## Iterated learning optimizes for simplicity

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#### Pressures shaping language

## Language

#### Pressures shaping language

Learning

simple Lar

## Language

#### Pressures shaping language

Learning

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## Language Informative

Communication

#### Kinship terms are simple and informative





#### Lab experiments



Learning-only



Learning + Communication



#### Learning and communication pressures





Kirby, Tamariz, Cornish, & Smith (2015)

Communication-only

#### Iterated learning gives rise to informative spatial terms





Generation 10





Carstensen, Xu, Smith, Regier (2015)



# Experiment



Angle

### Stimuli

### Stimuli

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### Stimuli

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Angle



#### Conditions

Angle-only



Easy to learn but low informativeness

#### Size-only

#### Angle & Size



Informative but hard to learn

#### Training phase

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#### Test phase





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#### Angle-only



#### Results





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Size-only

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#### Results





Angle & Size



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#### Results

#### Result: Learnability advantage for the less informative systems





# Experiment 2

#### **Iterated learning**





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![](_page_22_Picture_11.jpeg)

![](_page_22_Picture_12.jpeg)

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![](_page_23_Picture_13.jpeg)

![](_page_24_Picture_0.jpeg)

![](_page_24_Figure_1.jpeg)

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#### 3 categories

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O	C	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc \bigcirc \bigcirc \bigcirc$
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o	0	0	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc \bigcirc$

![](_page_24_Figure_7.jpeg)

![](_page_24_Picture_8.jpeg)

#### Measuring simplicity

![](_page_25_Picture_1.jpeg)

![](_page_25_Picture_2.jpeg)

#### Measuring simplicity

![](_page_26_Picture_1.jpeg)

![](_page_26_Figure_2.jpeg)

![](_page_27_Figure_1.jpeg)

![](_page_28_Figure_1.jpeg)

#### Informativeness

![](_page_28_Figure_3.jpeg)

10

![](_page_28_Picture_5.jpeg)

![](_page_29_Figure_1.jpeg)

#### Informativeness

![](_page_30_Figure_1.jpeg)

#### Informativeness

![](_page_30_Figure_3.jpeg)

10

![](_page_30_Picture_5.jpeg)

![](_page_31_Figure_1.jpeg)

**Expressivity** A system of many categories is more informative than a system of few categories

**Balanced categories** A system of equally sized categories is more informative than a system of unequally sized categories

**Dimensionality** A system that uses many dimensions is less (?) informative than a system that uses few dimensions

**Convexity** A system of convex categories is more informative than a system of nonconvex categories

ore **Discreteness** A system of discrete categories is more informative than a system of fuzzy categories

**Compactness** A system of compact categories is more informative than a system of noncompact categories

**Expressivity** A system of many categories is more informative than a system of few categories

**Convexity** A system of convex categories is more informative than a system of nonconvex categories

![](_page_32_Figure_3.jpeg)

![](_page_32_Figure_4.jpeg)

Learning Pressure for simplicity

#### Communication

Pressure for informativeness

![](_page_32_Figure_8.jpeg)

![](_page_32_Figure_9.jpeg)

**Expressivity** A system of many categories is more informative than a system of few categories

![](_page_33_Figure_3.jpeg)

![](_page_33_Figure_4.jpeg)

![](_page_33_Figure_5.jpeg)

**Expressivity** A system of many categories is more informative than a system of few categories

![](_page_34_Figure_3.jpeg)

![](_page_34_Figure_4.jpeg)

![](_page_34_Figure_5.jpeg)

**Expressivity** A system of many categories is more informative than a system of few categories

![](_page_35_Figure_3.jpeg)

![](_page_35_Figure_4.jpeg)

![](_page_35_Figure_5.jpeg)

**Expressivity** A system of many categories is more informative than a system of few categories

![](_page_36_Figure_3.jpeg)

![](_page_36_Figure_4.jpeg)

![](_page_36_Figure_5.jpeg)

#### Conclusions

itself through multiple semantic properties:

**Expressivity** Loss of words/categories to aid learning

learning does, making it difficult to identify the causal mechanism.

- The pressure from learning yields simple languages, but this can manifest

  - **Convexity** Reorganization of the meaning space to aid learning
- The pressure from communication has the same effect on convexity as
- In iterated learning, the pressure for simplicity favours semantic category systems that are convex – informativeness comes along for the ride.

![](_page_38_Picture_0.jpeg)

## Thanks!