

**Incremental  
Interpretation  
of Negation in  
Partial  
Propositions**

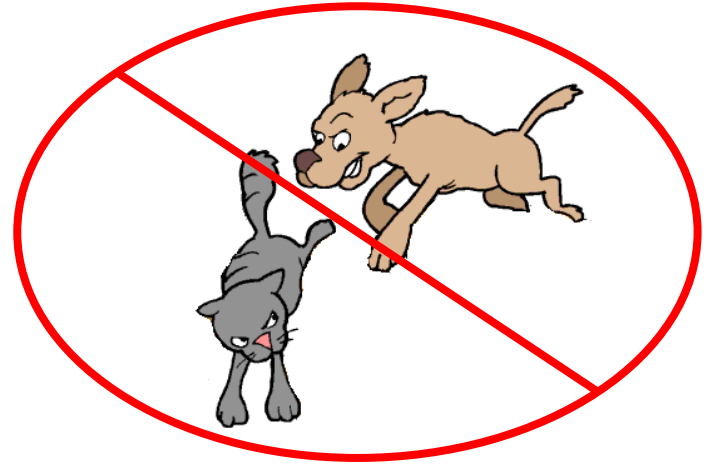
**Jon Burnsky, Emily Darley, Hanna Muller, Julia Buffinton, & Colin Phillips**

**How are sentences with negation understood?**

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*The dog didn't chase the cat.*

$\neg(\text{dog chased cat})$



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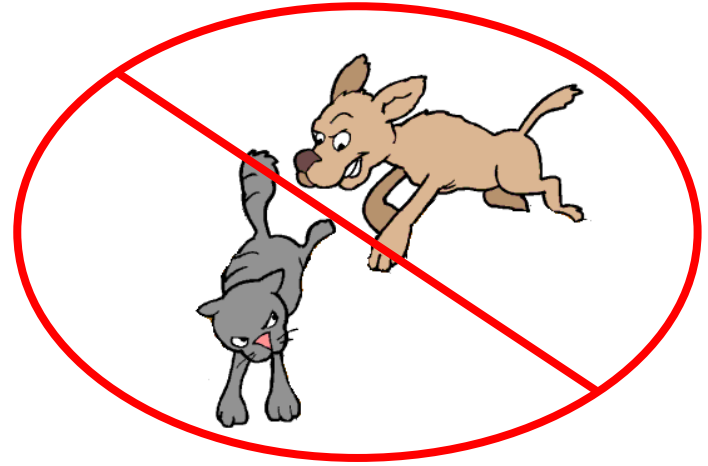
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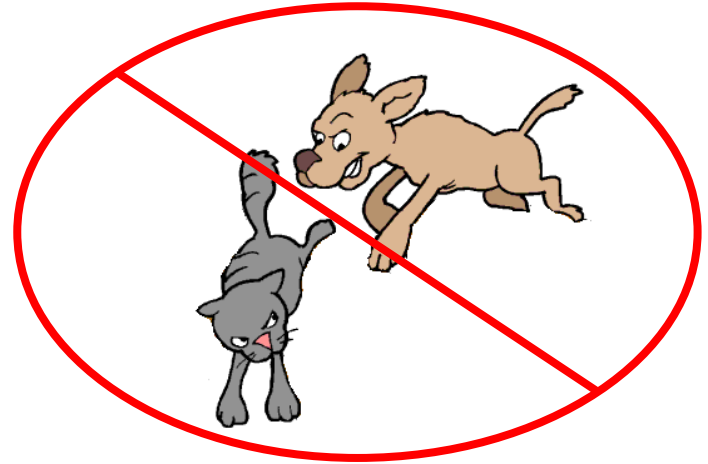
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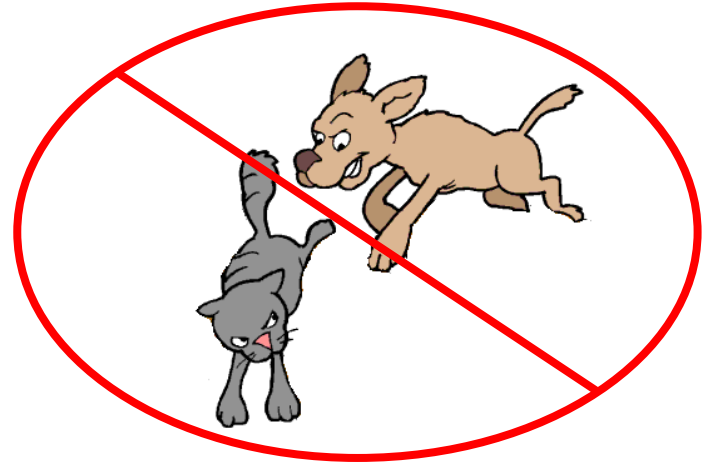
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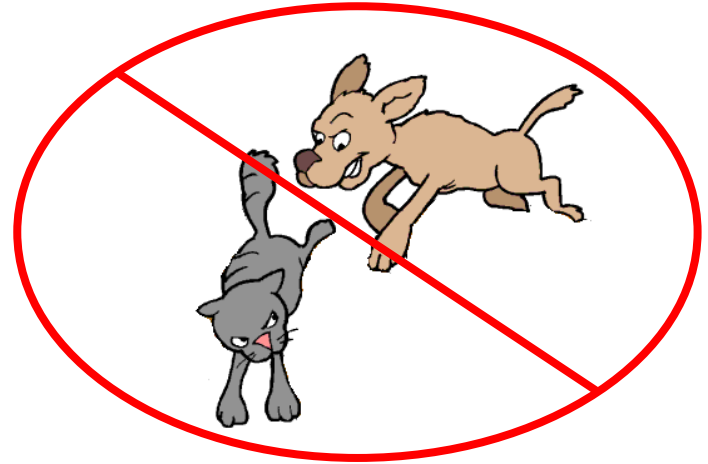
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# How are sentences with negation understood?

The dog *didn't* chase the cat.

