Counting and categorizing:

The relationship between the mass/count distinction and thought

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Introduction

Point of departure: It has been shown that

Speakers of languages with different counting systems make use of the same cognitive tools, albeit differently (Inagaki & Barner 2009; Barner, Inagaki & Li 2009)

English: count/mass, some nouns compared for cardinality, some for volume

Japanese: classifier, some nouns compared for cardinality, some for volume

This state of affairs rules out strong Whorfian accounts of language (Bale & Barner 2019)

Question

How can we best characterize the nature of the relation between the count/mass distinction and relevant cognitive tasks?

Proposal

The count/mass distinction has meddler and spotlight effects on thought (see Wolff and Holmes 2010)

Support

The interaction between syntax and categorization in noun acquisition count/mass and classifier languages (Gordon 1985; Imai & Gentner 1997; Lucy & Gaskins 2003)

Outline

Background

Wolff and Holmes (2010) On language and thought

Different counting systems: English (count/mass), Japanese (classifier)

Quantity comparison performance in English and Japanese (Inagaki & Barner 2009)

Data: Differences in nominal encoding

Conflicting cues in early English noun acquisition (Gordon 1985)

Noun acquisition in English & Japanese (Imai & Gentner 1997)

Noun acquisition in English and Yucatec Mayan (Lucy & Gaskins 2003)

Analysis

The meddler and spotlight effects of the count/mass distinction

Background

Pluralism about Language and Thought

- “Strong” Whorfianism: thought and NL are structurally parallel; NL reshapes and determines thought/categories/concepts
- “Weak whorfianism” (Gopnik, 2001; Wolff and Holmes, 2010):
    - Claim can be adjusted and reinterpreted: absence of rewiring does not exclude some influence on cognitive processes
    - Gopnik (2001): language might provide some clues for theory-building when it comes to learn about the world
    - Wolff and Holmes (2010): depending on the kind of effect investigated and on the theoretical angle, evidence can be encouraging

Background

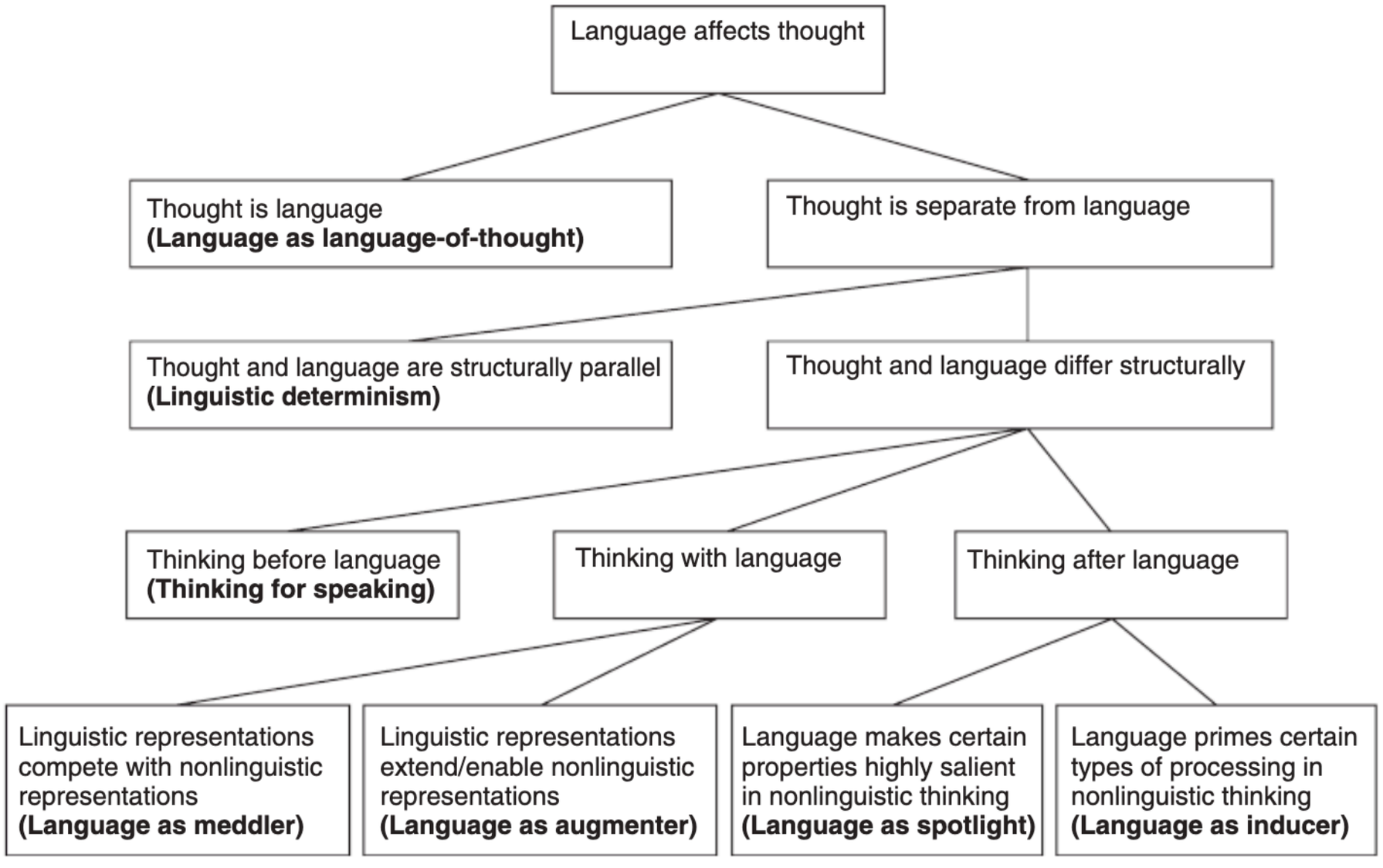
Pluralism about Language and Thought

- Beaulac (2014): it makes sense to assume a *pluralistic* perspective: effects of language can be of different kind, depending on what sort of input and what sort of mechanism we investigate
    - Language is not a monolith; what features of language can influence what mechanisms specifically?

- Lalumera (2018): some of the effects found are *task dependent* and *context dependent*
    - This does not make them less interesting; they are sign of some cognitive process being affected, though in possibly “fleeting” way (“weak whorfianism”)
    - This might tell us something about the flexibility of mental representations and the cognitive processes involving them

Background

Wolff and Holmes (2010)



Background

Wolff and Holmes (2010)

Language as spotlight: language highlights properties and draws attention to them (Boroditsky and Schmidt, 2003)

Thinking for speaking: the fact that a verbal response is needed influences the process (Casasanto et al. 2004)

Language as a meddler: effects of language occur from the spontaneous recruitment of linguistic coding along with nonlinguistic coding. (Winawer et al, 2007)

Background

Wolff and Holmes (2010)

Language as augmenter: linguistic representations enhance nonlinguistic representations/abilities (Dehaene, 1997)

Language as inducer: language may prime a particular mode of processing that is engaged even when language is not induced anymore (Holmes and Wolff, 2010)

Background

Wolff and Holmes (2010), Beaulac (2014)

Modified processes	*Enhanced Processes*	*New processes*
Language as a meddler	Language as augmenter	Language = Thought
Language as a spotlight		Inherently linguistic processes
Scaffolding		

Background

Different counting systems in English and Japanese

English: count/mass

(1) a. one kitten
b. two cows
c. three trees

(2) a. one ball of yarn
b. two bales of hay
c. three pieces of wood

Japaneses: classifier

(3) a. inu go-*(hiki)
dog five-$CL_{small.animal}$
`five dogs'

b. kamu itsu-*(tsu)
furniture five-$CL_{general}$
`five pieces of furniture'

c. yūbinbutsu go-*(bu)
mail five-$CL_{printed.material}$
`five pieces of mail'

b. mizu go-*(hon)
water five-CL_{bottle}
`five bottles of water'

"The mass-count distinction provides an ideal test of how language affects thought because it is subject to systematic cross-linguistic variation, making it easier to determine the effect of syntax on interpretation" (Barner et al. 2009, p. 2).

Background

Quantity comparison performance in English and Japanese (Inagaki & Barner 2009)

Goal: To shed light on the semantic encoding of Japanese nouns

Main idea:

English count and mass nouns are judged for cardinality and volume respectively
In quantity comparison tasks
    Object mass nouns (e.g. *furniture*) are also judge for cardinality

Japanese does not have a count/mass distinction like English does
    It is unclear whether nouns would be judged for cardinality, volume, or both

Quantity comparison tasks can shed light on Japanese noun encoding

Background

Inagaki & Barner (2009) Countability in Absence of Count Syntax: Evidence from Japanese Quantity Judgments

Participants
- Experiment 1: 22 Japanese Undergrads; 20 American Undergrads
- Experiment 2: 22 Japanese Undergrads; 20 American Undergrads

Materials
- Several sets of entities divided into two groups—e.g. groups of shoes
  - 1 group with larger volume and smaller cardinality—e.g. two large shoes
  - 1 group with smaller volume but larger cardinality—e.g. six small shoes

Presentation
- `Dotira-no hito-ga yori-ookuno kutu-o motte-iru desyoo?'
- `Who has more shoes?'

Questions:
1. Does the presence of count syntax change the interpretation of canonical count nouns in English (e.g., *shoe*) relative to equivalent nouns in Japanese (e.g., *kutu*), which lack count syntax?
2. Are words that denote substances as mass nouns in English (e.g., *mustard*) less likely to individuate in Japanese (e.g., *karasi*)?
3. Are words that denote individuals when used as mass nouns in English (e.g., *furniture*) less likely to individuate in Japanese (e.g., *kagu*)?
4. Do words that appear flexibly in both mass and count syntax in English (or that differ in mass-count status across English and French) support a single interpretation in Japanese, or do they support both individuated and unindividuated interpretations as in English?

Background

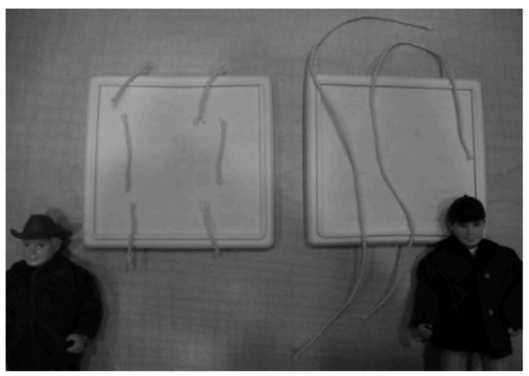
Inagaki & Barner (2009) Countability in Absence of Count Syntax: Evidence from Japanese Quantity Judgments

Materials

English: *Who has more shoes?*
Japanese: *Dotira-no hito-ga yori-ookuno kutu-o motte-iru desyoo?*
Figure 1. Example test items for count nouns.

English: Who has more furniture?
Japanese: *Dotira-no hito-ga yori-ookuno kagu-o motte-iru desyoo?*
Figure 3. Example test items for object-mass nouns.

English: *Who has more mustard?*
Japanese: *Dotira-no hito-ga yori-ookuno karasi-o motte-iru desyoo?*
Figure 2. Example test items for substance-mass nouns.



English: *Who has more string(s)?*
Japanese: *Dotira-no hito-ga yori-ookuno himo-o motte-iru desyoo?*
Figure 4. Example test items for mass-count flexible nouns.

Background

Inagaki & Barner (2009) Countability in Absence of Count Syntax: Evidence from Japanese Quantity Judgments

Results

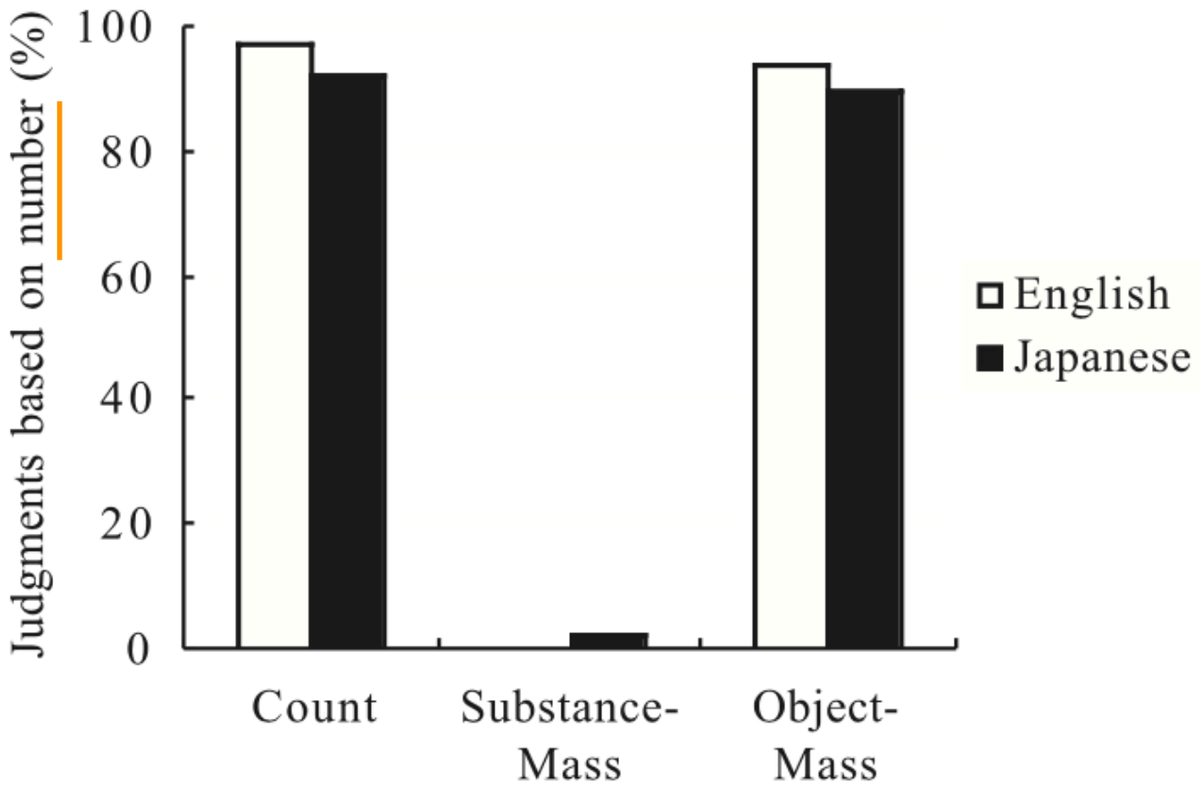


Figure 1. English and Japanese quantity judgments for count nouns (*shoe*), substance mass nouns (*mustard*), and object mass nouns (*furniture*).

