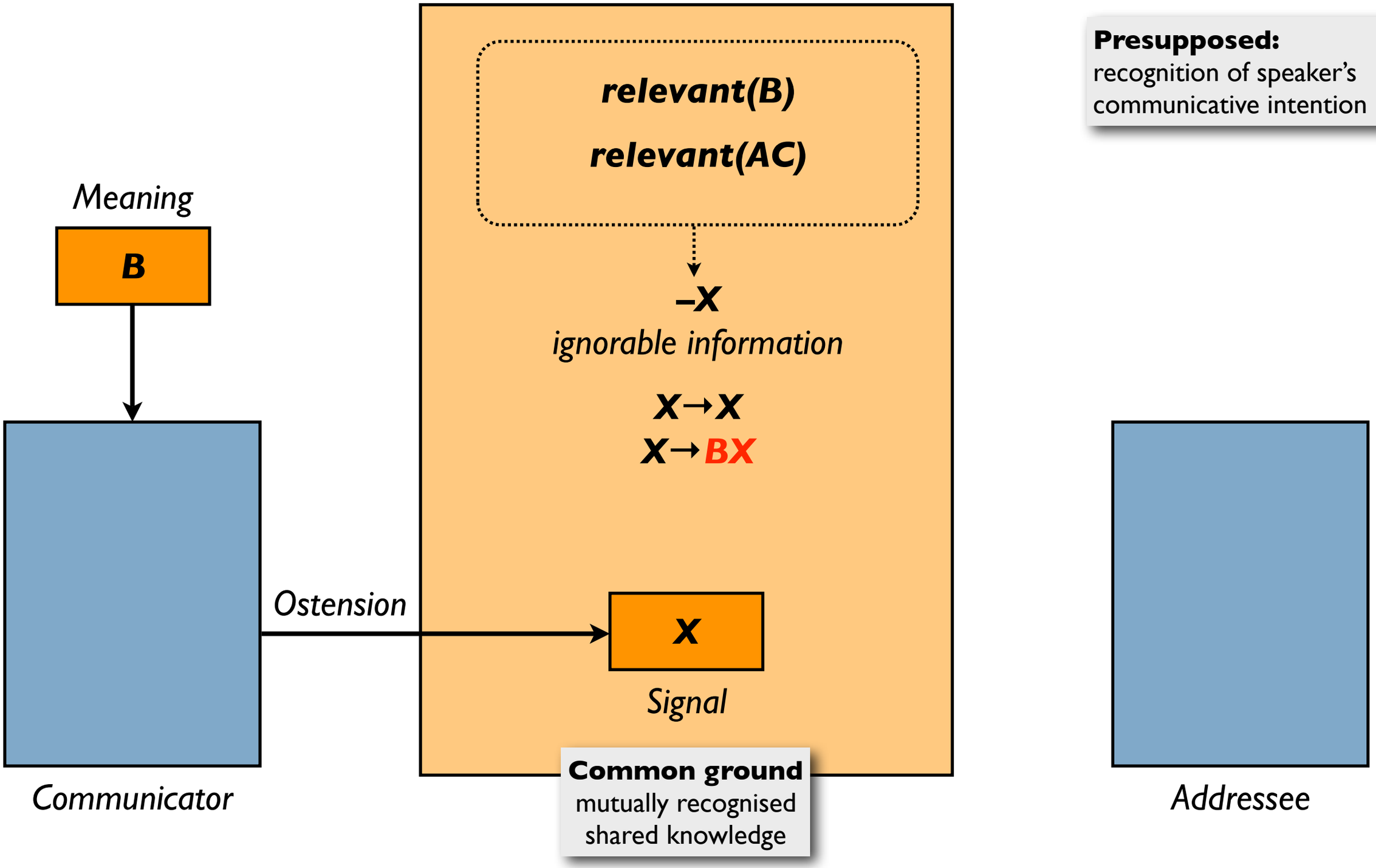
Common ground
mutually recognised shared knowledge

Modelling ostensive-inferential communication (3)



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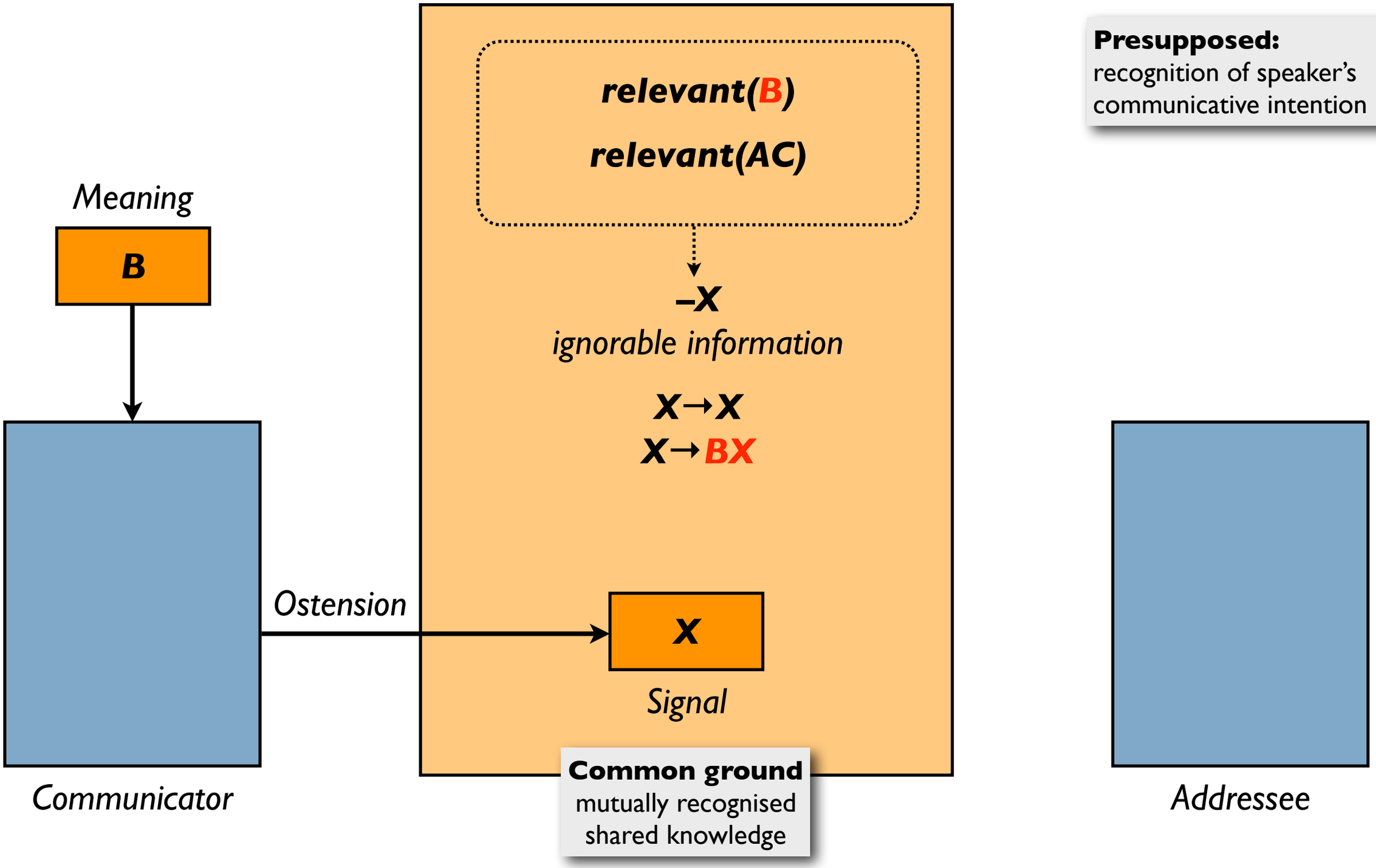

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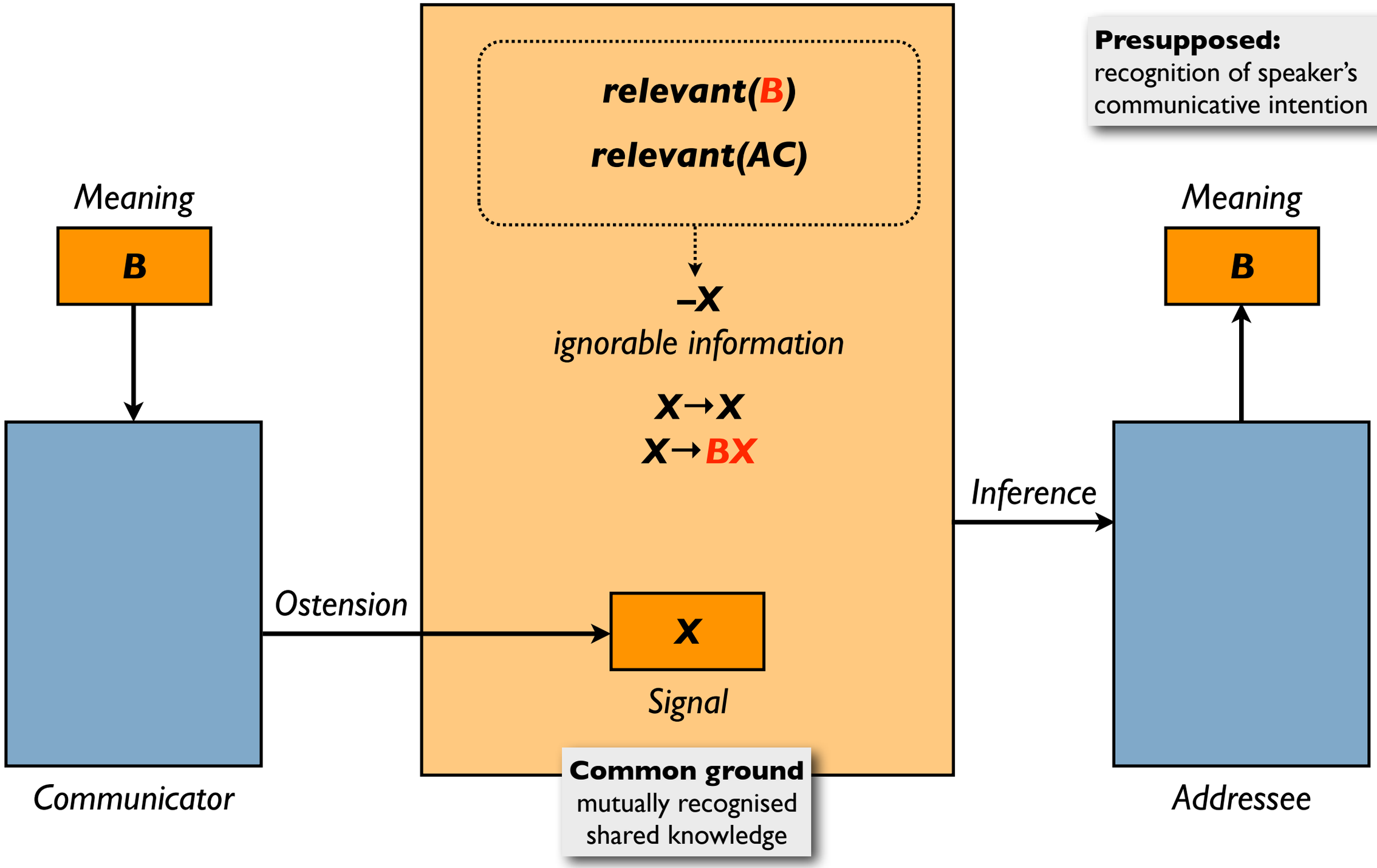

