Methods for Toddler's Comprehension of Negation

Masoud Jasbi, Annika McDermott-Hinman

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Main Question: At what age do toddlers understand negation in the context of rejecting desires?

Design

The study presents toddlers with video recordings and measures their looking time to the screen in a violation of expectation paradigm (Baillargeon, Spelke, Wasserman 1985). In each trial, there are two puppets and two objects on the screen. One puppet asks the other if they want one of the objects. The second puppets answers with "yes" or "no". Then the first puppet goes ahead to give them the object they wanted, or the object they did not want.

The study has four within-subject trial types. These four trial-types are created based on two factors:

1. Whether the answer to the question is positive or negative
2. Whether the reaction to the answer is consistent or inconsistent with the expressed desire

The table below summarizes the study's 2×2 design. Positive trial types consititue the control condition and negative trial types constitute the test condition. Additionally, there will be a familiarization trial at the beginning of the study to allow the children to become accustomed to the stimuli before the test trials.

Condition	Trial-Type	Objects	Question	Answer	Reaction
Control	Positive-Consistent	X, Y	Do you want the X?	Yes	gives X
Control	Positive-Inconsistent	X, Y	Do you want the X?	Yes	gives Y
Test	Negative-Consistent	X, Y	Do you want the X?	No	gives Y
Test	Negative-Inconsistent	X, Y	Do you want the X?	No	gives X

Stimuli

Puppets

[we should include the picture of the puppets and the objects used in the experiment]

5 Different puppets. 1 puppet that recieves the objects and 4 puppets, 1 per condition, that gives objects to the receiver puppet

Objects

Three pairs of objects for the three trial in a condition:

1. apple vs. banana
2. ball vs. car
3. ducky vs. kitty

Linguistic Stimuli

List of lexical items used: no, yes, want, you, do, the, apple, banana, ball, car, dog, cat, duck, bear

