When do we read minds? Methodological and developmental variation in pragmatic inference

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Introduction

RSA (Rational Speech Act) model (Frank & Goodman, 2012) successful in capturing intuitions about pragmatic processes and making quantitative predictions (e.g., scalar implicatures): pragmatic inference modelled as Bayesian inference where probability of speaker's meaning is proportional to speaker's expected utility/utterance informativeness.

However, model assumes high level of recursive thinking/interlocutor modelling whose psychological reality has been questioned by some theories of language processing (Keysar, Sin & Barr, 2003)

Less than optimal use of informativeness often found in reception (Keysar, Barr, Balin and Brauner, 2000; Koolen, Krahmer & Swerts, 2016; Engelhardt, Bailey & Ferreira, 2006) and production (Horton & Keysar, 1996, Lane & Ferreira, 2008, Rubio-Fernández, 2016) and ToM not always necessary (Kissine et al., 2015).

Large methodological and attentional effects on performance in false-belief tasks, especially in children (Rubio-Fernández & Geurts, 2012)

Some effects modelled as pragmatic inference involving reasoning about speaker's intentions and informativeness might result from lower-level mechanisms with theory of mind processes only activated in very specific circumstances.

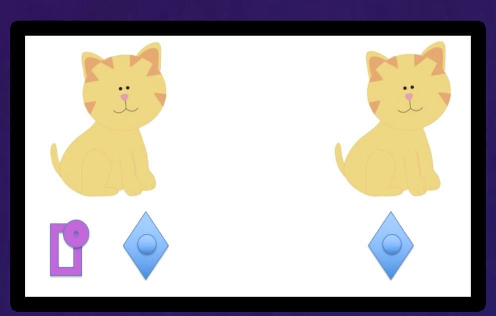

Figure 4. Example stimulus experiment 3.