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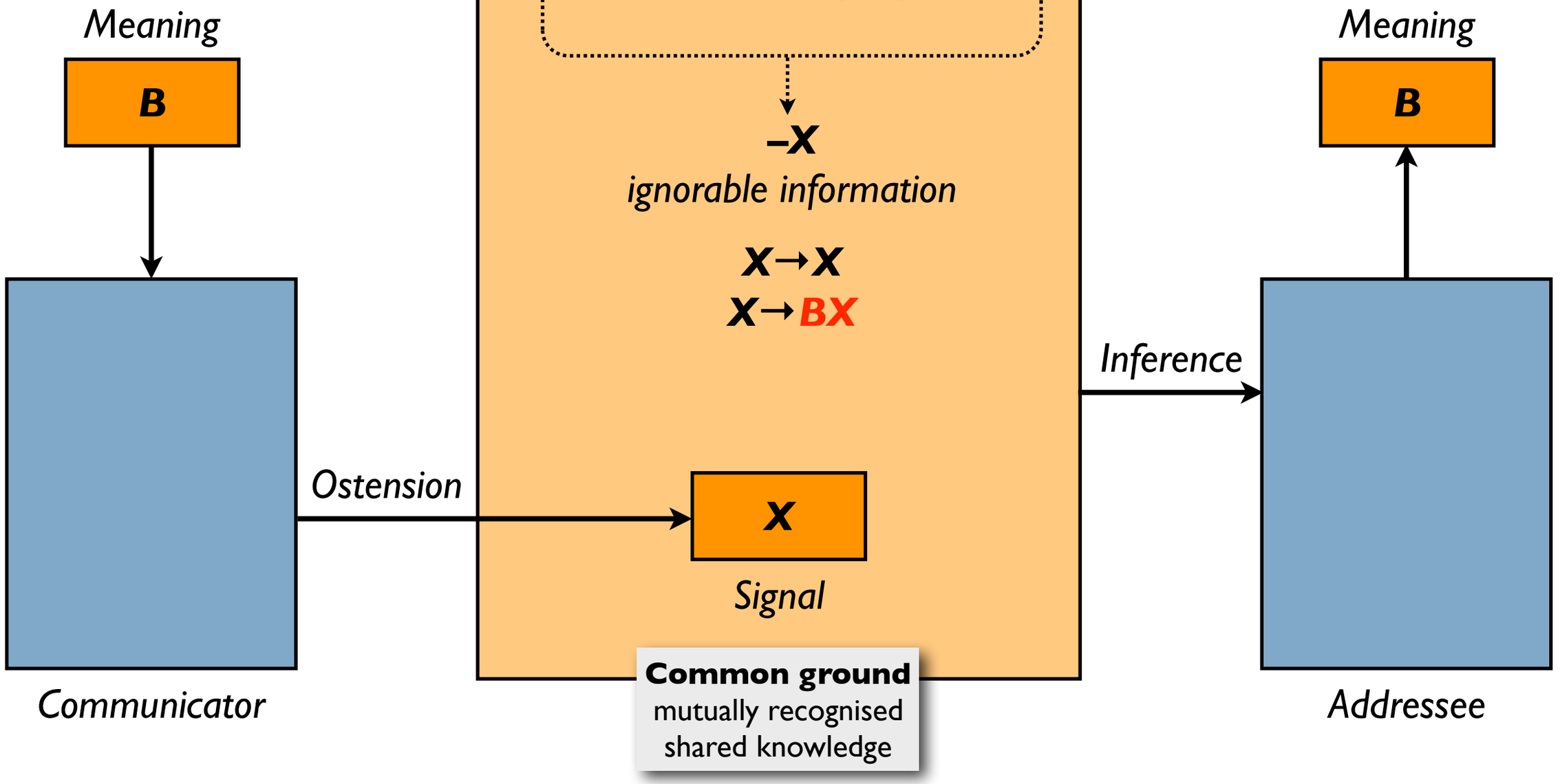

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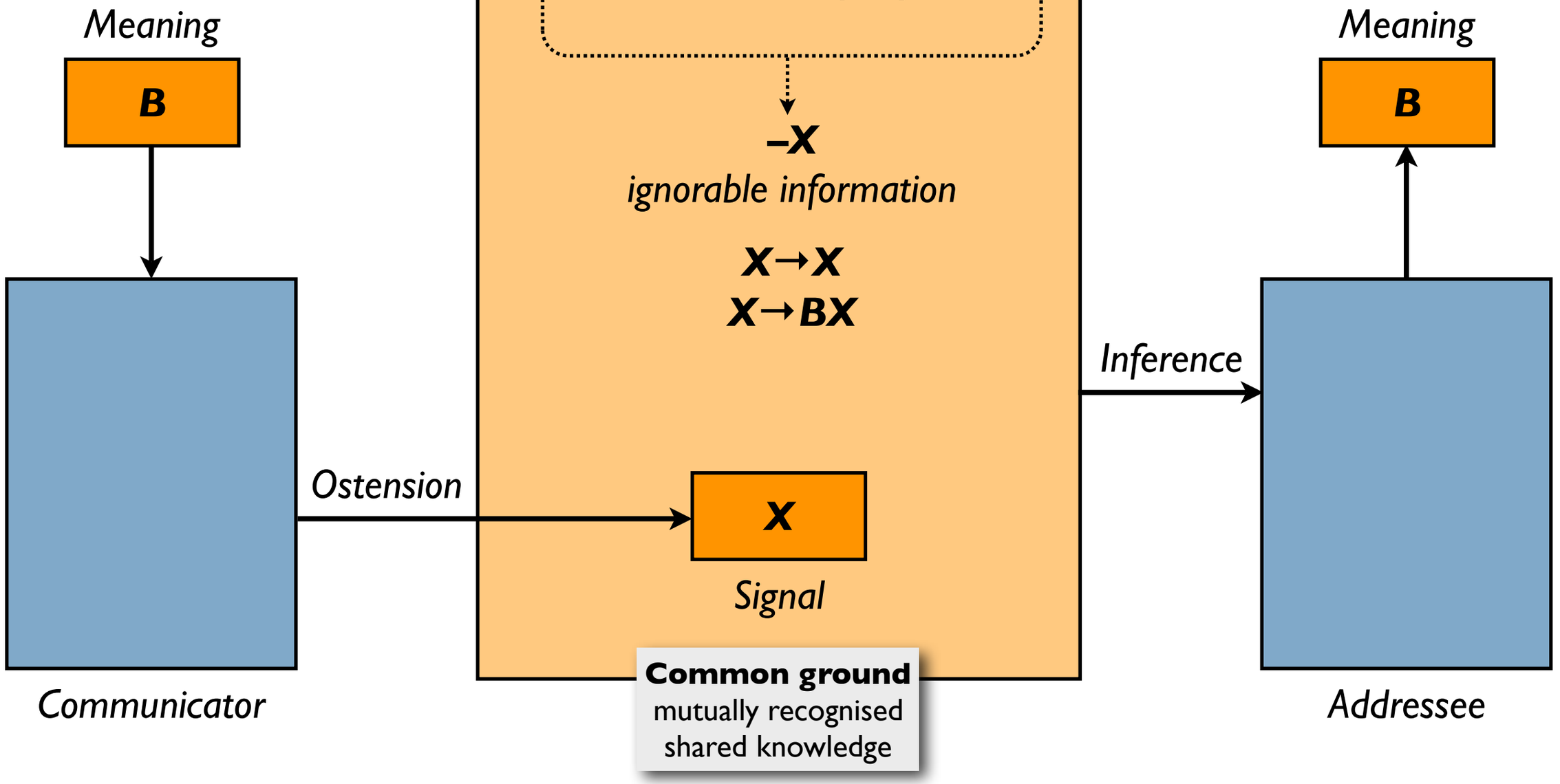

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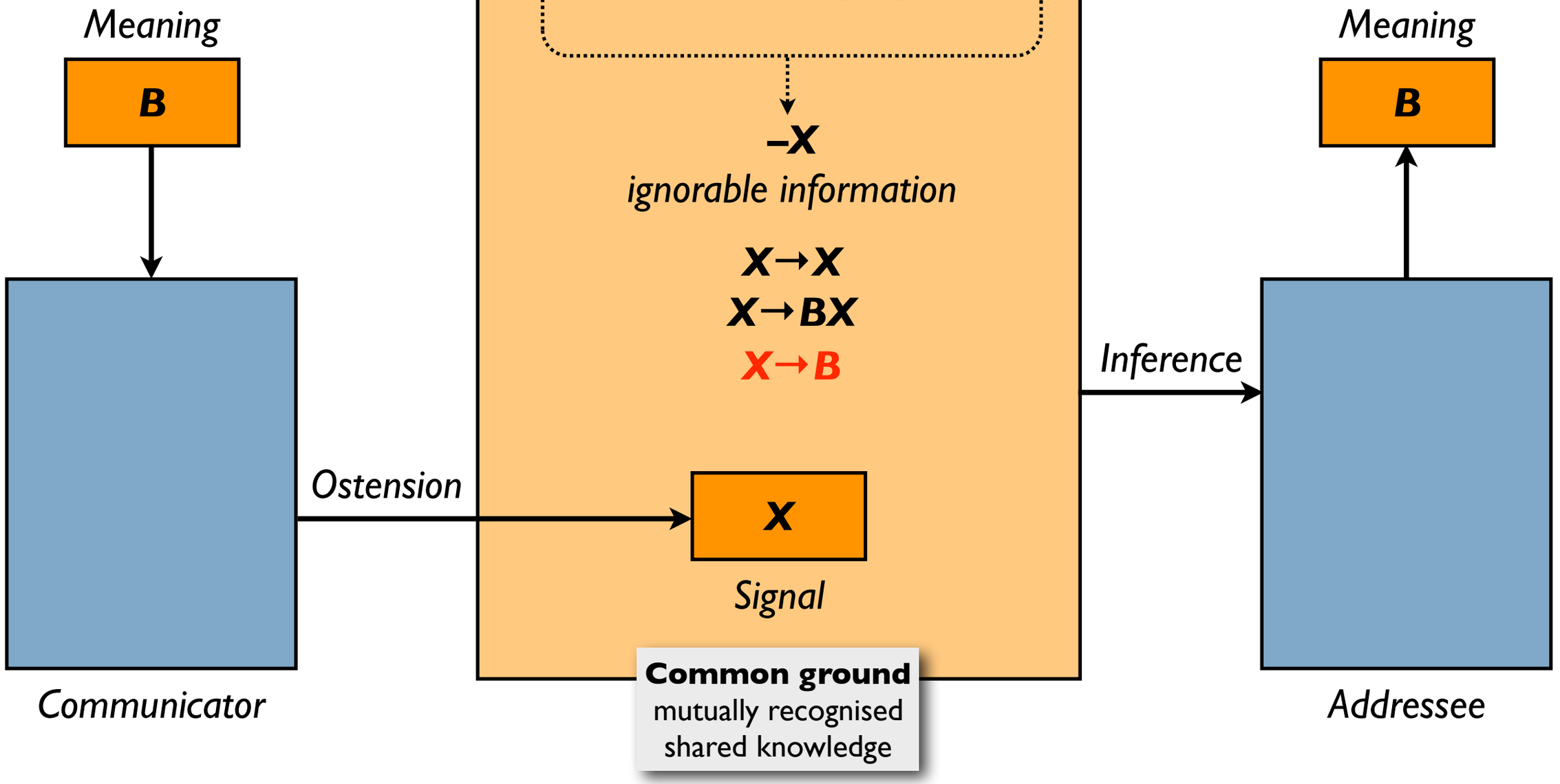
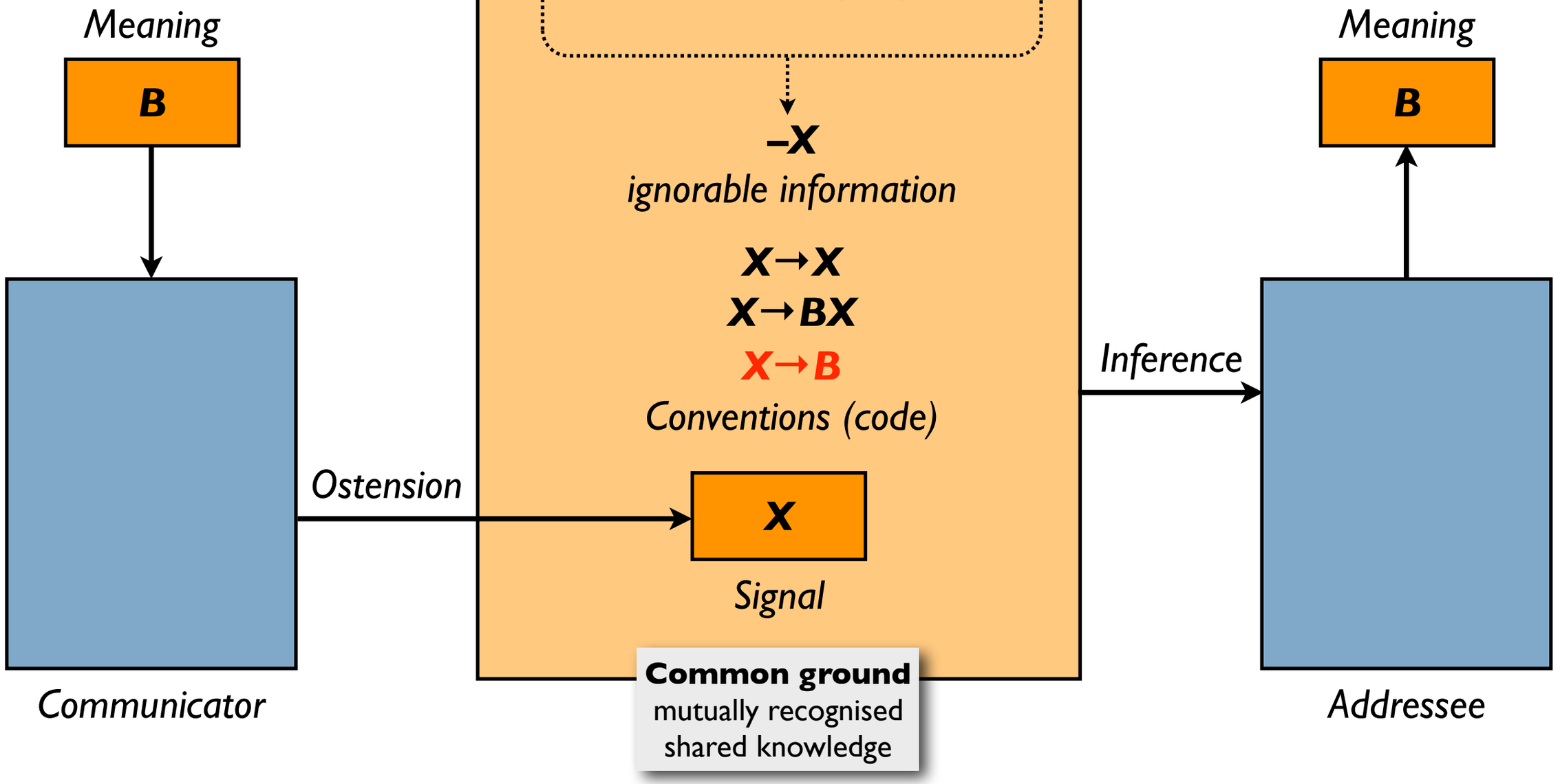


