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How language acquisition builds on cognitive development

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When children acquire a first language, they build on what they know – conceptual information that discriminates and helps create categories for the objects, relations and events they experience. This provides the starting point for language from the age of 12 months on. So children first set up conceptual representations, then add linguistic representations for talking about experience. Do they then discard earlier conceptual representations in favour of linguistic ones, or do they retain them? Recent research on the coping strategies that young children (and adults) rely on when they are unable to draw on language suggest that they retain both types of representations for use as needed.

At around 12–18 months of age, children embark on learning the language of their community, whether this turns out to be Korean, English, Hindi, French, Tagalog or Finnish. Languages differ in how they represent experience, so the language children learn will affect how they talk about objects and events. Some languages offer more terms than others for particular domains. Some indicate whether information comes directly from the observer or through hearsay. Some assign every noun a gender (masculine, feminine or neuter), and might also assign cases to nouns to mark grammatical roles (e.g. agent, location, instrument). And speakers of different languages learn different sets of grammatical elements that must be used in every utterance.

What do children already know when they embark on language? Some researchers focus on the first year of cognitive development and assume that children build on this to begin with, then narrow their focus to just what happens in a specific language. That is, representations of experience are taken to be co-extensive with what is needed in their specific language. A variant on this position is to ignore early cognitive development and simply assume that representations of experience are given and just need to be linked to the relevant linguistic categories when the time comes. A further proposal is that children first build on what they know before language, and then use language *as well* in constructing additional categories [1,2]. That is, cognition and language interact in a cyclical fashion as children learn more.

As researchers have examined acquisition across a range of languages, the picture of what children know and build on has become more complicated. So the fundamental question is, what information do children represent? Do their categories reflect only what their language offers, or do they – must they – make use of other representations too?

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Finding out about language

Children get their information about language from their caretakers and the adults around them. Infants are remarkably sensitive to statistical regularities they hear in language, in sound patterns, grammatical inflections on words, patterns for coining new words, and constructions in adult speech [3–6]. They tend to pick up on the most frequent nouns, verbs and adjectives first, and then extend their range. In doing this, they depend on social interaction. They attend to what is in the joint focus of attention for adult and child, to what is physically and conversationally present, and hence to the language directed to them as addressees. Indeed, social interaction is essential to the process of acquisition [7,8].

At the same time, people can identify, sort, and remember objects and events without using language. And the sorting they do without language does not always match what they do in response to language [9]. This suggests people must set up multiple representations of experience, representations based not only on representations linked to specific languages for encoding experience, but also on their cognitive development, for categorization, identification, sorting and remembering [10].

Children's earliest conceptual representations of objects, relations and events provide a general underpinning for linguistic categories and are one source for universals in language [11,12]. First, humans represent experiences gathered from perceptual input, along with information from inferences in context. In the first 12 months, infants start to organize what they know about entities and events before they gain access to the representational properties of language. But as they start to learn particular languages, their paths diverge. Languages differ subtly in how they encode experience, because they really only *evoke* ideas and offer people selective, schematic maps of the events talked about. That is, the grammatical and lexical options available in any one language do not express every detail of the conceptual categories available. Words draw attention to some elements and leave others aside, with a different selection available for each language. Children must work out

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which categories *their* language picks out [1]. This task continues into adulthood as children map each unfamiliar word and construction onto the relevant conceptual representations. Because languages differ, children learning different languages will often map different linguistic forms and structures onto the same conceptual domain of experience. How they talk about each domain depends on the language they hear. Some of these differences can be detected quite early, almost as soon as children begin acquiring a language. This can be seen in the domain of space.

