Exploring (Multimodal) Model Abilities in Grounding *Vague* Expressions

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Overview

- **Vague expressions** (most, small) ubiquitous in language

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- **Vague expressions** (most, small) ubiquitous in language
- Single but non-specified meaning: **Context dependence**
- Real-world **contexts are multimodal**, e.g. Language + Vision
- Can they be learned from **use in *grounded* (visual) contexts**?

Quantifiers

Quantity expressions

Quantity expressions

Numbers

Three dogs

Comparatives

More dogs than cats

Proportions

60% of pets are dogs

Quantifiers

Some pets are dogs

Quantity expressions: Precise vs fuzzy

Numbers

Three/~~two~~ dogs

Comparatives

More/~~less~~ dogs than cats

Proportions

60%/~~50%~~ of pets are dogs

Quantifiers

Some/~~all~~ pets are dogs

Quantity expressions: Precise vs fuzzy

Numbers

Three/~~two~~ dogs

Comparatives

More/~~less~~ dogs than cats

Proportions

60%/~~50%~~ of pets are dogs

Quantifiers

Some/~~all~~ pets are dogs

some ∼ **a few** ∼ **several** ∼ **most**

pets are dogs

Computational study

Questions

Can the meaning of **quantifiers** be learned from vision?

Can a single model **jointly** learn quantifiers, comparatives, and proportions?

Pezzelle, Sorodoc, Bernardi. *NAACL-HLT*, 2018

Motivation

Comparatives, quantifiers, proportions:

- describe (increasingly-complex) **relations** between sets

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- describe (increasingly-complex) **relations** between sets
- subtend different operation compared to **numbers**

  [Fabbri et al., 2012]

Dataset

Comparatives

more

Quantifiers

most 0.43, **some** 0.29, etc.

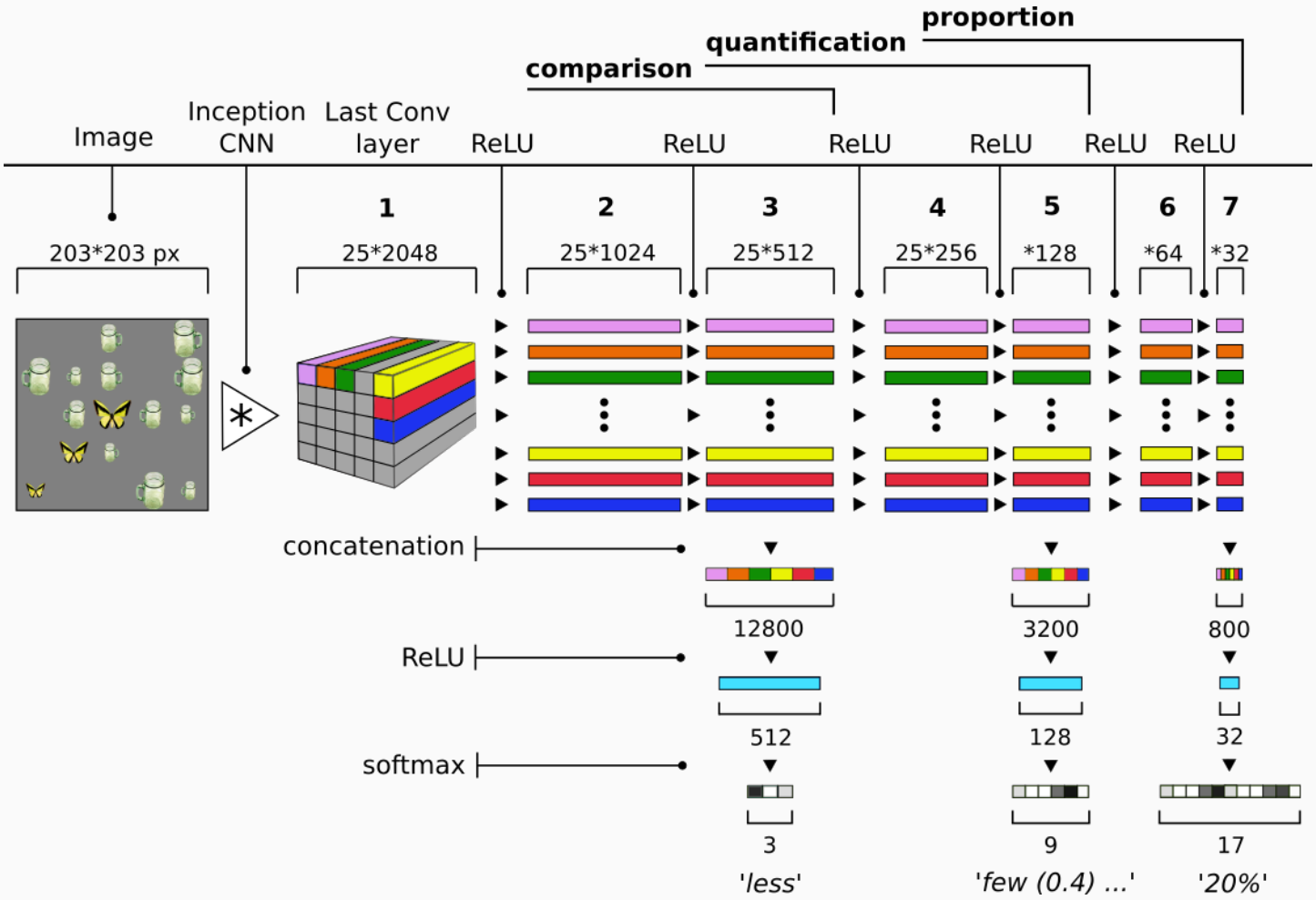
(Pezzelle, Bernardi, Piazza. *Cognition*, 2018)