Presupposed: recognition of speaker's communicative intention

Modelling ostensive-inferential communication (3)

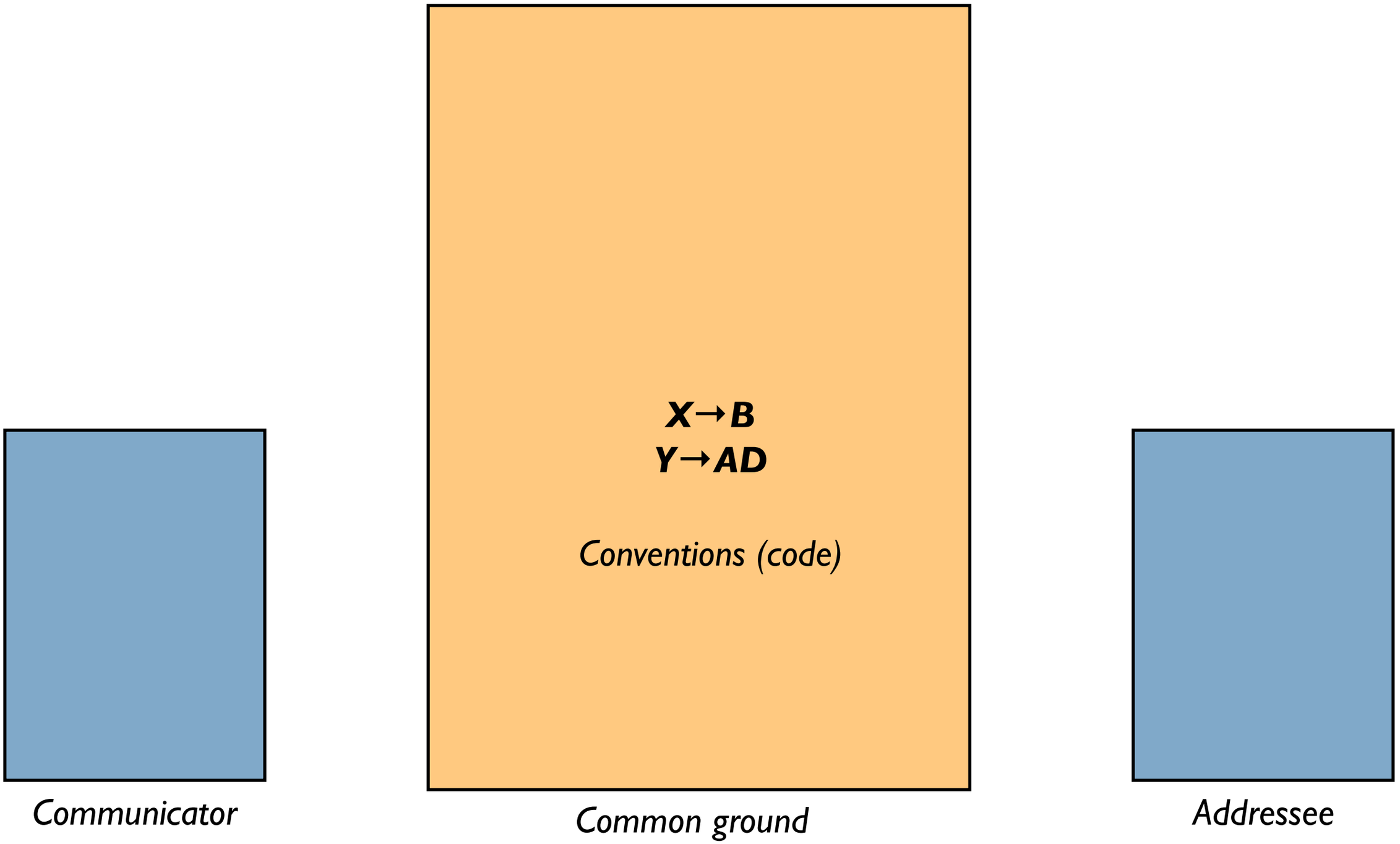
Signal meaning (***BX***) **overspecifies** speaker meaning (***B***)



Common ground
mutually recognised shared knowledge

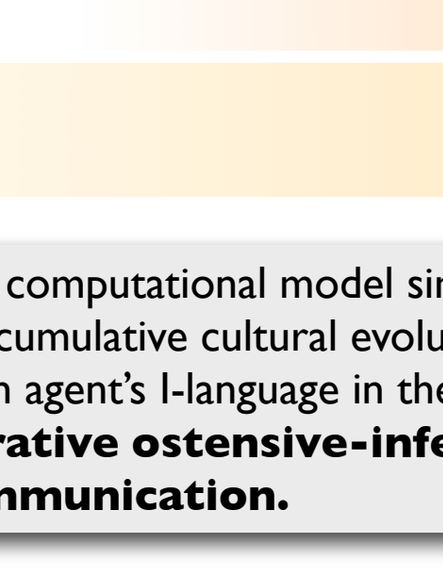
Presupposed:
recognition of speaker's communicative intention

The computational implementation

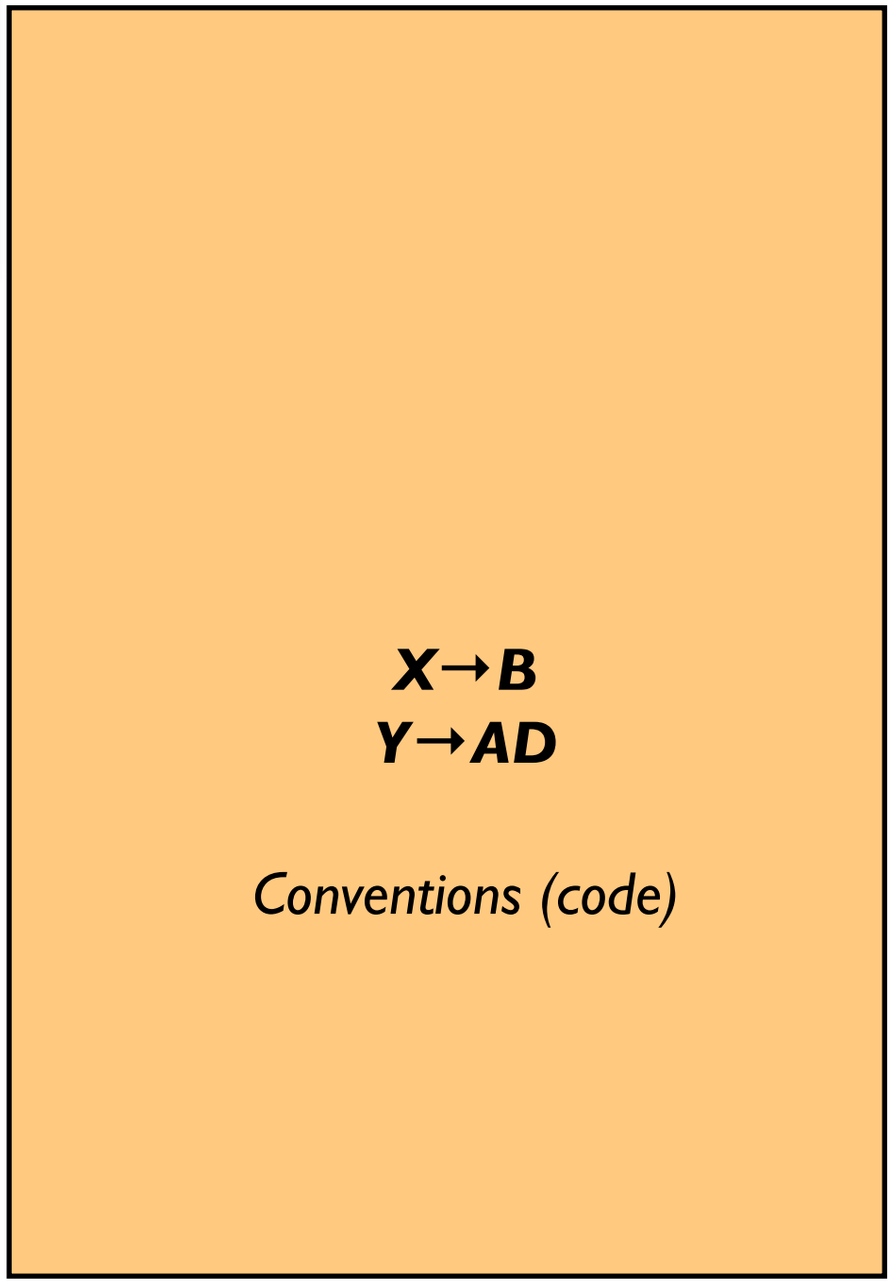


The computational implementation

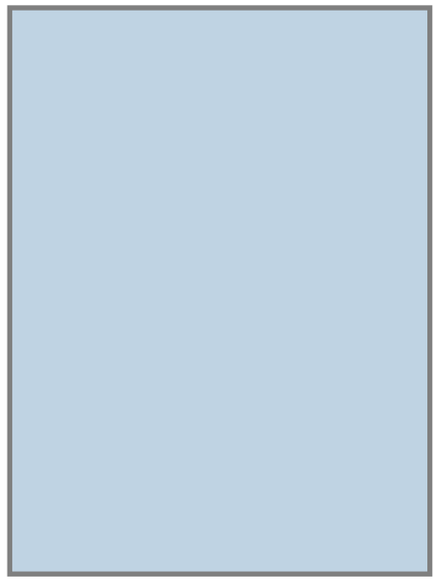
The computational model simulates the cumulative cultural evolution of an agent's I-language in the course of **iterative ostensive-inferential communication.**



Communicator



Common ground



Addressee

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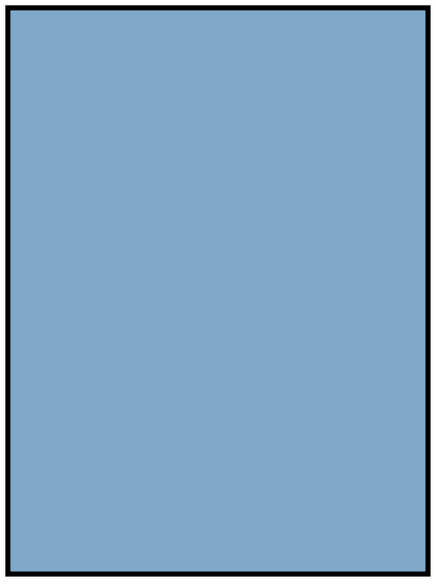
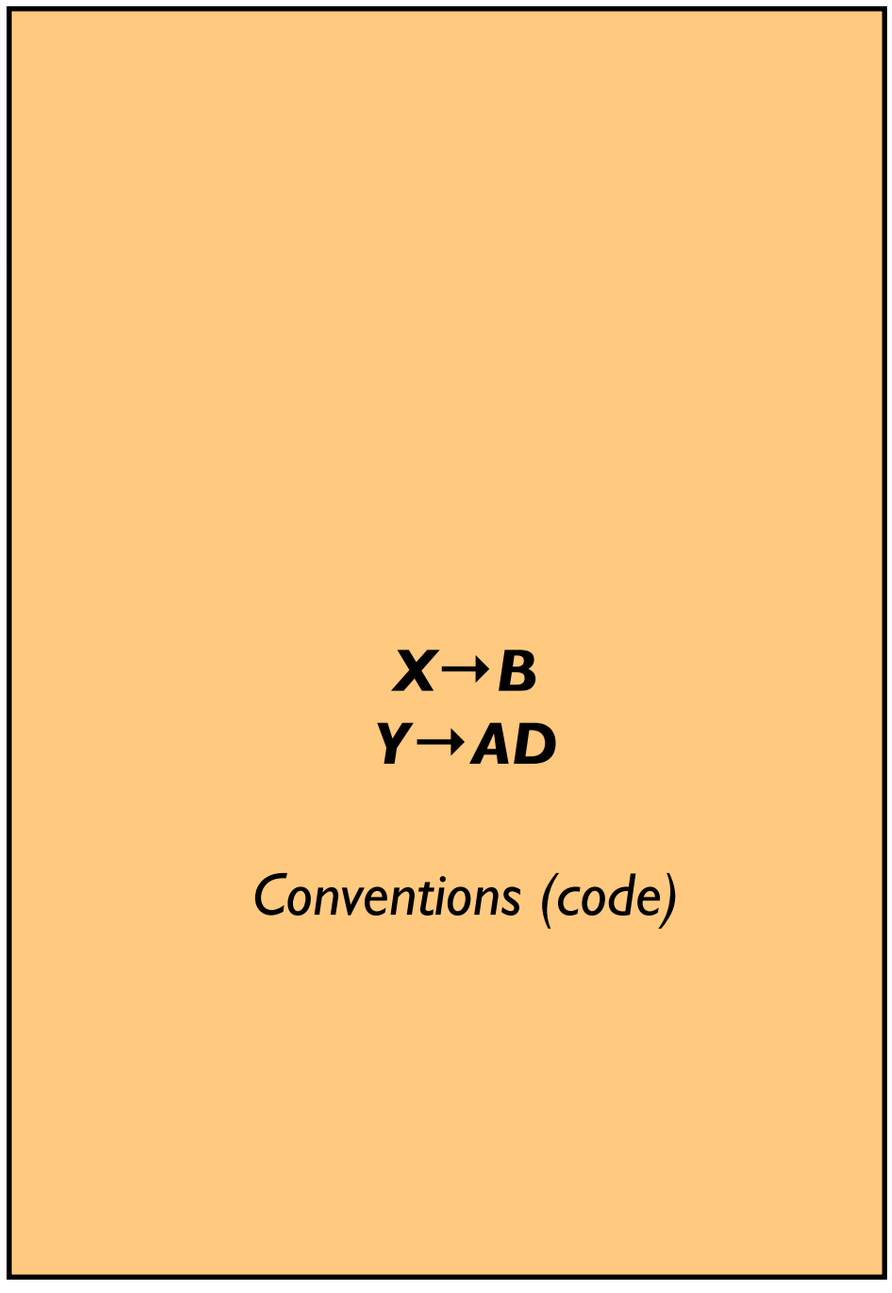