Background

Inagaki & Barner (2009) Countability in Absence of Count Syntax: Evidence from Japanese Quantity Judgments

Results

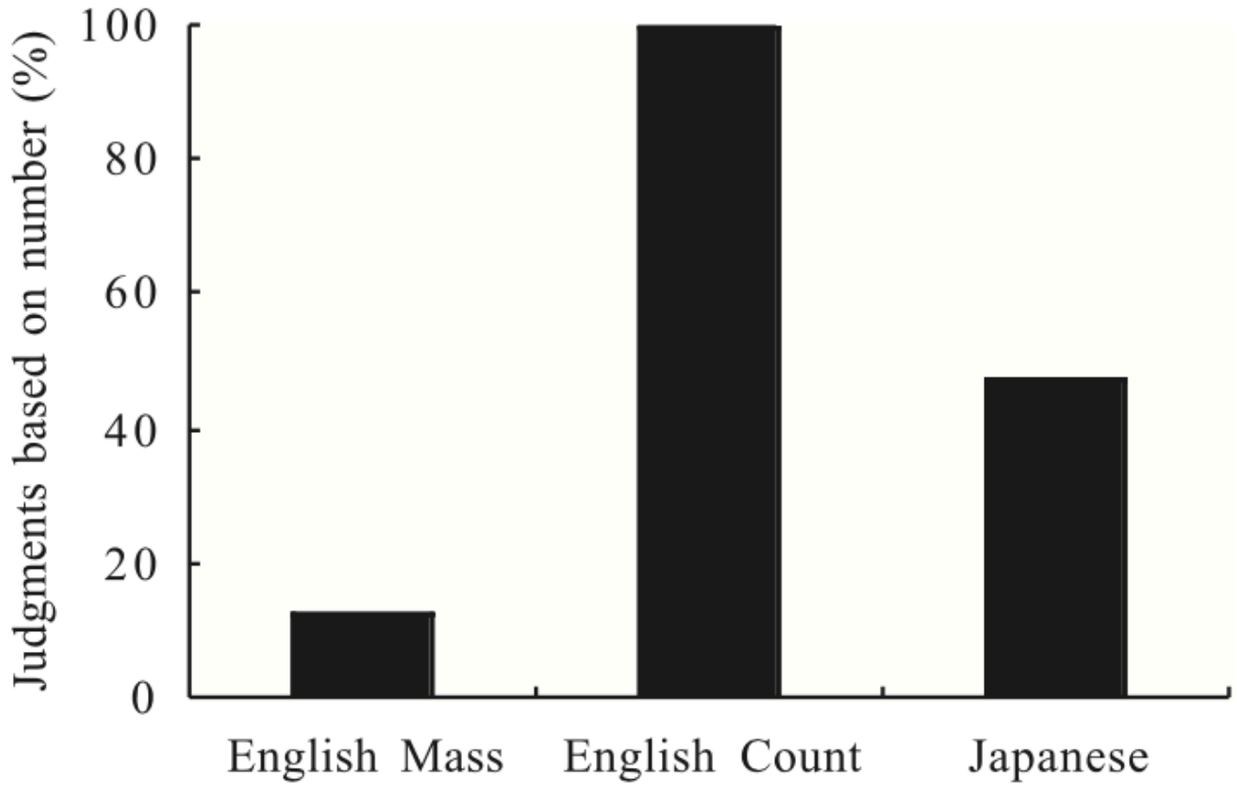


Figure 2. English and Japanese quantity judgments for mass-count flexible nouns (*string(s), stone(s)*).

Background

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Results

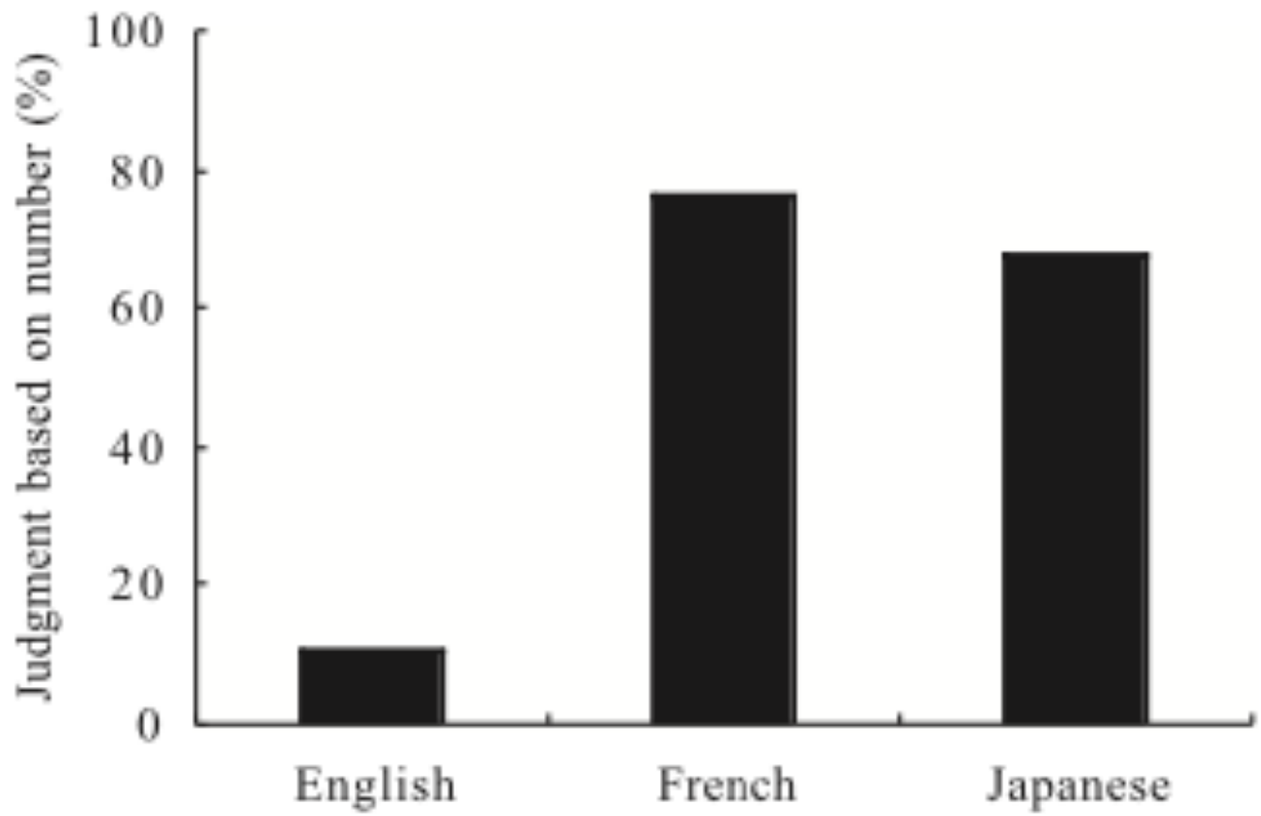

Figure 3. English, Japanese, and French quantity judgments for cross-linguistic variable nouns (*spinach, pasta*).

Data

Inagaki & Barner (2009) Countability in Absence of Count Syntax: Evidence from Japanese Quantity Judgments

Conclusions

> "individuation can be encoded by nouns cross-linguistically in absence of count syntax, and that for some words count syntax has no effect on interpretation" (p. 121)
>
> "count syntax may simply select between universally available meanings of nouns" (p. 122)
>
> "Japanese speakers access the same meanings as speakers of other languages" (p. 122)

Bale & Barner (2018): There is no strong Whorfian effect of language

Our proposal

The count/mass distinction has meddler and spotlight effects on thought.

It meddles with the categories object/substance

Mass syntax can give `substance' interpretations to objects

e.g. *stone, string, brick, rope,* etc.

It puts a spotlight on object characteristics

Count syntax can reinforce `object' interpretations

e.g. *stones, strings, bricks, ropes,* etc.

Japanese does not have such grammaticalized cues towards interpretation

(4) Anata-wa yori ooku-no kazu-no ishi-o motteimasu-ga,
you-top more many-gen number-gen stone-acc have-but,

watashi-wa yori ooku-no ryoo-no ishi-o motteimasu
I-top more many-gen amount-gen stone-acc have
`You have more stones (in number), but I have more stone (in volume).'

Outline

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Conflicting cues in early English noun acquisition (Gordon 1985)

Noun acquisition in English & Japanese (Imai & Gentner 1997)

Noun acquisition in English and Yucatec Mayan (Lucy & Gaskins 2003)

Analysis

The meddler and spotlight effects of the count/mass distinction

Data

Gordon (1985)

Research questions:

Is the count/mass distinction initially acquired as a semantic distinction defined referentially?

Do children form subcategories independent of support (object/substance) even if the support is available?

Main claims:

Syntactic cues dominate physical cues in noun categorization

The count/mass distinction is not acquired via the object/substance distinction

Data

Gordon (1985) Experiment 1

- Nonse word learning & sentence completion
  - Participants
    - Children divided into two age groups 3;5-4;1 (mean=3;9) and 4;2-5;5 (mean=4;9)
  - Materials
    - Objects painted unusual colors: electrical components, file clips, fuses, wall plugs
    - Unusual liquids in sets of four test-tubes
  - Conditions
    - “accord”
      - Objects presented in count syntax (*a garn*)
      - Substances presented in mass syntax (*some garn*)
    - “conflict”
      - Objects presented in mass syntax
      - Substances presented in count syntax
  - Task
    - Learning: “This is {a/some} garn”
    - Testing: “Over there we have more … what?”
  - Assumption
    - Singular noun response = mass
    - Plural noun response = count

Data

Gordon (1985) Results 1

Accord
17/20 younger children answered all questions correctly (with presented syntax)
3 got 3/4 correct
12/20 older got all correct
5 got 3/4 correct
Performance is significantly different from conflict condition

Conflict condition

- More than 50% of older children based 3 or 4 answers on synatx
- Half of younger children based 3 or 4 answers on syntax
- Only one child in either group based answers on entity type
- 6 younger and 7 older children pluralized all or neither, not showing bias for syntactic or semantic criteria

Conflicting cues affects children's ability to follow one set of cues vs. another

Data

Gordon (1985) Results 1

Figure 2. *Categorization patterns obtained for semantic and syntactic cues in accord (experiment 1).*