Space and spatial language in acquisition

When do infants set up a conceptual organization of space? Recent studies show that they can discriminate certain spatial distinctions at 6–7 months. For instance, 6-month-olds readily habituate to looking at a container seen from different angles and holding different objects [13]. By 9–10 months, they can discriminate among more spatial relations in preferential looking tasks. Between 9 and 11 months, they habituate to containment (e.g. a small object in a box), and do so before they attend consistently to either support (an apple on a plate, say) or tight-fit (a tape in a cassette case), which they manage only at 17–19 months. When tested for discrimination between tight-fit containment (a tape in a cassette case) versus loose support (an apple on a plate), and for tight-fit containment versus loose containment (an apple in a bowl), infants aged 9–14 months discriminated both contrasts, suggesting that by that age they are sensitive to a range of conceptual spatial contrasts, only some of which might be relevant to the language they eventually learn [14,15].

Cognitive strategies

These discriminations in infants bear out earlier proposals about children's non-linguistic knowledge about space [16,17]. Consider how 15–18-month-olds deal with spatial relations. In what was originally designed as a comprehension task, where an adult asked them to put a toy mouse *in* or *on* a box, these infants always placed the mouse in the box regardless of what the adult said. And if the box was presented lying on its side, 1- and 2-year-olds first turned it so its opening faced upwards. Asking children to put the mouse *on* this box elicited the same response: the box was turned opening upwards and the mouse placed inside. The conclusion is that these children attend to canonical orientation (the box with its opening upwards) and placement (the toy mouse), but they don't yet understand either *in* or *on*.

In other tasks, where they had to copy exactly what the experimenter did, the same children found it difficult to reproduce an array when the toy mouse was placed on an upside-down glass or next to an upright glass, or when the mouse was placed 2 cm away from the glass: children always placed the mouse inside the upright glass [16]. They had similar difficulties when the mouse was placed 2 cm away from a block: they placed it on the block. In short, 1- and 2-year-olds rely first on their general conceptual knowledge to respond with plausible spatial relations between objects and locations.

This knowledge appears to be built on infants' early experience of how objects and places are typically related: smaller objects go inside containers but on supporting surfaces; objects are typically placed in contact with a target location rather than separated from it; and objects and locations tend to be oriented canonically – boxes and cups stand with openings upwards; supporting surfaces are horizontal; inherently vertical objects are oriented with tops up, and objects that move autonomously move forwards [17–22]. Young children also treat target locations as goals of motion rather than as sources [23]. Their knowledge is displayed in their general cognitive strategies for dealing with relations in space.

Strategies for organizing space appear firmly established in 15- to 18-month-olds, guiding their responses to requests to put an object somewhere. When asked to place objects with spatial terms they do not yet understand, they cope by relying on strategies like those listed in Table 1. If there is a container available, it takes priority over other possible locations. If there is no container present, children look for a supporting surface. And if there is a gap between the target location and the object, children close it up. They also treat any places mentioned as goals of motion, not sources or points of departure, and they attend to canonical orientation for objects and locations – people sit on chairs, toys go in boxes, flowers in vases, boats in water, trains on rails, shoes on feet, corks in bottles, and so on [16,17]. Notice that such strategies can only be established in act-out tasks that leave open choices of placement for the child. Preferential looking with its forced choice establishes discriminations among placements [24,21], but not full comprehension. But as they get older, children become better at following linguistic instructions about space, and relinquish their organizing strategies in favour of procedures consistent with the meanings of words for specific relations [16,24].

Strategy versus word meaning

How are children's organizing strategies related to the meanings of language-specific terms for space? Notice that where there is coincidence between the outcome of a strategy and the meaning of a word, mapping that word onto the spatial relation ought to be relatively easy. Where there is only a partial or no match, learning how to map the word onto a conceptual spatial relation should be harder. This is consistent with data for children's acquisition of English *in* (a match for containment), *on* (a match for support), and *under* (no match for containment or support)

Table 1. Spatial notions and cognitive strategies

Early cognitive discriminations among spatial relations
Containment: 6–7 months onwards
Tight-fit containment: 9–14 months
Loose-containment: 9–14 months
Loose support: 9–14 months
Support: 17–19 months
Strategies used from 15–18 months onwards to relate an object (X) to a location
Containment: if the location is a container, put X inside.
Support: if the location is a supporting surface, put X on top
Contact: if the location is nearby, put X in contact with it
Goal: if the location is mentioned, move X towards it
Canonical orientation: if the location is not canonically positioned, return it to its normal orientation

as well as other prepositional and phrasal spatial terms in English [25,26]. Children's reliance on earlier cognitive strategies, then, appears to account both for early systematic errors and for the initial order of acquisition for English spatial terms.

