

Preverbal logical inferences scaffold early comprehension of verbal disjunction: an experimental study with young preschoolers.

What is the relation between logical reasoning and language? Recent work suggests that preverbal infants can already draw disjunctive inferences from visual events ($A \vee B$; *exclude* $A \rightarrow B$)^[1,2]. For example, 12-month-olds look longer at outcomes that violate such inferences, suggesting that deductive reasoning emerges before language. By contrast, children do not consistently assign adult-like interpretations to sentences with the linguistic connective “or” until age 6-7^[3,4], or they do only in certain contexts^[5]; in production, “or” is also rare and much less frequent than other connectives like “and”^[6,7], leaving it unclear when children start understand it as logical disjunction. Our study investigates the relation between preverbal disjunctive inferences and the acquisition of “or” and finds evidence that this precursor of logical reasoning supports children’s early comprehension of verbal disjunction.

Methods In two preregistered experiments with 36-to-42-month-old English-speaking children, we asked (i) whether the early meaning of “or” supports deductive inferences and (ii) whether *preverbal* disjunctive inferences can scaffold early “or” comprehension. In Experiment 1, 24 children (age $M=39;05$ months) completed first an *inferential cognitive task* involving only visual events: two objects with identical tops were hidden, a cup scooped one, revealing only its top; then, the other object reappeared, and children were asked to answer to “What’s in the cup?” (**Figure1A**). Then, they completed an *inferential linguistic task*, where they had to integrate a disjunctive statement (e.g., “the object is the car OR the ball”) with visual information to provide the correct response (**Figure1C**). In Experiment 2, a new group of children ($N=22$; age $M=38;21$; data collection is nearly complete) performed the same inferential linguistic task, but this time it was preceded by a *non-inferential control task*, in which they directly saw which object the cup scooped (**Figure1B**).

Results and discussion (Figure 2) Children succeeded in the *inferential cognitive task* (Exp1; chance=50%, $M=84.03\%$, $BF=323.5$, all tests are Bayesian Wilcoxon Signed-Rank tests) and in the *non-inferential control task* (Exp2; chance=50%, $M=95.07\%$, $BF>10000$), by naming the correct object. In the linguistic task, we preregistered two distinct tests, targeting distinct components of verbal disjunctive reasoning. First, we tested whether children understood that “or” restricted the set of the objects’ possible identities to the verbal disjuncts (e.g., from {ball, car, umbrella} to “ball or car”), and found that children named either disjunct above chance in Exp1 (chance=66%; $M=88\%$, $BF=48.09$) but not in Exp2 ($M=75\%$, $BF=0.685$). Next, we tested whether children could exclude one of the two disjuncts based on visual information; we found that children were more likely to name the correct object over the other one in both experiments (chance=50%; Exp1: $M=84\%$, $BF=323.5$; Exp2: $M=86\%$, $BF=963.5$). Finally, we compared children’s comprehension of “or” as a possibility restrictor in the two experiments and found that they performed significantly better in Exp1 (two-sample Bayesian Mann-Whitney test: $BF=765.64$).

Our results have major implications for the development of logical reasoning, the acquisition of verbal disjunction, and the relation between the two. First, we found that at age 3 children are not only highly proficient in deductive reasoning based on visual information but can also generate disjunctive inferences by integrating their comprehension of “or”-phrases with visual information. This suggests that the ability to draw deductive inferences may contribute to the early meaning of “or”^[8]. Crucially, we also found that, at the onset of verbal disjunction, even a brief practice with the non-verbal disjunctive inference documented in infants^[1,2] improves

children’s comprehension of verbal disjunction. These findings provide strong support for the proposal that preverbal disjunctive inference functions as a developmental precursor scaffolding the acquisition of the meaning of “or”.