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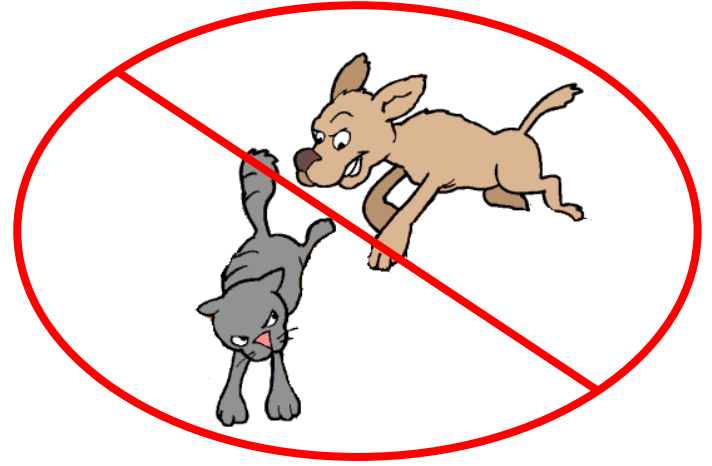




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*The dog didn't chase the cat.*

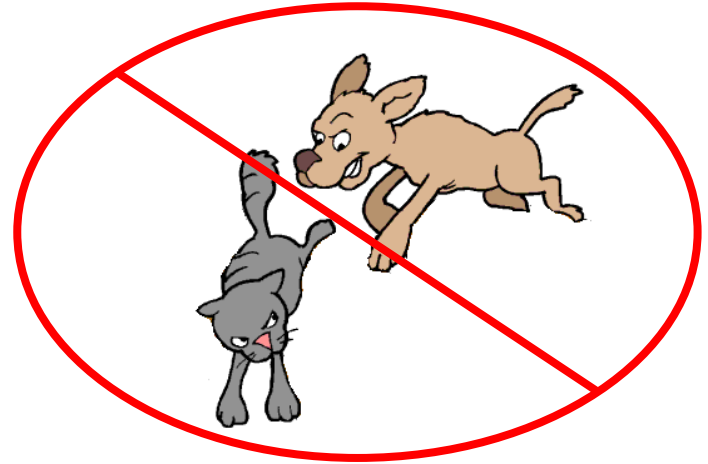
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# Outline

1. Why Negation?
2. Background
3. Experiments 1 and 2: **Evidence for incrementality**
4. Experiment 3: **Limitations of incremental interpretation**
5. Discussion: **Alternatives to two-stage processing**

# Why Negation?

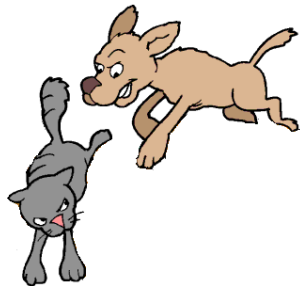
# Why Negation?

The dog chased



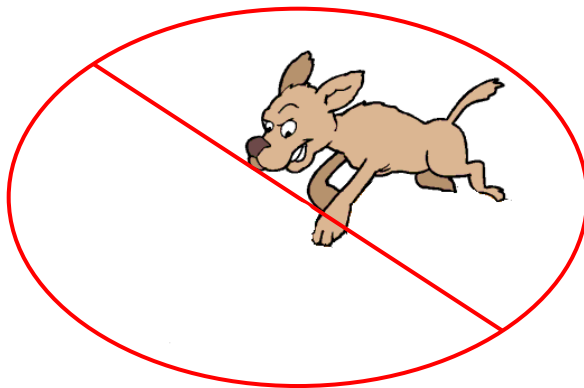
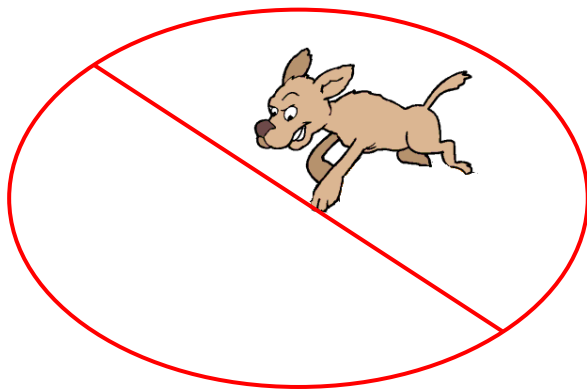
# Why Negation?

The dog chased the cat.

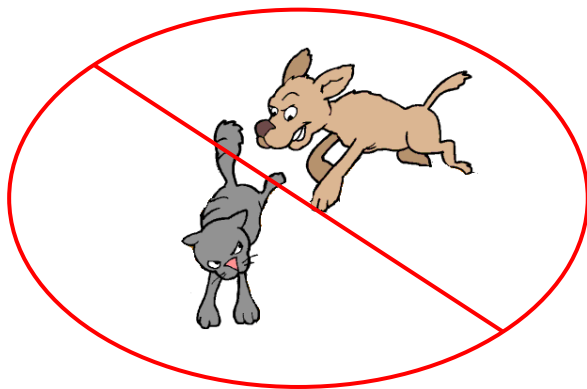


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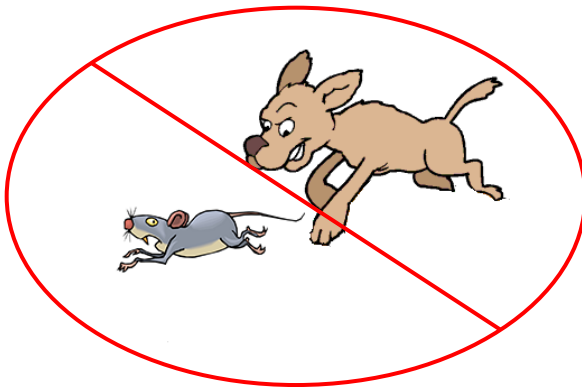
The dog didn't chase



# Why Negation?



The dog didn't chase the cat.





# Background

**Two stages:** a non-incremental view of negation

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**Incremental interpretation:** *some* information that negation contributes to the meaning of the sentence is available as soon as you hear it

*The dog didn't chase the cat.*

Operationalizing interpretation

- ❖ Truth judgment
- ❖ Differing behaviors for negative versus affirmative sentences

# Background

Truth value judgment task

Just & Carpenter (1971), Clark & Chase (1972), Kaup, Lüdtke, & Zwaan (2006)

Negation-veracity interaction

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## Truth value judgment task

Just & Carpenter (1971), Clark & Chase (1972), Kaup, Lüdtkke, & Zwaan (2006)

## Negation-veracity interaction

*slower* ↓  
*The dog chased the cat.*  
*The dog chased the mouse.*  
*The dog did<sup>n</sup>'t chase the cat.*  
↓ *The dog did<sup>n</sup>'t chase the mouse.*

← True

← False

← False

← True



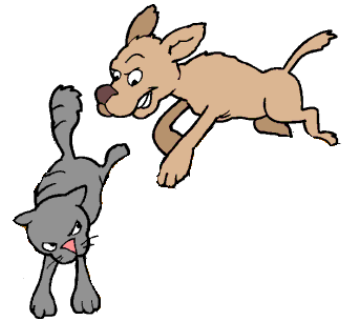
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Picture verification requires computing the prejacet before applying negation

Clark & Chase (1972)

Comprehension requires computing the prejacet before applying negation

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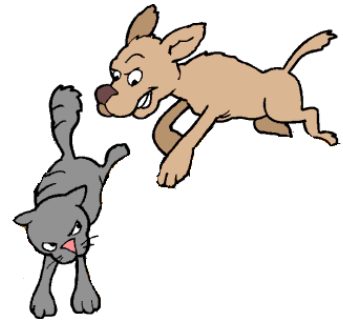
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Children's difficulty isn't just about suppressing the affirmative

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Pragmatics of negation matter