Proportions

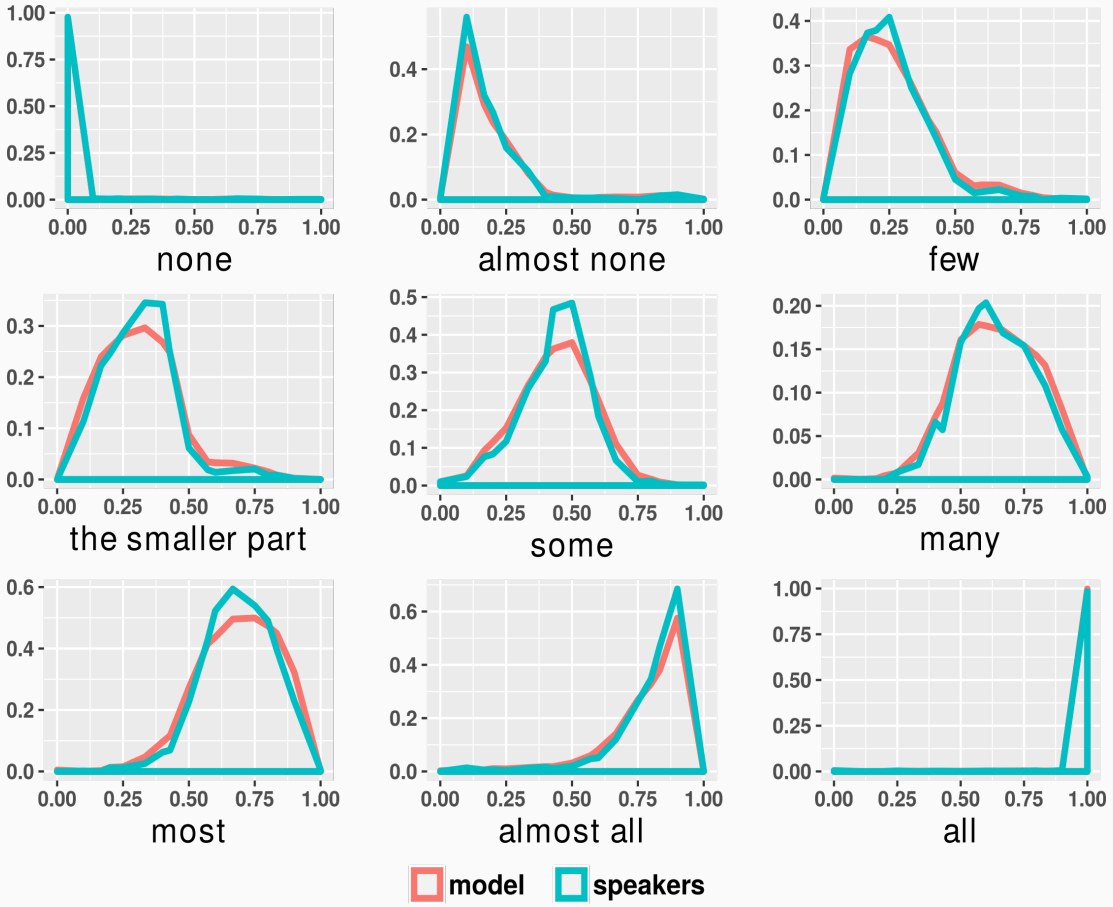
57%

Synthetic: (1) perfect balancing; (2) NO