

LSci 51/CogS 56L: Acquisition of Language

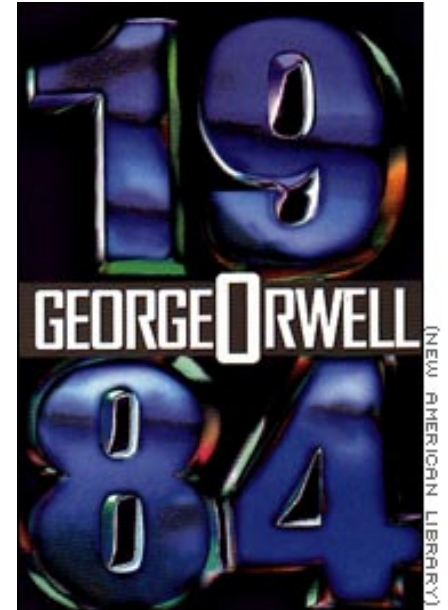
Lecture 18 Language & Cognition

Sapir-Whorf hypothesis

The **structure of one's language** [linguistic] influences the manner in which one **perceives and understands the world** [non-linguistic].

“Don't you see that the whole aim of Newspeak is to **narrow the range of thought**? In the end, we shall make thought crime literally impossible, because there will be no words in which to express it...”

- George Orwell, *1984*



“Neo”-Whorfian question

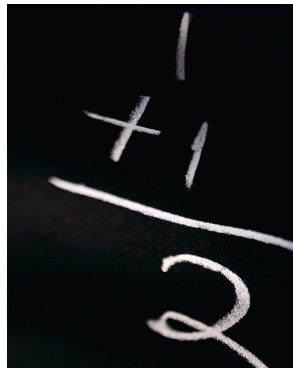
Language as a Toolkit: Does language **augment** our **capacity** for reasoning and **representation** (and thereby determine our perception of the world)?



Also sometimes referred to as
“**language** as **augmenter**”
(Wolff & Holmes 2010)

What the language toolkit can do

Language is a symbolic system that can help with **cognitive off-loading**.



Cognitive off-loading example (from Wolff & Holmes 2010)



FIGURE 3 | Series of gears in which the first turns clockwise. In which direction will the last gear turn?

“This problem could be solved by **mental simulation**; that is, by imagining the first gear turning to the right, then the second gear turning to the left, and so on. Alternatively, people might notice that each successive gear turns in the opposite direction from the previous one and generate the parity rule that ‘**odd and even gears turn in different directions**’. This rule, which may depend on **linguistic coding**, can then be applied more quickly than the laborious process of mentally rotating each gear.”

Cognitive off-loading & linguistic coding across languages

https://www.ted.com/talks/lera_boroditsky_how_language_shapes_the_way_we_think/transcript?language=en

“...people who speak different languages will pay attention to different things, depending on what their language usually requires them to do.” — Lera Boroditsky



Cognitive off-loading & linguistic coding in bilinguals

<https://www.sciencedaily.com/releases/2017/05/170502112607.htm>

“...people who speak two languages fluently think about time differently depending on the language context in which they are estimating the duration of events...By learning a new language, **you suddenly become attuned to perceptual dimensions** that you weren't aware of before.”



Bylund & Athanasopoulos 2017

Sapir-Whorf, linguistic coding, & uncertainty

Regier & Xu 2017

“...the **mental uncertainty** essentially **opens** the door to language to fill in some of the **missing elements**, and there should be a relatively strong effect of language.”



Sapir-Whorf, linguistic coding, & uncertainty

Regier & Xu 2017

“In contrast, when relevant nonlinguistic information is comparatively certain, when object details are already clearly mentally available, there is **little missing information for language to supply**, so there should be little or no effect of language. Essentially, **uncertainty may be thought of as providing a kind of ‘cognitive control knob’** that sweeps continuously from no effect of language on cognition, to stronger such effects.”



Language as a toolkit

Today:

Theory of Mind (realizing that someone can have a different point of view than you - when does this realization come, and how?)



Theory of mind

“I know you **think** you **understand** what you **thought** I said, but I'm not sure you **realize** that what you heard is not what I **meant**.”

— Alan Greenspan



Theory of mind

https://www.ted.com/talks/rebecca_saxe_how_brains_make_moral_judgments?language=

3:28 - 3:52: Development of theory of mind

7:19 - 8:14: Neuro bases of theory of mind [Extra]

12:51 - 13:16: Neuro development of theory of mind [Extra]



Some helpful language

complementizer sentence

Sarah thought **that** Hoggle had betrayed her.

sentential complement



(but maybe he really hadn't)

sentential complement

Sarah **thought** **that** Hoggle **had** **betrayed** her.

(but maybe he really hadn't)



The **embedded sentence** (also called a **sentential complement** here) encodes the **contents of Sarah's mind**.

sentential complement

Sarah thought that Hoggle had betrayed her.



(but maybe he really hadn't)

NOT

True or False: Is this true?

True or False: Did Sarah
think this or not?



The 'truth value' of the embedded sentence can't be evaluated with respect to the real world. It must be evaluated with respect to Sarah's mental world (what Sarah thought).

sentential complement

Sarah thought that Hoggle had betrayed her.



(but maybe he really hadn't)

NOT

True or False: Is this true?

True or False: Did Sarah
think **this** or not?



How does a child figure this out?