Communicator



Common ground

Iteration

(represents an act of ostensive-inferential communication)

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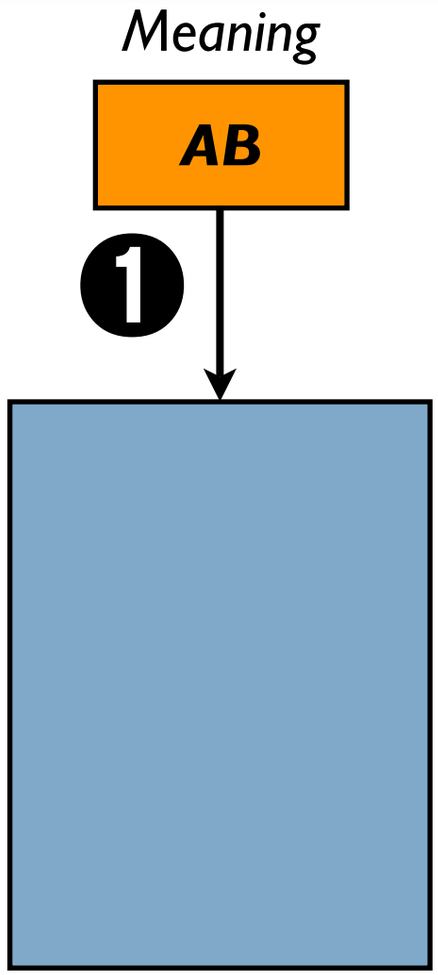

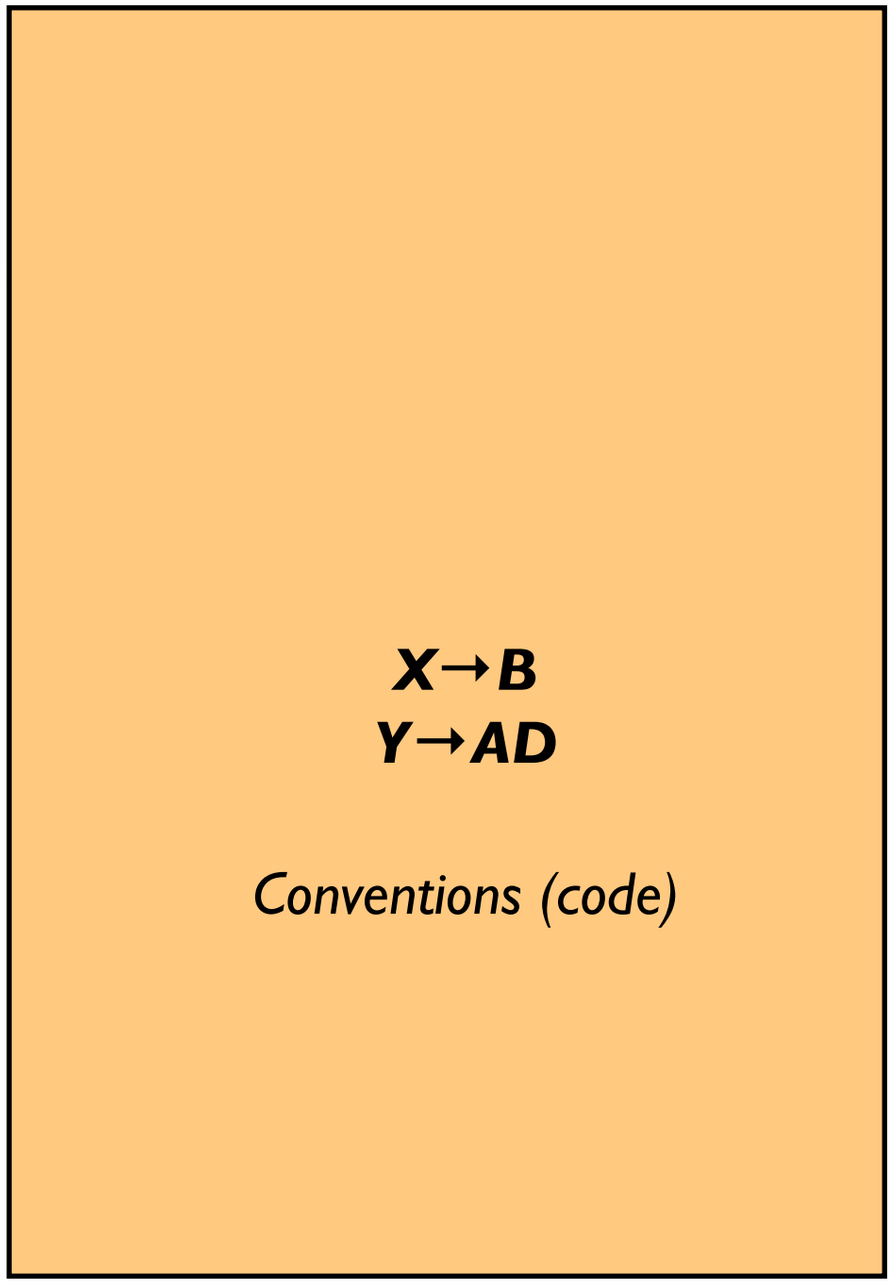

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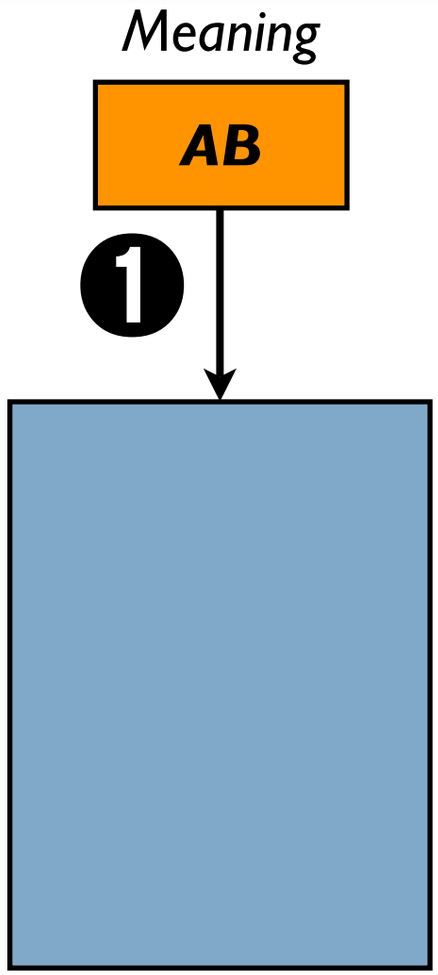

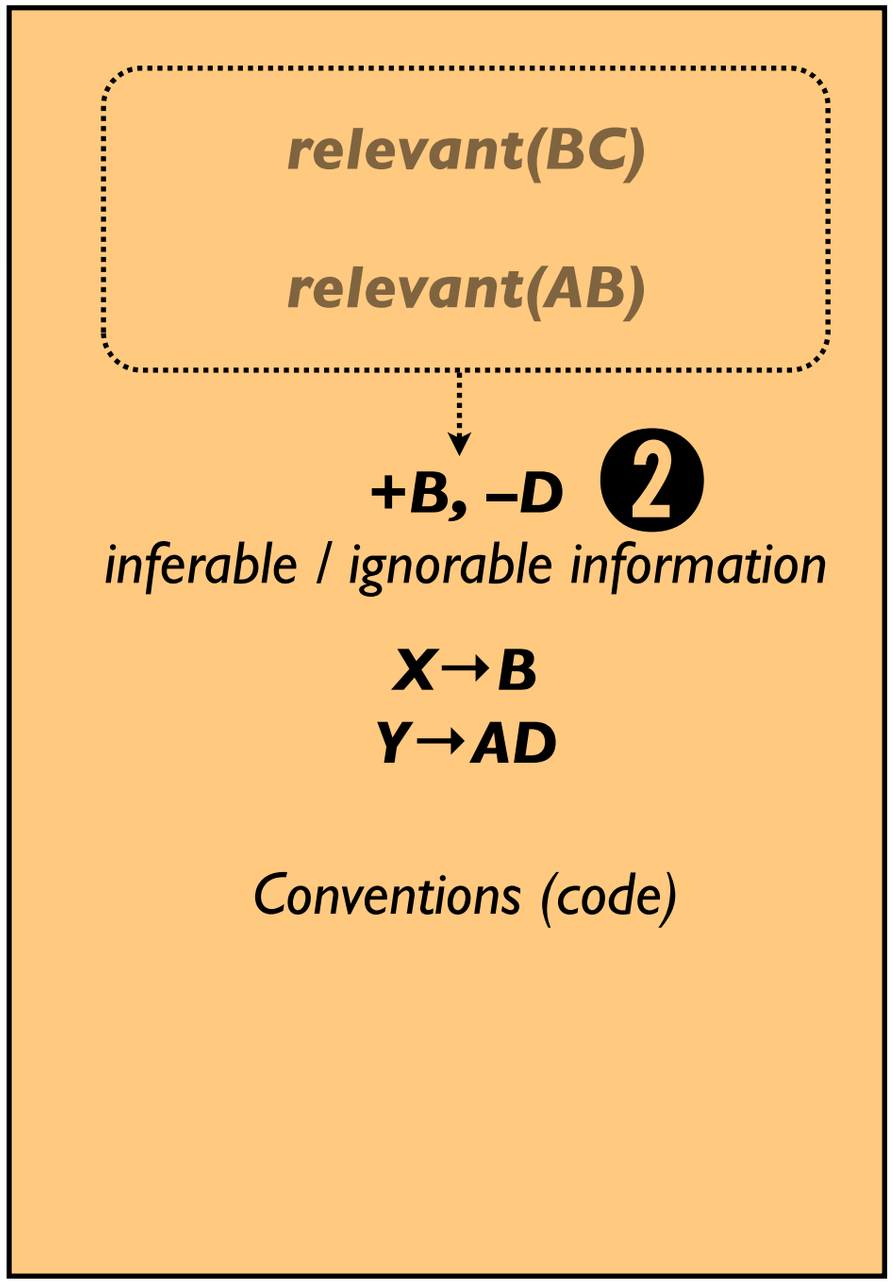

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A speaker meaning for the agent to communicate is generated randomly.

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Some *inferable and ignorable information* is generated randomly.