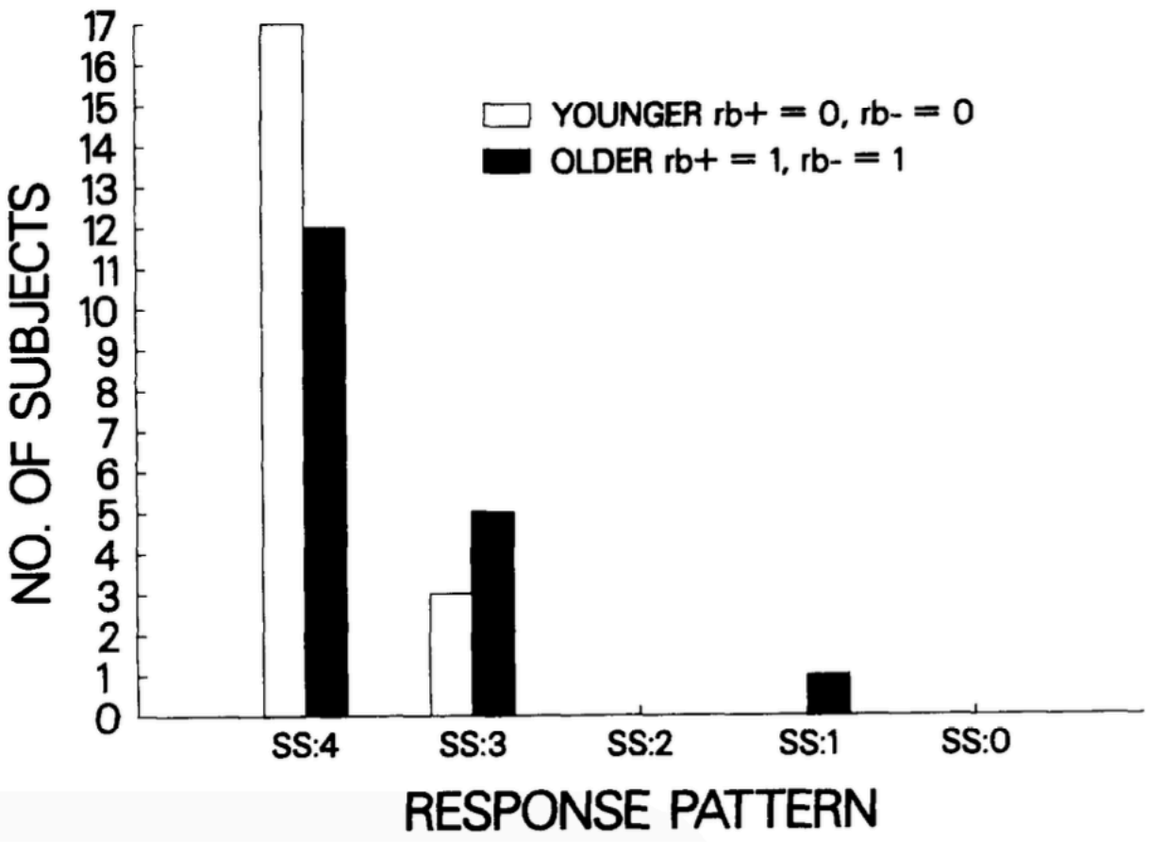
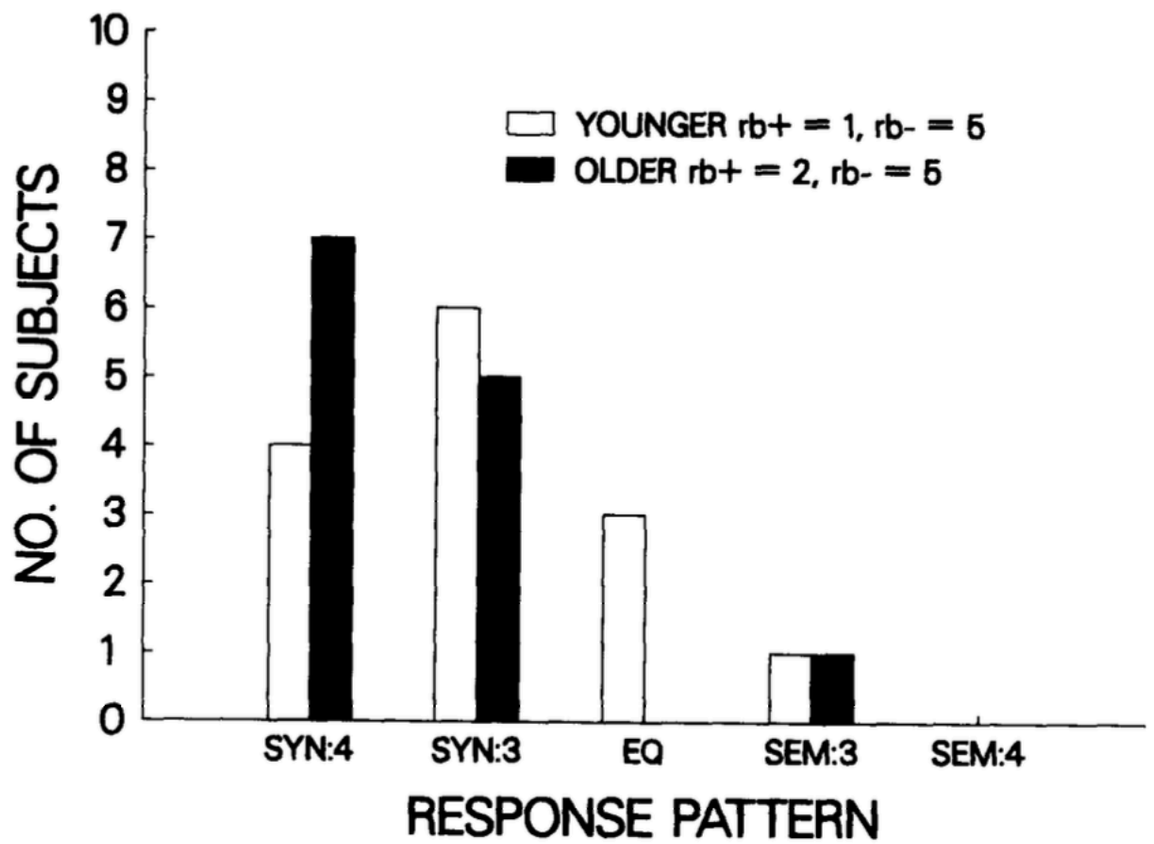


Figure 1. *Categorization patterns obtained for semantic and syntactic cues in conflict (experiment 1).*



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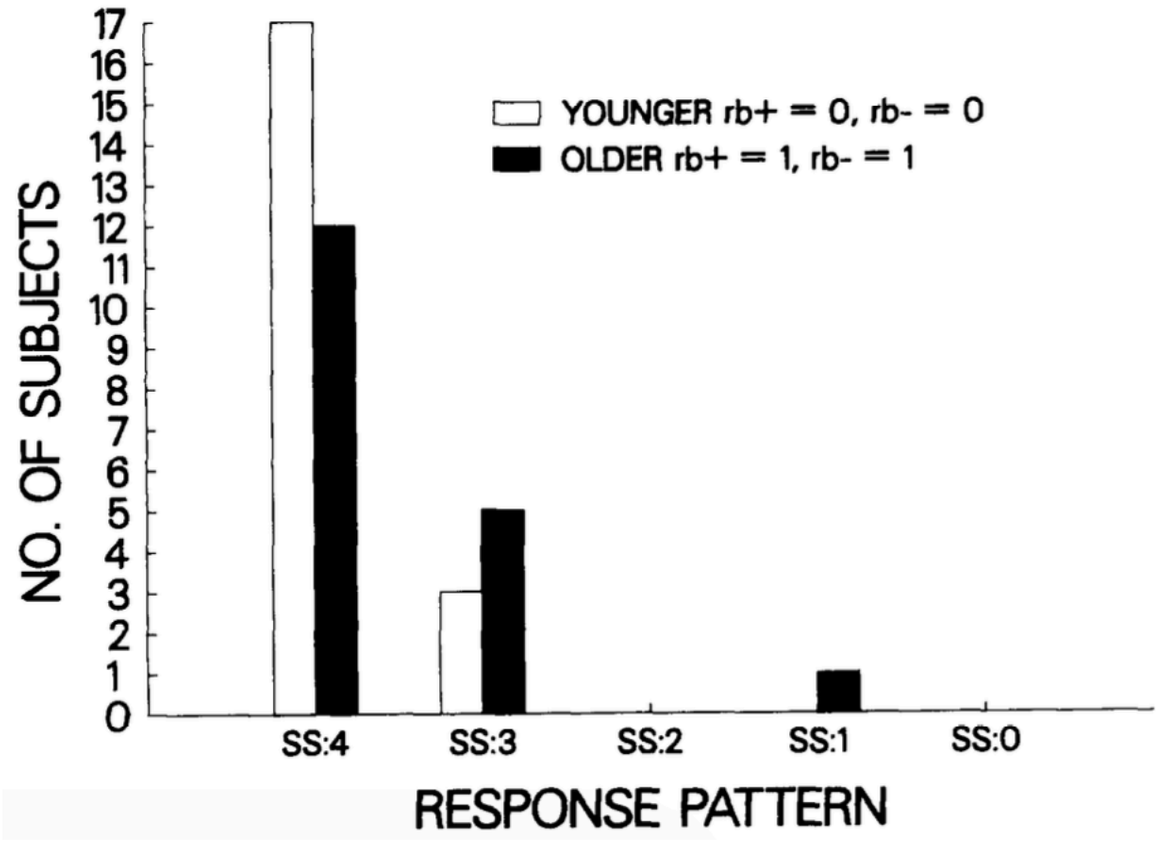

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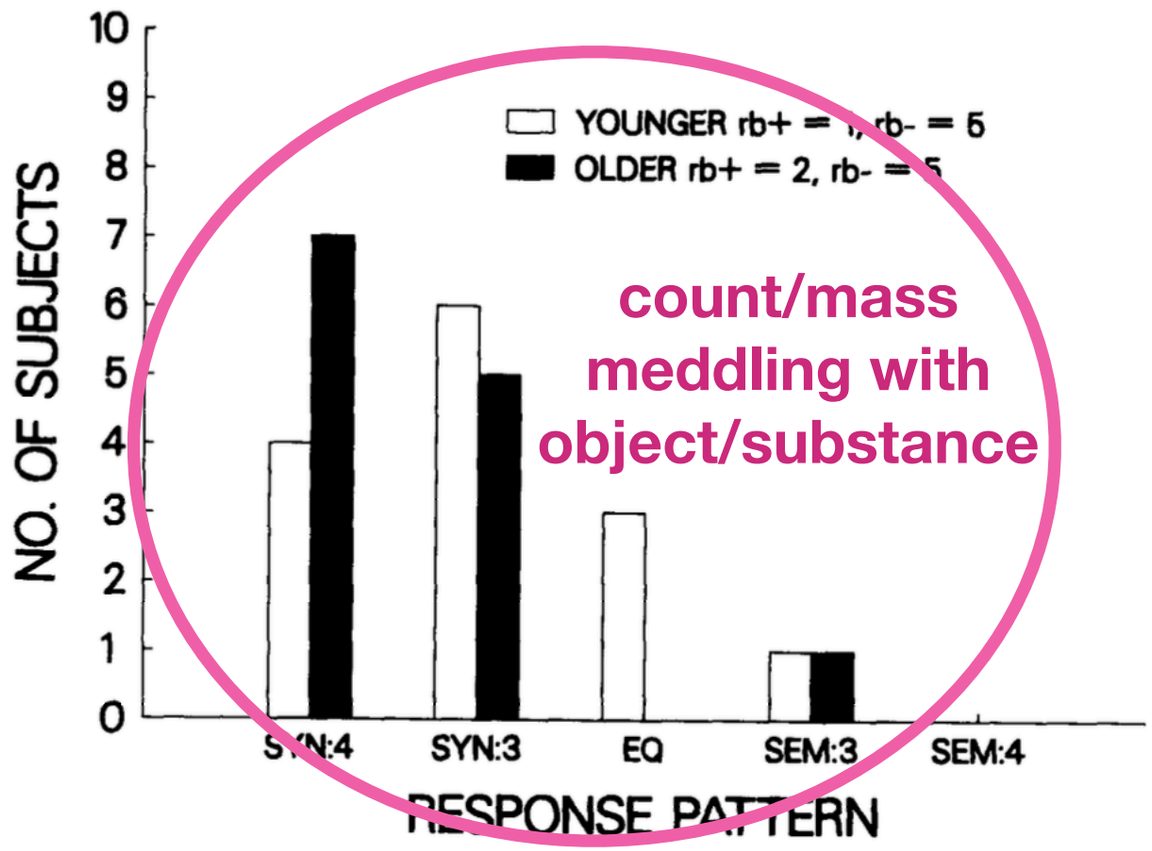

Data

Gordon (1985) Main claims

The results show that the count/mass distinction is essentially, but not exclusively syntactic

Syntactic cues dominate semantic cues as cues for noun categorization

Entity type is less strong than syntax for categorization

The count/mass distinction is not acquired via the object/substance distinction

When object/count and substance/mass cues align, categorization is more robust

Data

Imai & Gentner (1997) A cross-linguistic study of early word meaning; universal ontology and linguistic influence

Goal: To test if the object/substance distinction is linguistically or conceptually driven

Main idea: comparing English and Japanese children in word learning tasks with neutral syntax
English has a count/mass distinction; Japanese doesn't
If the count/mass distinction has a role in learning the object/substance distinction, then we should see a difference in English and Japanese participants

The evidence vs. the claims
Count/mass syntax is not seen to have a role in word learning for 2;0 children (Soja et al. 1991)
It does not affect performance in object/substance naming tasks

However, it is impossible to know if the children have zero count/mass knowledge

A language without count/mass syntax should be ideal for testing linguistic influence on object/substance ontology

Data

Imai Gentner (1997) Empirical study

- Participants
  - 14 early 2 year olds (~2;0)
  - 15 late 2 year olds (~2;8)
  - 14 4-year-olds (~4;2)
  - 18 adults
- Materials
  - Complex objects (4 sets)
  - Simple objects (4 sets)
  - Substances in presented gestalt shapes (4 sets)
- Presentation
  - Learning: Novel item and word in neutral syntax “Look at this *dax*.”
  - Extending: Same shape vs same material (material in 1 or 3 pieces)
    - “point to the tray that also has the *dax* on it.”
- Predictions:
  - If object/substance are universal, then performance of Japanese children should be identical to English speaking children
  - If object/substance is linguistically based, performance should differ between Japanese and English speaking children
    - They'll either choose randomly, or based on material only