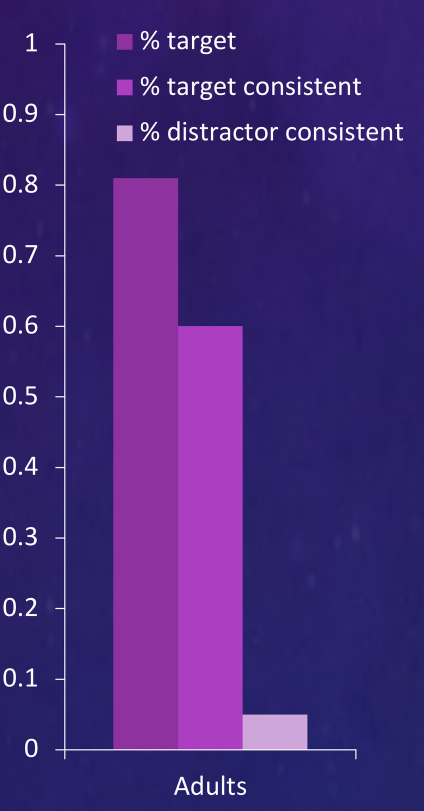

Figure 5. Exp 3 results

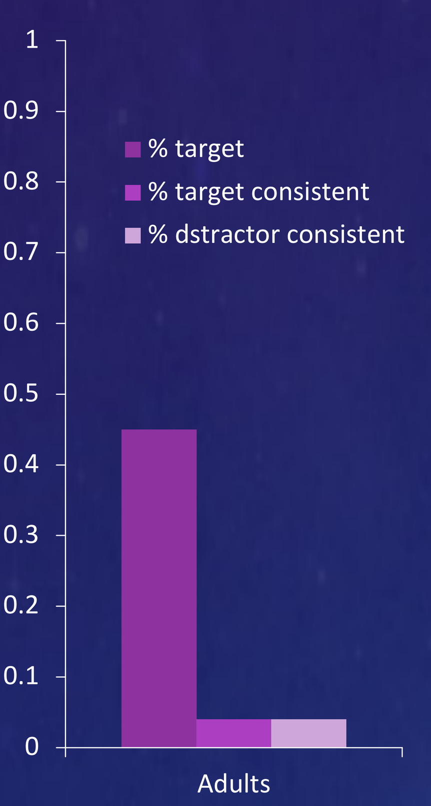

Figure 7. Exp 3 results

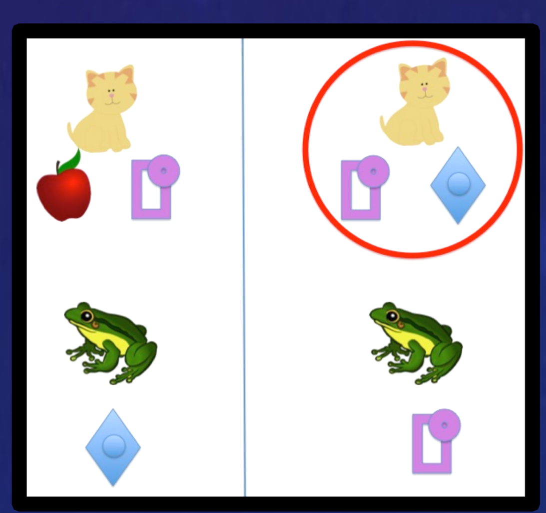

Figure 6. Example stimulus experiment 4.

Method

Experiment 1 (fig. 3): a version of Frank and Goodman's (2014) word learning experiment (exp2-4) with children (n=107, mean age=5;1) and adults (n=32). Participants prompted with instructions of type 'Oh, that's a kitten with a fep! Can you show me the frog that has a fep?'.

Experiment 2: target character explicitly referred to (e.g., 'Oh, the kitten **circled in red** has a fep! Can you show me the frog that has a fep?') (n adults=28, n children=110, mean age=5;6)

Experiment 3 (fig. 4): participants directly asked to pick target character (e.g., 'Oh! A kitten with a fep! Can you show me which one of the kittens is the one that has a fep?') (fig. 4) (n=83)

Experiment 4 (fig. 6): familiar object added in training (in addition to explicit reference to target character) (fig. 5) (n=26)

Research question(s)

Do adults and children reliably derive pragmatic inferences for fast-mapping in word learning contexts with low risks/rewards? Do parameters influencing activation of ToM/considerations of speaker informativeness, such as array complexity, affect adults and children in the same way? Are these effects truly driven by iinformativeness?

	% target (sd)	% consistent target	% consistent distractor
Model	0.67/0.60	/	/
Exp 1 (adults)	0.47 (0.50)	0.38	0.41
Exp 1 (children)	0.25 (0.43)	0.04	0.36
Exp 2-4 (Frank & Goodman, 2014)	0.67(0.47)-0.88 (0.33)	0.63-0.69	/
Exp 2 (adults)	0.65 (0.48)	0.28	0.04
Exp 2 (children)	0.51 (0.50)	0.06	0.05
Exp 3 (adults)	0.80 (0.26)	0.60	0.05
Exp 4 (adults)	0.45 (0.50)	0.04	0.04

Table 1. Summary of results

Results

Model prediction= 0.67 target (0.60 with training and testing items). Chance is 0.50 for each trial and 0.0625 (0.50^4) for consistent target or distractor answers (with conservative assumption of independent trials). Logistic regression mixed model (participants and items).

Experiment 1. Adults at chance (b=-0.12, z=-0.29, p=0.8) and sign higher in ctrl (b=2.77, z=6.33, p>0.0001), children sign below chance (b=-1.18,z=-7.24, p<0.0001). Closer investigation shows substantial proportion of both adults (0.41) and children (0.36) consistent distractor choice. Similar proportion of adults (0.38) but not children (0.04) consistently pick target object.

Experiment 2: Adults above chance (b=0.06, z=2.89, p=0.004) and not sign differ from ctrl (b=- -9.697e-07, z=0, p=1), choose target consistently but not distractor. Children at chance (b=0.05, z=0.45, p=0.64) and sign higher in ctrl (b=1.82, z=9.31, p<0.0001.