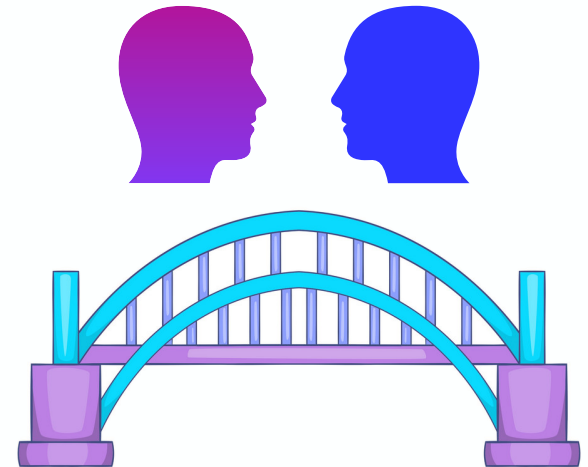
What you need to know to evaluate the truth value of these statements

Syntactic Knowledge: you know that some verbs (*think, believe, say, ...*) can take sentential complements

Sarah thought that
Hoggle had betrayed her.

Social Cognitive Knowledge: you know that other people can have a false belief

Bridge: you know that there is a connection between this syntactic form and the expression of potentially false beliefs



Which comes first, social or syntactic knowledge?
Usual Pattern: Social/Conceptual ---> Linguistic
Whorfian: Linguistic ---> Social/Conceptual

Which comes first, social or syntactic knowledge?

Usual Pattern: Social/Conceptual ---> Linguistic

Whorfian: Linguistic ---> Social/Conceptual

We can find out by testing children's development of the **social** knowledge and the **syntactic** knowledge.



A little problem...

How do you measure children's understanding of the **social** knowledge that other people can have **false beliefs**?

(abstracted away from their **linguistic ability** to represent false beliefs)



False belief task (Unseen displacement)

The child is introduced to two puppets, Sir Didymus and Ambrosius.



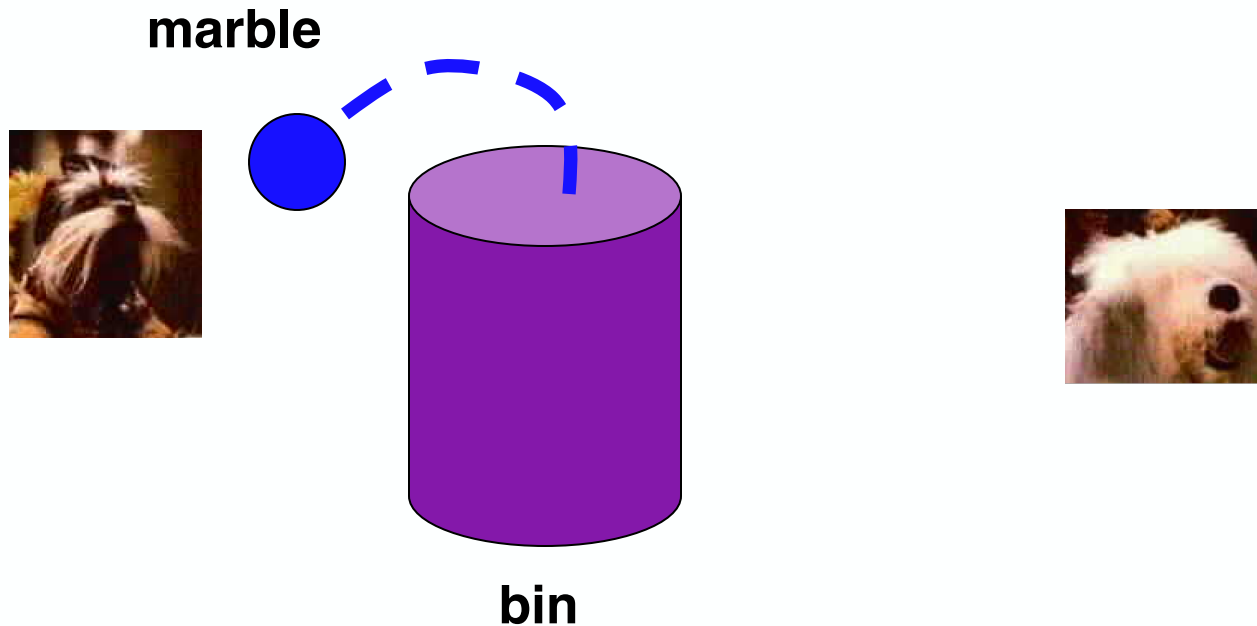
Sir Didymus



Ambrosius

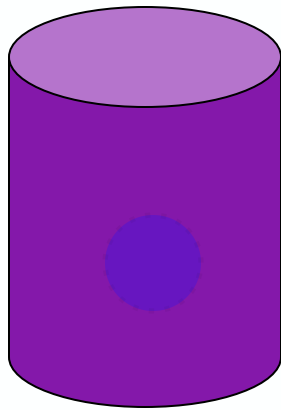
False belief task (Unseen displacement)

While playing, Sir Didymus puts a marble into a bin and then goes outside (the puppet disappears under the table, for example).