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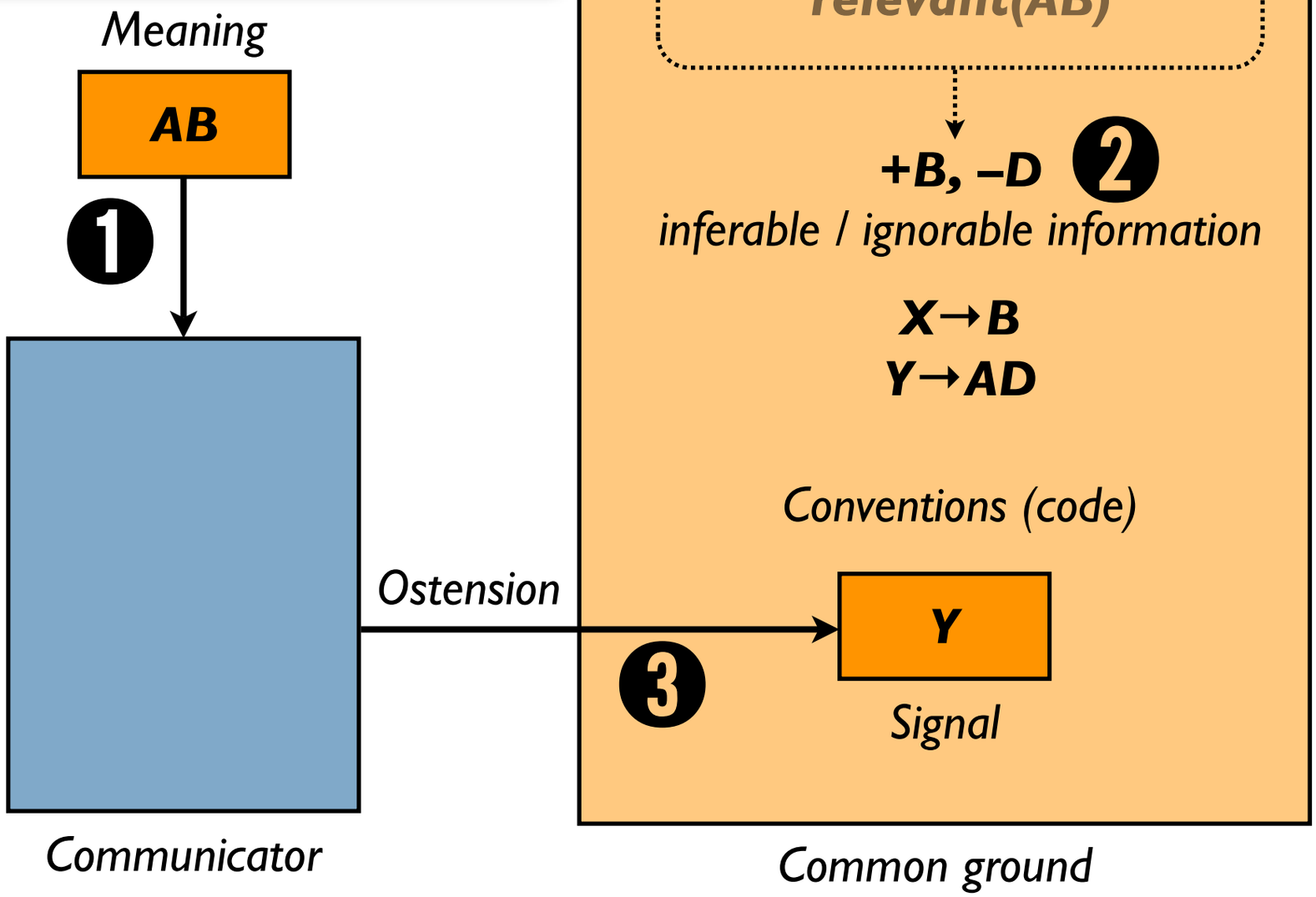

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Step 3: Use *(potentially innovative)*
Agent produces an appropriate signal.

The signal meaning may under- and/or overspecify the given speaker meaning.

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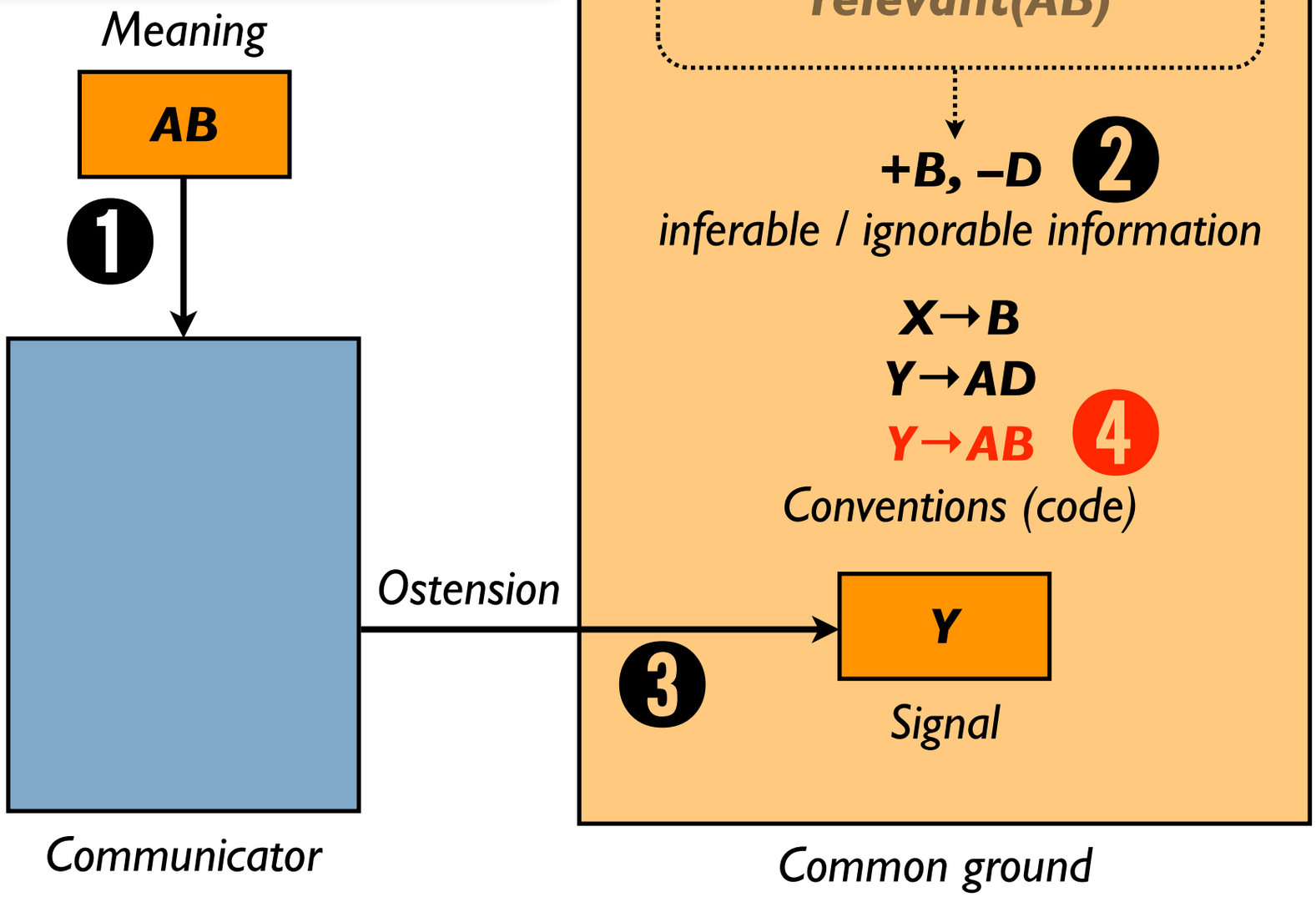

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Step 4: Learning *(exemplar-based)*
Agent stores the association between the used form and the communicated meaning in his I-language – or entrenches it further if it already exists.

Special characteristics of the model

- The model can simulate both **symbolic** and **non-symbolic communication** (and the emergence of one from the other) because it recognises that
  - both forms of communication are **ostensive-inferential** and therefore based on the *same* set of cognitive mechanisms, particularly **under- and overspecification** and **usage memorisation**.
  - forms can be represented like meanings: as **decomposable conceptual units**.
- The latter makes it possible to represent **iconic** form-meaning associations.

The emergence of symbolism

- **Initially**, the agent's I-language contains **no conventional form-meaning assocations** but only a set of **producible stimuli** (forms).

- **Conventional associations** between forms and meanings (code) emerge when the memory of the ***under- and/or overspecified use*** of ostensive stimuli enters common ground.

- Further ***under- and/or overspecified use*** of established conventions results in **semantic change**:

    - the conventionalisation of underspecified use leads to **semantic narrowing**

    - the conventionalisation of overspecified use leads to **semantic broadening**

- **Symbols** emerge **gradually** from iterated ostensive-inferential communication when such usage-induced semantic change results in the relationship between the form and the meaning becoming ***arbitrary***.

The emergence of grammar

- I propose that **concatenation** can itself serve as an ostensive stimulus:

  the proximity of two elements ***x*** and ***y*** may, for instance, serve to trigger the inference that '***x*** is somehow related to ***y***'.

- Like other ostensive stimuli too, such schemata can become **conventionally associated** with the meaning they communicated.

- Once conventionally associated, schematic conventions can also be re-used in under- and/or overspecified ways and thus undergo **semantic change**.

- **Conclusion**: grammatical constructions emerge like any other symbol too.

- This analysis is consistent with the tenet held in **Cognitive Linguistics** (e.g. Goldberg 1995) that grammatical constructions are associated with meaning just like lexical items.

Overview

In my thesis, I have

1. developed a **mechanistic model** of the cultural evolution of language that includes the fact that language use exhibits ***pragmatic plasticity***, and

2. argued that such a model has the **explanatory capacity** to account for:

    a) the **emergence puzzle** (how language emerges from no language)

    - the emergence of symbolism
    - the emergence of grammar

    b) three aspects of the **design puzzle** (how language comes to exhibit the appearance of design for communication)

    - expressivity
    - signal economy
    - ambiguity.

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Expressivity

- Human language is by far more **expressive** than the communication system of any other animal.
  - How do we get from a hypothetical "first symbol" to a symbolic communication system as expressive as human language?
  - How does the expressivity of a symbolic communication system come to be **adapted** to the communicative needs of its users?
- **Pragmatic plasticity** is creative language use:
  - Extant conventions can be used as **stepping stones** to express novel meanings.
  - These novel usages then become **conventionalised** themselves and provide new stepping stones that reach yet another set of meanings.
  - Through iterated use and conventionalisation, a **cumulative** adaptation ("*ratchet effect*") to the users' communicative needs is achieved.