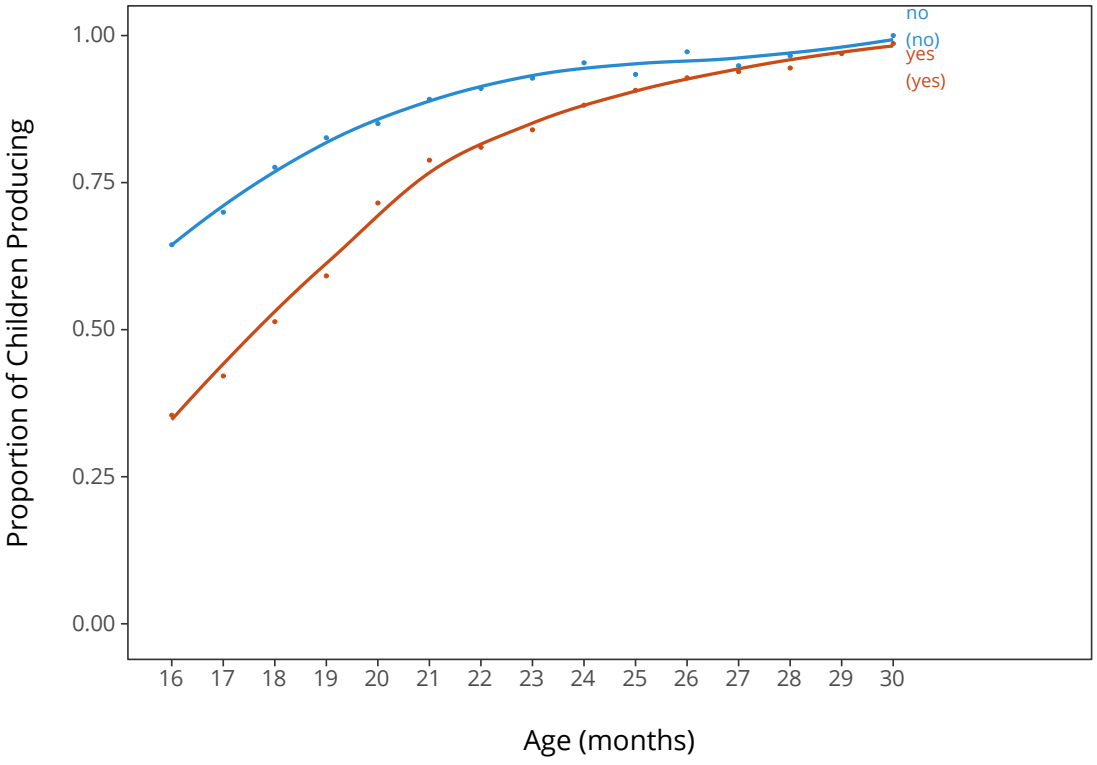

Figure 1: Production for Yes and No

According to CDI data (accessed through wordbank.stanford.edu), around 27 months of age almost all children produce "yes" and "no". The names for all of the objects used are produced by more than 75% of children at 27 months, and are among the first nouns that children produce, as reported by parents (wordbank.stanford.edu). Additionally, Bergelson and Swingley (2012, 2015) provide good evidence that children understand common nouns long before they begin to produce them (as early as 6-9 months).

The remaining words used in the study (do, you, want, the) are clustered around 50% in terms of production at 27 months, and that proportion is increasing rapidly at that age, as seen in the graph. There were not data in the Stanford database for the word 'want', so 'want to/wanna' has been taken as a proxy under the assumption that production of 'want' is at least as high as production of 'want to'.

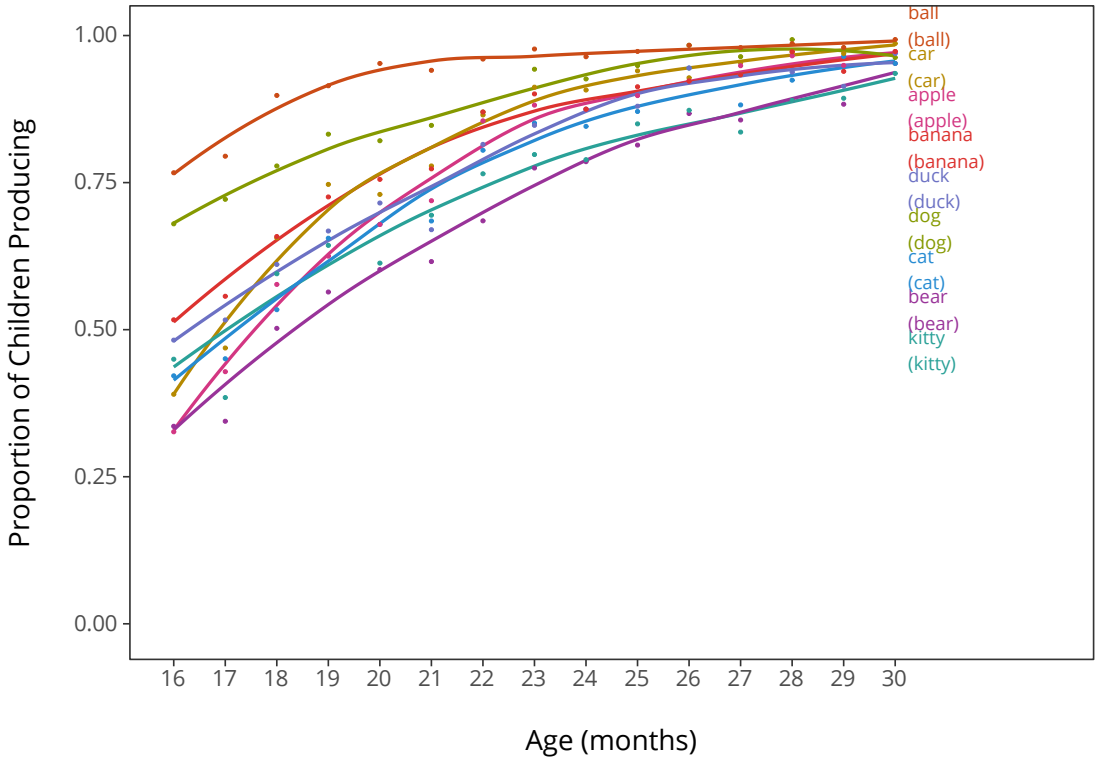

Figure 2: Production for Object Words

Video Recording and Editing

Trials

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Block 1: Positive Consistent

Objects	Question	Answer	Reaction
Apple, Banana	Do you want the apple?	Yes	gives apple
Ball, Car	Do you want the ball?	Yes	gives ball
Duck, Cat	Do you want the kitty?	Yes	gives cat

Block 2: Positive Inconsistent

Objects	Question	Answer	Reaction
Apple, Banana	Do you want the apple?	Yes	gives banana
Ball, Car	Do you want the ball?	Yes	gives car
Cat, Duck	Do you want the kitty?	Yes	gives duck