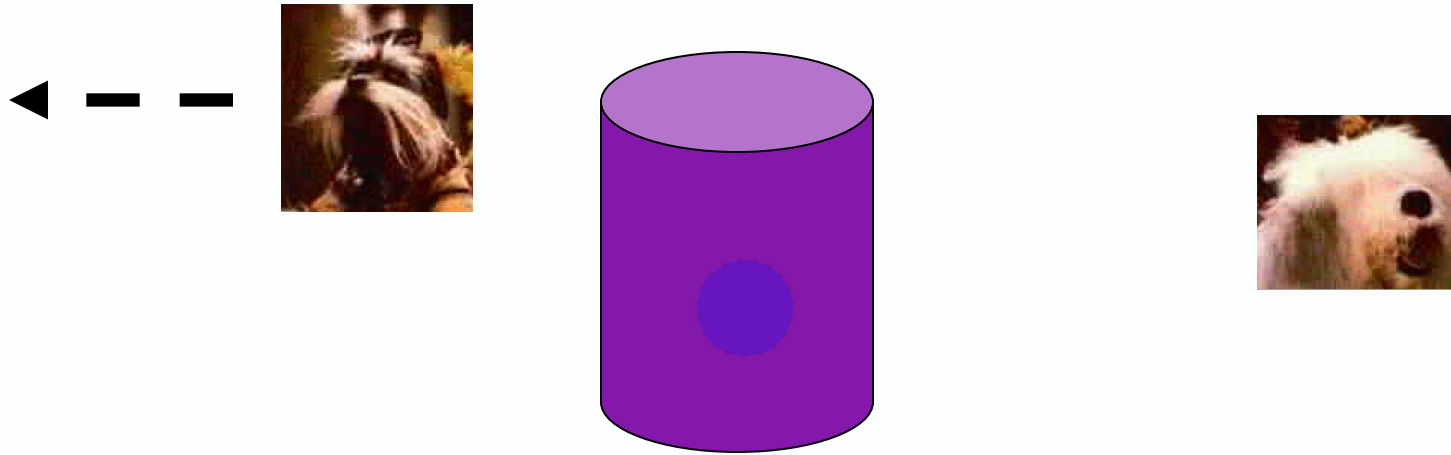
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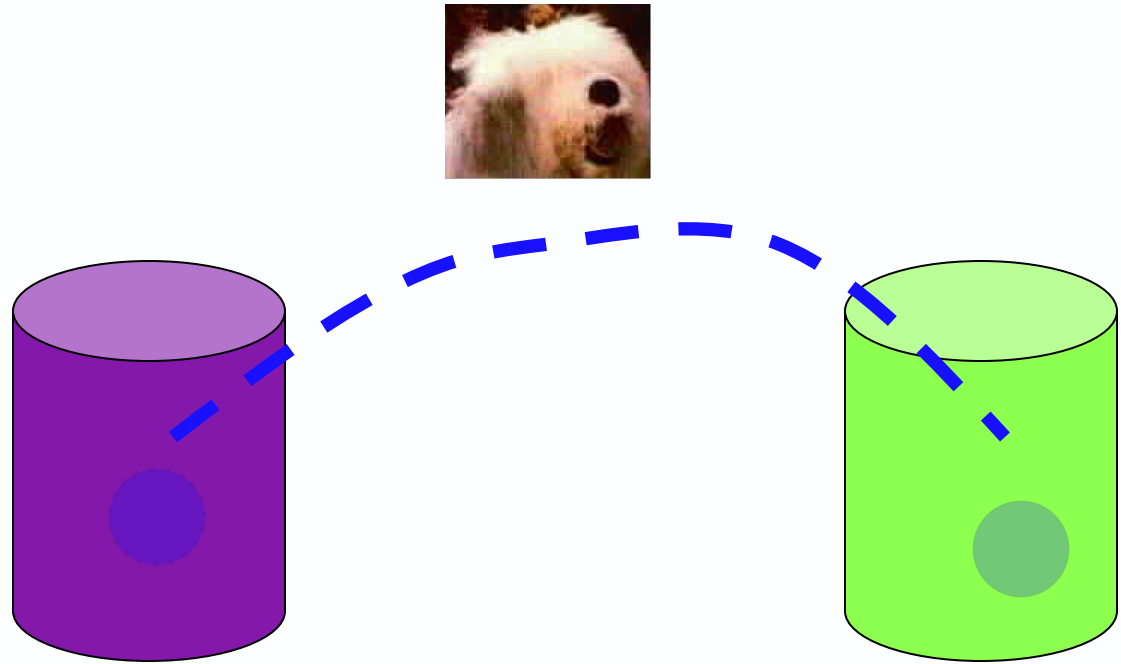
False belief task (Unseen displacement)

While playing, Sir Didymus puts a marble into a bin and then goes outside (the puppet disappears under the table, for example).



False belief task (Unseen displacement)

When Sir Didymus is not around, naughty Ambrosius changes the location of the marble. He takes it out of the bin and puts it in a different bin.