Data

Imai Gentner (1997) Empirical study

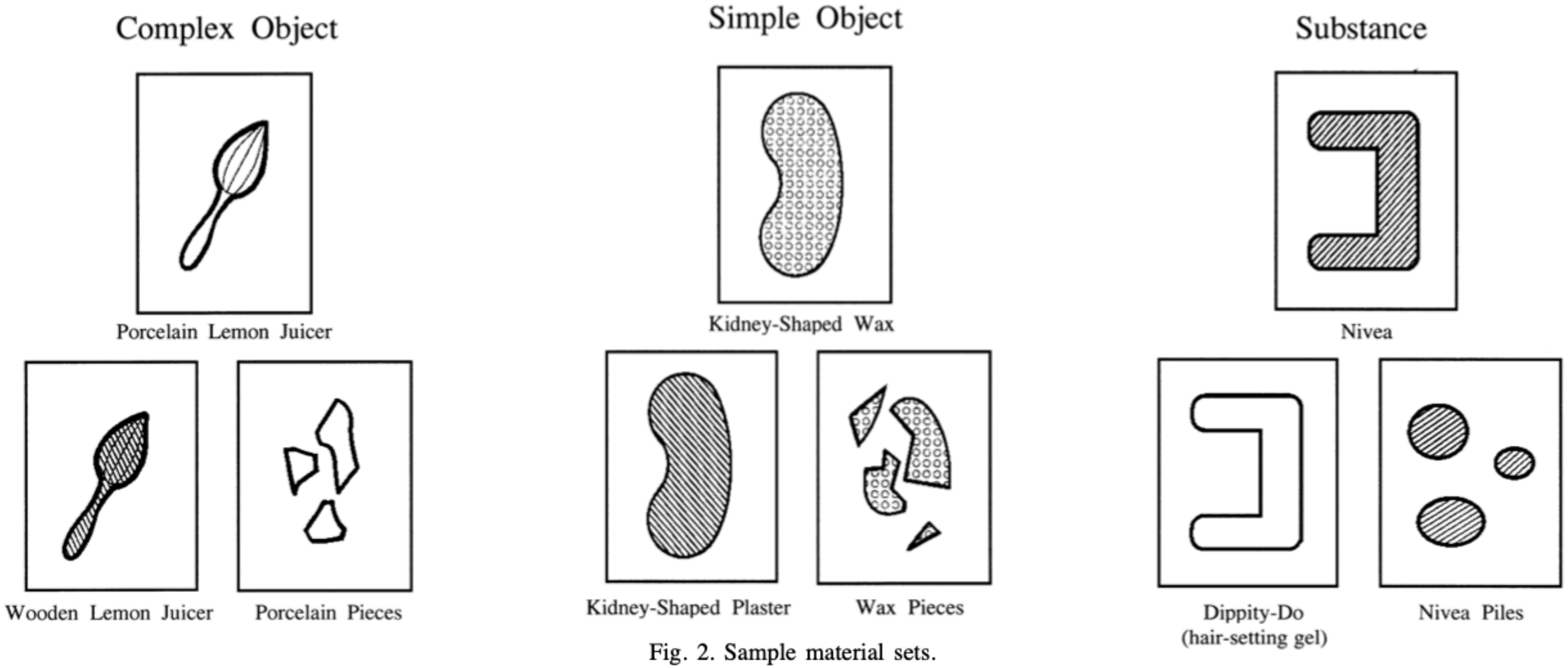

Fig. 2. Sample material sets.

Data

Imai Gentner (1997) Results

American English vs. Japanese
- Each show differences in decisions across entity classes
- Differences in decisions age X entity groups
- Complex objects: no difference in language
- Simple objects: difference in language (Japanese at chance)
- Gestalt substances: difference in language, language X age (English at chance)

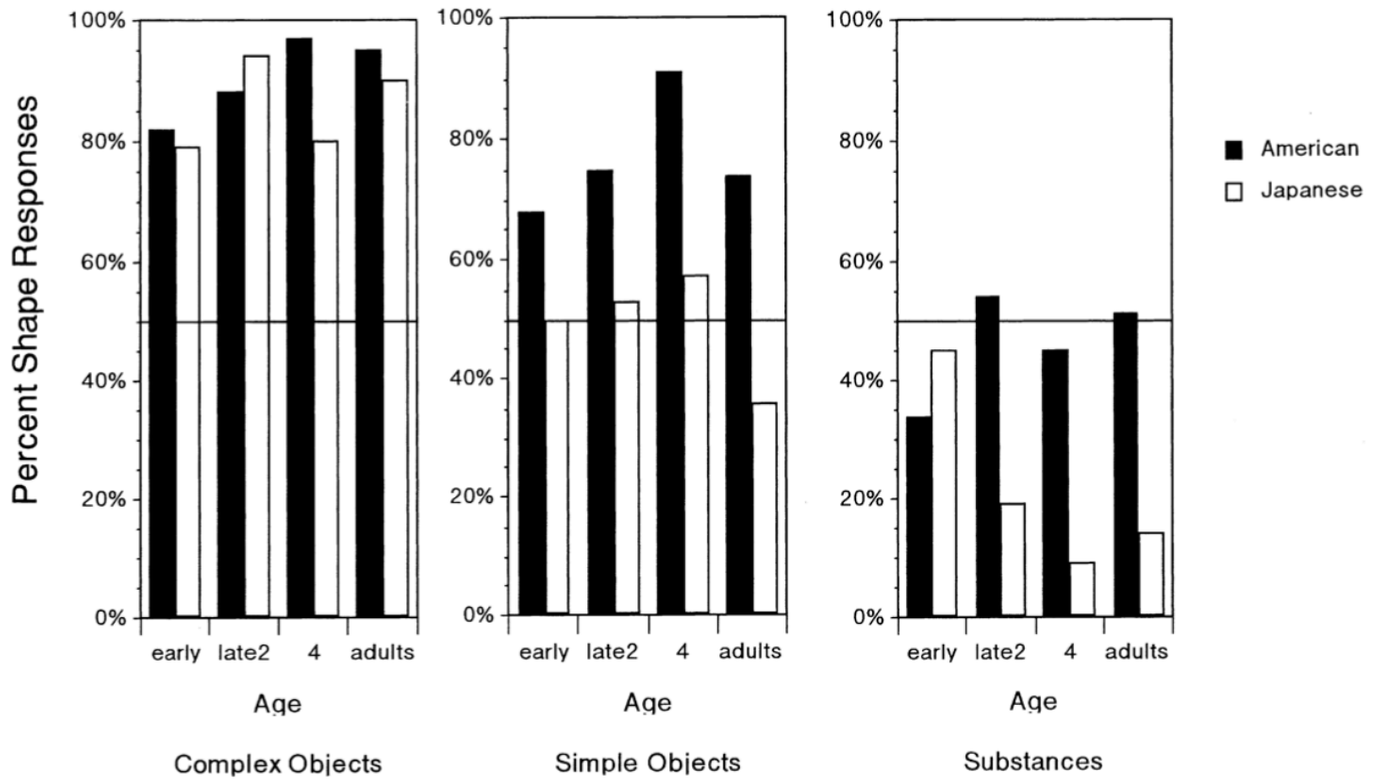

Fig. 3. Proportion of shape responses on (a) complex object trials, (b) simple object trials, and (c) substance trials.

Data

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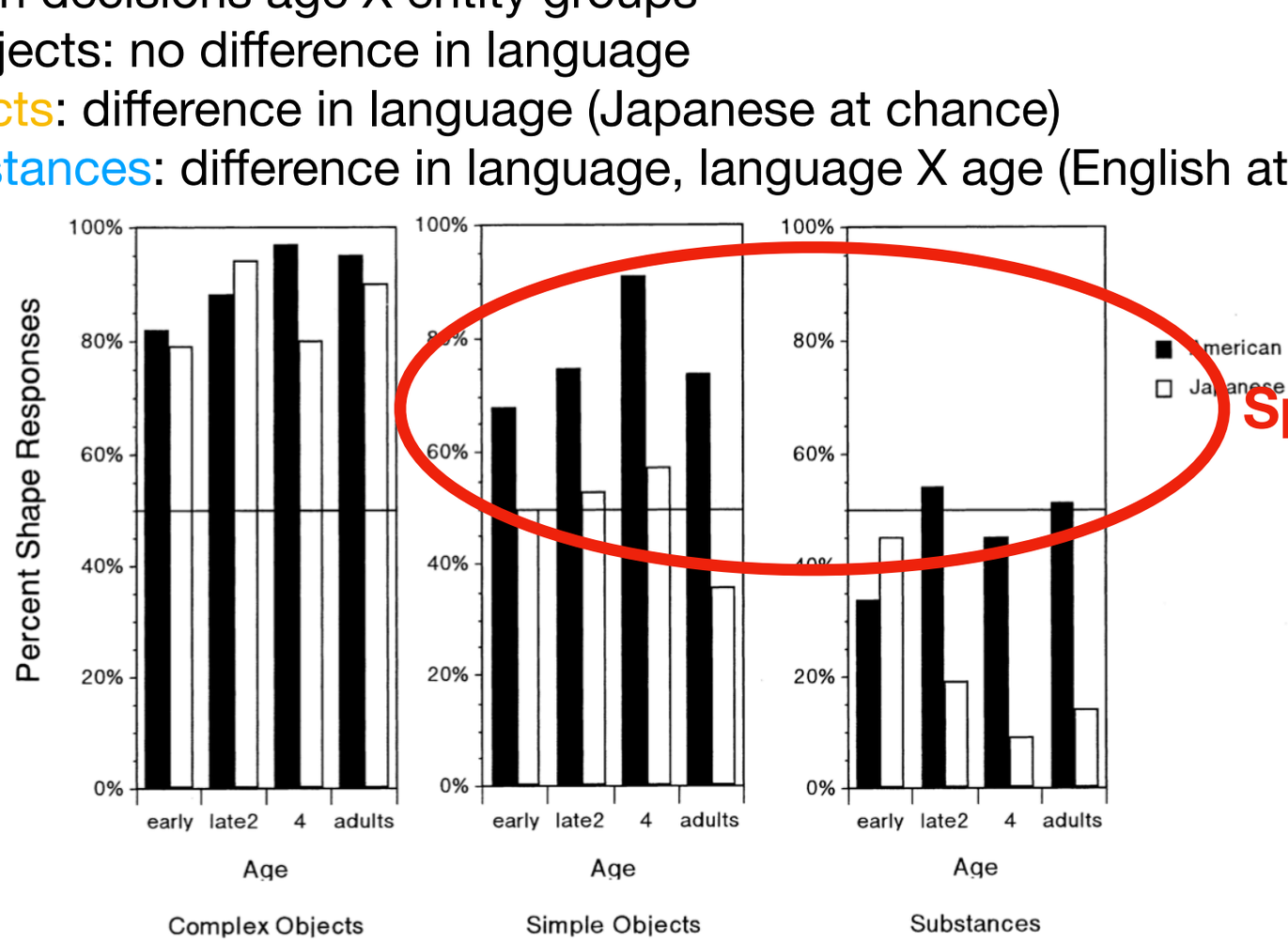

Spotlight: shape

Fig. 3. Proportion of shape responses on (a) complex object trials, (b) simple object trials, and (c) substance trials.

Data

Imai Gentner (1997) Discussion

Evidence of universal ontological distinction

In complex object results American and Japanese participants strongly favor shape
In gestalt substance results, the decisions are different

Evidence of linguistic distinction

Americans extend names for simple objects according to shape
Japanese people extend names for simple objects randomly (shape or material)

Americans extend names for gestalt substances randomly (shape or material)
Japanese people extend name for gestalt substances according to material

Claims: the object/substance distinction is not linguistically driven

Though there are linguistic differences in conceptualization of individuals

Data

Lucy & Gaskins (2003) Interaction of language type and referent type in the development of nonverbal classificatory preferences

Goal: A structure centered approach to comparative-developmental research

Main idea:

Investigate the extent to which grammatical differences correspond to differences in behavior towards certain types of entities

To what extent do the count/mass distinction in English and the classifier system in Yucatec Mayan correspond to differences in preference for classifying entities?

Hypotheses:

Yucatec speakers should attend relatively more to the material composition of objects.
English speakers should attend relatively more to the shape of objects.
Both Yucatec and English speakers should attend relatively more to the material composition of malleable objects.