Adults continue to draw on their initial conceptual organization of space. Consider how you remember where you left the house keys or where the car is parked, how you work out how to put a bookcase together, and myriad other tasks where you draw on spatial information without using language. Notice that if we assume that linguistic encoding of space results in a basic restructuring of children's conceptual representations of space, then any earlier cognitive organization should be *replaced* by the organization derived from each language [27]. This would mean that people's representations of space would depend on, and be limited to, the meanings and contrasts in each specific language. The alternative is that when children learn to talk about spatial relations in a specific language, they learn to attend to some distinctions and to ignore others. Under this view, people retain access to cognitive principles for categorizing, sorting and remembering [9], and these remain available for use when linguistic information is absent.

A parallel with speech perception?

At around 10–12 months, infants begin to attend closely to phonological distinctions in the surrounding language and cease making distinctions they had managed at 6–8 months [28,29]. Do infants lose their earlier discriminative ability, or merely set it aside because they are paying more attention to the surrounding language? Evidence for the latter is that children can later acquire the phonology of additional languages. If they had lost their ability to discriminate, this should be impossible [30]. A similar relation probably holds for conceptual versus linguistic representations: we become so used to 'thinking for speaking' [31] that we generally ignore conceptual information that is not needed for speaking. But this information remains available and can be invoked under the appropriate circumstances.

Cognitive categories and linguistic forms

The mapping of spatial terms onto conceptual categories differs by language. Consider the static spatial relations depicted in Figure 1 [32]. Spanish maps the same preposition, *en*, onto all three relations – containment, support, and attachment; English maps *in* onto containment and contrasts it with *on*, which is mapped to both support and attachment. Dutch uses three prepositions: *in* for containment, *op* for support, and *aan* for attachment. Finally, Finnish maps the inessive case, the suffix *-ssa* 'in', to containment and attachment, in contrast to the adessive suffix, *-lla* 'on', mapped to support. So although infants start with the same cognitive representations of spatial relations, they follow different paths as they learn how their own language maps onto these cognitive notions.

The degree of fit between linguistic meanings and children's conceptual representations is one factor in order of acquisition. But languages differ more generally in their

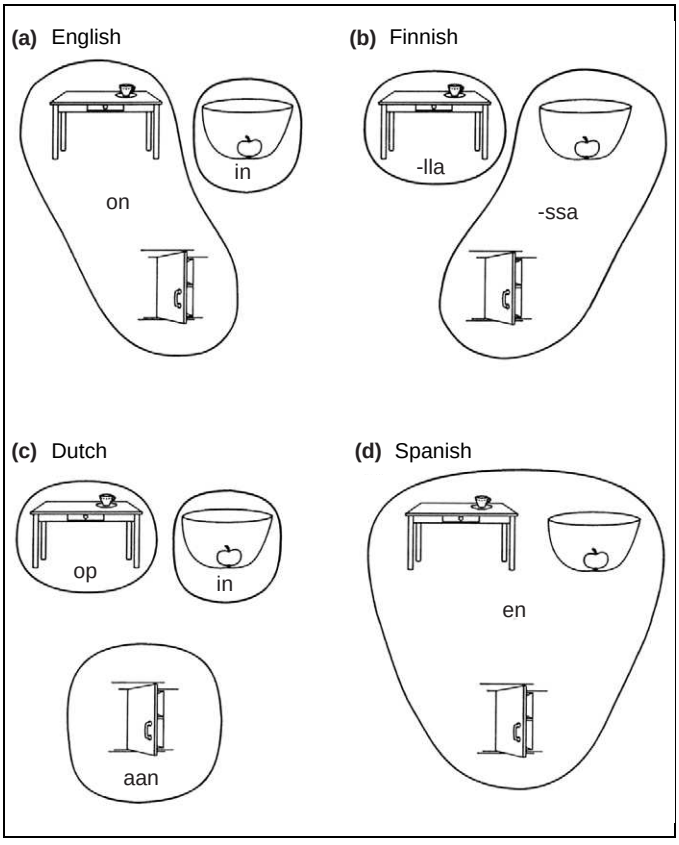

Figure 1. Linguistic terms for three static spatial relations compared for English, Finnish, Dutch and Spanish, for talking about the locations of the cup, apple and handle in the settings pictured [32].