bias; (3) NO world knowledge

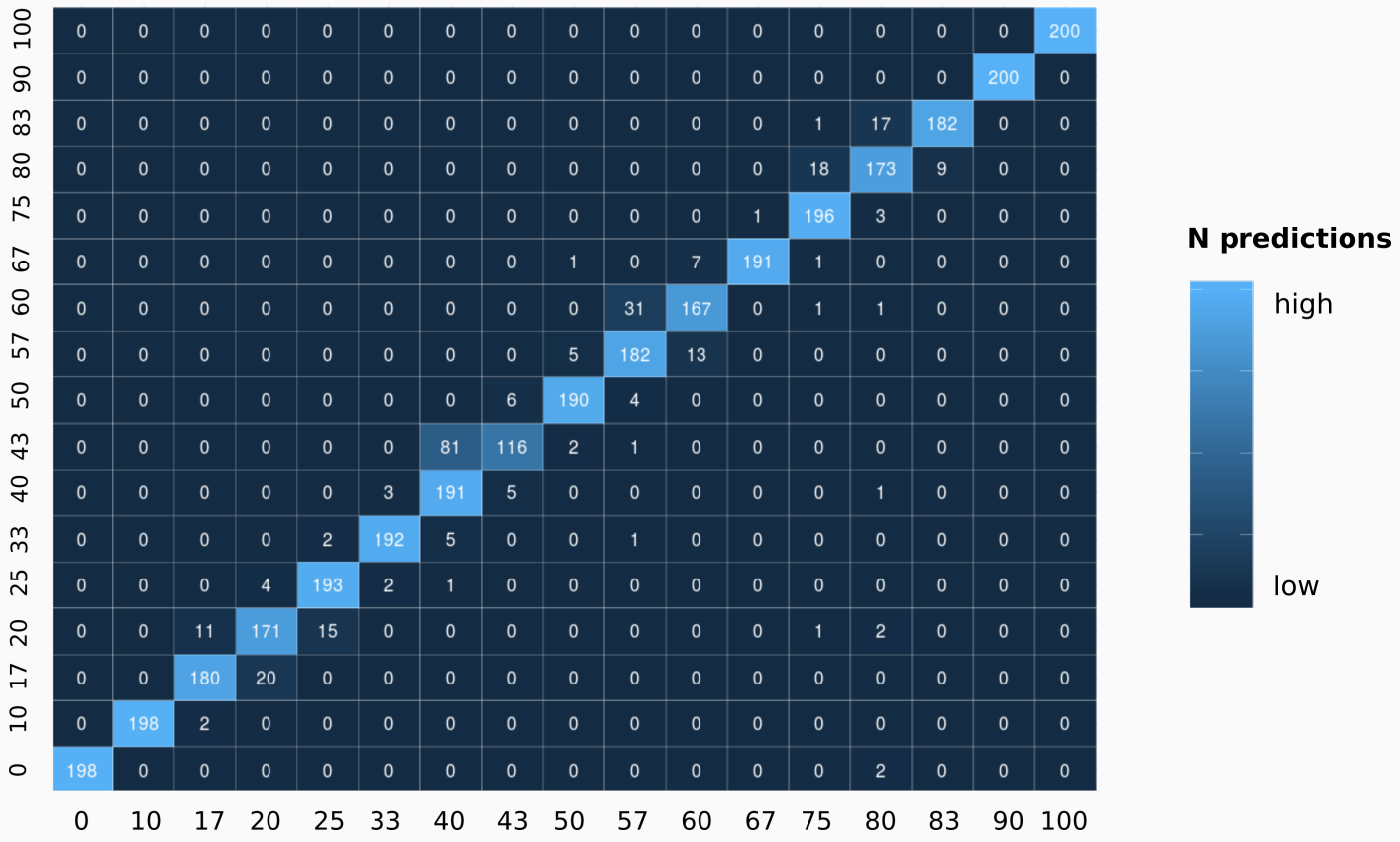
Multi-Task Learning (MTL)