Data

Lucy & Gaskins (2003) Interaction of language type and referent type in the development of nonverbal classificatory preferences

Materials: triads of solid objects and non-solid substances

Task: match the pivot object to one of the other two

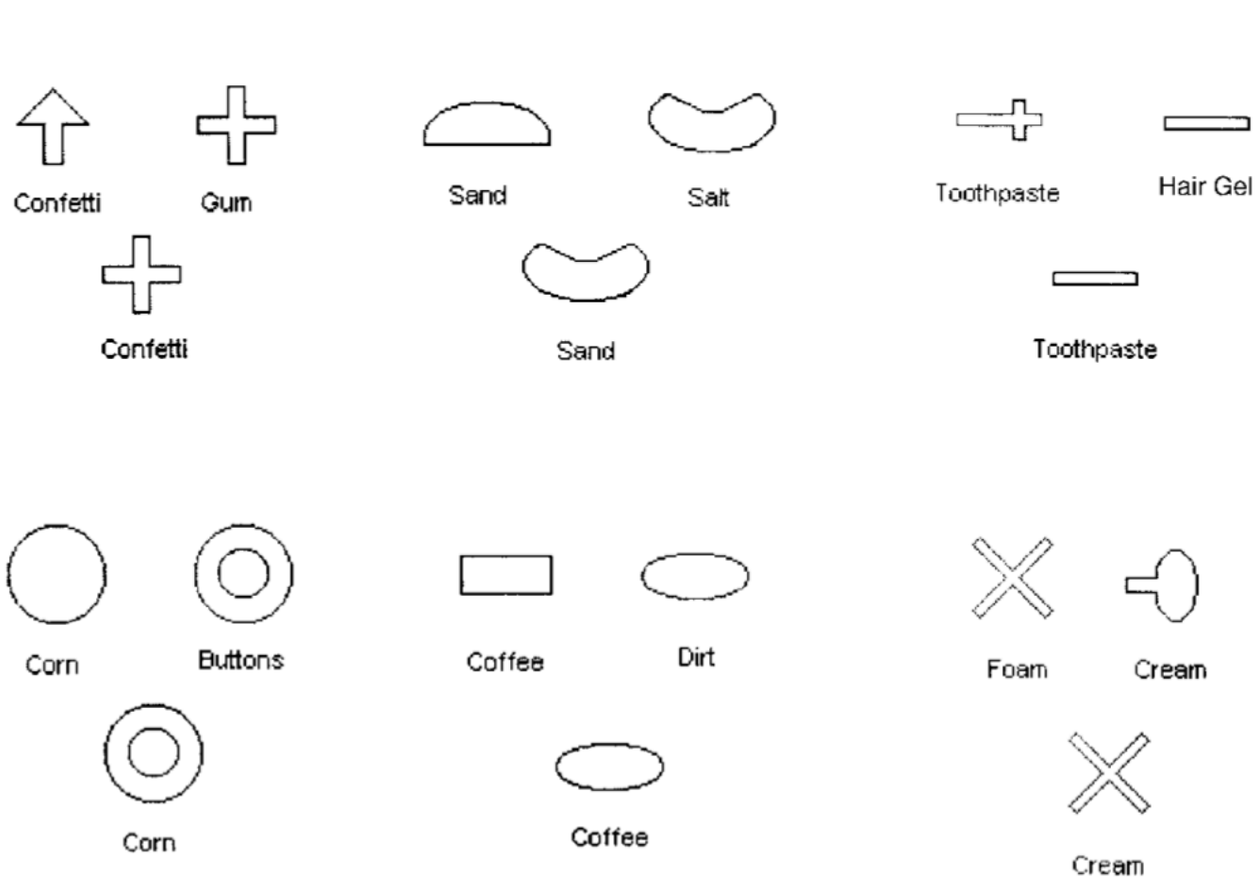

Figure 15.2
Examples of triad stimuli for malleable objects

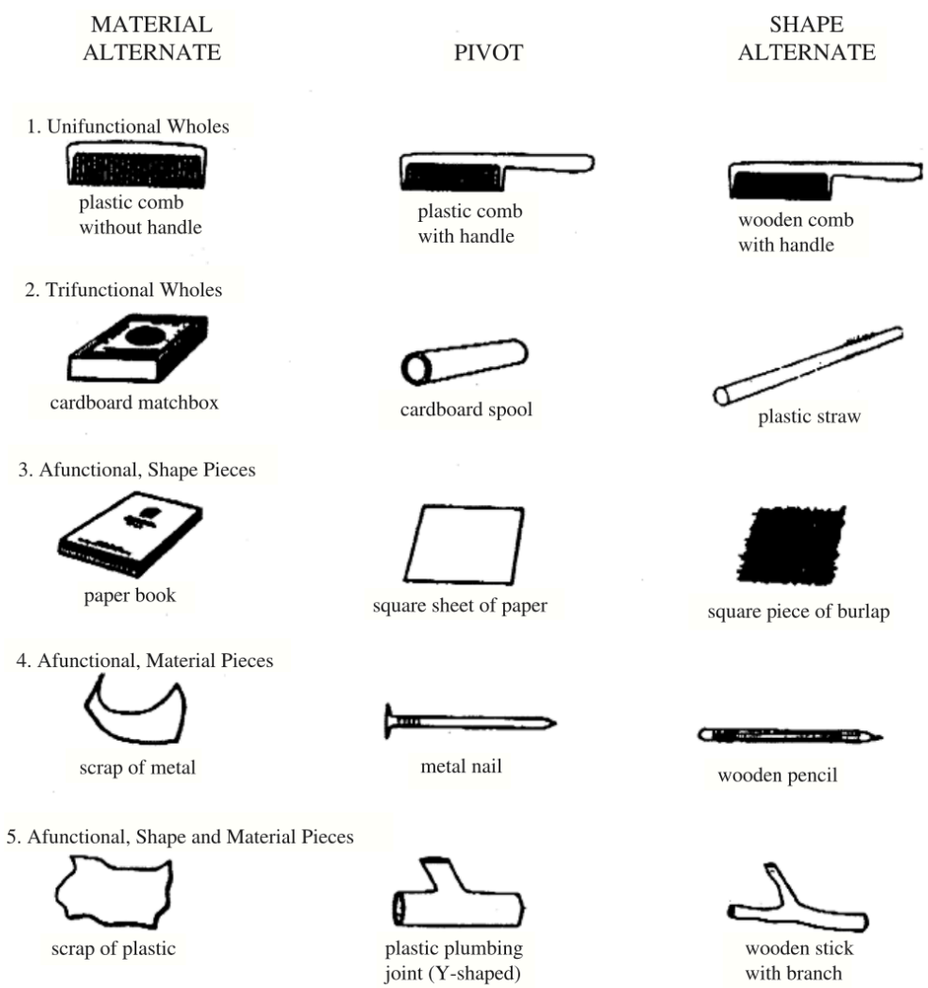

Figure 15.1
Examples of triad stimuli for stable objects. (Excerpted from figure 9.1 in Lucy and Gaskins 2001, 266.)

Data

Lucy & Gaskins (2003) Interaction of language type and referent type in the development of nonverbal classificatory preferences

Results:

7 year-old children behave the same across cultures

9 year-old Yucatec Mayan children show a developed behavior

Solid objects are grouped by material more often than before (though less that 50%)

Adults show distinct behavior across cultures

Yucatec Mayans group more by material, Americans group more by shape

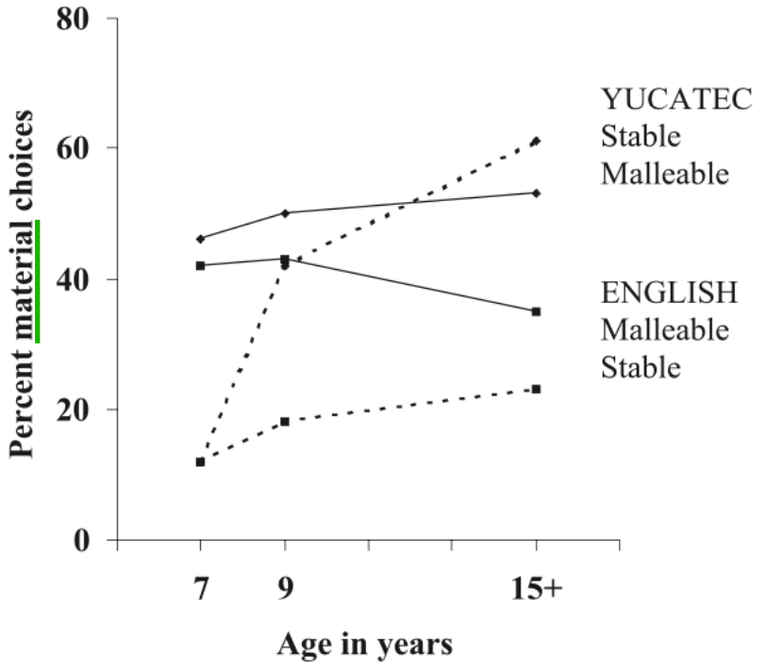

Figure 15.5
Developmental pattern for English and Yucatec classification preferences with both stable and malleable objects: material versus shape

Data

Lucy & Gaskins (2003) Interaction of language type and referent type in the development of nonverbal classificatory preferences

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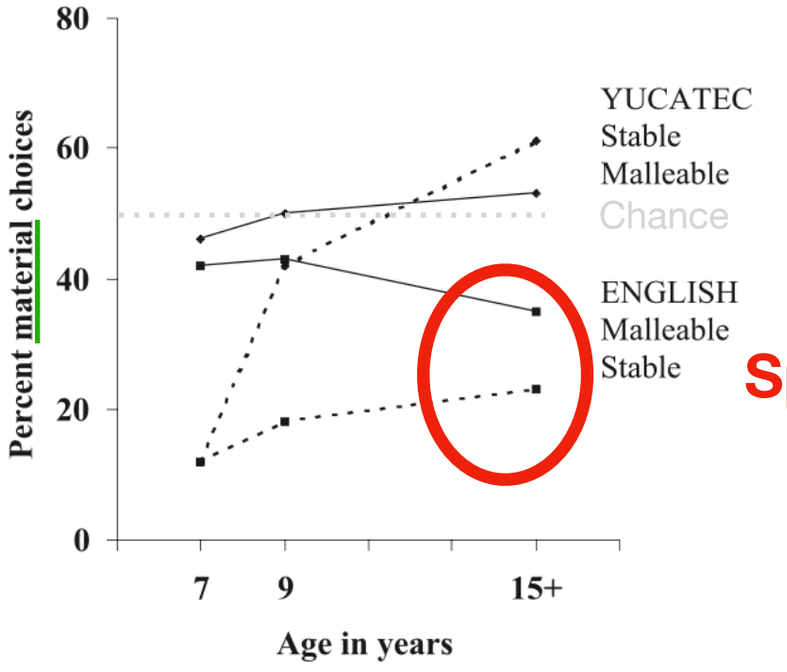

Spotlight: shape

Figure 15.5
Developmental pattern for English and Yucatec classification preferences with both stable and malleable objects: material versus shape

Data

Lucy & Gaskins (2003) Interaction of language type and referent type in the development of nonverbal classificatory preferences

Conclusions:

Number marking patterns seem to correspond to differences in behavior in entity-grouping tasks

Entity types generally corresponding to nouns counted directly warrant more shape based groupings

Objects for native English speaking participants

Entity types generally corresponding to nouns counted with classifiers warrant more material based groupings.

All entities for native Yucatec Mayan speaking participants
Substances for native English speaking participants

Outline

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Analysis

The meddler and spotlight effects of the count/mass distinction

Analysis

Gordon 1985

- “Confusion” arises when there is dissonance between entity type and syntactic clues
  - Dissonance: object : mass :: substance : count
  - Meddling: Conflict between physical and syntactic cues can lead to changes in categorization patterns

Analysis

Inagaki & Barner (2009)

- English count/mass distinction can be used to spotlight certain interpretations
    - For dual life nouns, count & cardinality correspond, so do mass & volume
        - e.g. *stones* : cardinality :: *stone* : volume
    - Of course, countability does not entail particular interpretations
        - e.g. *furniture* : cardinality
- Japanese has not been shown to have such spotlighting morphosyntax, rather lexical specification seems to be necessary
    - *kagu* (‘furniture’) : cardinality
    - *mizu* (‘water’) : volume
    - *inu* (‘stone’) : cardinality or volume

Analysis

Imai & Gentner (1997)

- While distinction between objects and substances is universal, some effect of language is present:

- Meddling:
  - English and Japanese speakers behave differently extending names for substances/simple objects

- Spotlight:
  - English count/mass syntax seems to correspond to a spotlight on shape

While it is about categorization, it is still a verbal task

Analysis

Lucy & Gaskins 2003

- Support results in Imai & Gentner (1997)
    - Meddling:
        - English and Yucatec Mayan speakers behave differently categorizing entities
    - Spotlight:
        - English count/mass syntax seems to correspond to a spotlight on shape
- The effect might be temporary and limited to certain tasks but shows an interaction between linguistic and non-linguistic coding

A broader picture: Language and Cognition

Barner, Inagaki and Li (2009):

Results like Imai and Gentner (1997) can be explained in terms of **lexical statistics:** count nouns are massively more frequent than mass nouns in English, so it is more likely that the new noun refers to something countable

This leaves unexplained cases =/= from lexical extension, e.g. Lucy and Gaskins 2003

A broader picture: Language and Cognition

Another role for statistical information

Label Feedback Hypothesis (LFH; Lupyan, 2012)

Describing the influence of language as something that can affect low-level processes (e.g. perception) while also being susceptible to verbal interference

Labels have the function of re-aligning representations in categorical perception, “warping” the perceptual space to make specific features in a representation particularly salient.