Nieuwland & Kuperberg (2008),  
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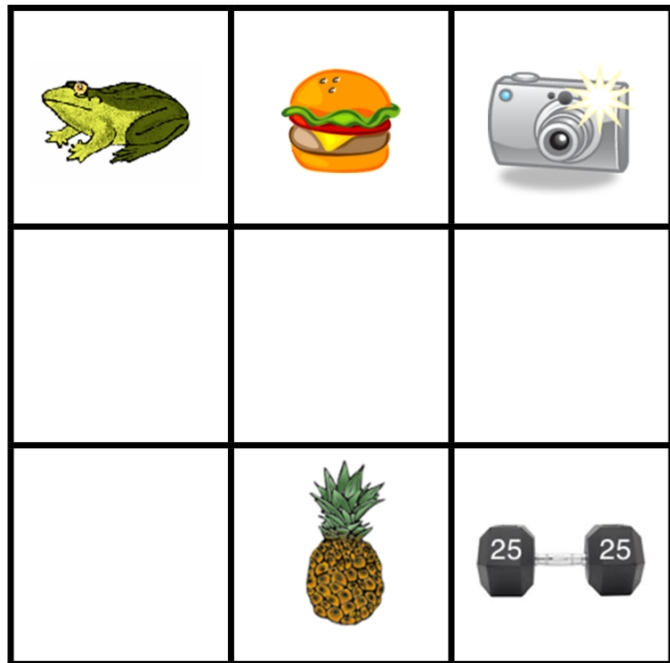
*A robin is not a tree.*

# Experiment design

Question: How do people utilize the semantic contribution of negation incrementally?

How we test this: Using the Visual World (VW), eye fixations guided by interpreting negation.

# Experiment 1



Task: Find the object mentioned in the second sentence, and answer a question querying some feature about it.

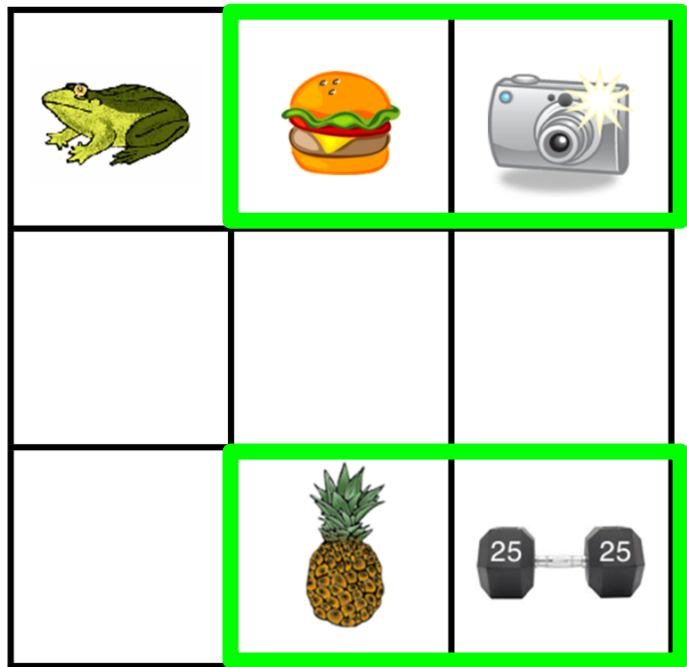
# Experiment 1



Task: Find the object mentioned in the second sentence, and answer a question querying some feature about it.

“Was the camera’s flash going off?”

# Experiment 1



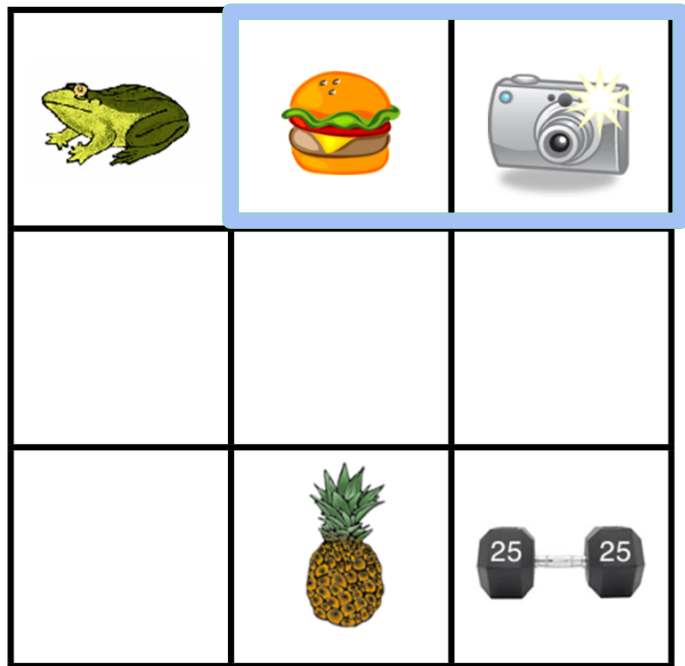
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*“The top row contains the frog ...*



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*“The top row contains the frog ...*