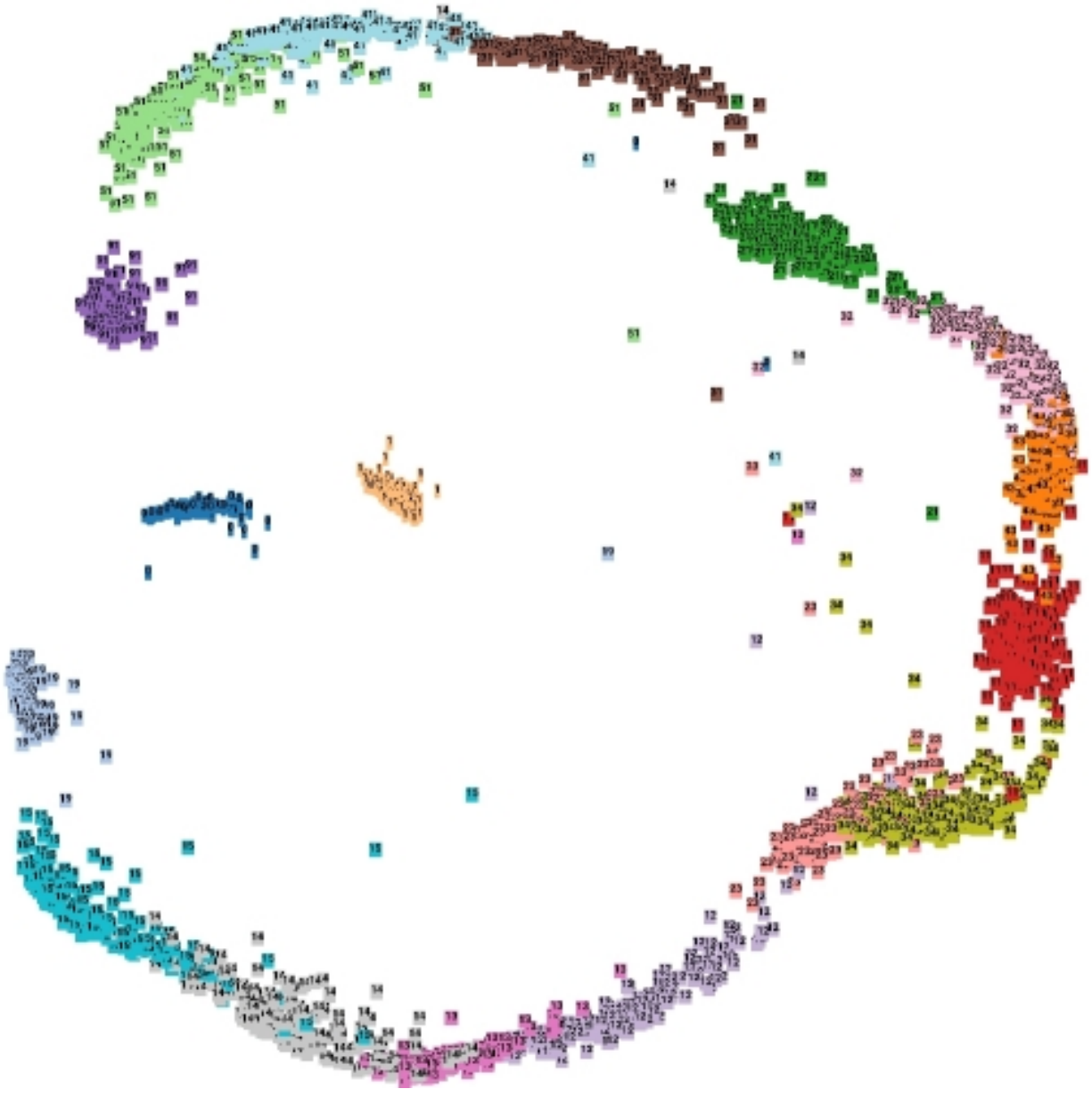
1a. Does the MTL model learn (quantifiers)?