A broader picture: Language and Cognition

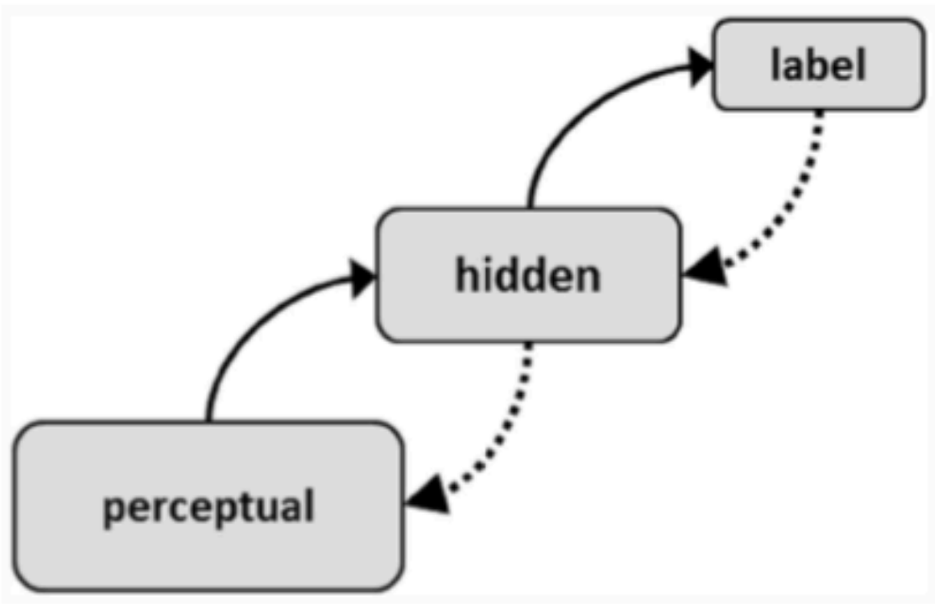


FIGURE 1 | A schematic of a neural network architecture for exploring on-line effects of labels on perceptual representations. See text for description.

- Learning: association between label and members of a category; perceptual properties related to the label are **co-registered.**

- Some of the properties —> stronger correlation with label; hearing a label helps to focus on these features.

- Feedforward and feedback connections form a loop —> perceptual- linguistic hybrid representation

A broader picture: Language and Cognition

Possible accommodation of the above results:

- Linguistic information brings attention to specific features of objects:
    - Count/mass languages: labels associated with objecthood, features including shape
    - Classifier languages: lack of these associations

- When it comes to individuate/classify a new object, the perpetual space might be **differently warped** to focus on those features

- Diagnostic properties are more strongly associated and thus the perceptual space is warped accordingly; this can lead on a “perceptual bias” towards those properties

A broader picture: Language and Cognition

Possibile route to explain it:

The effect of perceptual warping is constant: even in absence of labels (as in the Lucy and Gaskins' task), the association is persistent: constantly having certain features highlighted influences our general outlook

But:

- LFH focuses on online processing
- We'd fall back on a Whorfian picture

A broader picture: Language and Cognition

Another possible route:

If Lupyan is right, representations are hybrid (percepts + linguistic information)

The representations recruited in the sorting task include linguistic information, and the related associations; that includes the relevant features (e.g. shape) that are diagnostic of the object

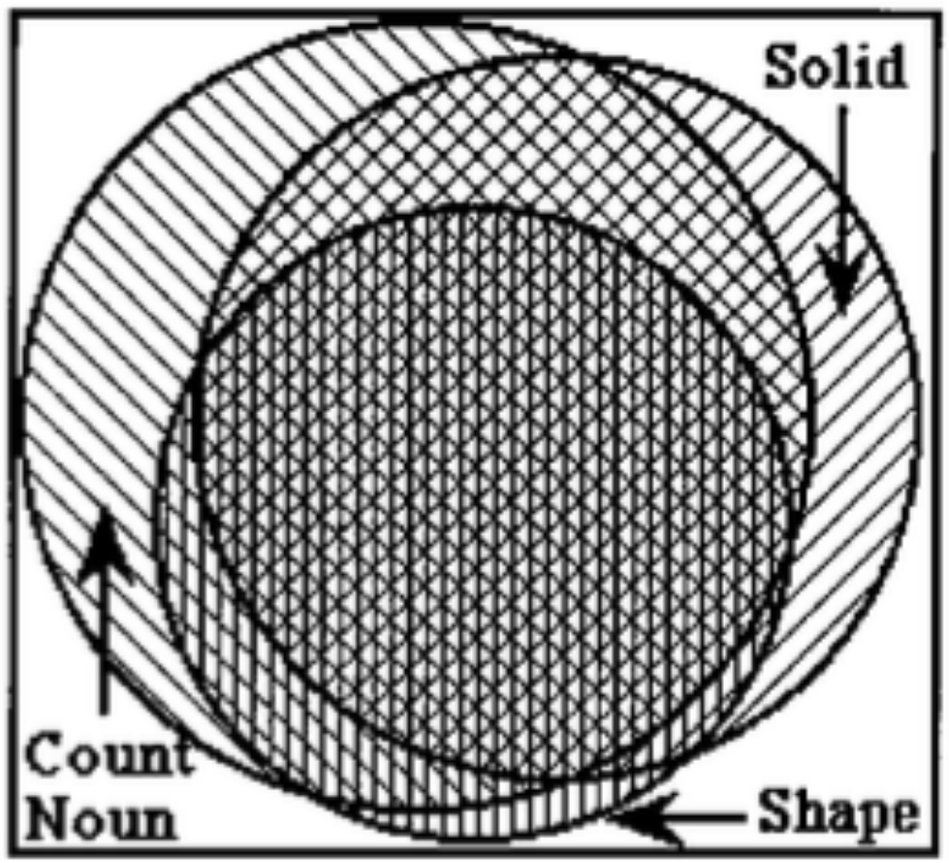
Language and Cognition Synthesis

For English speakers,

Count nouns prompt a bias for shape

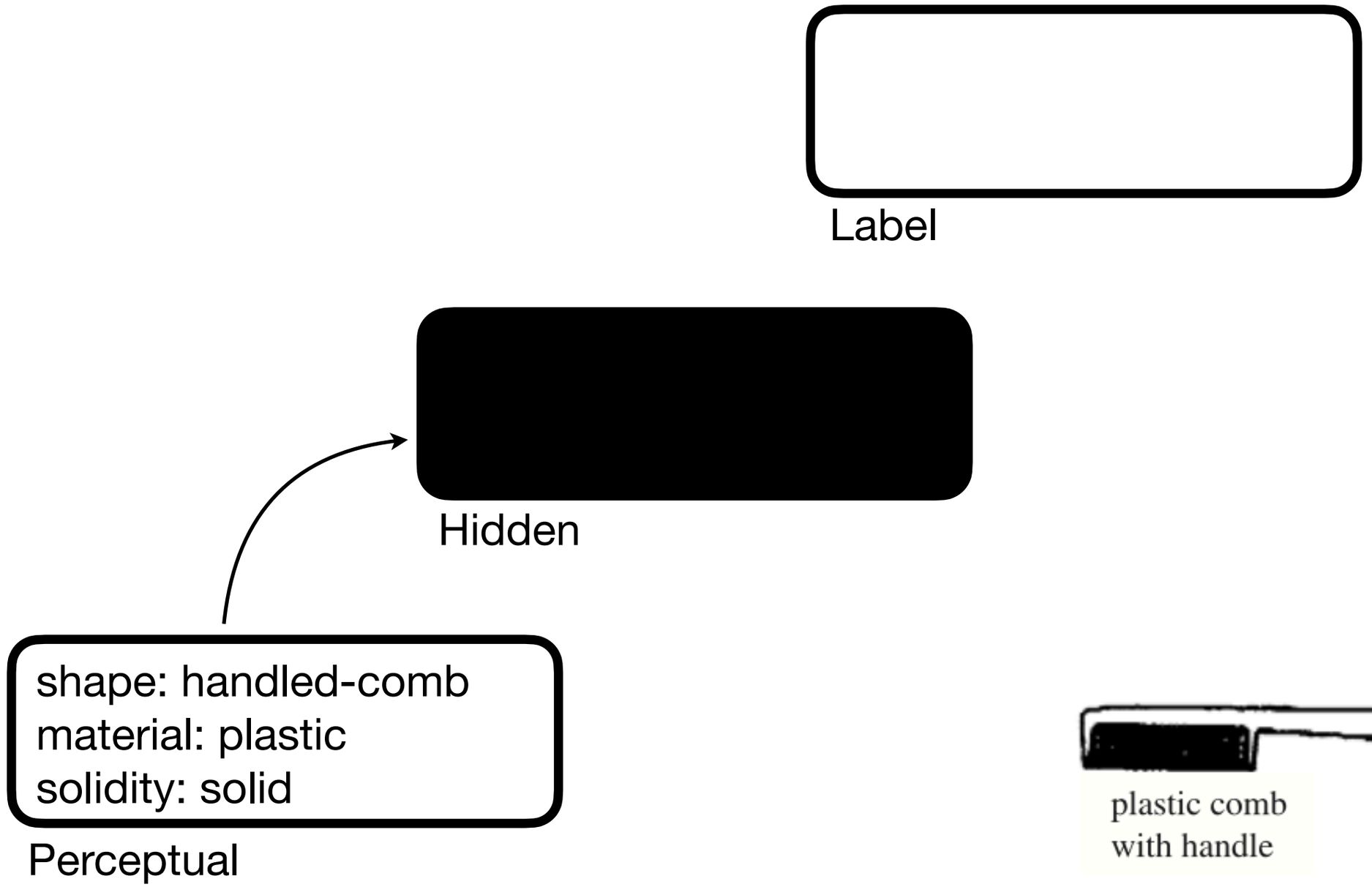
Feedforward/back connections create a hybrid representations with the most strongly correlating features