*It {also / doesn't} contain(s) the ...*

# Experiment 1



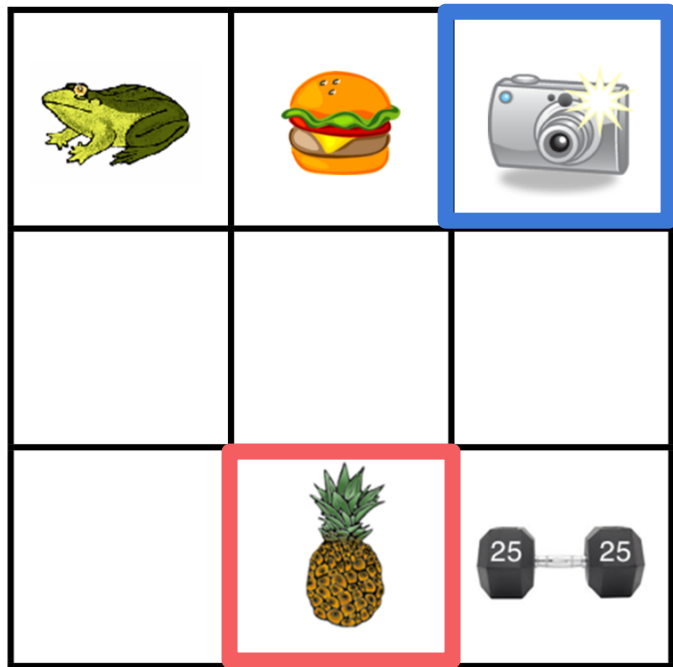
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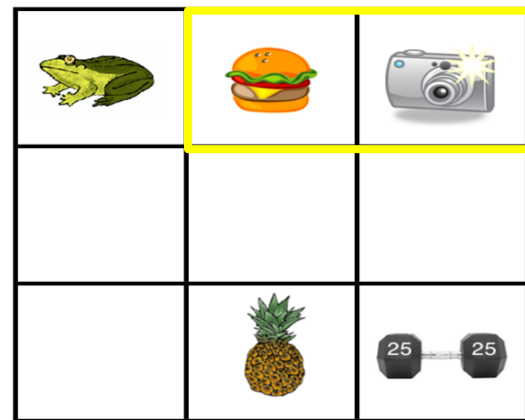
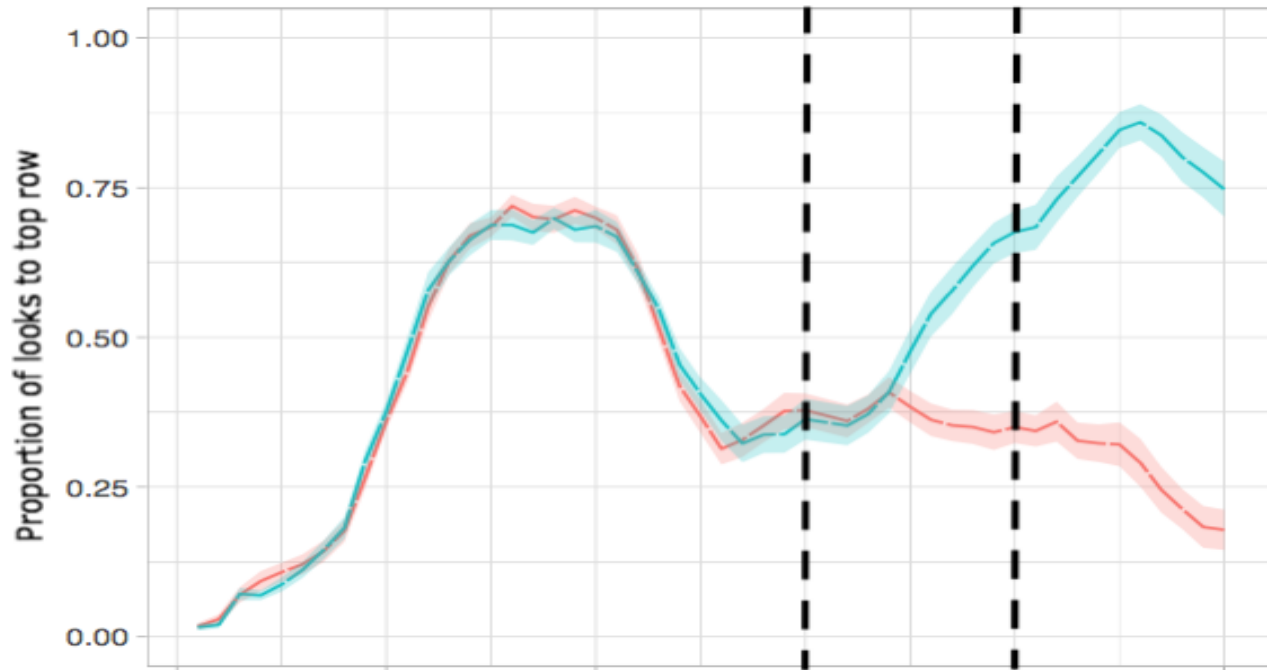
*“The top row contains the frog ...*

*It {also / doesn't} contain(s) the ...*

*{camera/pineapple}.”*

# Experiment 1: Results

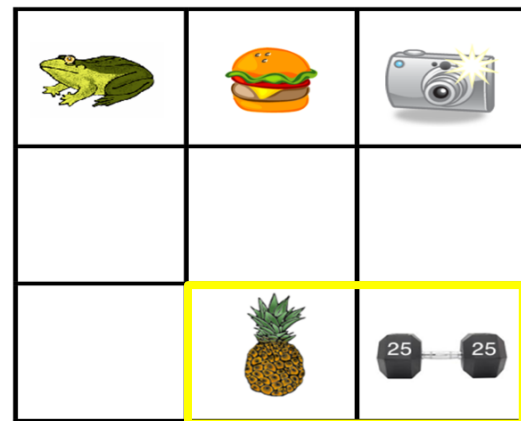
The top row contains the frog; it **also** contain(s) the **camera**.  
**doesn't** **pineapple.**



condition  
— Neg  
— Aff

# Experiment 1: Results

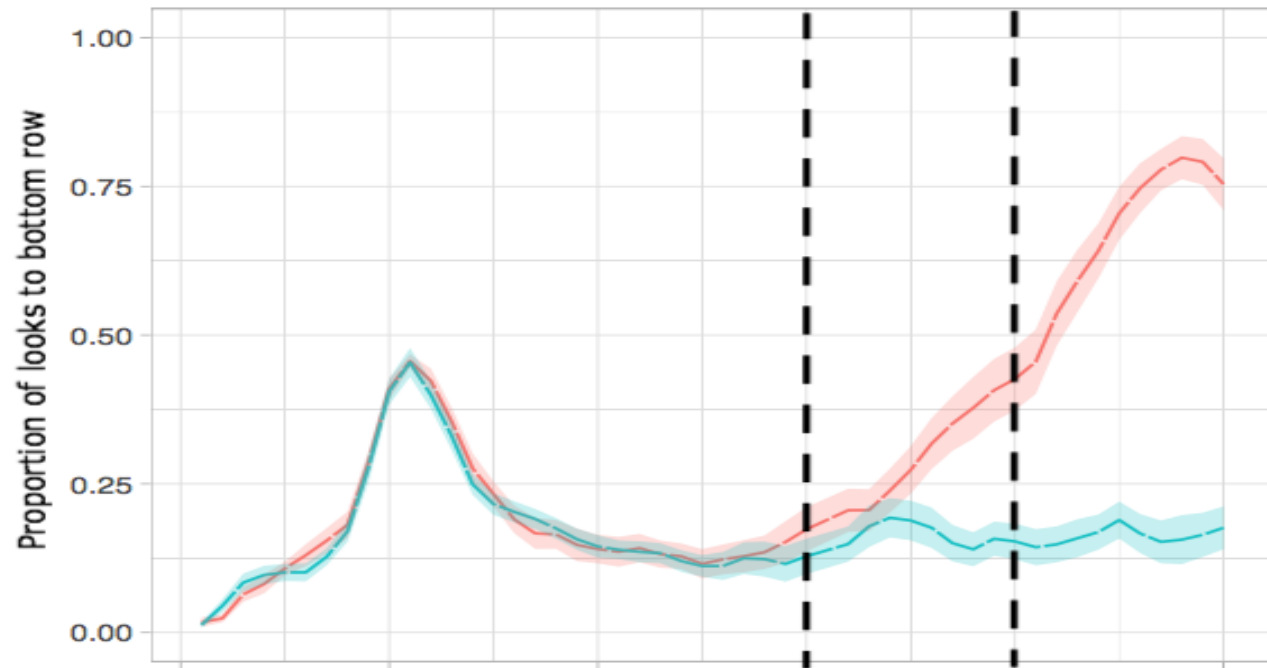
The top row contains the frog; it **also** contain(s) the **camera**.  
**doesn't** **pineapple.**



