Methods for Toddler’s Comprehension of Negation (Pilot Study)

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Add that we cared about monolingualism

Question 1: At what age do toddlers understand negation in the context of rejection of 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, and 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 puppet answers with “yes” or “no”. Then the first puppet gives the desired object, or alternatively, the object that was rejected. We hypothesize that knowledge of negation in the context of rejecting desires results in surprise when the puppet provides a rejected object.

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 (yes) or negative (no)
2. Whether the desired or the rejected object is given

The table below summarizes the study’s design. Positive trial types consititue the control condition and negative trial types constitute the test condition.

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

## Stimuli

### Puppets

The study has two puppets: Yuni the unicorn and Diego the Dragon. Yuni is the puppet that receives objects and Diego is the puppet that asks Yuni what she wants and gives an object to her.

### Objects

We used four pairs of objects (one per trial type):

*an apple vs. a banana* a small ball vs. a toy car *a rubber ducky vs. a teddy bear* a cup and a spoon

### Words

This study used the following words in its test trials: *no*, *yes*, *do*, *you*, *want*, *the*, *apple*, *banana*, *ball*, *car*, *duck*, *bear*, *cup*, *spoon*. This section provides evidence that the majority of children between 24 and 30 months are faimilar with these words. We used the MacArthur-Bates Communicative Development Inventory (MB-CDI), accessed via (wordbank.stanford.edu)[wordbank.stanford.edu] (**???**), and children’s productions in CHILDES, accessed via (childes-db.stanford.edu)[childes-db.stanford.edu].

According to CDI data (accessed through ), 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) and Bergelson and Swingley (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’.

![Production for Yes and No](data:application/pdf;base64,)

Production for Yes and No

![Production for Object Words](data:application/pdf;base64,)

Production for Object Words

![Production for Other Words](data:application/pdf;base64,)

Production for Other Words

### Video Recording and Editing

Voice was recorded using X. Videos were edited using Y and recorded voice was overlaid on the video using the same video-editing software.

## Trials

Here we present a trial by trial descirption of the study. Blocks 1, and 2 are presented in the same order. Blocks 4 and 5 are presented in a randomized and counterbalanced manner. All the stimuli are made available on the study’s gitub repository.

The study starts with the puppets introducing themselves:

Diego: Hi! I’m Diego! Yuni: Hi! I’m Yuni! Diego: Hello Yuni! Yuni: Hello Diego!

### Block 1: Introduction

Yuni leaves [stage right]. Diego leaves [stage left].

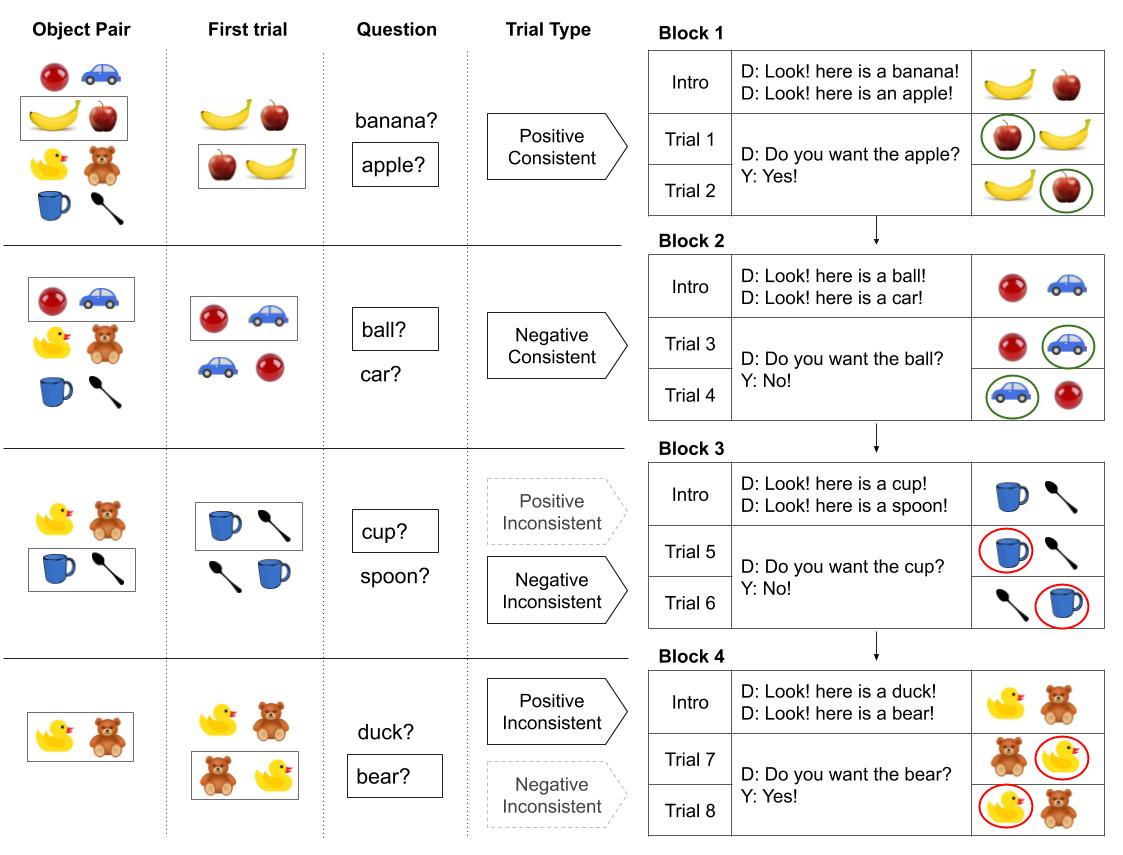
Then diego enters the next scene [stage right]. An apple and a banan are placed on a stage on the right side. He says:

Diego: Look! Here is an apple! Here is a banana!

He walks out [stage left] and the screen freezes to measure looking time at the apple and the banana. This process is repeated for the other two pairs of objects as well:

Diego: Look! Here is a ball! Here is a car! Diego: Look! Here is a duck! Here is a cat!

Measuring looking time on the pairs of objects will let us know how interesting the objects are on their own.



Study design, randomization, and example trials.

### Block 1: Positive Consistent Match

Once the introduction block ends, the experimental blocks 1, 2, 3, and 4 start. They all have a similar sequence of events. Diego is next to a pair of objects. Yuni walks in. Diego asks if Yuni wants an object (i.e. the apple), Yuni responds, and Diego gives an object to Yuni:

Diego: Hey Yuni! Do you want the apple? Yuni: Yes! Diego: OK! [gives the apple to Yuni]

In block 1 trials, all answers are positive (i.e. yes), Diego’s reaction is consistent with the answer, and the objects given match what was mentioned in the question.

|  |  |  |  |
| --- | --- | --- | --- |
| 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, Bear | Do you want the ducky? | Yes | gives duck |

### Block 2: Negative Consistent Non-Match

Block 2 is similar to block 1, except all answers are negative (i.e. no) and the objects given do not match what was mentioned in the question. Diego’s reaction is still consistent with Yuni’s answer.

Diego: Hey Yuni! Do you want the apple? Yuni: No! Diego: OK! [give the banana to Yuni]

|  |  |  |  |
| --- | --- | --- | --- |
| Objects | Question | Answer | Reaction |
| Apple, Banana | Do you want the apple? | No | gives banana |
| Ball, Car | Do you want the ball? | No | gives car |
| Duck, Bear | Do you want the ducky? | No | gives bear |

### Block 3: Positive Inconsistent non-Match

In block 3, all answers are positive (i.e. yes) and the objects given do not match what was mentioned in the question and Diego’s reaction is inconsistent with Yuni’s answer.

Diego: Hey Yuni! Do you want the apple? Yuni: Yes! Diego: OK! [give the banana to Yuni]

|  |  |  |  |
| --- | --- | --- | --- |
| Objects | Question | Answer | Reaction |
| Apple, Banana | Do you want the apple? | Yes | gives banana |
| Ball, Car | Do you want the ball? | Yes | gives car |
| Duck, bear | Do you want the ducky? | Yes | gives bear |

### Block 4: Negative Inconsistent Match

In block 4, all answers are negative and the objects given match what was mentioned in the question but Diego’s reaction is inconsistent with Yuni’s answer.

Diego: Hey Yuni! Do you want the apple? Yuni: No! Diego: OK! [give the apple to Yuni]

|  |  |  |  |
| --- | --- | --- | --- |
| Objects | Question | Answer | Reaction |
| Apple, Banana | Do you want the apple? | No | gives apple |
| Ball, Car | Do you want the ball? | No | gives ball |
| Duck, Bear | Do you want the Ducky? | No | gives duck |

## Participants

Csibra et al. (2016) report that the average effect size in infant looking time studies is about 0.6. Based on this they recommend at least 12 participants and for smaller than usual effect sizes at least 26 participants. Therefore, for our pilot study we aimed at recruiting between 12-26 participants in the age range of 24-30 months.

## Measurment

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](https://github.com/jfkominsky/PyHab/releases).

The stimuli will be controlled by the experimenter, unaware of 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.

## Reliability

Trial data provided by each participant will be recoded by an independent coder unaware of the stimuli and the experimental hypotheses. The coder uses the pyHab software and relibaility is computed automatically for raw percentage agreement, weighted percentage agreement, Cohen’s Kappa, and Pearson’s r. We determined the agreement threshold between coders to be 95%.

## 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. (2013), 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 Csibra et al. (2016), we log-transform the infant looking time for our statistical analyses.

## Alternative Accounts

* label-object matching account: if the object given is the label mentioned then no surprise, but if it’s a different one = surprise. Predicts surprise at match trials 1 and 4.
* Response matching: if the puppet says no, then there is a surprise. Not if it says yes. Predicts surprise at negative blocks.

## References

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