terminology for space. In English, static and dynamic spatial relations are represented with prepositions (*in, on, up*, etc.) and locative particles (*on, off, out*, etc.) as well as verbs of motion (*go, run, swim, leave*, etc.) and location (*put, sit, lie*, etc.). In Finnish, the same spatial relations are marked instead with case-endings on the nouns for places. Other languages like Russian use both prepositions and case endings, and still others, like Tzeltal, use only verbs to express motion and location. Languages conflate information about space (direction, motion, manner and location) in different ways into distinct lexical items; they favour different construction-types (prepositions versus case-endings, for example), and they distribute information about locations and objects-placed differently [33–35].

Children display their first linguistic knowledge of spatial words by 18 months. Because the only spatial terms they hear come from adult speakers, their linguistic encoding of space is necessarily shaped by the language around them. Comparison of English and Korean acquisition, for example, shows that children pick up on the ways adults speak about space early on. English-speaking children produce particles like *up* (for motion up or down in space), *in* (for objects contained in something), and *on* (for objects supported on something), whereas Korean children begin with verbs for objects in tight-fit (*kkita*) versus loose-fit (*nehta*) configurations [36,37]. Children make use of the expressions adults offer – locative particles and prepositional phrases in English, locative

verbs in Korean – as they begin to talk about space, even when their uses are not yet fully conventional.

Children begin mapping the terms and constructions in the language around them onto their cognitive organization of space as soon as the words become available. They master conventional spatial expressions beginning around 18 months and, for some languages, not ending until they are 8 or 9 years old. In languages like Tzeltal or Tzotzil, where verbs alone indicate position and motion relative to a location, children do not over-extend locative particles because there are none [38–41]. Instead, they produce numerous locative verbs early. In English, where many verbs combine with particles to mark location or direction, children often favour particles alone before verb–particle combinations. In each case, their linguistic encoding of space reflects what they hear from adults.

Coping en route to acquiring linguistic forms

When children don't understand something, they typically cope by relying on various strategies for responding. In tasks where children have to place objects in space, children at first simply rely on what they know about spatial relations. Then, as they learn what specific spatial words mean, they use those meanings in place of earlier coping strategies. In Korean, for example, children continue to attend to loose- versus tight-fit, because the meanings of certain verbs are relevant to this distinction, but in English, children need not do so. In English, children must attend to containers versus supports in choosing *in* versus *on*, but in Spanish, children need not do so. In Spanish, children must attend to boundaries and goals in relation to motion, but in English they need not do so [42]. Children's coping strategies reflect their initial conceptual knowledge about spatial relations, knowledge that provides a starting point for their acquisition of the meanings of the spatial verbs, prepositions, particles and case-markings they hear from their caretakers.

Words for objects, actions, parts, properties and events

Children follow a similar path as they map words for objects onto their conceptual categories of objects [43,44,45]. As they acquire language, and even before that, they rely on shape in sorting and grouping objects that are similar [46]. They might produce a word like *apple* first for apples, then over-extend it to oranges, round door-knobs, tennis balls and other round objects. Over-extensions can indicate attention to properties like texture, size, sound and motion as well, although shape dominates [7]. They also attend to some aspects of function [47,48]. But where infants start and the path they follow depends on more than just mapping words onto pre-established categories [49]. It also depends on the social setting and the kinds of information adults offer as children map their words onto cognitive categories.