Block 3: Negative Consistent

Objects	Question	Answer	Reaction
Apple, Banana	Do you want the apple?	No	gives banana
Ball, Car	Do you want the ball?	No	gives car
Cat, Duck	Do you want the kitty?	No	gives duck

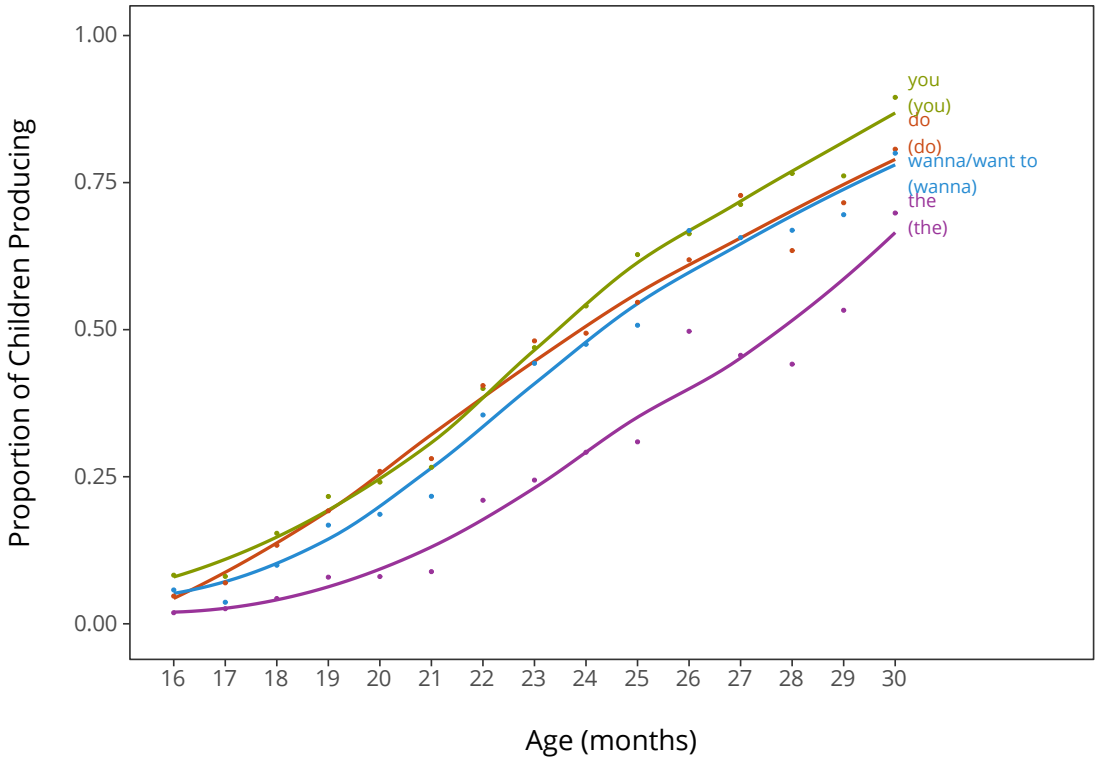

Figure 3: Production for Other Words

Measurment & Reliability

We use the duration of infant's looking at the screen after a trial video has ended as our dependent measure. All trials end with the last frame frozen on the screen. We move to the next trial if infants stop looking at the screen for more than 2 seconds. Timing, trial ordering, and presentation were managed using the open source software PyHab developed by Jonathan Kominsky.

The stimuli will be controlled by the experimenter, blind to the stimuli but with a live feed of the child. The experimenter will code the child's looking time by pressing a key when the child is looking at the screen and releasing when the child looks away. Each trial will end when the last frame is showing and the experimenter has indicated that the child has been looking away from the screen for 2 seconds. The next trial will then start automatically. Each participant will be recoded by an independent coder blind to the stimuli and to the experimental hypotheses, with a 95% agreement threshold between coders.

Reliability Coding

Procedure

Results and Analyses

We predict that toddlers who understand our task will look longer at inconsistent trials than consistent ones. In the control condition, success includes correct comprehension of the positive word "yes". In the test condition, success involves correct comprehension of the negative word "no".

To test toddler's performance we use a Bayesian linear regression with the following as predictors: answer (yes/no) and reaction (consistent/inconsistent). Following Barr et al, we use the maximal by subject and

item random effects. Item here is interpreted as the object handed to the second puppet by the first. Following the adivce of Csibra et al (2016) we log-transform the infant looking time for our statistical analyses.