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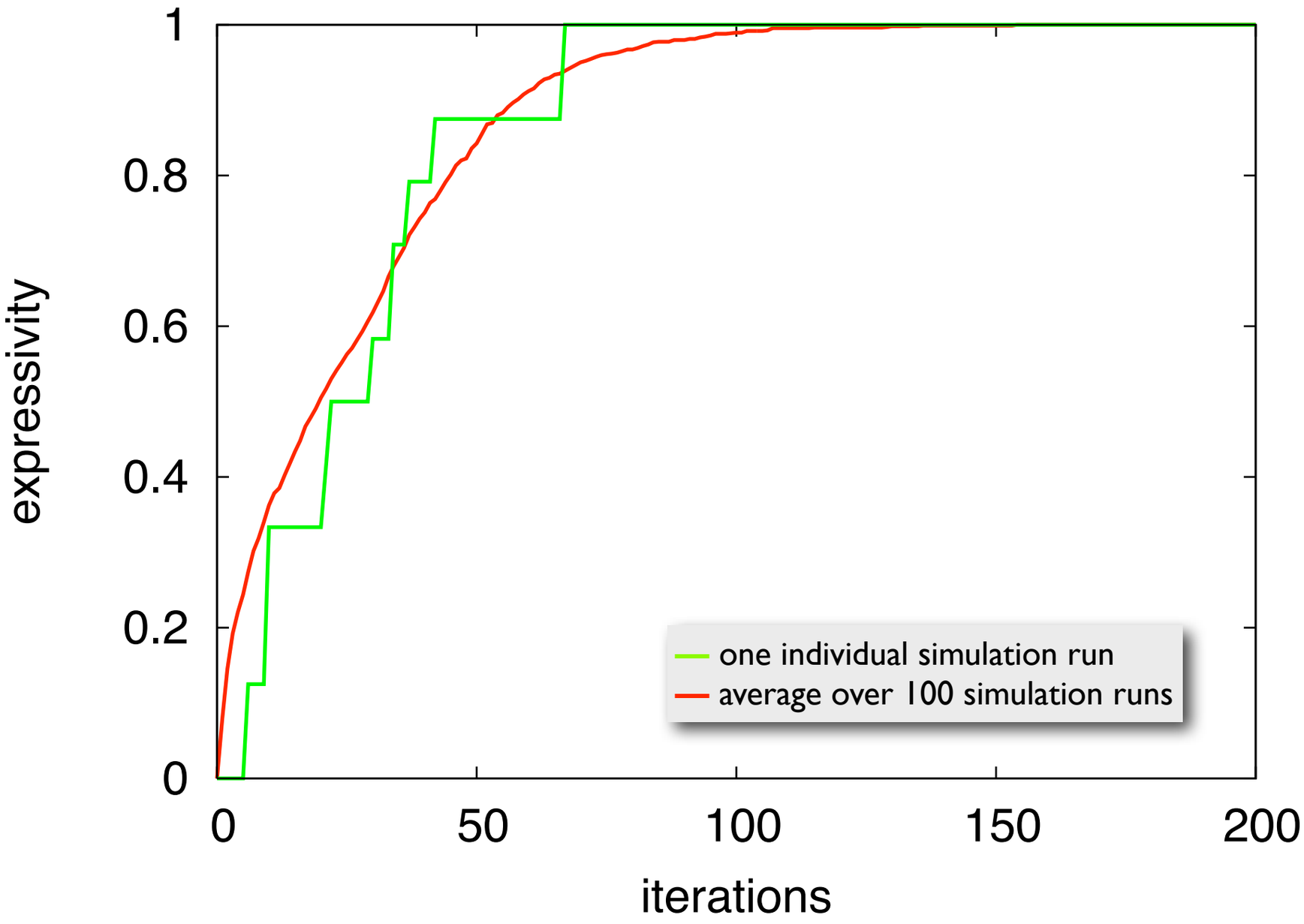
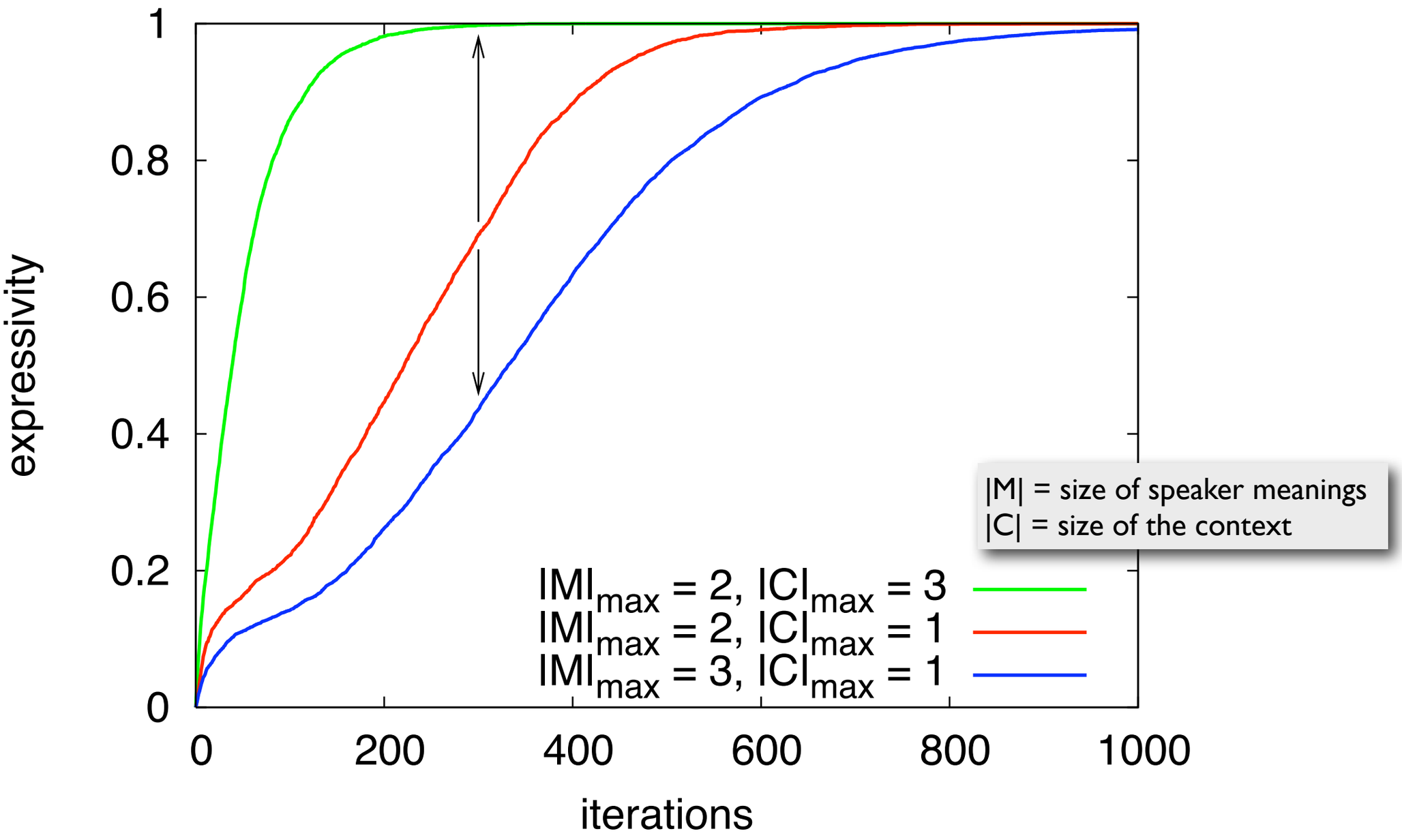
This process can be studied with the help of **computer simulations**.

Ratchet effect



Semantic space: A, B, X, Y, AB, AX, AY, BX, BY
Initial signals: X→X, Y→Y
Context size: 1

Meaning and context size have opposite effects



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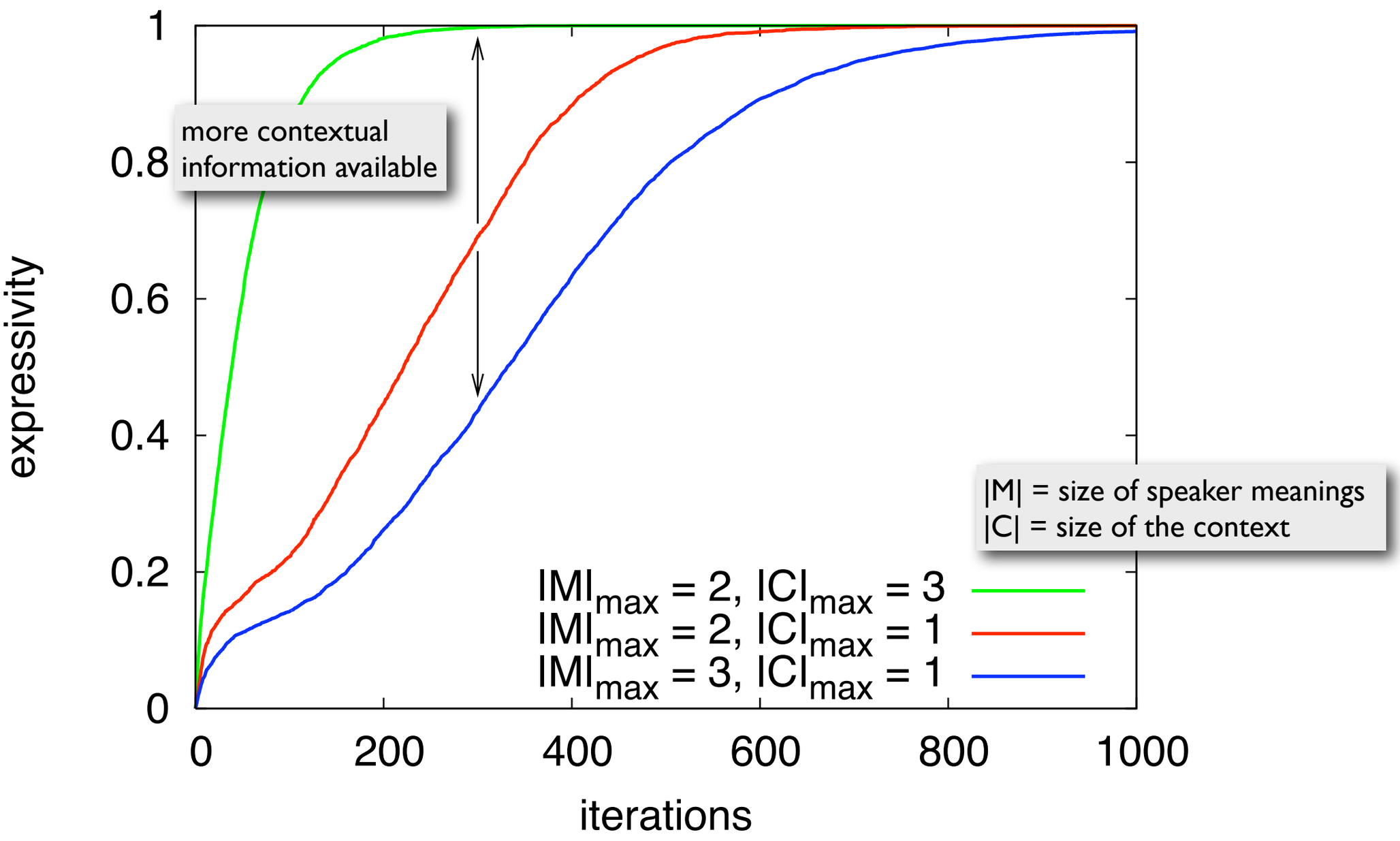

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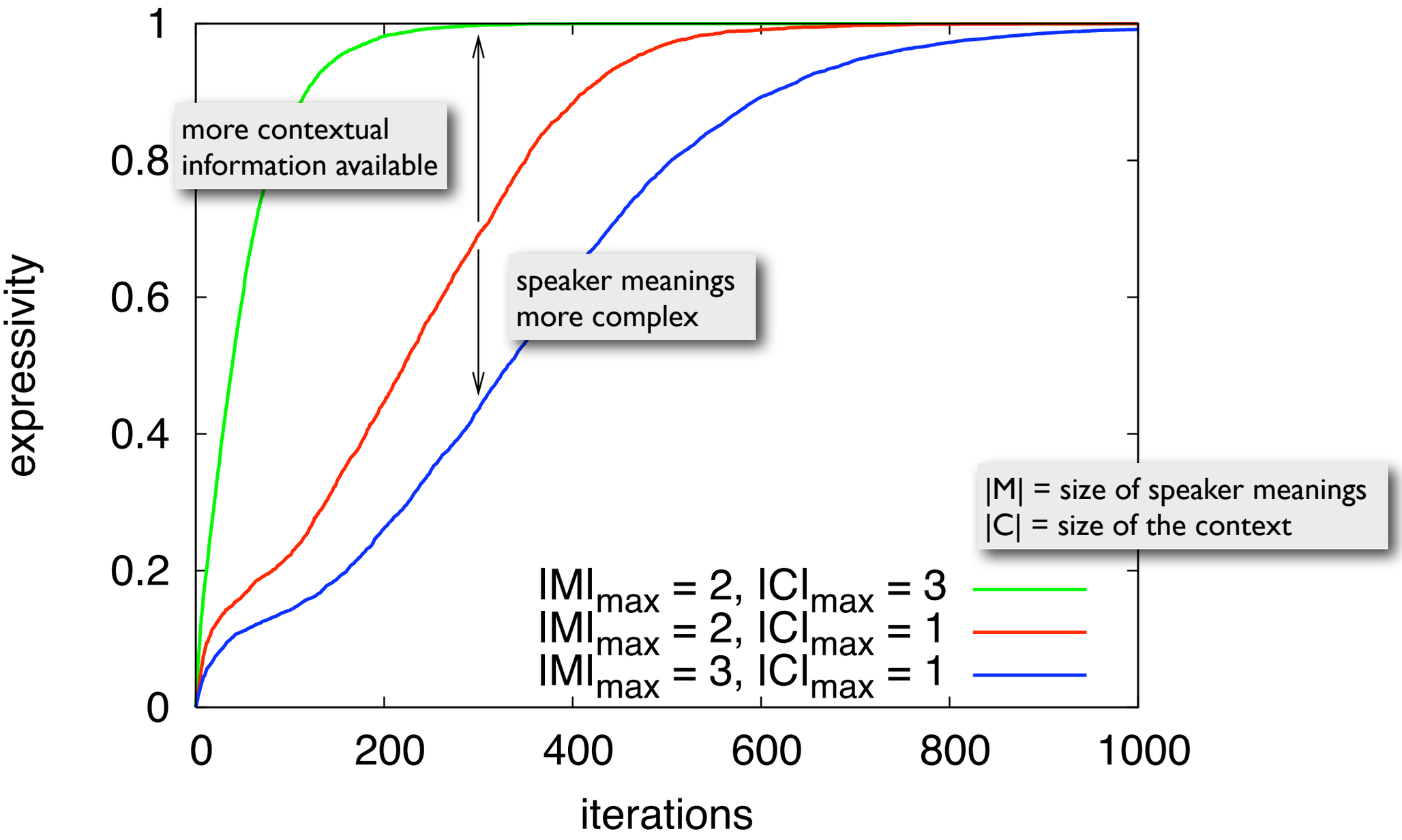