Experiment 3: **A**dults above chance (b=2.77, z=6.01, p>0.0001) and do not choose distractor consistently. Performance not sign differ from ctrl (b=0.09, z=0.37, p=0.71)

Experiment 4: **A**dults at chance (b=-0.21, z=-0.68, p=0.49) and sign higher in ctrl (b=0.98, z=2.31, p=0.02) and do not consistently choose target or distractor.

Figure 1. Exp 1 results

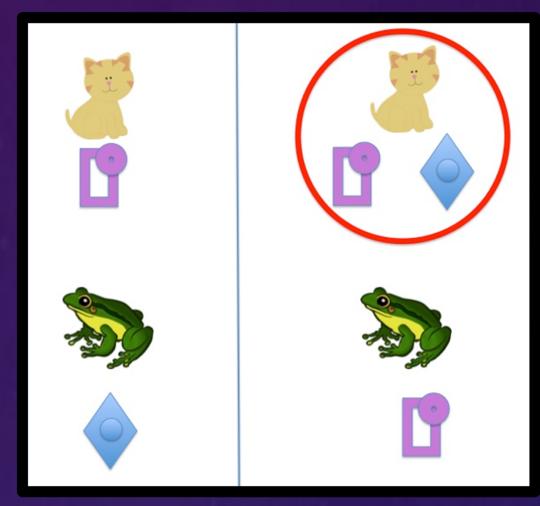

Fig 3. Example stimulus exp 1 and 2 (target=blue object)

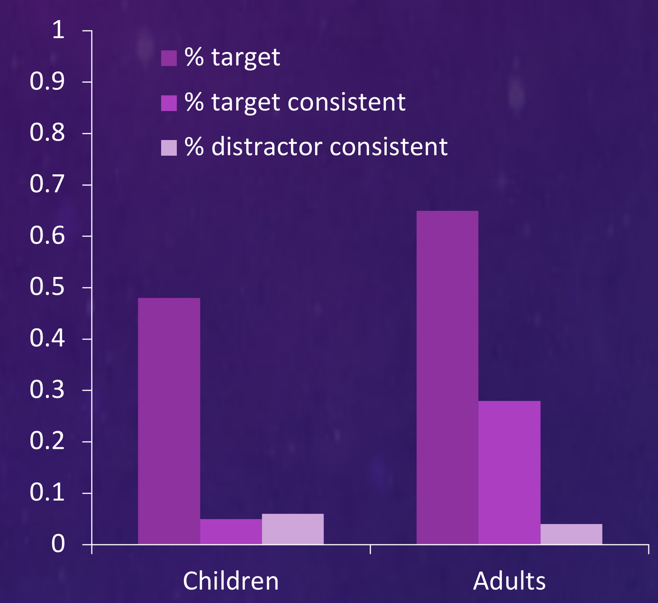

Figure 2. Exp 2 results

Discussion

Exp 1: results against model's predictions or afford no explanatory power to it (chance). Even when removing consistent distractor choices, target choices in children still below chance .

Exp 2 confirms participants in exp 1 misinterpret target character: **semantic ambiguity** or **alternative scalar implicature**

Exp 3 : pragmatically ambiguous but semantically unambiguous ('the one that has a fep') instruction blocks consistent distractor choice
=>NOT alternative implicature.

Adults and children's performance in exp 2 still lower compared to Frank and Goodman (2014): **'informativeness dilution' effect** or **'salience dilution effect'** due to simultaneous presentation of training and testing items and affecting children more than adults.

Addition of object reducing salience but not informativeness of target object in **exp 4** results in random performance : original inference **not driven by ToM/ informativeness?**

Additional experiment: participants referring to '(small) blue banana' even to distinguish only from other (big) blue banana: overspecification **non-optimally informative AND not driven by ToM/efficiency** as previously suggested? (Rubio-Fernández, 2016; Degen et al., 2016).

Conclusions

Some inferences usually described as the result of ToM processes are easily disrupted as processing costs increase due to methodological or developmental reasons and might actually be driven by lower-level salience mechanisms, with online informativeness optimisation/interlocutor modelling being the exception rather than the rule.

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