condition

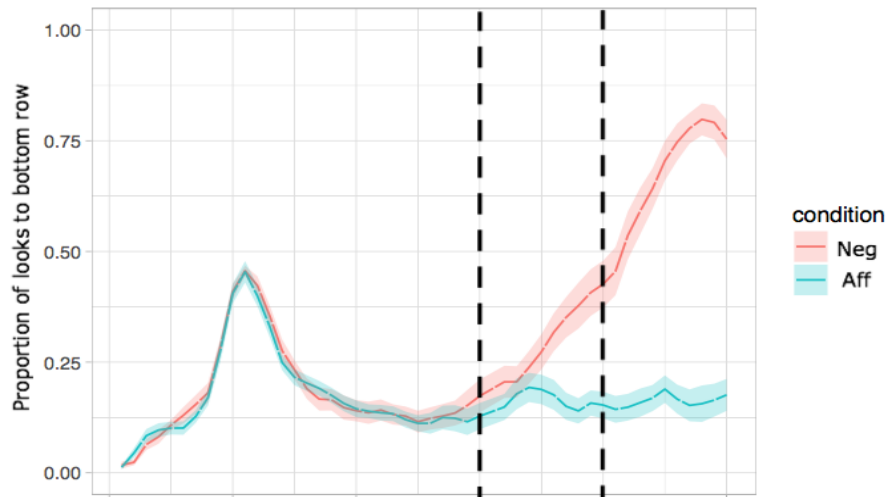
Neg

Aff



# Experiment 1: Conclusions

Anticipatory fixations were early and guided by negation



## Experiment 2: Adding variation

Variation disallows the “shallow / task-specific” interpretation of negation



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Variation disallows the “shallow / task-specific” interpretation of negation

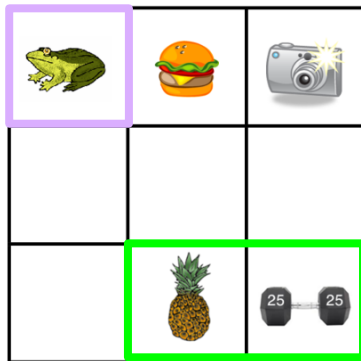
“It also contains ...”





# Experiment 2: Adding variation

Variation disallows the “shallow / task-specific” interpretation of negation



“It doesn’t contain ...”

## Experiment 2: Adding variation

Variation disallows the “shallow / task-specific” interpretation of negation



Same task. New sentences.

8 conditions. Each use negation and affirmation in different ways.

# Experiment 2

Same exact conditions as Experiment 1.

	First Sentence Affirmative	First Sentence Negative
Second Sentence Affirmative	The top row contains the frog. It <b>also</b> contains the camera.	The bottom row <b>doesn't</b> contain the frog. But it <b>does</b> contain the camera.
Second Sentence Negative	The top row contains the frog. It <b>doesn't</b> contain the camera.	The bottom row <b>doesn't</b> contain the frog. And it <b>doesn't</b> contain the camera.

# Experiment 2

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Addresses potential “affirmative fixation advantage.”

# Where to look in the new sentences

The bottom row doesn't contain the frog.



# Where to look in the new sentences

The bottom row doesn't contain the frog.



And it doesn't contain  
the camera.

Negation = Stay

# Where to look in the new sentences

The bottom row doesn't contain the frog.



But it does contain the pineapple.

Affirmation = Move

# Experiment 2

## Fillers

	First Sentence Affirmative	First Sentence Negative
Second Sentence Affirmative	The top row contains the frog. The frog <b>is</b> green.	The bottom row <b>doesn't</b> contain the frog. The frog <b>is</b> green.
Second Sentence Negative	The top row contains the frog. The frog <b>isn't</b> orange.	The bottom row <b>doesn't</b> contain the frog. The frog <b>isn't</b> orange.

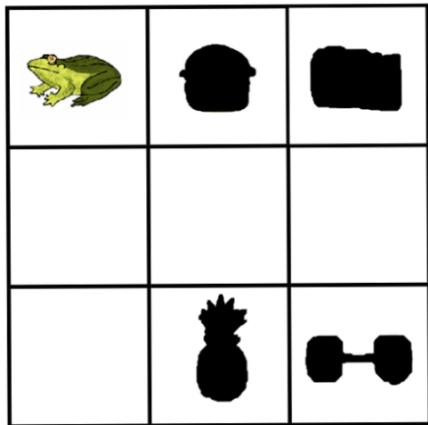
Use negation in ways that don't inform movement.



# Experiment 2

We also replaced images with silhouettes for the beginning of the trial.

“The top row contains the frog. It {also / doesn’t} contain(s) ...

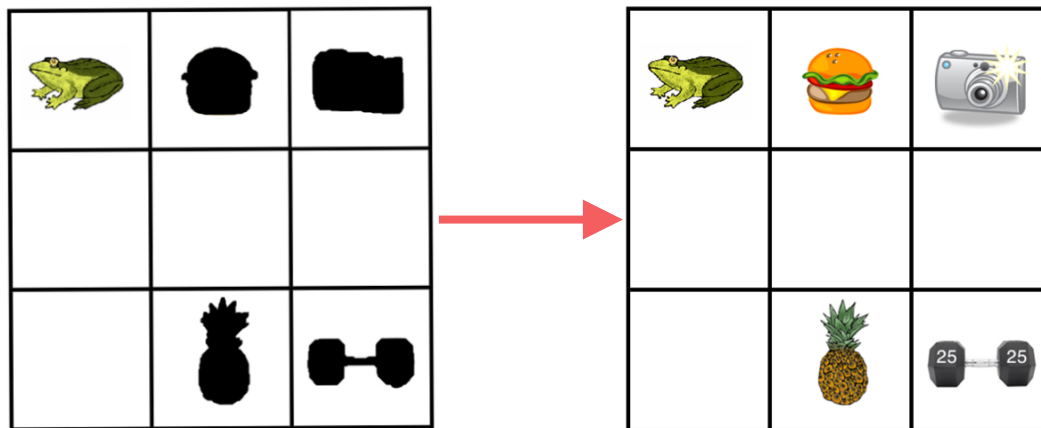


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The camera / pineapple.”

