

## Restrictions on the meanings of determiners: typological generalisations and learnability

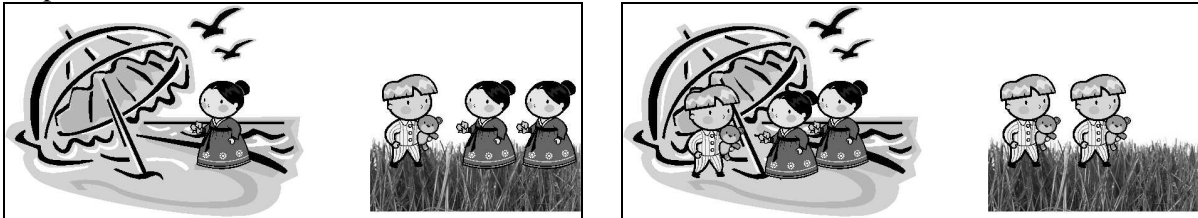
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Children's abilities to acquire novel words tell us about the hypothesised word meanings that children entertain. We investigate children's abilities to learn a range of determiner meanings that are not attested in natural languages. For those unattested determiners that children do not successfully learn, we propose that their typological absence is due to an inherent property of the language faculty that prevents determiners (a class of words defined distributionally) from taking on those meanings. Specifically, we find that the lack of nonconservative determiners in the world's language may be due to this kind of constraint, while the lack of determiners with the meaning "less than half" can not be.

We conducted a number of experiments testing the abilities of four- and five-year-old children to learn various novel determiners, using a variant of the "picky puppet task" (Waxman & Gelman, 1986). Children are familiarised with a puppet who has an unknown criterion for whether he likes a particular scene (illustrated on cards) or not: all that is known to the child is that the criterion is expressed by "The puppet only likes cards where gleeb girls are on the beach". The child is shown a collection of cards that the puppet is known to like (showing scenes where it is true that gleeb girls are on the beach) and a collection of cards that the puppet is known to not like (showing scenes where it is not true that gleeb girls are on the beach). All these cards constitute the *training cards*. The child must then "help the experimenter" by sorting some remaining cards (the *test cards*), into two piles according to whether the puppet likes them or not. We measure the success of the child in learning the meaning of 'gleeb' by recording how many of these remaining cards are successfully sorted.

This methodology was used in all the experiments reported here. Whatever the meaning of the determiner that children were being exposed to, it was pronounced "gleeb". Of course, the cards that the puppet liked and disliked varied according to the determiner under investigation. Two sample cards are shown below.



The first experiment we report uses this methodology to investigate the learnability of nonconservative determiners. While it is widely-known that all attested determiners in natural languages are conservative, as defined below (Barwise & Cooper, 1981; Higginbotham & May, 1981), whether or not children entertain nonconservative determiner meanings is still an open question despite some impressions to the contrary (Inhelder & Piaget, 1964; Crain et al., 1996).

$D$  is conservative iff  $D(X)(Y) \equiv D(X)(X \cap Y)$

We compared children's ability to learn a novel nonconservative determiner with their ability to learn a novel conservative determiner. Of twenty participants, ten were exposed to the conservative determiner D1, and ten were exposed to the nonconservative determiner D2.

$D1(X)(Y) \equiv \neg (X \subseteq Y)$  (conservative)

$D2(X)(Y) \equiv \neg (Y \subseteq X)$  (nonconservative)

Thus the meaning represented by D1 corresponds to the English expression "not all": for this experiment, the puppet would like the first sample card above because "gleeb girls are on the beach" would be true, but would not like the second sample card above because "gleeb girls are on the beach" would be false. We found that while children exposed to D1 performed significantly better than chance at sorting the test cards, children exposed to D2 did not, despite the two determiners' being matched for complexity in all respects other than the significance of specifically

being an internal or external argument. This supports the hypothesis that the lack of nonconservative determiners in the world's languages derives from a constraint on the way the language faculty computes meanings compositionally, such that the syntactic frame that defines the class of determiners cannot express a nonconservative relation between (the sets denoted by) the determiner's arguments. This raises the challenge of defining a theory of compositional semantics that captures this restriction, which is unexpected under standard GQT treatments of determiners (Mostowski, 1957).

Further experiments of the same form investigate the learning of proportional determiners. We compare children's abilities to learn two unattested proportional determiners, D3 and D4, which can be thought of as two variants of the English determiner 'most'.

$$\text{most}(X)(Y) \equiv |X \cap Y| > |X - Y|$$

$$\text{D3}(X)(Y) \equiv |Y \cap X| > |Y - X|$$

$$\text{D4}(X)(Y) \equiv |X \cap Y| < |X - Y|$$

D3 differs from 'most' with respect to the order of its arguments: it is the nonconservative "mirror image" of 'most' in the same way that D2 is the nonconservative "mirror image" of D1 above. The findings of the previous experiment would suggest that D3 should likewise be unlearnable.

D4 differs from 'most' in a different way: the direction of the cardinality comparison is reversed, so it corresponds to the English expression "less than half". This determiner, though unattested, is conservative, since it depends on the same two cardinalities as does (the attested, conservative) 'most'. If the only restriction on the meanings of determiners is that they must be conservative, then we would predict that children should succeed in learning D4. On at least one theory of 'most', however (Hackl, to appear), D4 is also predicted to be impossible. Preliminary results in this experiment suggest that children do succeed in learning D4, telling against a theory where this meaning is not possible. This suggests that the absence of this determiner in natural languages does not derive from inherent constraints imposed by the language faculty, perhaps instead being a consequence of its relatively low information content.

Considering the results of experiments with all four of these novel determiners, varying with respect to conservativity and first-order definability as indicated in the table below, we can approach (i) a formal characterisation of the boundary line between learnable and unlearnable determiners, and (ii) a clearer understanding of the relationship between the class of unattested determiners and the class of unlearnable determiners.

	First-order	Second-order/Proportional
Conservative	D1	D4
Nonconservative	D2	D3

## References

- Barwise, J. and Cooper, R. (1981). Generalized quantifiers and natural language. *Linguistics and Philosophy*, 4:159–219.
- Crain, S., Thornton, R., Boster, C., Conway, L., Lillo-Martin, D., and Woodams, E. (1996). Quantification without qualification. *Language Acquisition*, 5(2):83–153.
- Hackl, M. (to appear). On the Grammar and Processing of Proportional Quantifiers: 'Most' versus 'more than half'. To appear in *Natural Language Semantics*.
- Higginbotham, J. and May, R. (1981). Questions, quantifiers and crossing. *The Linguistic Review*, 1(1):41–80.
- Inhelder, B. and Piaget, J. (1964). *The Early Growth of Logic in the Child*. Routledge & Kegan Paul, London.
- Mostowski, A. (1957). On a generalization of quantifiers. *Fundamenta mathematicae*, 44:12–36.
- Waxman, S. R. and Gelman, R. (1986). Preschoolers' use of superordinate relations in classification and language. *Cognitive Development*, 1:139–156.