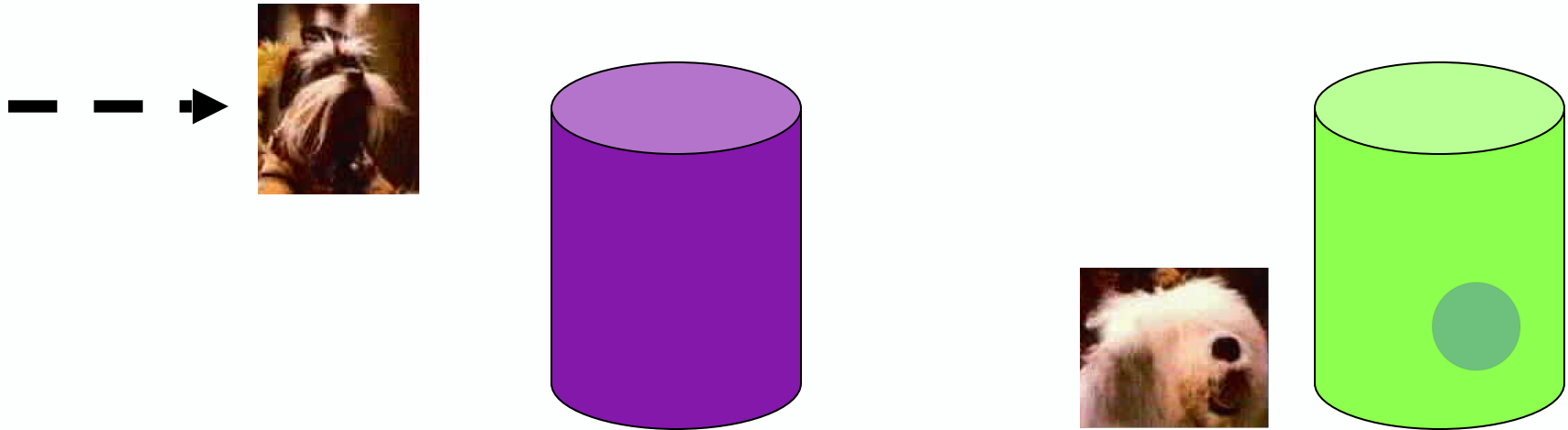


False belief task (Unseen displacement)

Some time later Sir Didymus comes back and wants to play with his marble.

Children are then asked the critical question:

Where will Sir Didymus look for his marble?

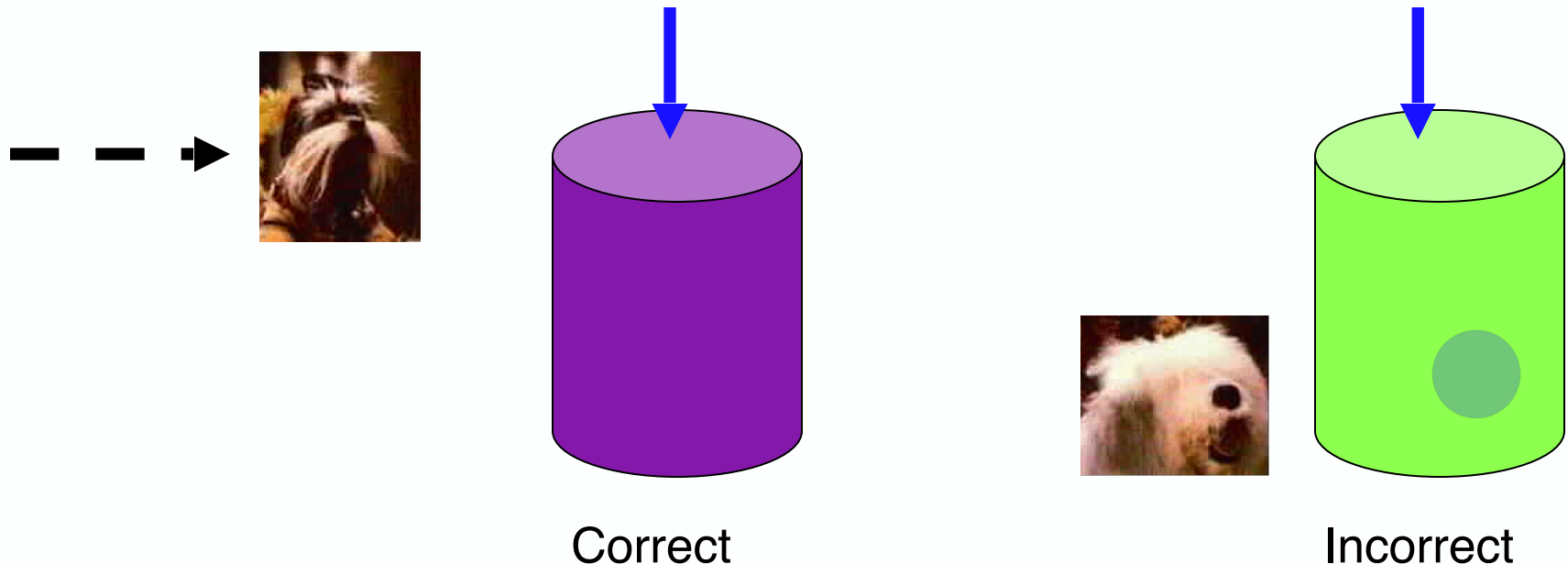


False belief task (Unseen displacement)

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False belief task (Unseen displacement)

[Extra]

https://www.ted.com/talks/rebecca_saxe_how_brains_make_moral_judgments?language=
3:52 - 6:15: False belief task with 5-year-old vs. 3-year-old



False belief task (Unexpected Contents)

http://www.youtube.com/watch?v=8hLubgpY2_w



If we're looking for a language connection...

At what age do children start **talking about thoughts/beliefs**? At what age do children first begin to **use sentential complements**?

2-year-olds talk a lot!

- ... about what they did, what they want

- ... about what others do

- ... **possibly about what others say**

- **not about what others think**



If we're looking for a language connection...

At what age do children start **talking about thoughts/beliefs**? At what age do children first begin to **use sentential complements**?

