Acquisition of quantity, relevance and word learning inferences, and their relationship with Theory of Mind

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Aims

1. What is the relationship between scalar quantity, ad hoc quantity and relevance implicature inferences in children's pragmatic development?
2. Is word learning by exclusion a similar pragmatic inference?
3. What is the relationship between pragmatic inferencing and Theory of Mind development?

Background

- Recent studies find younger age of development for implicature inferences, down to 3 years, but studies focus on single implicature type [1] [2]
- Word learning by exclusion has been proposed as a pragmatic forerunner to implicatures [3], or as a lexical heuristic [4], but no comparison with undisputed pragmatic skills has been made to test this
- A Gricean model of implicatures implies reasoning about others' beliefs and intentions – Theory of Mind – and increasing complexity of inferences from word learning, to relevance, ad hoc quantity, then scalar implicature [5]

Key Terms

Implicature – a speaker's intended meaning beyond the literal meaning of what is said, which can be inferred by assuming that the speaker is informative (quantity implicature) or relevant (relevance)

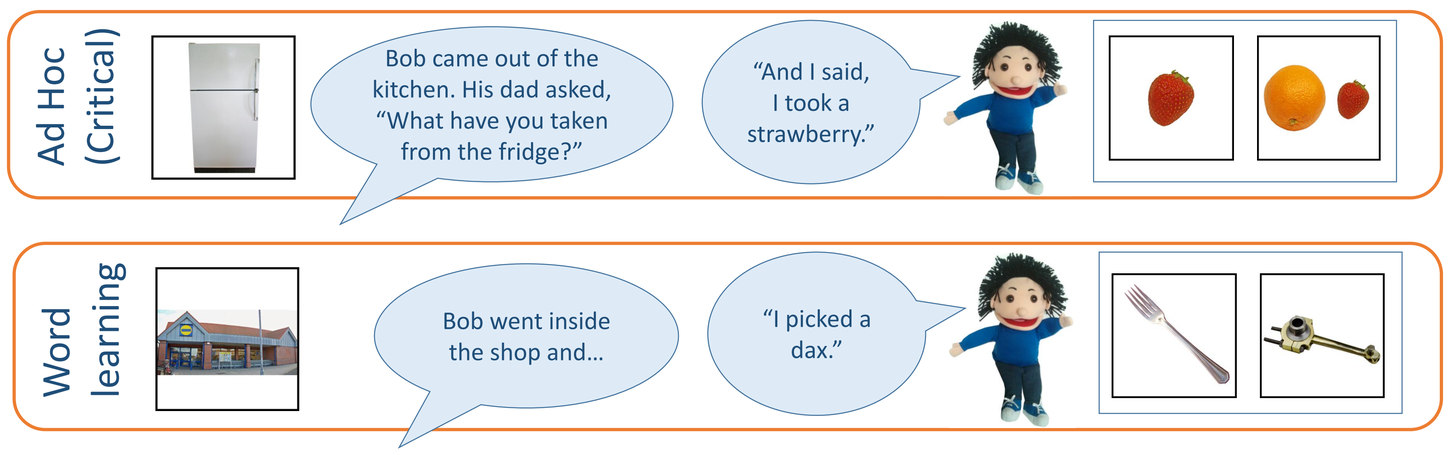
Word learning by exclusion – a strategy of picking a novel object as the referent of a novel label instead of an object with a known label

Theory of Mind (ToM) – the ability to reason about others' beliefs, desires and intentions

Control - semantic (Ad Hoc)	Bob came out of the kitchen. His dad asked, "What have you taken from the fridge?"	"And I said, I took an orange and a strawberry"
Relevance	It was breakfast time. Bob's dad asked, "What would you like for breakfast?"	"And I said, I'll get the milk"
Scalar quantity	Bob made a crash in the kitchen. His mum asked, "What did you do with the pile of plates?"	"And I said, I broke some of the plates"
Word learning	Bob went inside the shop and…	"I picked a dax."

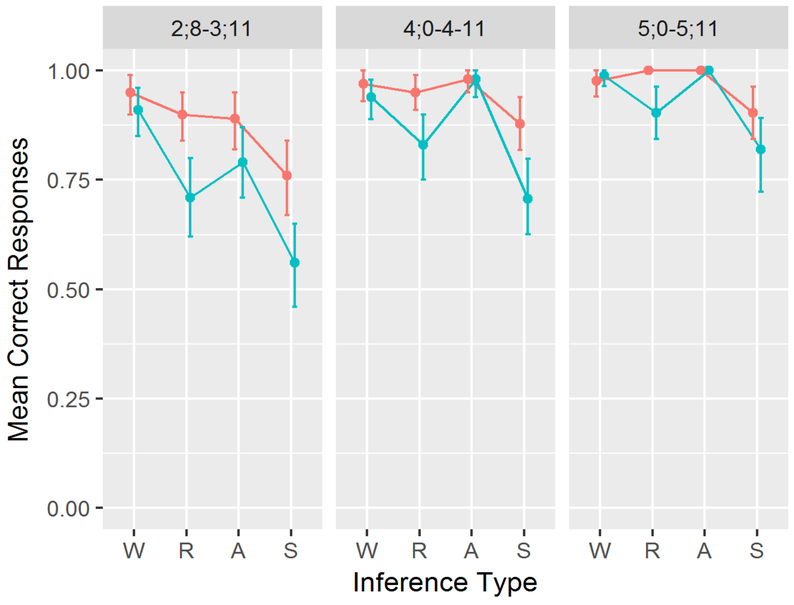
Method

- Inference type (Scalar, Ad hoc, Relevance, Word Learning) x Critical/Control x Agegroup
- 32 items across 5 'stories', binary picture-selection task, narrated by experimenter and puppet (recorded)
- Theory of Mind tests: Sally-Anne and unexpected contents tasks [6] [7]
- N = 71 monolingual English-speaking children aged 2;8 - 5;11. N = 15 adult controls