1b. Does the MTL model learn (proportions)?



2a. What does the MTL learn?



2b. What does the MTL learn?

- **Not about number** of targets! Counting animals hurts performance of previous tasks

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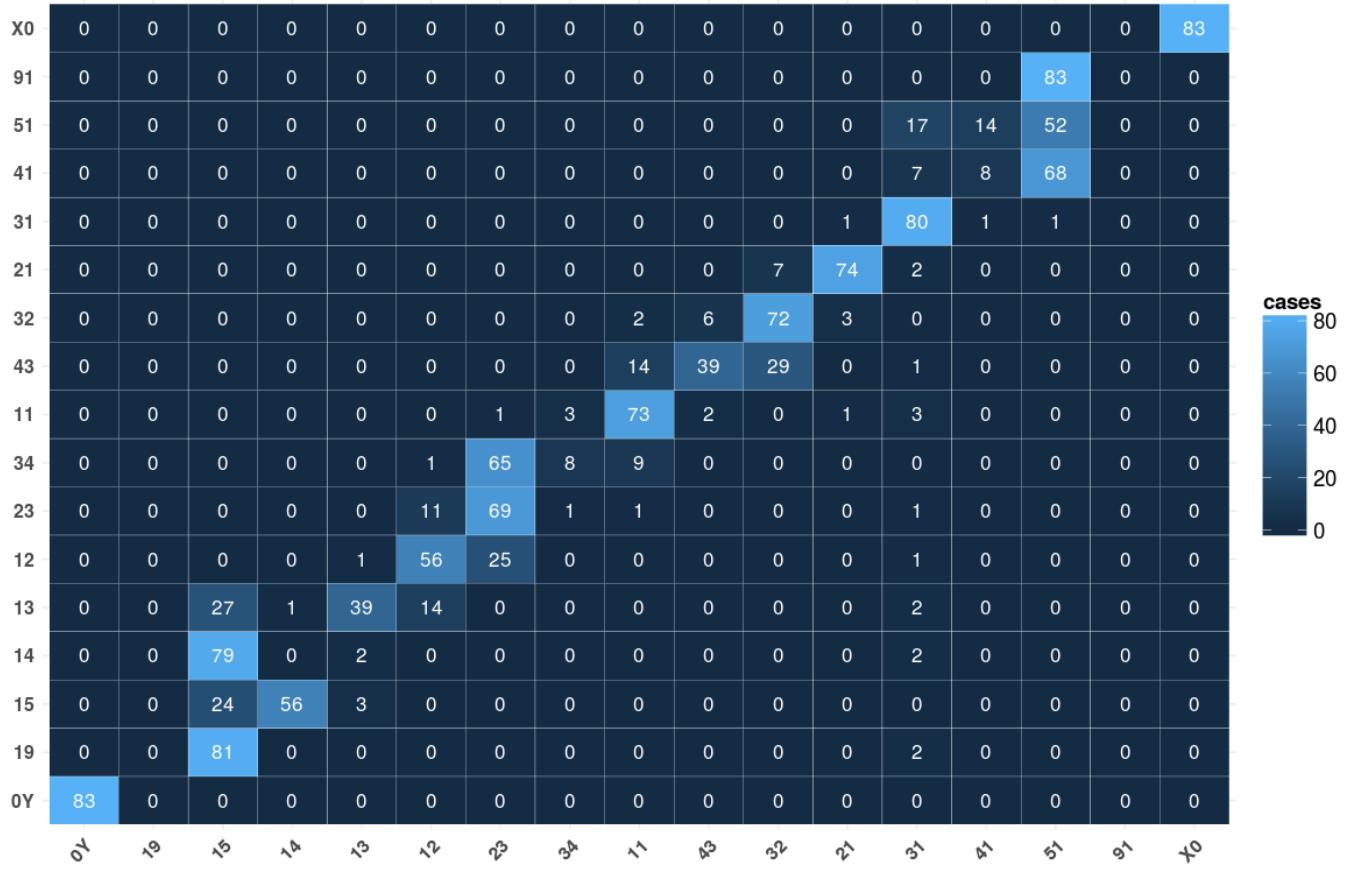
- **Not about number** of targets! Counting animals hurts performance of previous tasks
- Hierarchical ordering of (difficulty of) tasks: **Reversing architecture does not work**