Children's comprehension of sentential complements

“Sir Didymus **said he bought peaches**. But look! He **really bought oranges**.
What did Sir Didymus say he bought?”

3-year-olds: **oranges** (reality, not mental state)



4-year-olds: **peaches** (key into “**say**”)



If we're looking for a language connection...

At what age do children start **talking about thoughts/beliefs**? At what age do children first begin to **use sentential complements**?

At around four years of age, children understand that mental verbs can take a whole sentence as their object (**a complement**)

Sir Didymus thought **that the shampoo was the toothpaste**.



If we're looking for a language connection...

At around four years of age, children understand that mental verbs can take a whole sentence as their object (a complement)

Sir Didymus thought that the shampoo was the toothpaste.



The embedded sentence can be FALSE from the child's point of view, but TRUE for Sir Didymus.

Once the child has this capacity, he can represent two worlds: his own, and someone else's mental world.

This usually coincides with children's production of mental state verbs.

Testing typically developing children

De Villiers & Pyers 2002: Measures of **comprehension and production of sentential complements** far more **correlated** with children's **performance on false belief tasks** than any other linguistic measure.

Causation? Unclear.

“In every case, children who passed false beliefs gave us evidence that they had productive command of complementation.”



How exactly do children learn that connection?

One idea

- Difficult to observe: someone else's thoughts
- Easier to observe: what people say

“**She** said **that** she ate the ~~peach~~.”



- Children will sometimes hear sentences like this in a context where there is overt evidence to suggest that the embedded proposition is false.



- Children can use evidence from verbs like *say* to generalize to verbs like *think* and *believe*

Syntactic bootstrapping

How exactly do children learn that connection?

One idea

Syntactic bootstrapping

- **Syntactic** Knowledge: you know that some verbs can take sentential complements

“She **said** **that**...”

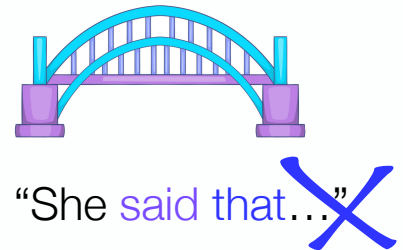
“She **thought** **that**...”

How exactly do children learn that connection?

One idea

Syntactic bootstrapping

- **Syntactic Knowledge**
 - “She **said** that...”
 - “She **thought** that...”
- **Bridge**: you know from **hearing communication verbs** and **from observing the world while hearing them** that there is a connection between this syntactic form and the expression of **potentially false propositions**.



How exactly do children learn that connection?

One idea

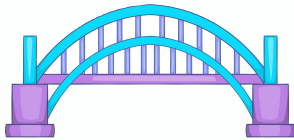
Syntactic bootstrapping

- Syntactic Knowledge

“She said that...”

“She thought that...”

- Bridge



“She said that...”

- Having learned this connection from communication verbs, you then generalize that since mental verbs also take sentential complements, their sentential complements must also potentially be false.

“She said that...”

“She thought that...”

How exactly do children learn that connection?

One idea

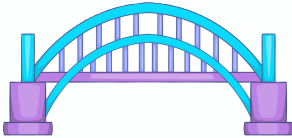
Syntactic bootstrapping

- Syntactic Knowledge

“She said that...”

“She thought that...”

- Bridge



“She said that...”

- generalize about mental verbs

“She said that...”

“She thought that...”

- Social Cognitive Result: Therefore you can contemplate other (mental) worlds



Testing the importance of language in other ways and in other populations

What if you train children on **communication verbs** that take sentential complements? Do they improve on false belief tasks? (Hale & Tager-Flusberg 2003)



Testing the importance of language in other ways and in other populations

train children on **communication verbs**

What if you make children **use mental state verbs** that take sentential complements? Do they improve on false belief tasks? (Ornaghi, Brockmeier, & Grazzani Gavazzi 2011)



Testing the importance of language in other ways and in other populations

train children on communication verbs

make children use mental state verbs

Test development in deaf children who are language-delayed vs. not (de Villiers & de Villiers 2003, Pyers & Senghas 2009, Richardson, Koster-Hale, Caselli, Magid, Benedict, Olson, Pyers & Saxe 2020)



Testing the importance of language in other ways and in other populations

train children on communication verbs

make children use mental state verbs

development in deaf children who are language-delayed vs. not

Test other primates (who are non-verbal) (Call & Tomasello 1999, Gouteux, Thinus-Blanc, & Vauclair 2001, Krupenye, Kano, Hirata, Call, & Tomasello 2016)



Testing the importance of language in other ways and in other populations

train children on communication verbs

make children use mental state verbs

development in deaf children who are language-delayed vs. not

Test other primates (who are non-verbal)

General results: Language not required, just extraordinarily helpful.

Important: Explicit training on false belief tasks can also yield success (even without language training).



Theory of mind:

Links to executive function

Executive function (a set of cognitive processes that regulate, control and manage other cognitive processes, including inhibition, working memory, cognitive flexibility, and planning) has been shown to correlate with children's performance on theory of mind tasks (Carlson, Koenig, & Harms 2013).

Idea (discussed more thoroughly in Bradford, Jentsch, & Gomez 2015): Children must be able to suppress their own internal representations of events (*inhibition of their own perspectives*) before they can reflect accurately about the mental states of others.