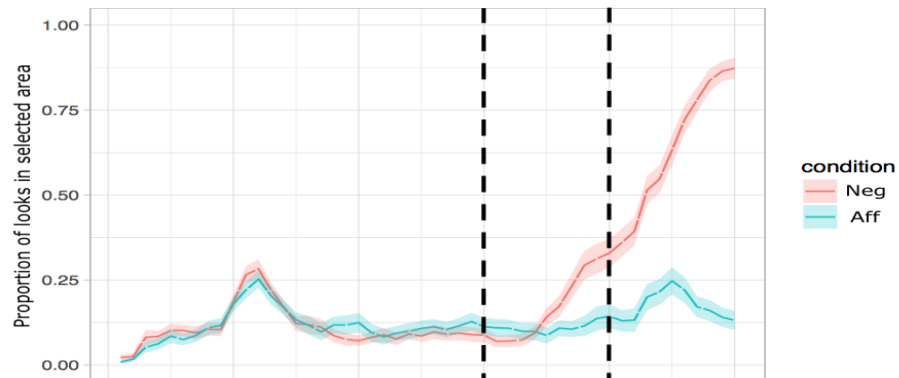
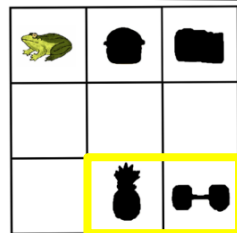
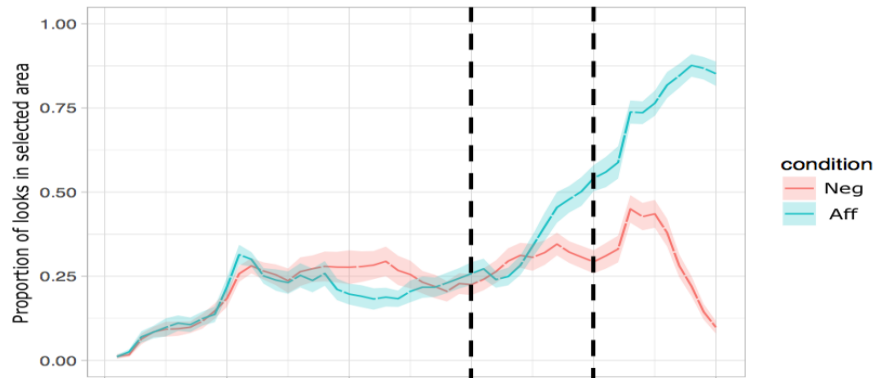
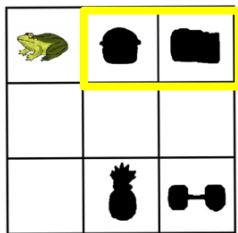


# Experiment 2: Results

The top row contains the frog.

It **doesn't** contain the pineapple.

It **also** contains the camera.

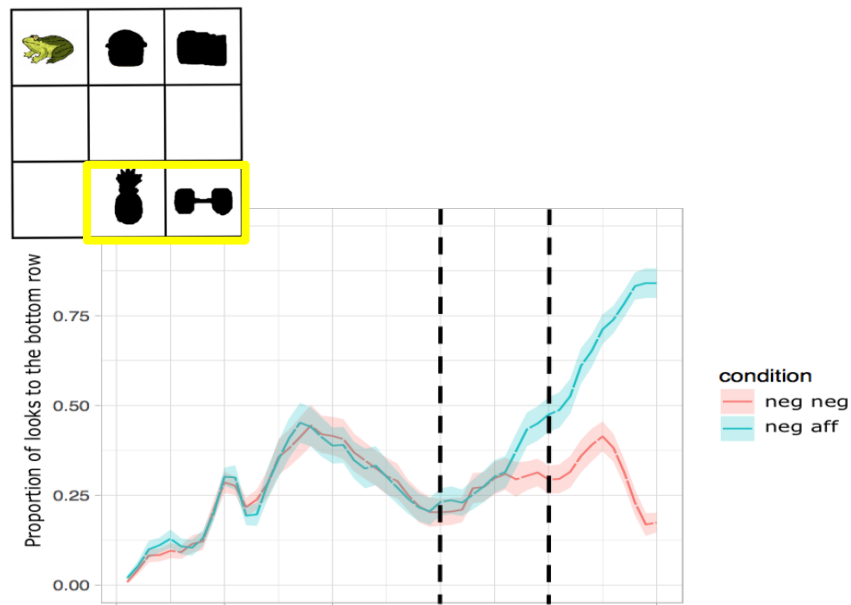
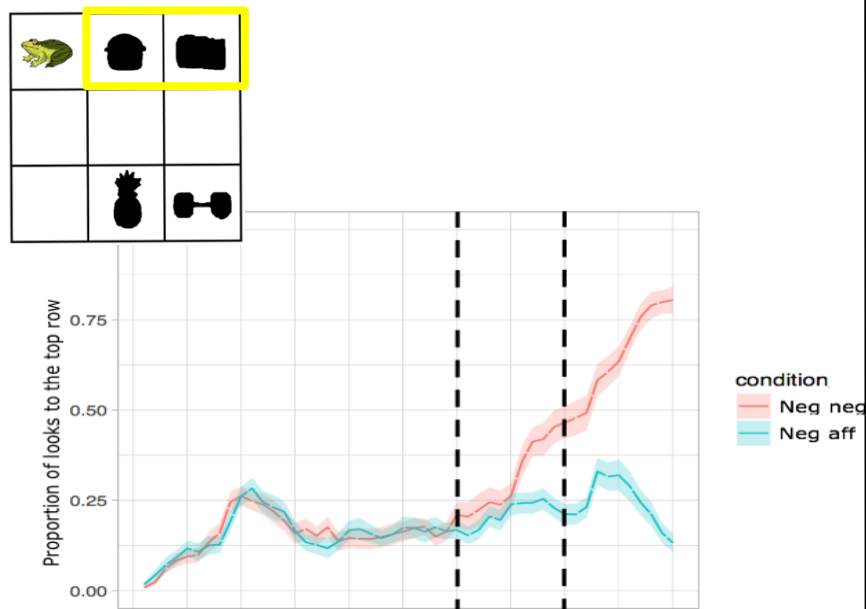


# Experiment 2: Results

The bottom row doesn't contain the frog.

And it **doesn't** contain the camera.

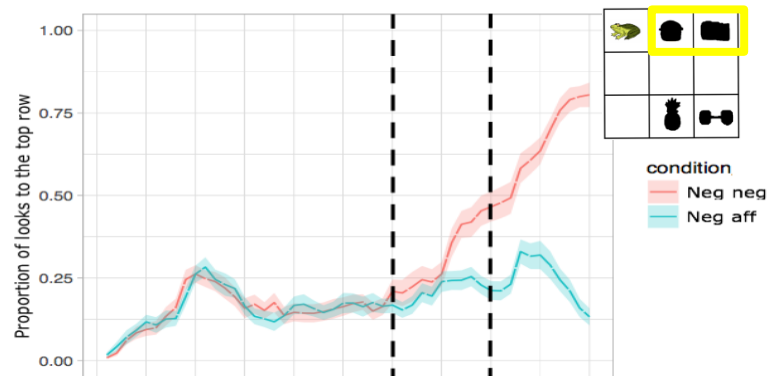
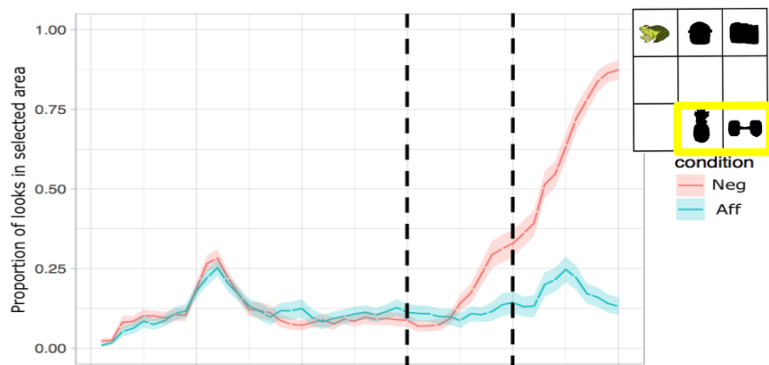
But it **does** contain the pineapple.