count ∩ solid ∩ shape

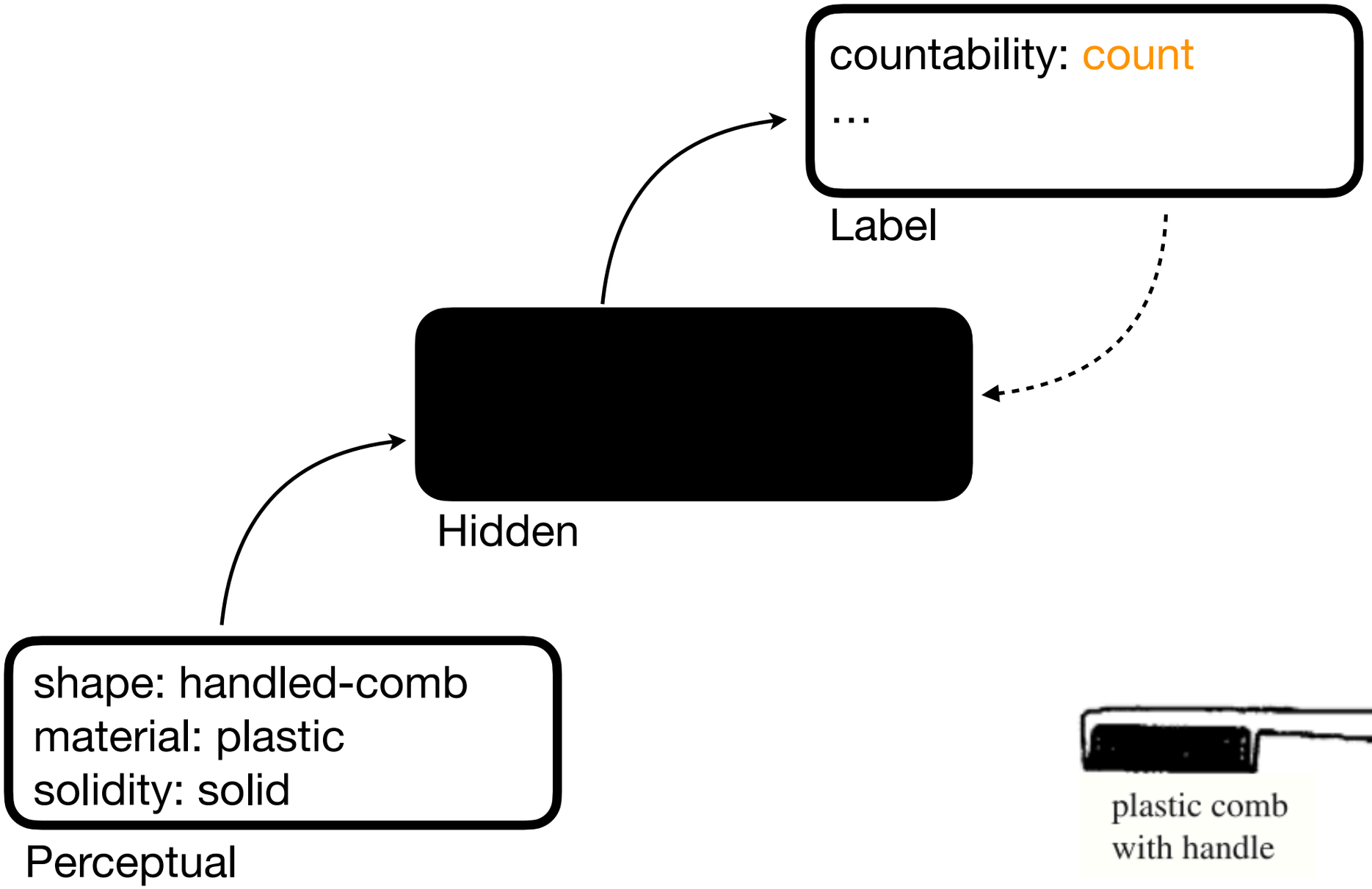


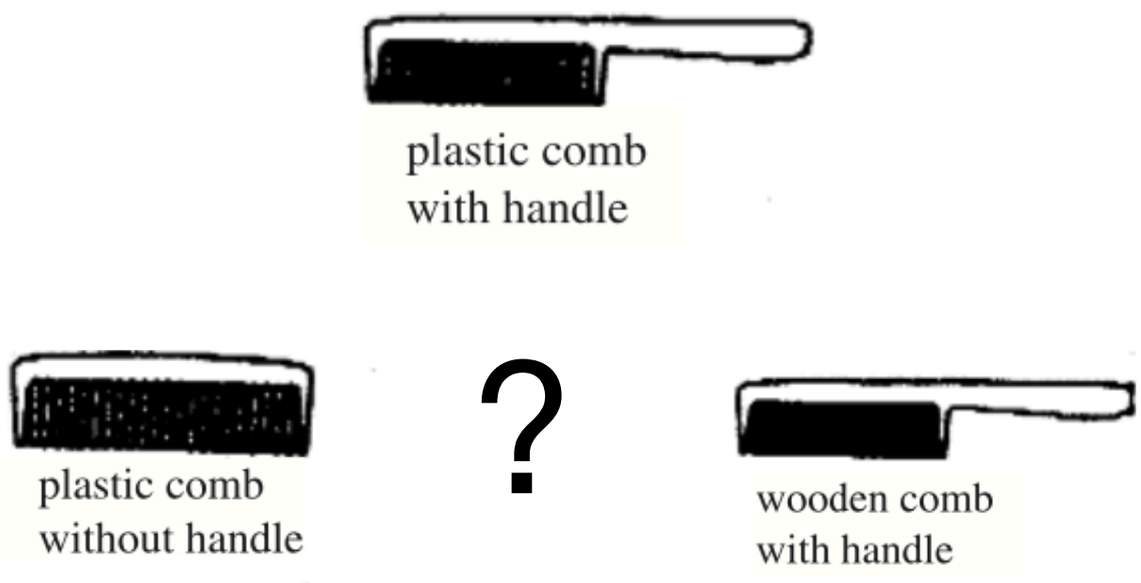
Relationship between solidity, syntax, shape in English MCDI nouns (Samuelson & Smith 1999)

Language and Cognition Synthesis



Language and Cognition Synthesis





Language and Cognition Synthesis

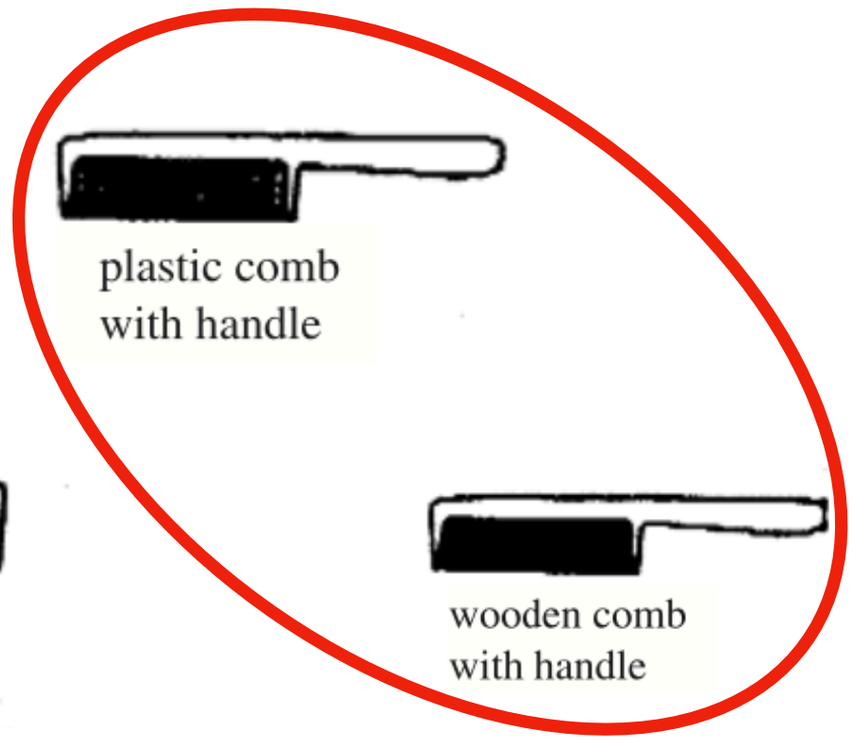
countability: count
...

Label

Hidden

shape: handled-comb
material: plastic
solidity: solid

Perceptual



Conclusions

The nature of the influence of the count/mass distinction on non linguistic cognition seems multifaceted and complex

The distinction between object and substance seems not to be dependent on count/mass; however, the two dimensions can interact when it comes to conflicting clues

Conclusions

Where the count/mass distinction seems to have a stronger effect is when it comes to highlighting certain features of objects

Some of the studies seem to indicate that linguistic clues might help making certain features salient and/or relevant for categorisation

Conclusions

The effects can be classified according to the Wolff and Holmes (2010) distinction as a matter of language meddling with cognitive processes and acting as a spotlight on object features

This opens up the possibility of explaining the effect of count/mass syntax on other cognitive processes in terms of **relationship between labels and features.**

Thank you!

Counting and categorizing:

The relationship between the mass/count distinction and thought

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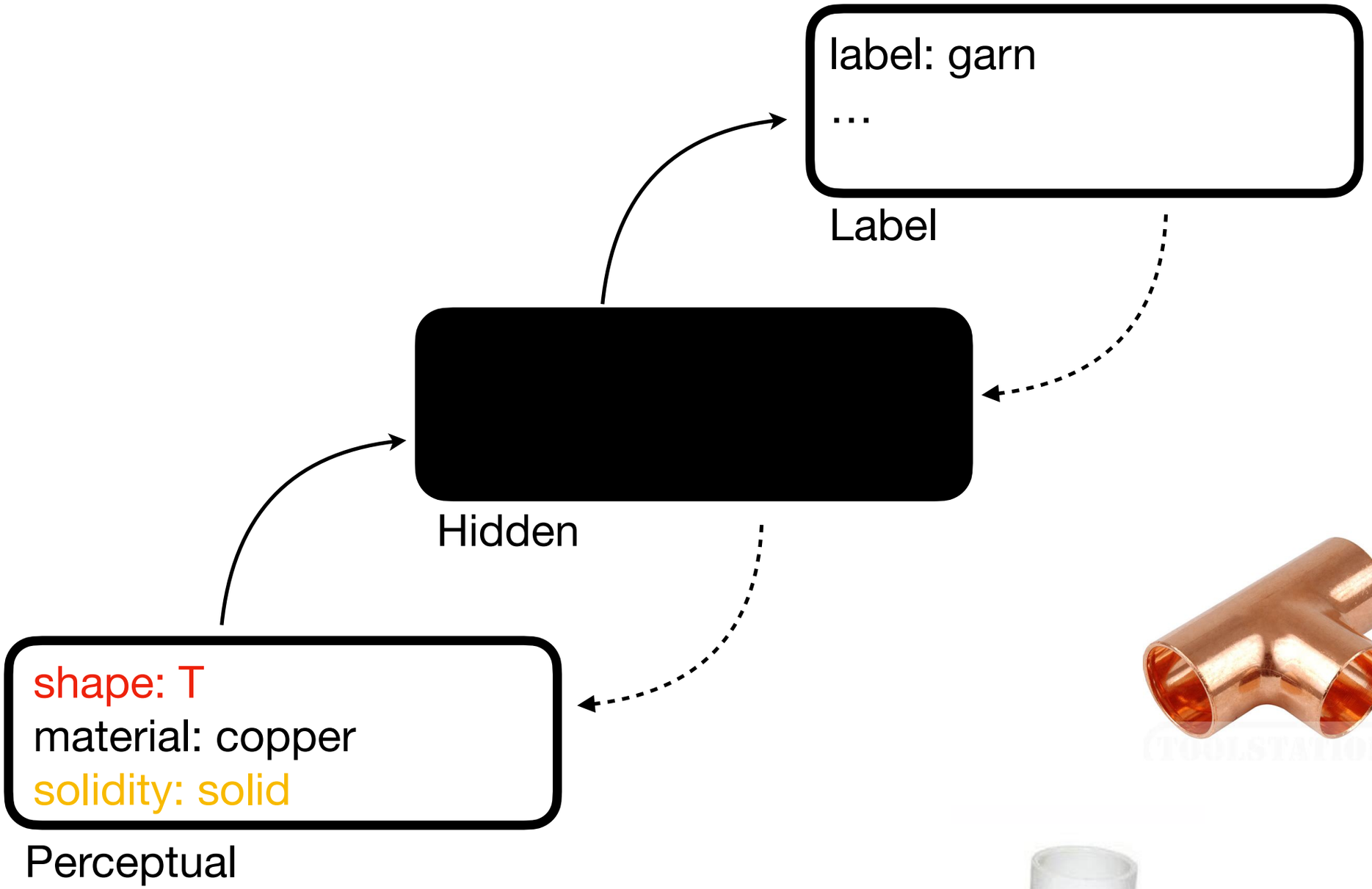
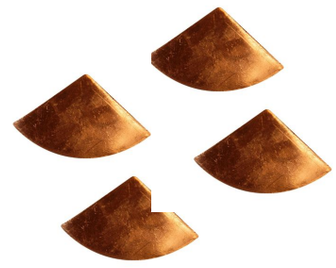
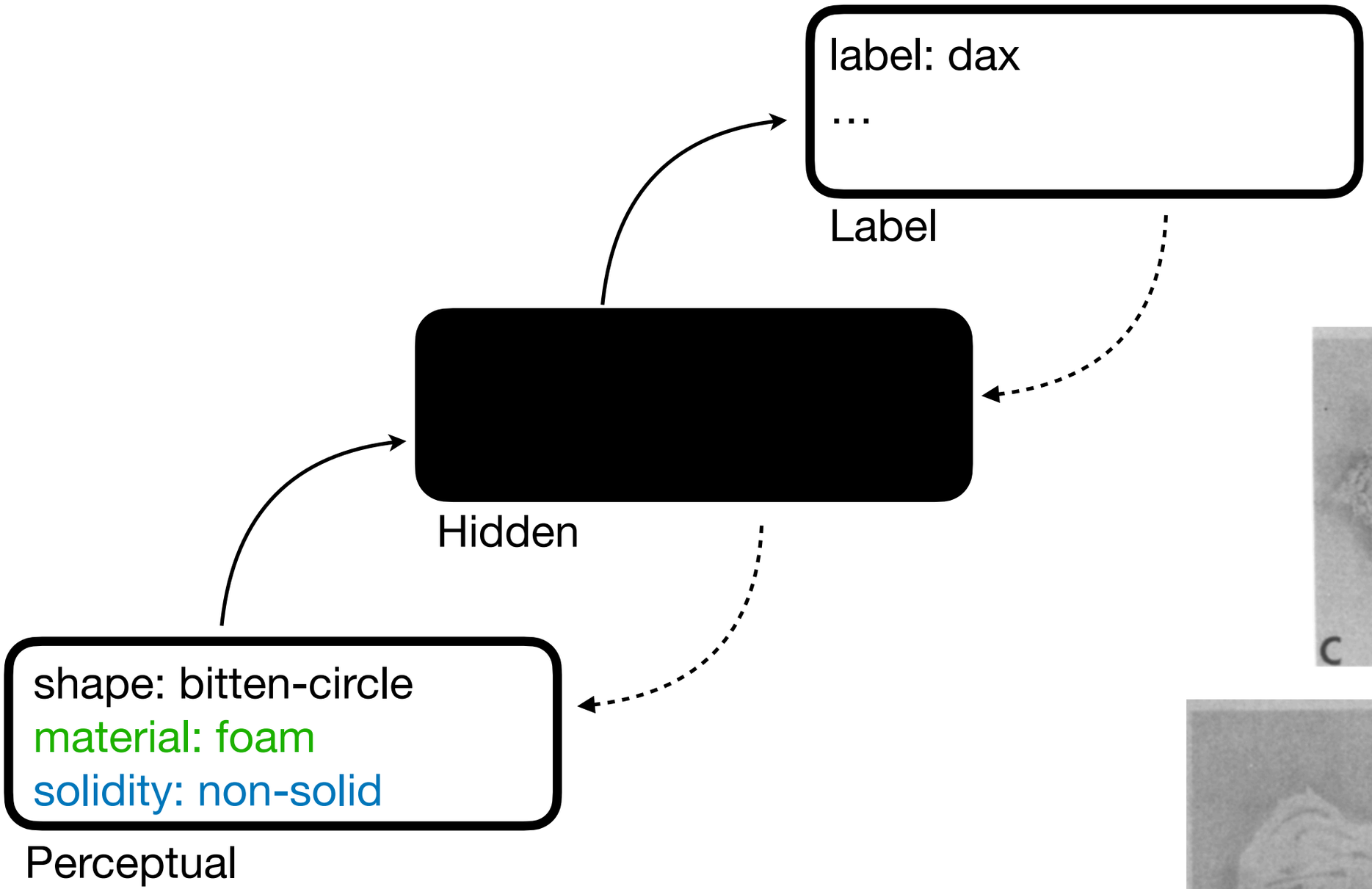
Appendix