Theory of mind:

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Specific evidence:

(1) Training studies of executive function lead to improved false belief performance (Kloo & Perner 2003).

(2) Individual differences in executive function predict the extent to which children benefit from direct theory of mind training (Benson et al. 2013) - children with higher executive function benefit more



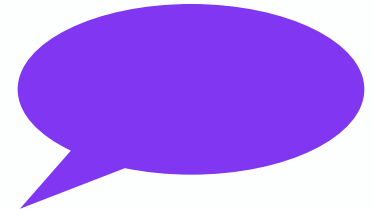
Theory of mind: Link to language is...?

Evidence that language is necessary for adults to pass false belief tasks:

Verbal shadowing: A technique that interrupts subconscious use of language for cognitive off-loading.

Newton & de Villiers 2007:

Adults doing verbal shadowing fail false belief tasks, but adults doing rhythm shadowing can still pass them. This suggests adults unconsciously rely on language when reasoning about theory of mind.



Theory of mind: Link to language is...?

Evidence that language isn't always so necessary for adults to pass false belief tasks – it may have more to do with working memory:

Dungan & Saxe 2012:

When the verbal and rhythm shadowing are matched with respect to their demands on working memory, adults struggle to pass false belief tasks no matter which kind of shadowing they're doing.

Familiar implication: Language is extraordinarily helpful but not explicitly required.



Theory of mind: Link to language is...?

Additional evidence from Baillargeon, Scott, & He 2010:

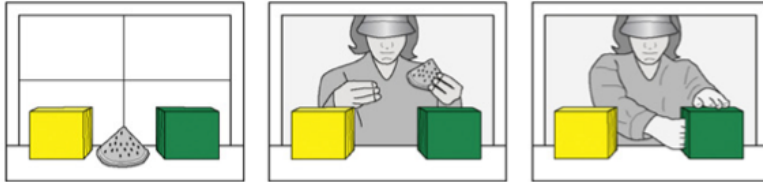
2-year-olds can pass a false belief task when they are tested indirectly. How do we test them indirectly? We can gauge their spontaneous responses (as assessed by looking time) to events they are shown. Baillargeon et al. 2010 argue that this is an easier task than requiring the children to answer a question directly using language.

Familiar implication: Language is extraordinarily helpful but not explicitly required.

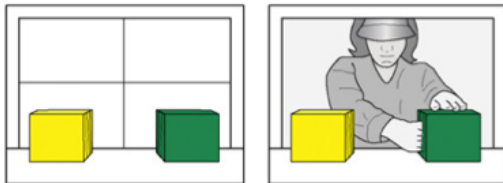
Baillargeon, Scott, & He 2010

Familiarization trials

Trial 1



Trials 2 and 3

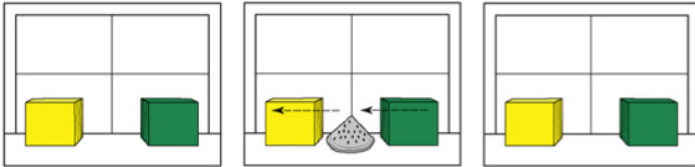


Familiarization:

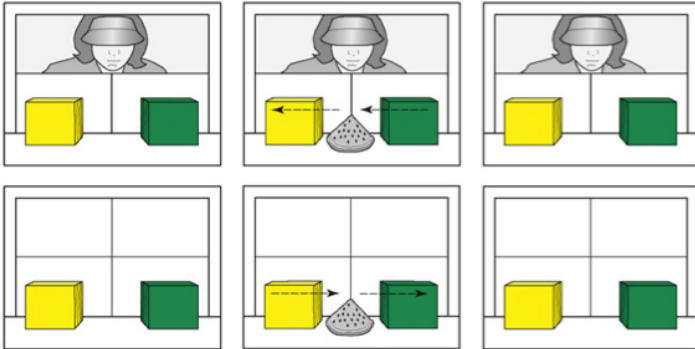
In trial 1, a toy stood between a yellow and a green box; a female agent entered the apparatus, played with the toy briefly, hid it inside the green box, and then paused, with her hand inside the green box, until the trial ended. In trials 2 and 3, the agent reached inside the green box, as though to grasp her toy, and then paused.

Baillargeon, Scott, & He 2010

Belief-induction trial
False-belief-green condition



False-belief-yellow condition



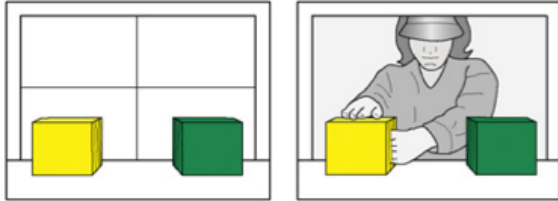
Belief Induction:

In the belief-induction trial, the toy either moved from the green to the yellow box in the agent's absence (false-belief-green condition) or moved to the yellow box in the agent's presence but then returned to the green box after she left (false-belief-yellow condition).