# Experiment 2: Conclusions

Action is not an artifact of “shallow processing.”

There are still anticipatory looks with variation.

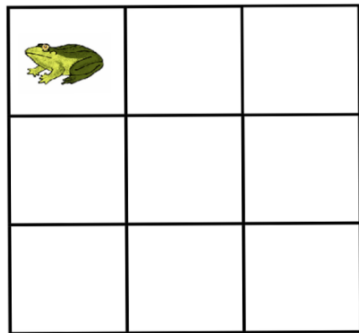


# Experiment 3: The Invisible World

Back to the 2 conditions of Experiment 1

Only one visible object at first.

“The top row contains the frog. It {also / doesn’t} contain(s)...



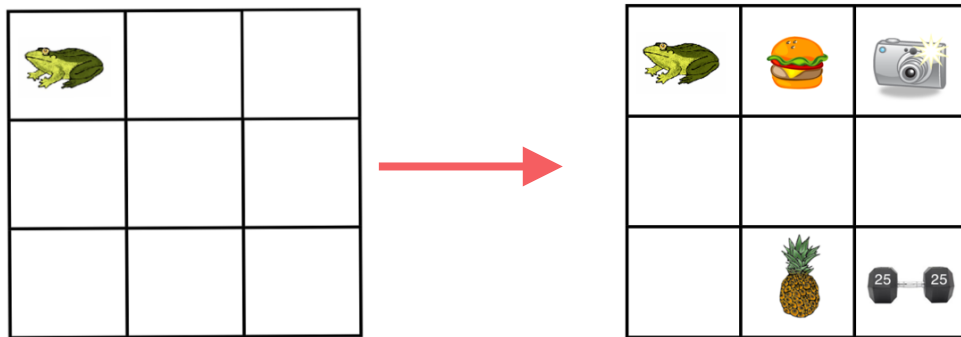
Altmann & Kamide (2004) did something similar, but instead they measured looks to blank squares *after* objects had already been there then been removed.

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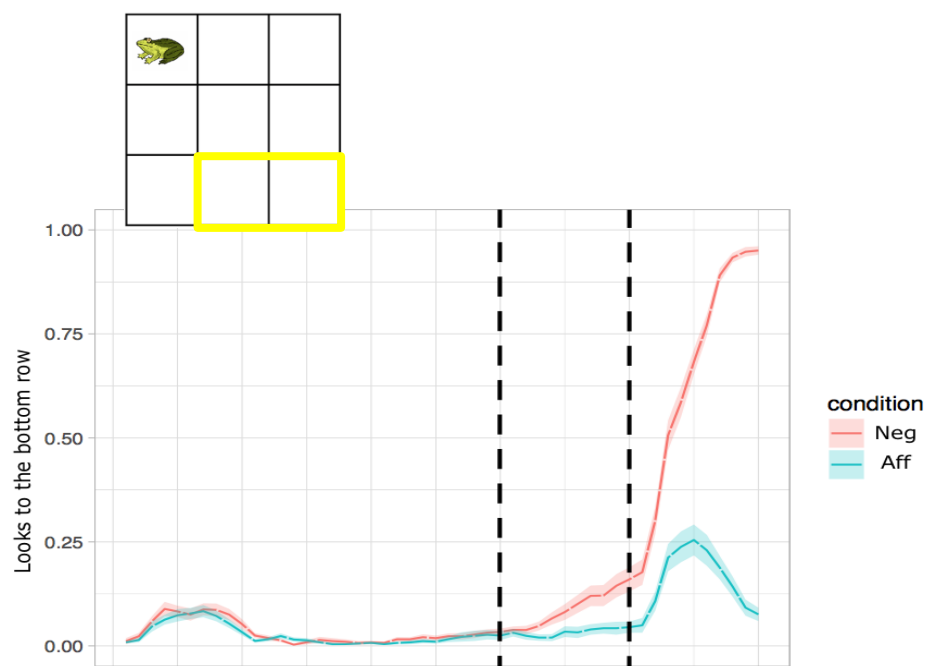
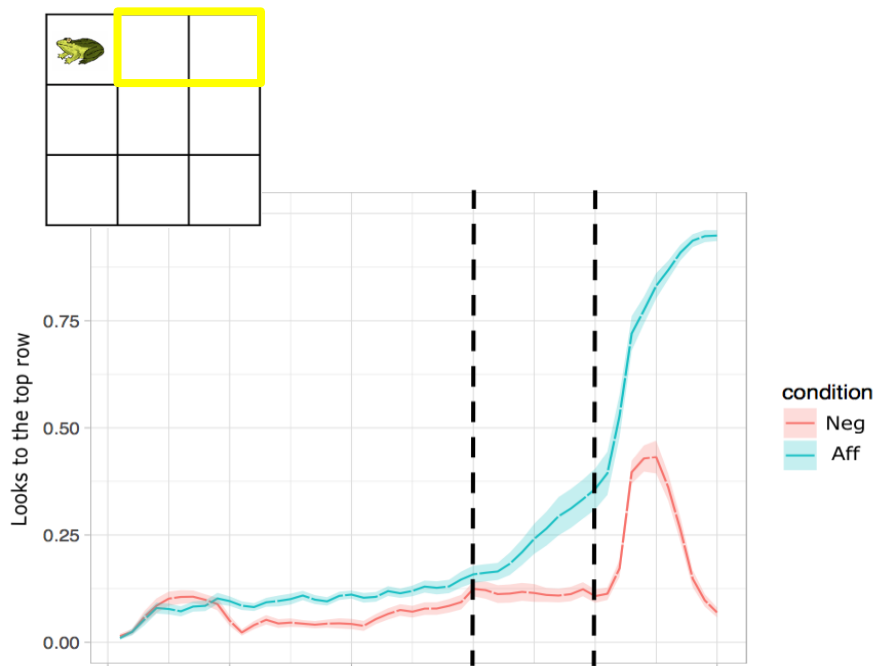
“The top row contains the frog. It {also / doesn’t} contain(s)... The camera / pineapple.”



Altmann & Kamide (2004) did something similar, but instead they measured looks to blank squares *after* objects had already been there then been removed.