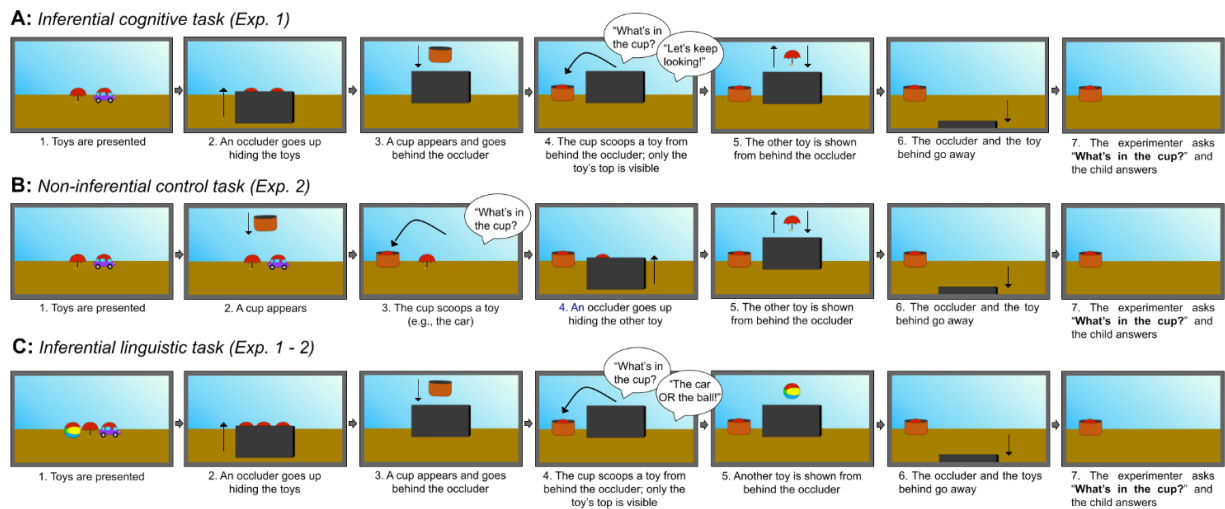


Figure 1: Stimuli and procedure for the three tasks. Examples are taken from one of the 16 counterbalanced conditions, which vary the target answer, the toys’ positions, and trials’ order. Speech balloons display the prerecorded sentences heard by the child. **A: Inferential cognitive task** in Experiment 1: Children can infer the hidden object’s identity by reasoning from visual information alone. **B: Non-inferential control task** in Experiment 2: Children do not need to infer the identity of the hidden object, as they can directly see which object the cup scoops. **C: Inferential linguistic task** in Experiments 1 and 2: Children can infer the hidden object’s identity by integrating visual and linguistic information.

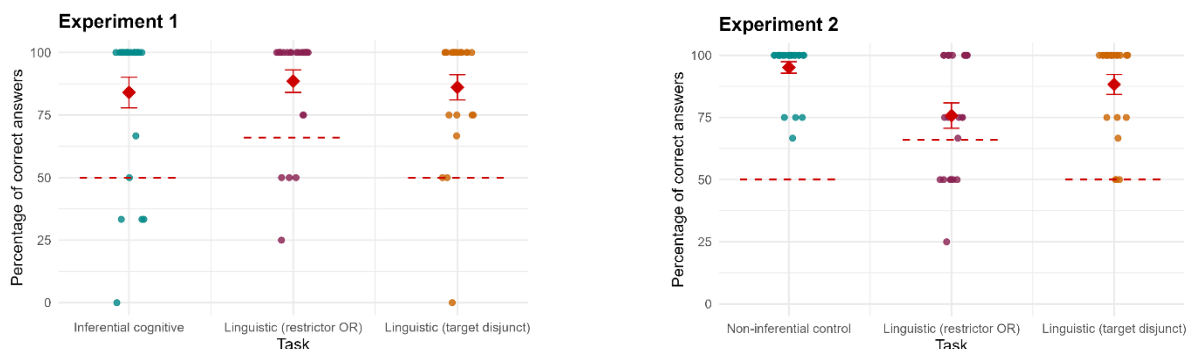


Figure 2: Percentage of correct answers across tasks in the two experiments. *Inferential cognitive task*: percentage of trials in which a child named the correct object; *Linguistic task (restrictor OR)*: percentage of trials in which a child named either verbal disjuncts; *Linguistic task (target disjunct)*: percentage of trials in which a child named the correct object among the two verbal disjuncts. Dots show participants’ scores, red rhombuses the group means, error bars the standard errors, and the dashed red lines the chance level.

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