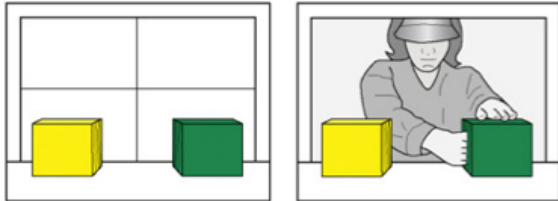
Baillargeon, Scott, & He 2010

Test trial

Yellow-box event



Green-box event



Testing:

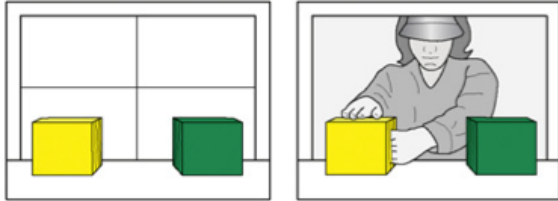
In the test trial, the agent returned, reached inside either the yellow box (yellow-box event) or the green box (green-box event), and then paused.

In each condition, the infants expected the agent to reach where she falsely believed the toy to be hidden, and they looked reliably longer (because they were surprised) when she reached to the other location instead.

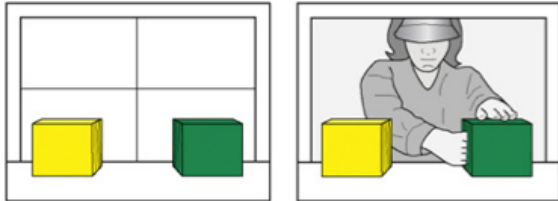
False belief younger than two

Test trial

Yellow-box event



Green-box event



Onishi & Baillargeon 2005:
This same procedure showed
that 15-month-olds have
similar expectations and
reactions.



Baillargeon et al. 2016: Many more examples of children under two demonstrating understanding of false beliefs in “spontaneous-response” tasks like this.

Barone & Gomila 2020: This may be because indirect false belief tasks don’t require participants to understand the concept of “false belief” in as sophisticated a way.

False belief younger than two

Kovács et al. 2010, Luo et al. 2009, Luo 2011a:

6- and 7-month-olds behave as if they understand other agents can have false beliefs (looking-time tasks)



False belief younger than two

Southgate & Vernetti 2014: EEG evidence from 6-month-olds

Compared to a baseline period, infants showed motor activation when an agent falsely believed a box contained a ball, but they showed no motor activation when the agent falsely believed the box contained no ball. Infants thus anticipated that **the agent would search for the ball when she falsely believed it was present**, but not when she falsely believed it was absent.



Indirect verbal false belief tasks at 2

Additional evidence from He et al. 2011, He et al. 2012, Scott et al. 2012:
2-year-olds can pass a *verbal* false belief task when they are tested indirectly. How do we test them indirectly but still verbally?

One way (Scott et al. 2012): Children watched a typical direct false belief scene along with an adult “subject” who was then asked where one character would look for her toy when she returned (Scott et al. 2012). Children looked longer when the adult “subject” responded incorrectly and pointed to the toy’s current — as opposed to original — location.



Theory of mind: Link to language is...?

Language is useful for cognitive off-loading? Perhaps when children are tested directly on false belief tasks (that is, required to show their knowledge with language), having mental state verbs in their linguistic repertoire allows them to easily encode what's going on. Then, it's easier to do the task, which requires more mental work than tasks where children are tested indirectly.



Theory of mind:

An issue with standard false belief tasks

Another idea (Lewis, Hacquard, & Lidz 2012, 2017): We often use mental state verbs (especially *think*) to indicate how certain we are about something (sometimes this is called a *parenthetical endorsement*).

Where did Lily go?

Lily is in the forest, *I think*.



Who stole the bracelet?

Hoggle thinks that Sarah is the thief.



Studies of children's spontaneous utterances suggest that this is the most common way children under age 4 use mental state verbs.

Theory of mind:

An issue with standard false belief tasks

Lewis, Hacquard, & Lidz 2012, 2017: Notably, in parenthetical endorsements, the complement is the focus of the communication, and is **usually assumed to be true (to some degree)**.

Where did Lily go?

Lily is in the forest, I think.



Who stole the bracelet?

Hoggle thinks that Sarah is the thief.



Theory of mind:

An issue with standard false belief tasks

Lewis, Hacquard, & Lidz 2012, 2017: Children could assume in standard false belief tasks that the **mental state verbs are being used as parenthetical endorsements**.

Where did Lily go?

Lily is in the forest, I think.



Who stole the bracelet?

Hoggle thinks that Sarah is the thief.



In that case, it makes sense to assume the sentential complement is **true (to some degree)** – which is **precisely how to fail a standard false belief task** (where the **complement is false, by design**).

Theory of mind:

An issue with standard false belief tasks

Lewis, Hacquard, & Lidz 2012, 2017: This would mean that if children are made aware that **the beliefs themselves are being questioned** (which is what the mental state verbs refer to), they should do better at passing false belief tasks.

What does Hoggle think?

Hoggle **thinks** **that** Sarah is the thief.



Theory of mind:

An issue with standard false belief tasks

Lewis, Hacquard, & Lidz 2012, 2017: This is precisely what Lewis and colleagues found when they tested 4-year-olds. 4-year-olds improved their performance significantly when the belief (of the characters in the story) was made more salient.

What does Hoggle think?

Hoggle thinks that Sarah is the thief.



Theory of mind:

An issue with standard false belief tasks

Lewis, Hacquard, & Lidz 2012, 2017: This suggests that young children know quite a bit about how to use language to encode mental states of others – it's just that they have difficulty adjusting to atypical uses of mental state verbs. (Remember: Most of the time, 4-year-olds use them as parenthetical endorsements, not as literal statements of belief. Some false belief tasks test children explicitly with the literal statement of belief.)

Who took the bracelet?