# Experiment 3: Results

The top row contains the frog; it **also** doesn't contain(s) the **camera**. **pineapple.**

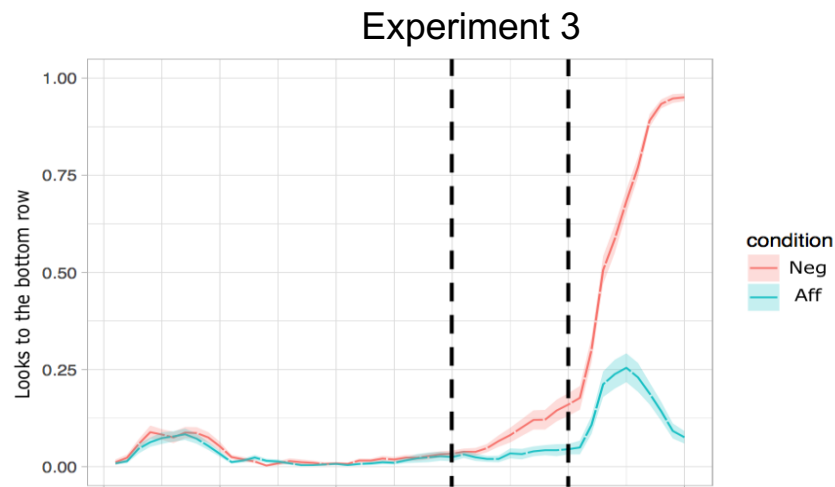
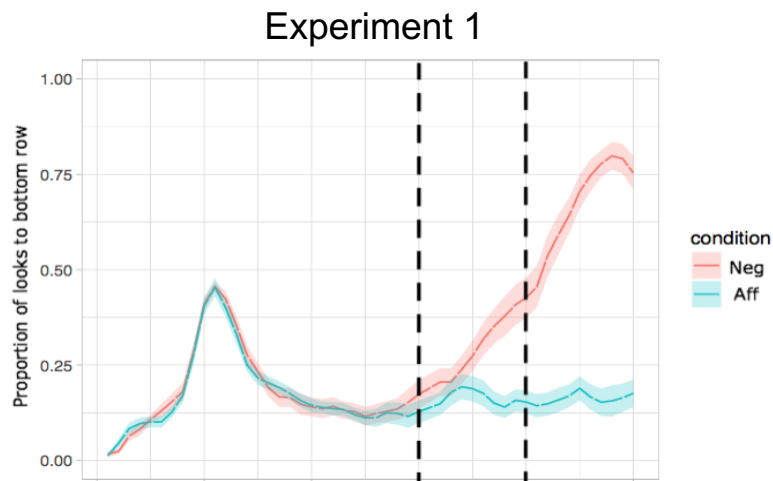




# Experiment 3: Conclusions

We still see some anticipatory looks, but far less than earlier versions

How can we explain the degradation in performance?



# Recap of Findings

## Experiment 1:

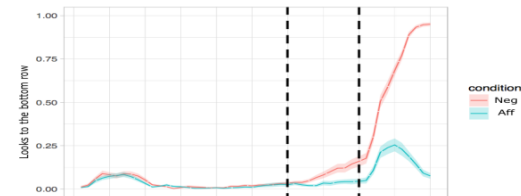
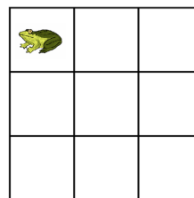
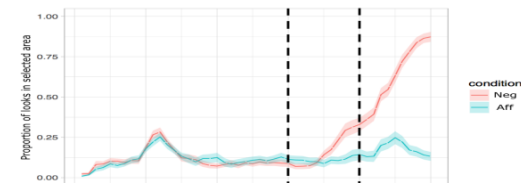
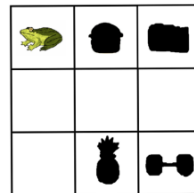
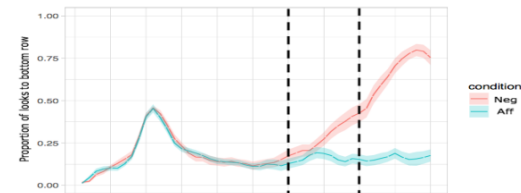
Incremental interpretation of negation

## Experiment 2:

Not an artifact of shallow processing

## Experiment 3:

Visual scene facilitates anticipatory looks



# General Discussion

## Understanding Incrementality

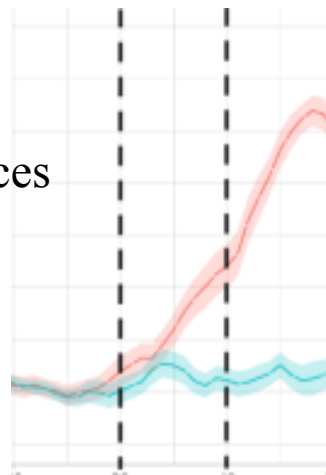
Interpretation turns into action prior to the full proposition

Incremental consequences of negation: license NPIs, contrastive inferences

Immediately update understanding of a scene and make predictions

Nieuwland & Kuperberg (2008)

Doesn't mean that the whole of  $\neg P$  is generated prior to P



# General Discussion

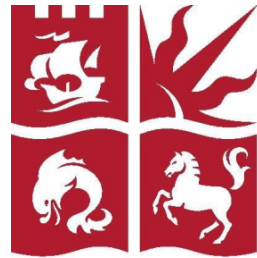
## A Modified Two-Stage Theory

Comprehenders could be predicting upcoming material.

Two stages are likely necessary for verification

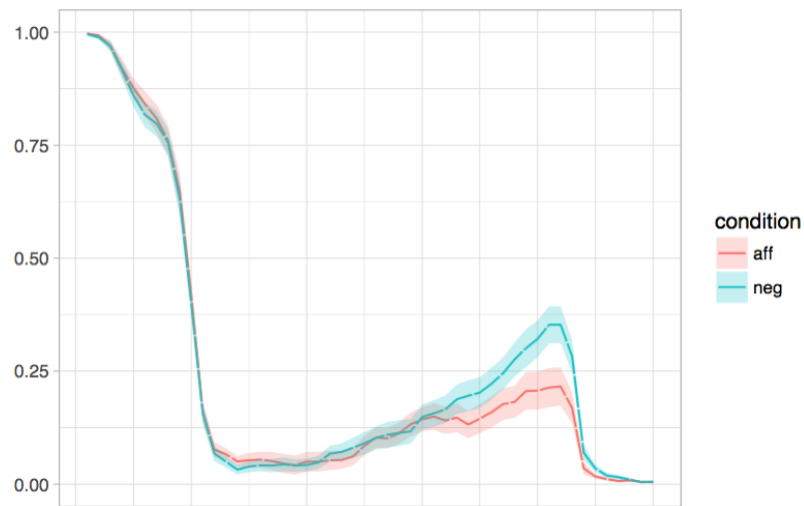
Two stages may not be necessary for every component of interpretation

**Thank you!**



University of  
**BRISTOL**

# Misc.



Proportion of looks to the center in Exp 3