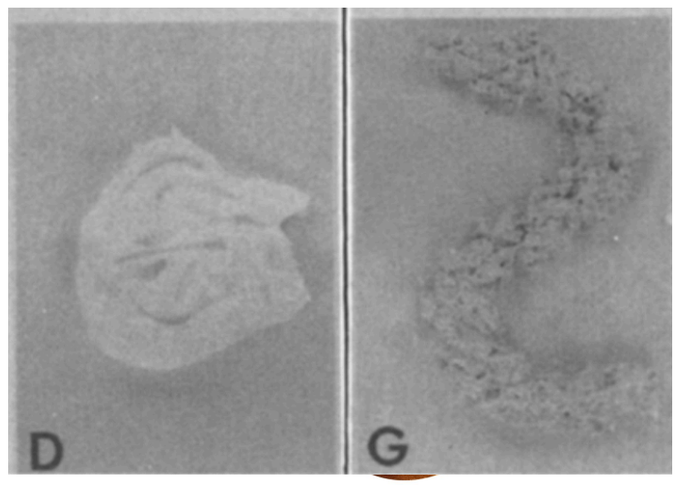
Learning Object and Substance





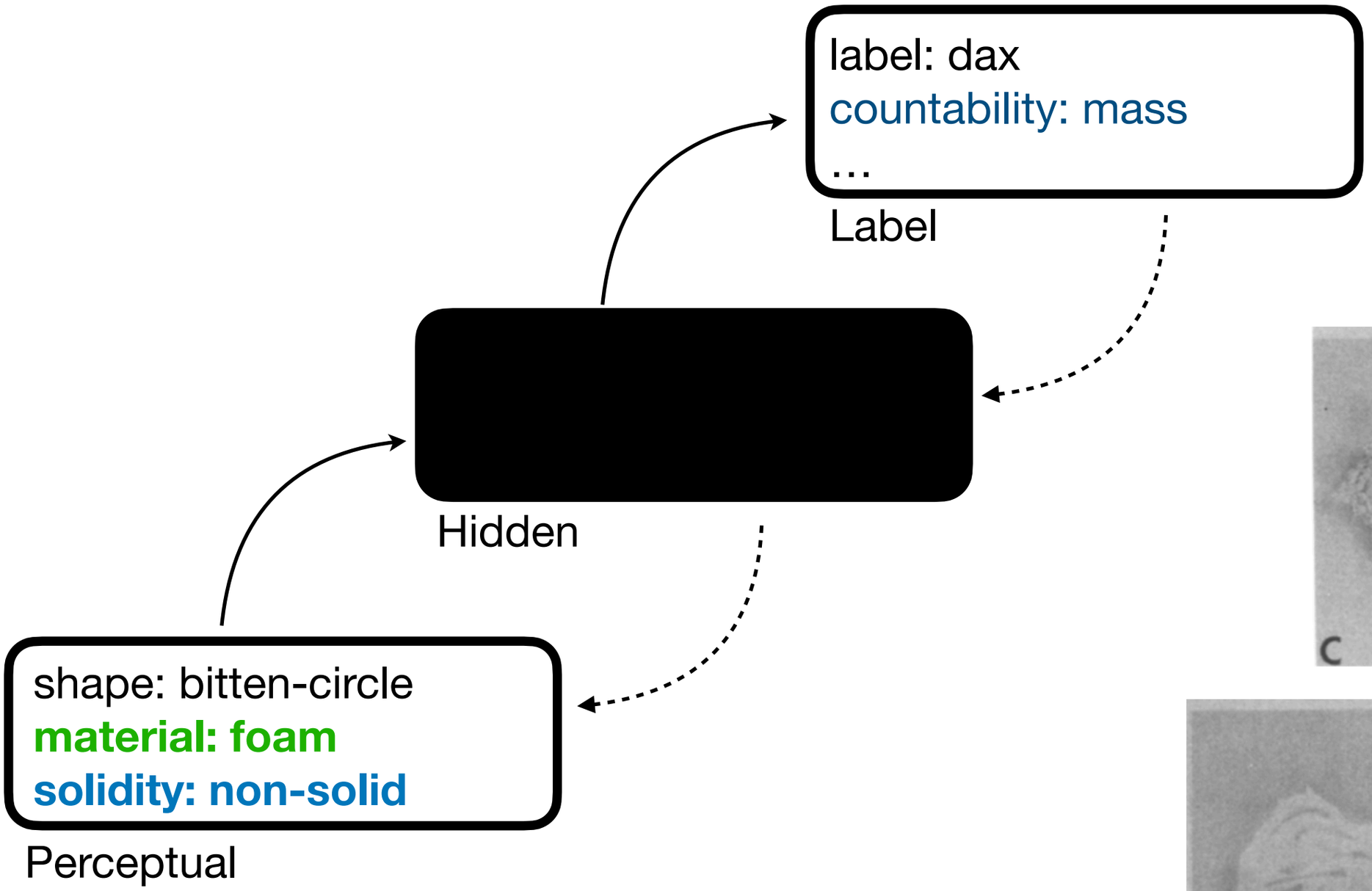
Learning Object and Substance

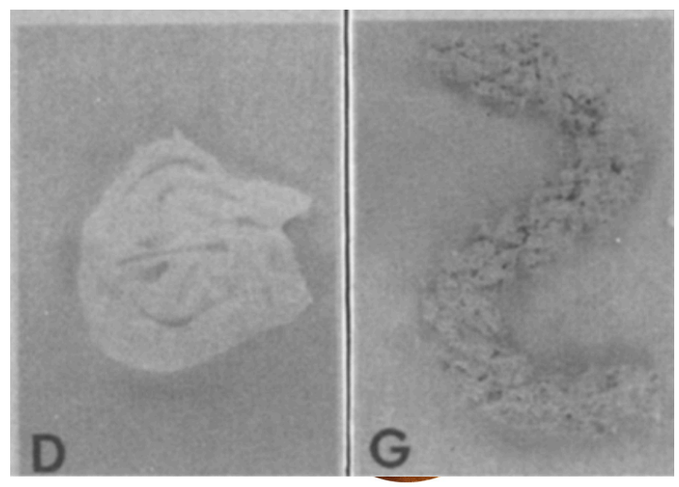




Assumption: associating non-solids with materials and solids with shape does not require linguistic input

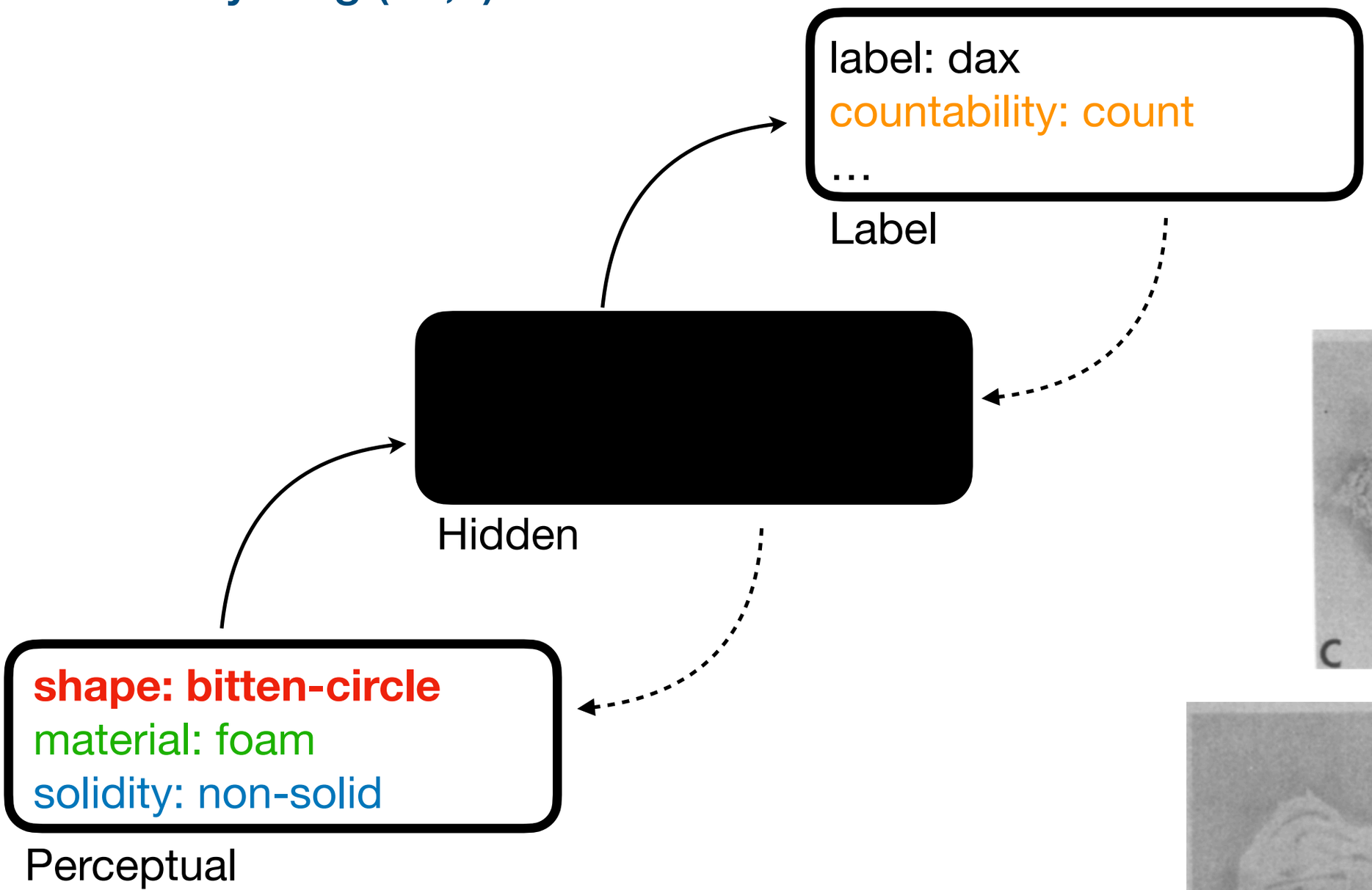
Learning Mass and Count on top of Object and Substance

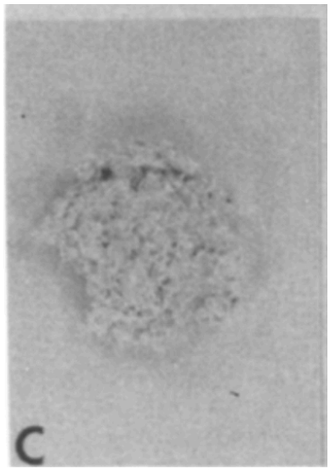


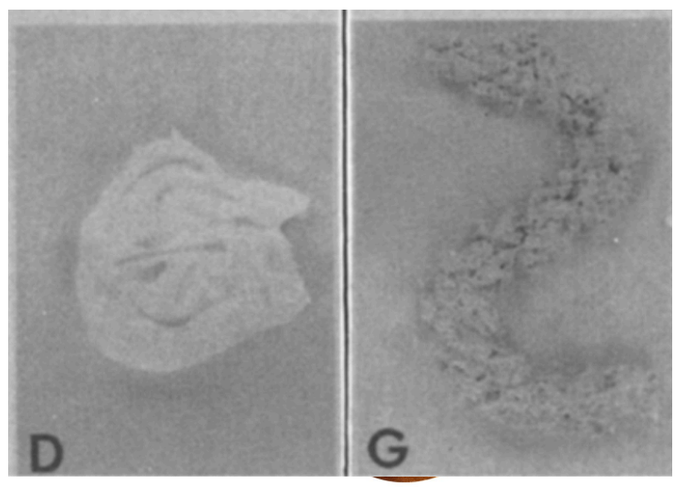


Assumption: learning a noun in mass syntax refers to non-solid does not meddle with the existing association between non-solids and materials

Mass and Count Meddling with Object and Substance
The case of young (~3;4) children







Assumption: learning a noun in count syntax refers to a non-solid meddles with the existing association between non-solids and materials

Mass and Count Meddling with Object and Substance
The case of young (~3;4) children

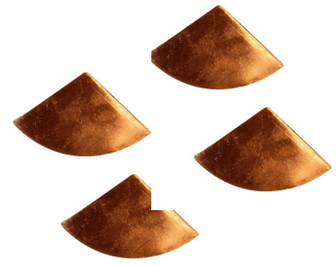
label: garn
countability: mass
...

Label

Hidden

shape: T
material: copper
solidity: solid

Perceptual



Assumption: learning a noun in mass syntax refers to a solid meddles with the existing association between solids and shape

Learning Mass and Count on top of Object and Substance
The case of adults