Results

- Adults score at ceiling in all conditions
- For children, a mixed effects logistic regression model, with Inference Type, Critical/Control and Agegroup as fixed effects (sum coding), and Item by Condition, Agegroup and story order random slopes, shows a main effect of condition (control higher than grand mean), inference type (scalar lower), and Agegroup (2;8 - 3;11 lower) – Table 1.
- The same model but with successive difference contrasts indicates: Relevance is lower than Word Learning; no difference between Relevance and Ad Hocs; but Scalars lower than Ad Hocs. Also, 4-yos perform worse overall than 5-yos, and 3-yos worse than 4-yos – Table 2.
- For agegroup 2;8-3;11, there is no evidence for a relationship between Relevance and Word Learning inferences (tau = -.05, z = -.34, p = .73), but between Ad Hoc and Word Learning (tau = .34, z = 2.3, p = .02)
- Model comparison shows that ToM is not a predictor of implicature score, when age, gender, SES and core language skills (grammar) are taken into account – Table 3.



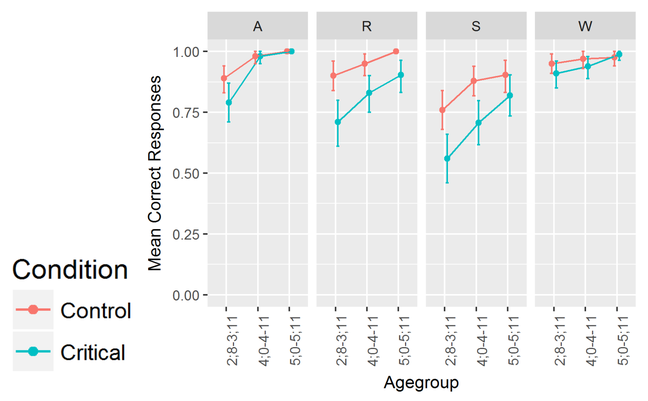


Fig. 1. **Mean Correct Response by agegroup and inference.**
Fig. 2. **Mean Correct Response by inference and agegroup.**
Error bars show bootstrapped 95% confidence intervals for between-subject comparison.
W = Word Learning by Exclusion inference; R = Relevance; A = Ad Hoc quantity; S = Scalar quantity implicature

	β	SE	z	p
Intercept	2.81	.16	17.1	<.001
Control	0.53	.13	4.2	<.001
Ad Hoc	0.37	.22	1.72	.086
Relevance	-0.15	.2	-0.78	.44
Scalar	-1.25	.12	-6.56	<.001
2;8-3;11	-1.02	.16	-6.34	<.001
4;0-4;11	0.014	.14	0.1	0.92

Table 1: Response ~ Condition + Type + Agegroup + (1 + Condition + Agegroup + Block | Item) Glmer, family = binomial, optimizer = bobyqa, contrast coding

	β	SE	z	p
Intercept	2.8	.16	17.1	<.001
Critical – Control	-1.06	.25	-4.2	<.001
R – WL	-1.18	.39	-3.03	.0024
AH – R	.052	.32	1.64	.1
SI – AH	-1.63	.33	-4.89	<.001
4;0-4;11 – 5;0-5;11	-0.99	.33	-3.04	.0024
2;8-3;11 – 4;0-4;11	-1.04	.2	-5.05	<.001

Table 2: as Table 1 with successive difference coding

	Df	AIC	Log Lik	Deviance	χ2	p
Score ~ 1 + (1 + Age + Gender + SES + Grammar + TOM + Multiling | Item.no)	22	609.92	-282.96	565.92		
Score ~ Age + (ran effects)	23	582.46	-268.23	536.46	29.47	<.001
Score ~ Age + Gender + (ran effects)	24	584.35	-268.18	536.35	0.11	0.74
Score ~ Age + Gender + SES (ran effects)	25	582.74	-266.37	532.74	3.61	0.06
Score ~ Age + Gender + SES + Grammar + (ran effects)	26	584.16	-266.08	532.16	0.58	0.45
Score ~ Age + Gender + SES + Grammar + ToM + (ran eff)	27	586.04	-266.02	532.04	0.12	0.73

Table 3 Model comparison for Age, Gender, SES, Grammar, and ToM

Findings

- A developmental trend for pragmatic inferences: word learning emerges first, then relevance / ad hoc, then scalar implicatures
- This partially reflects complexity of inference implied by Gricean model of implicatures, and corroborates previous studies
- Word learning inferences correlate with ad hocs – suggestive of pragmatic nature of word learning by exclusion, or just because of the shared exclusion mechanism
- No evidence for relationship of implicatures and ToM here

Discussion

- Generally high performance due to child-friendly nature of task
- Pre-school years seem to be key stage for implicature development
- Whether word learning is pragmatic or lexical requires further research
- Contrary to Gricean model, is it possible that some pragmatic inferencing abilities do not depend on ToM [8]? Or is correlation between false-belief and implicature tasks too crude a measure? They could depend on different aspects of ToM or linguistic skills; a more integrated method is needed (see [9]).

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