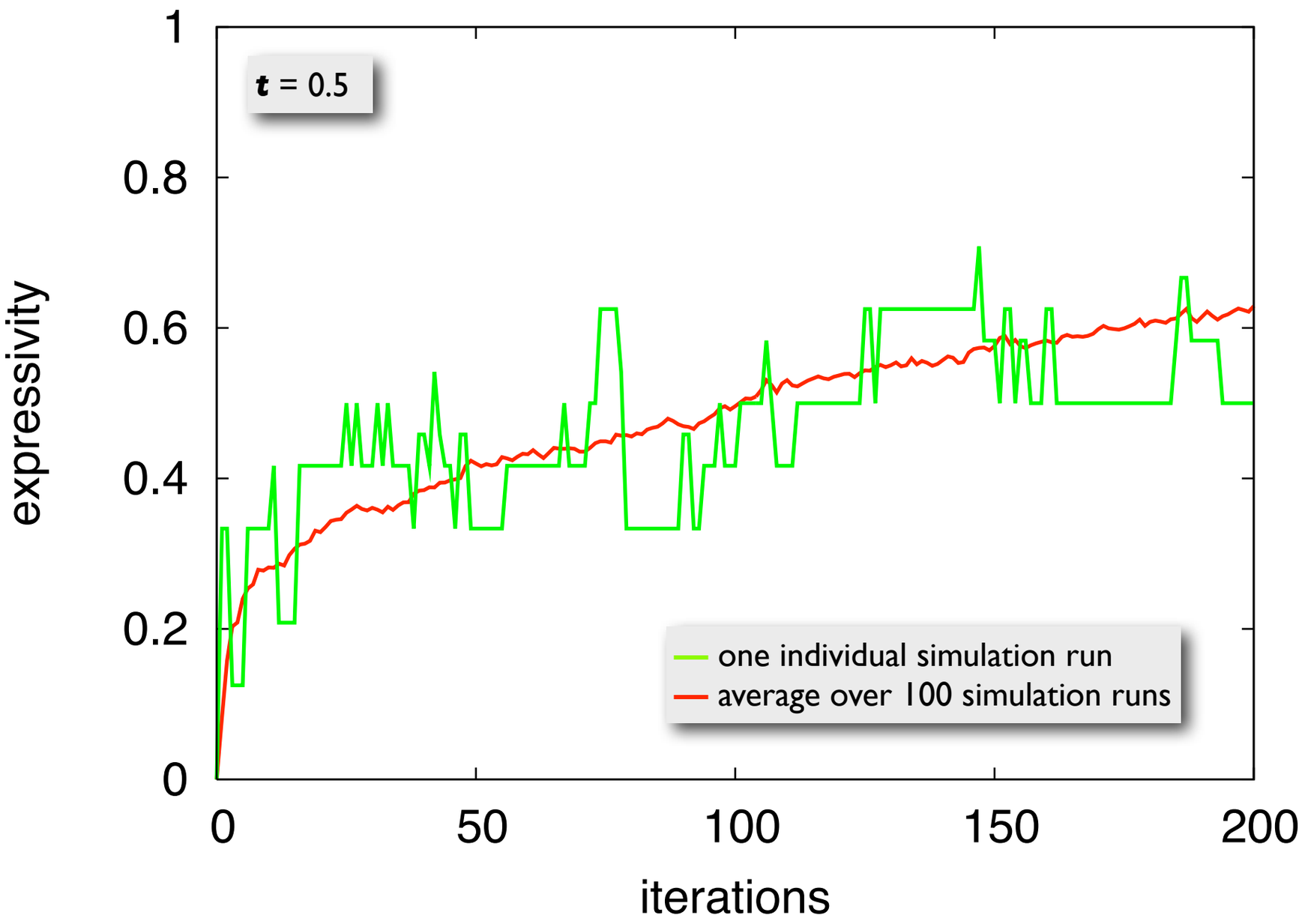
Entrenchment, decay and loss

- The **entrenchment** of a convention
  "is reinforced through use and decays through lack of use" (Croft 2000:73)

- **Loss:**
  conventions whose entrenchment falls below a certain **threshold *t*** are lost.

  - *Limiting cases:*
    If ***t*** = 0.0, no form-meaning association is ever lost;
    if ***t*** = 1.0, no form-meaning association is ever remembered.

Loss leads to slippage in the ratchet effect



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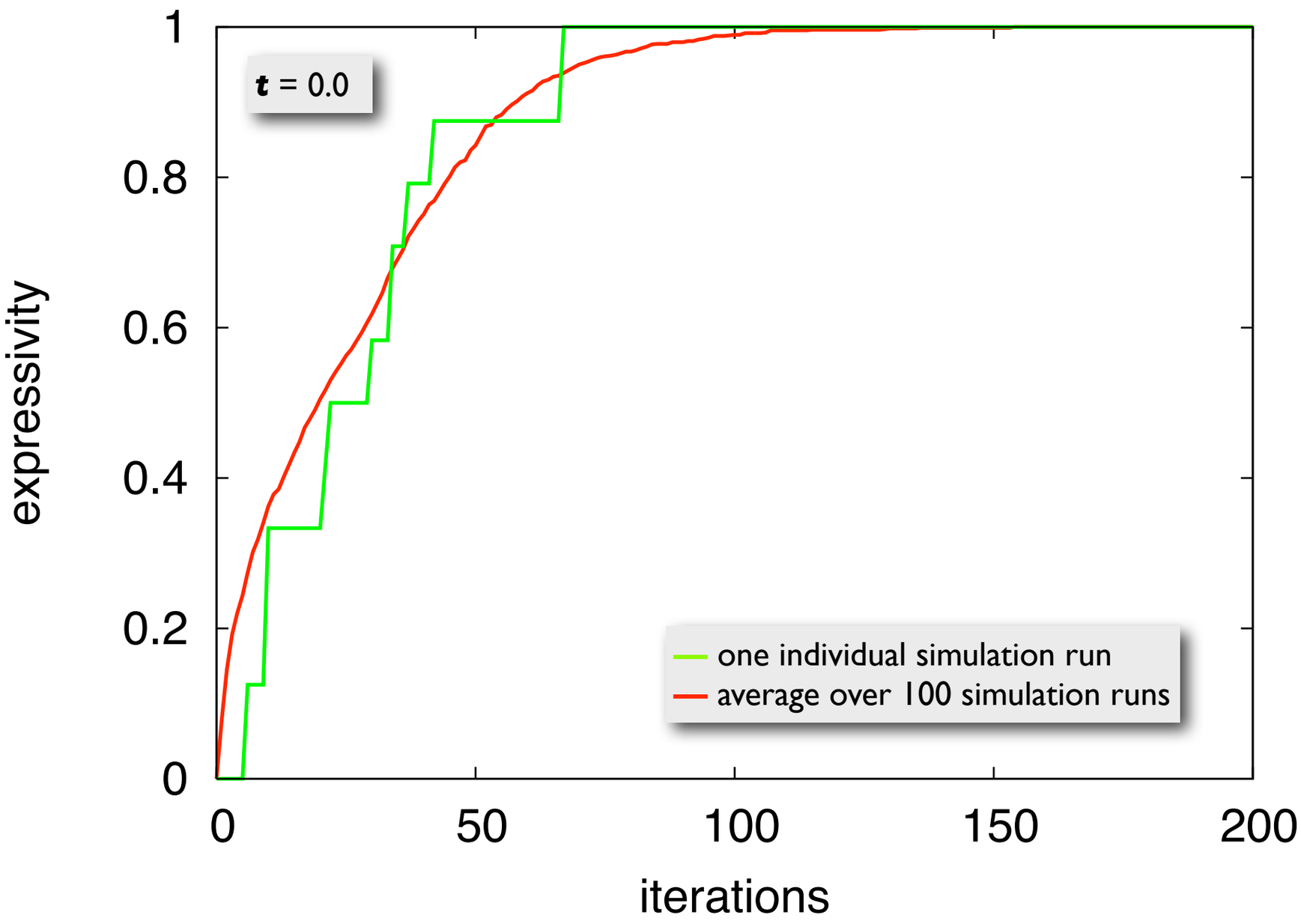

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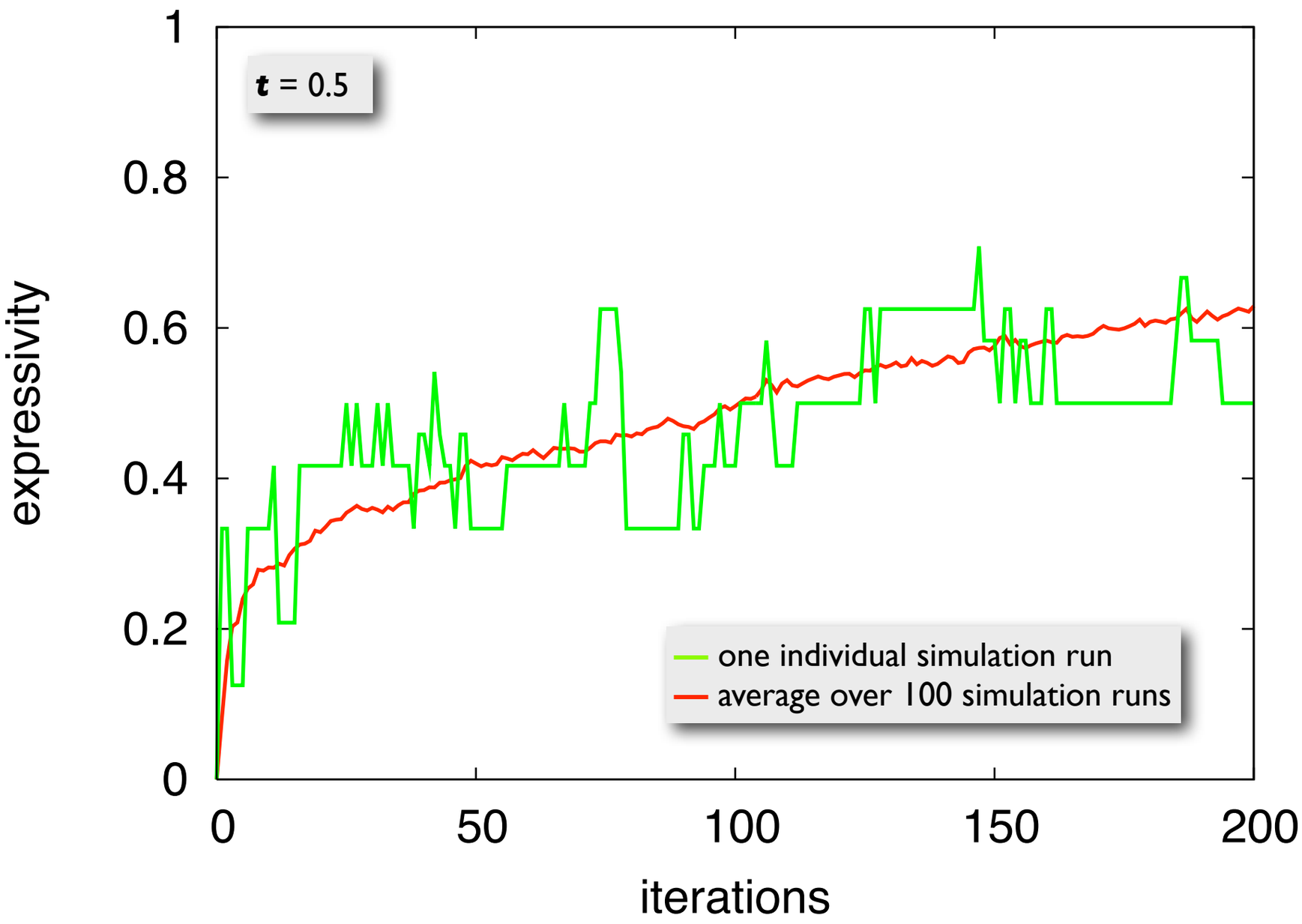
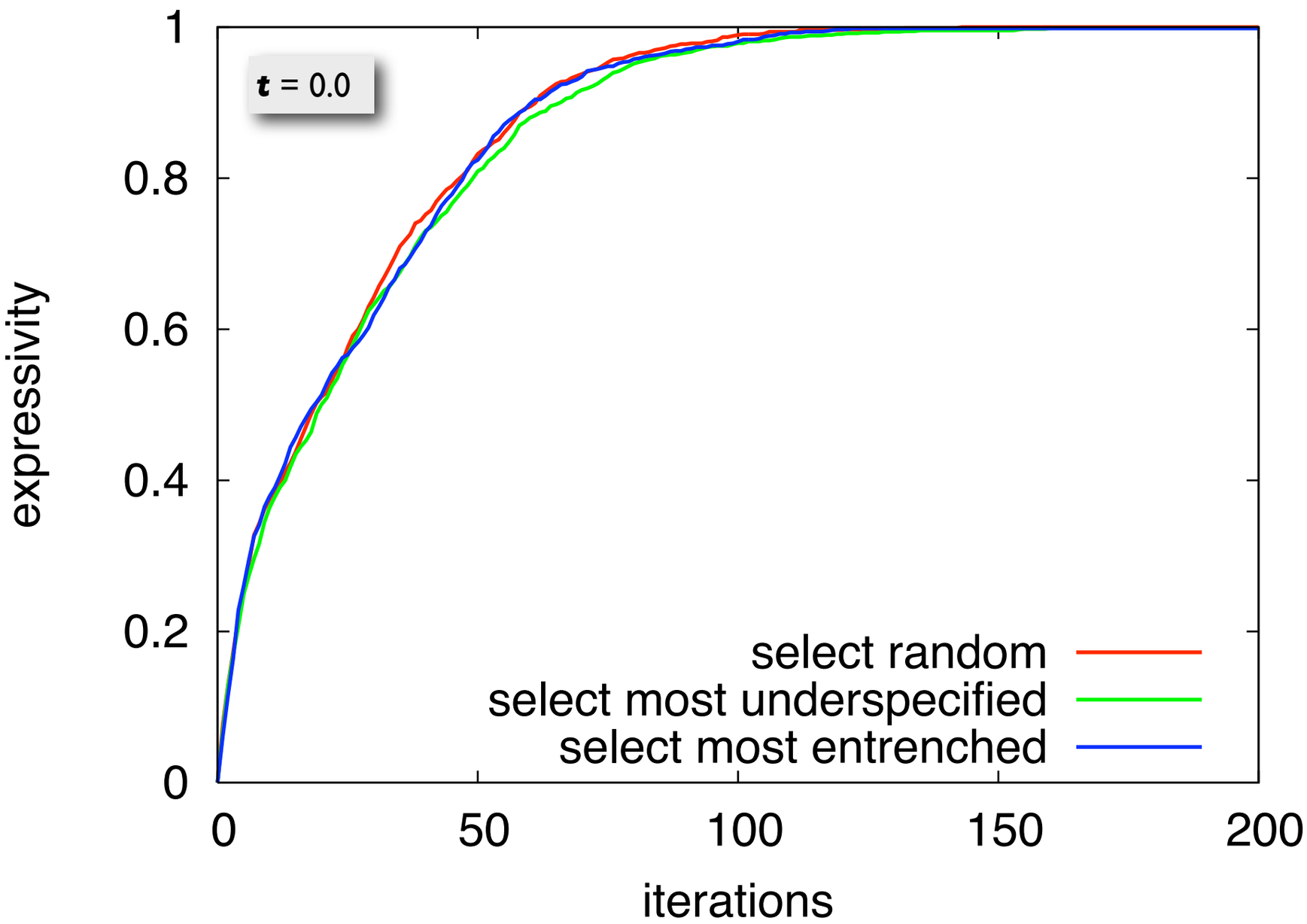