3. Does it generalize to unseen combinations?



Gradable Adjectives

Adjectives: Gradable vs Non-gradable

Adjectives: Gradable vs Non-gradable

Non-gradable

The **open** car

the **green** car

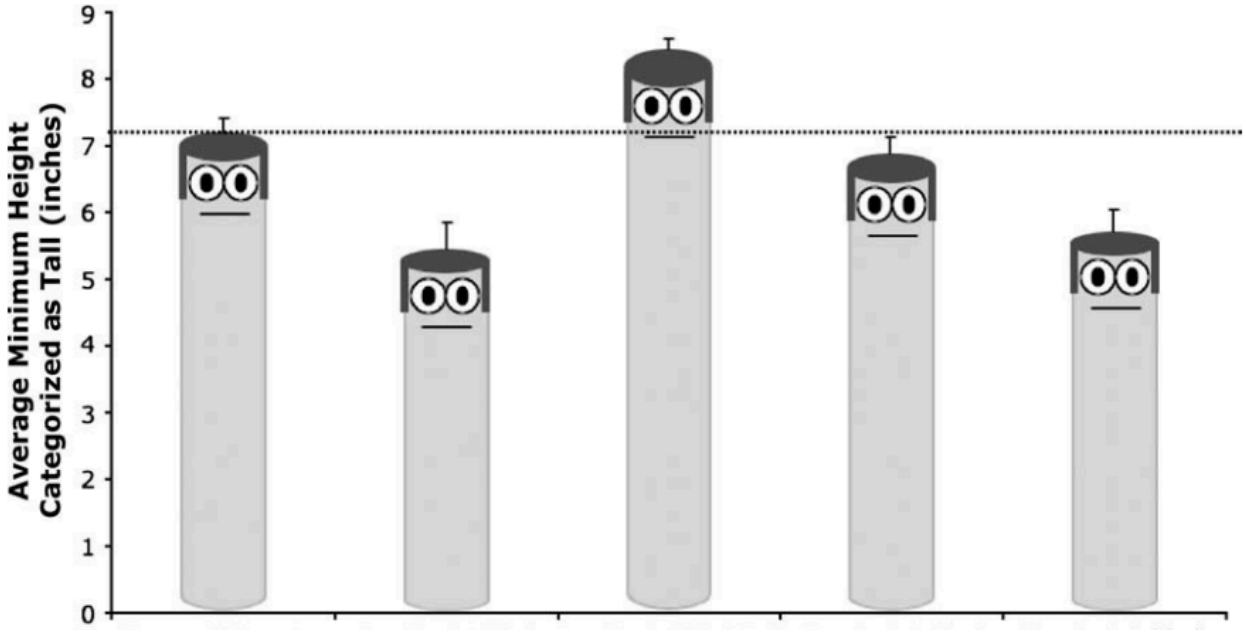
Gradable

The **old/older/oldest** car

The **small/smaller/smallest** car

GAs: A *function* over a set of comparison

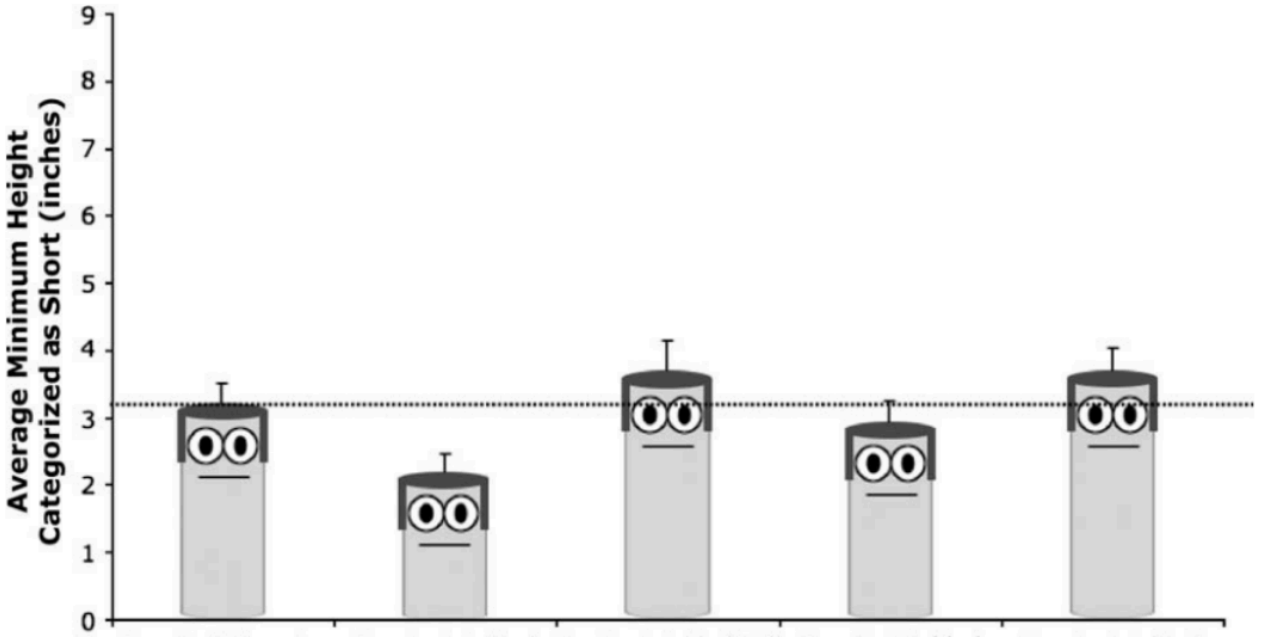
Tall/short use dependent on **height** of comparison set



Barner & Snedeker, 2008, Child Development

GAs: A *function* over a set of comparison

Entity *short* in one **context** can be *tall* in another one



Barner & Snedeker, 2008, Child Development

Computational study (ongoing)

Question

Can a multimodal model learn to use **positive GAs** (i.e. big/small) in a given **visual context**?

Pezzelle, Fernández, *in preparation*, 2019

Motivation

Size GAs:

- represent functions that map objects onto **scales of degrees**

  [Cresswell, 1976, Kennedy, 2013]

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Motivation

Size GAs:

- represent functions that map objects onto **scales of degrees**

  [Cresswell, 1976, Kennedy, 2013]
- subtend a statistical **operation** over a comparison set

  [Barner and Snedeker, 2008, Schmidt et al., 2009]
- learned through their use in *grounded* contexts, i.e. **vision**

  [Schmidt et al., 2009]

1. Do models learn vague GAs?

Battery of tasks to evaluate **model abilities**:

- (A) **Superlative GAs** (biggest/smallest) –> **measurement/sorting**
- (B) Positive GAs in **same-shape scenes** –> **threshold**
- (C) Positive GAs in **different-shape scenes** –> **threshold**
- (D) Positive GAs in **same-shape sets** –> **comparison set**

3. Do models generalize?

Battery of experiments to test **generalization**:

- train on scene-level tasks, test on **comparison set-level** ones
- train on **mixed-task datasets**: Some shapes in train, different shapes in test
- train on mixed-abilities cases, test on **single-ability** ones

Expected results

We expect **models** to:

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- error patterns in line with **difficulty of cases** (i.e. distance from threshold)

Few/many/big/small questions?

References i

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