Hoggle thinks that Sarah is the thief.

parenthetical endorsement:

Sarah is the thief = TRUE to some degree.

Reasonable response: *Yeah, I think so too.*



Theory of mind:

An issue with standard false belief tasks

Lewis, Hacquard, & Lidz 2012, 2017: This suggests that young children know quite a bit about how to use language to encode mental states of others – it's just that they have difficulty adjusting to atypical uses of mental state verbs. (Remember: **Most of the time, 4-year-olds use them as parenthetical endorsements, not as literal statements of belief.** Some false belief tasks test children explicitly with the literal statement of belief.)

What is Hoggle thinking?

Hoggle thinks that Sarah is the thief.

literal statement of belief:

Sarah is the thief = UNKNOWN.

Reasonable response: *Yeah, he often thinks that.*



Theory of mind:

Explicit false belief tasks undersell children's abilities

Harrigan, Hacquard, & Lidz (2018) on 3-year-old abilities with sentential complements for the verb *want* (though not in a standard false belief task):

“...we find that 3-year-olds successfully interpret *want* sentences, suggesting that their ability to represent conflicting desires is adult-like at this age.”

Not an issue of the cognitive concept of false beliefs or desires or the ability to interpret sentential complements

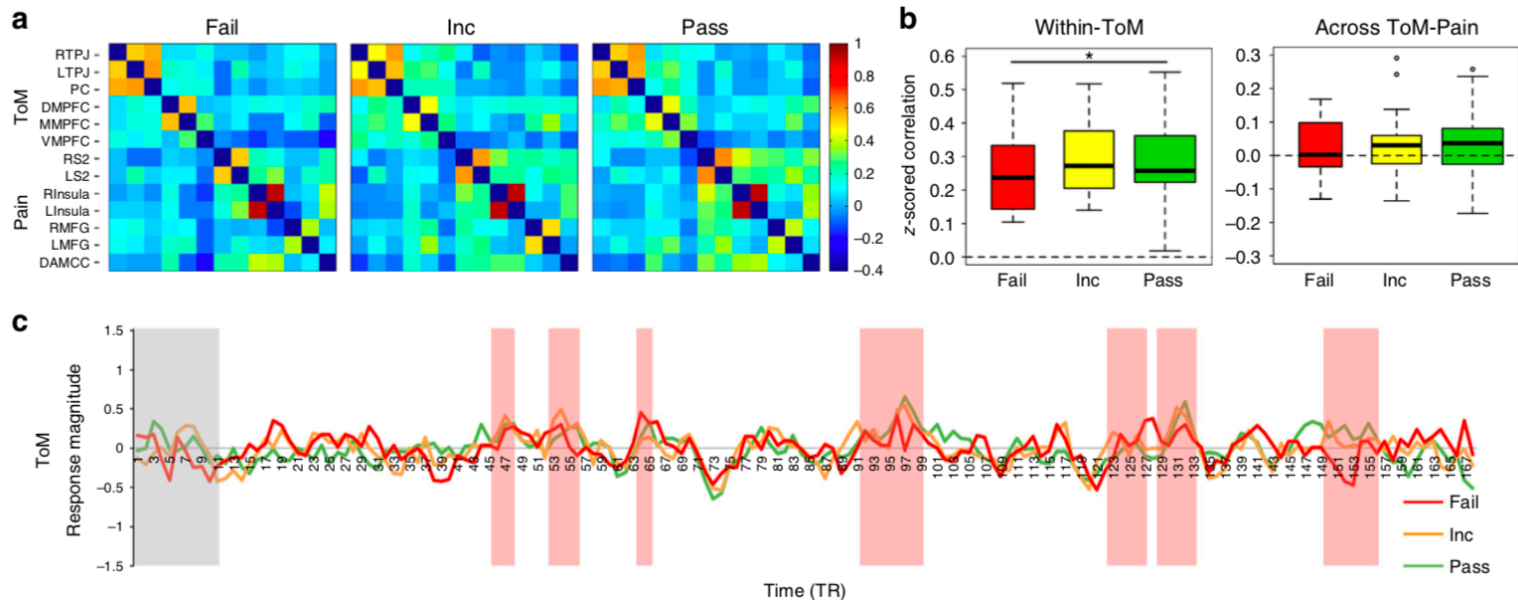


Theory of mind: Explicit false belief tasks undersell children's abilities

Richardson, Lisandrelli, Riobueno-Naylor, & Saxe (2018) on why explicit false belief tasks aren't such a great gauge of theory of mind:

“...we find that a distinct neural response to others' minds and bodies is present before—and continues to develop after—children pass explicit false-belief tasks.”

Similar theory of mind functional responses in children who fail, have inconsistent responses, or pass explicit false belief tasks.



Language & cognition: Recap

Neo-Whorfianism is a variant of Whorfianism that believes **language** augments **thought**, so we can think more complex thoughts.

For theory of mind, we have seen evidence for cases where language seems to enable more complex thought - **or at least to enable it to happen more easily.**

It seems in many cases that language is like a hammer – it's a really good tool (and probably better than a shoe) for getting the (cognitive) job done. But that doesn't necessarily mean the job can't get done without it.

False belief tasks, which have been a standard way to assess when children have a theory of mind, may not allow children to accurately demonstrate their theory-of-mind knowledge.



Questions?



You should be able to answer all the questions on the language & cognition review questions, and up through 4 on HW6.