Synonym selection

- In many situations, **more than one** signal has the capacity to convey the intended speaker meaning.
- Different **strategies** have been implemented and compared:
    - choose a signal at ***random*** (NULL-hypothesis)
    - choose the signal that ***underspecifies*** the speaker meaning ***most*** (neo-Gricean principle: "*say no more than you must*")
    - choose the signal with ***most entrenched*** conventions (relevance-theoretic "*check interpretative hypotheses in order of their accessibility*")

Synonym selection without loss



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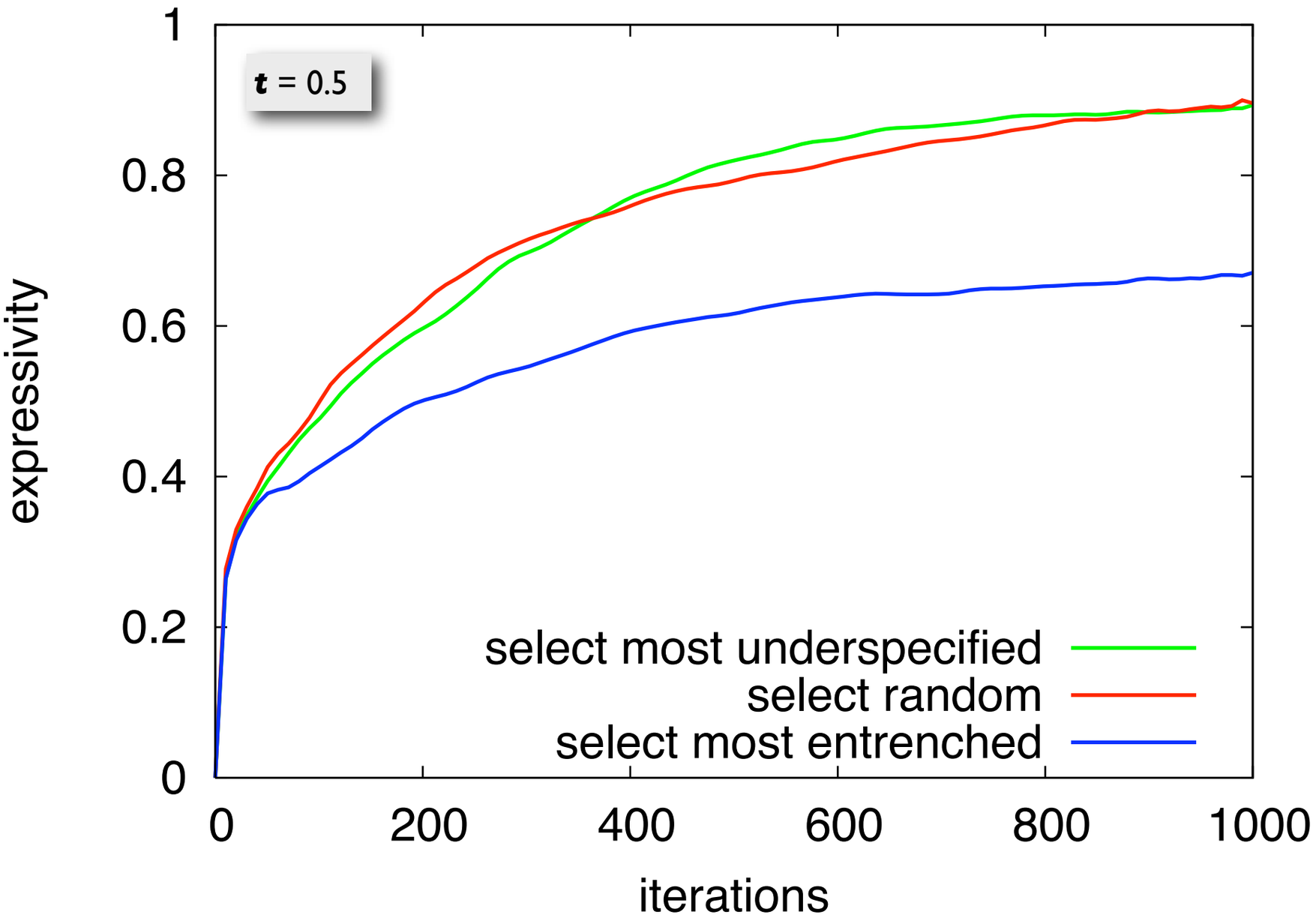

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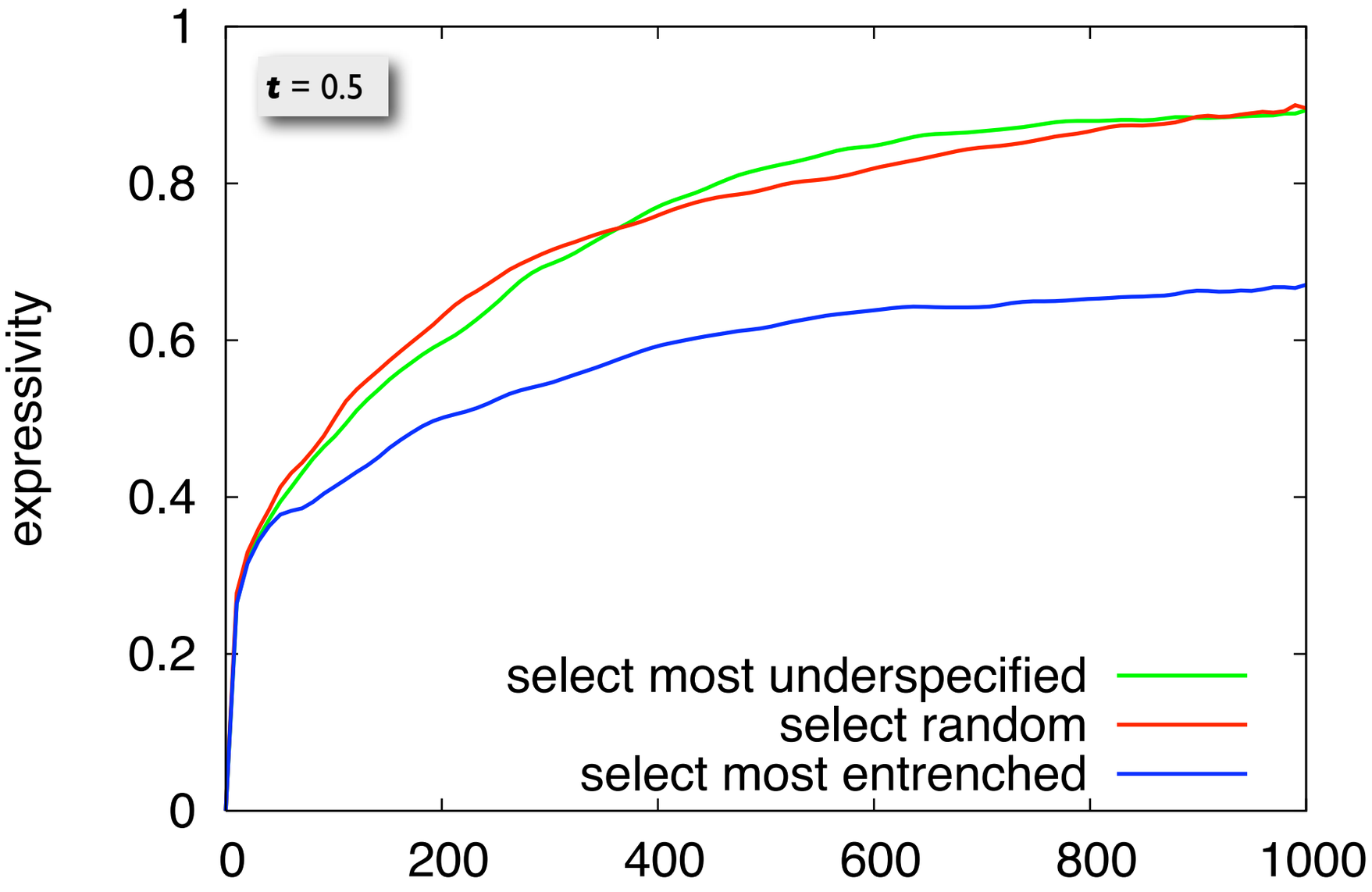

Observation:
Some factors (e.g. the chosen synonym selection strategy) only have an effect in **combination** with other factors (e.g. the rate of loss)
→ this makes the behaviour of the system **hard to predict**

Signal economy

- **The articulation bottleneck**
  Articulation (physical production of the signals) slows down communication
  → lower average signal length = better design for communication

- **Pragmatic plasticity** provides "tools" for context-specific signal-reduction:

  - Underspecification (e.g. ellipsis):
    Most hearing aids are sold to old men and [old] women.

  - Overspecification (e.g. metaphor vs. circumscription):
    Sally is a chameleon. [Sally frequently changes her appearance].

- **Conventionalisation** of under- and/or overspecificied usages
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- ***Simulation results***:
  Pragmatic plasticity keeps the signal length low
  if **some loss** is combined with selecting the **most entrenched** signal.

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NB this is in opposition to an optimal increase of **expressivity**!

Ambiguity

- Ambiguity is often considered ***dysfunctional***.

- From a diachronic perspective, ambiguity is ***functional*** because it facilitates

  - **Expressivity**
    Without ***layering***, pragmatic plasticity could not unfold its expressivity-enhancing potential.

  - **Signal economy**
    Ambiguous codes allow for a lower average signal length.

- **Conclusion**
  Ambiguity as a ***feature*** is functional,
  only a high ***degree*** of ambiguity in a code can become dysfunctional.

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Interpretation of simulation results

- For a symbolic communication system to become as expressive as human language, the individuals that develop it must have good ***memory*** capacities, so that little of what they observe is ever lost.

- At the same time, they need to be able to make use of extensive amounts of ***contextual information***.

- The presence of mechanisms of ***automatisation*** contributes to an adaptation of the system to the articulation bottleneck and to keeping its ambiguity at a level where it does not constitute an impediment for communication.

- **Hypothesis**
  The availability of refined capacities of
  (1) **recognising common ground** and **drawing inferences** from it,
  (2) **memorisation** and
  (3) **automatisation**
  may explain why humans have language but other animals do not.

Conclusions (1)

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- I have shown that by including **pragmatic plasticity** in our modelling, we gain a picture of the origins of linguistic communication in which
  - language **emerges gradually** and **continuously** from **iterated ostensive-inferential communication** without exhibiting a distinct intermediate stage or "protolanguage"
  - and **continuously adapts** its expressivity and signal economy to the ever-changing conceptual environment of its users.

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  - and **continuously adapts** its expressivity and signal economy to the ever-changing conceptual environment of its users.
- The developed model of the cultural evolution of language *reconciles* the **ILM**
  - with models of **general cultural evolution** that emphasise the fidelity of learning and
  - with models of **language change** that identify use, rather than learning, as the locus of innovation.

Future research

- Apart from making a number of theoretical arguments, my thesis provides a general **framework** that can be used as a **tool** for further investigations by means of computer simulations:
    - Can we simulate the emergence of **complex syntactic phenomena** by replacing forms and meanings with more specific representations?
    - Can **phonological change** be included by modelling it as an under- and/or overspecification not of meanings but of forms?
    - What can the model tell us with regard to the development of the degree of **iconicity** in an emerging and evolving communication system?