Children also map words for actions, parts, properties and events initially onto pre-established conceptual categories. As they acquire the meanings of words for actions and for objects, they follow adult usage closely. Their early verb uses, for example, are generally appropriate for the relevant categories of action: *run* for running events, *eat* for eating, *give* for giving, and so on [50]. They attend to adult uses of words for object categories, and also to the information adults offer about properties and parts characteristic of specific category members [51,52] (e.g. teeth, paws, wheels and handles).

Emergent categories

En route to learning a language, children sometimes momentarily mark distinctions that are not conventional

Box 1. Some emergent categories in English acquisition

Emergent categories are categories children mark that might not have linguistic expression in the ambient language (and so must be abandoned) or that call for some conventional means of expression instead [53].

Over-extensions

Until the age of 2–2.5 yrs, children frequently over-extend words in production, typically relying on similarities in shape, and occasionally motion, texture, size and sound:

ball – first applied to balls, then to apples, grapes, squash, bell-clapper, or anything round
tee – first applied to sticks, then to a cane, umbrella, old-fashioned razor, board of wood, and all stick-like objects
cottybars – first applied to the bars of a cot/crib, then to a large toy abacus, a toast-rack, and a building with a columned façade
mum – first applied to horses, then to a cow, calf, pig, moose, and all four-legged animals

Control versus absence of control

At around age 2 yrs, English-speaking children sometimes assign non-conventional meanings to distinct first-person pronoun forms, typically using *me* or *my* for events where the child controls the activity and *I* for events where the child lacks control:

With control:		Without control:	
	My wear it		*I wear it*
	Me jump		*I like peas*
	My taked it off		*I no want those*

Source

Young children also group events that are conventionally encoded with distinct forms or constructions. For example, in English, they might identify a range of events as involving a source or initiator of action through their uses of *from* (in the examples, the child is identified by a letter, and their age given in yrs;mths.days):

D (2;2.3 – of pieces of sandwich pushed off plate): *These fall down from me*. (agent, by)
D (2;11.12): *Look at that knocked down tree from the wind*. (natural force, by)
A (3;0): *I see boats from Mommy*. (possessor, belonging to)
W (3;1.15 – of a toy rabbit): *See, this ear is longer from the other one*. (comparison, than)

in that particular language, but are nonetheless common in the languages of the world [53]. These are called emergent categories. Children who take up such categories mark distinctions that are non-conventional. They do this in some cases for a few weeks or months before dropping or replacing such usage. Emergent categories are a further source of information about children's prelinguistic categorization of objects and events.

Examples of emergent categories in English are shown in Box 1. These emerge as children appear to look for the relevant elements that are grouped together by a linguistic term or construction just acquired. Sometimes the requisite meaning is simply absent from the language in question (e.g. the distinction between control and absence of control over an action); at other times, the relevant meaning (e.g. the source of an action or a comparison) might be subdivided into several parts. In either case, children have to give up their emergent category in favor of the conventional options in use in that speech community. Emergent categories offer further evidence for a common cognitive basis to most or all languages.

The information young children rely on in constructing their initial conceptual categories – shape, texture, motion and function – is also a source for their inferences about the probable meanings of words for those categories. They use existing conceptual information as they build up word meanings and link them to other words – for objects, parts, properties, relations and actions. But which information is pertinent to specific word meanings again depends on the language.

The role of language

Does language itself play a role in cognitive development? To what extent do cognitive development and language interact as children learn more language? First, some researchers have suggested that words themselves might be regarded as invitations to form categories and to individuate object kinds [54–56]. Words undoubtedly direct young children's attention [57,58]. That in turn can influence how young children organize and consolidate what they know about particular kinds and relations.

Second, language can influence cognitive development through its availability as a representational resource. Having a word or phrase for an object, action or relation can draw attention to similarities between cognitive categories across domains (e.g. the notion of 'actor' across different types of action: driving, pushing, picking up, hitting). That is, language might enable analogies that allow for greater complexity of thought [59,60].

Third, language offers children a way to make explicit different perspectives on the same event. Speakers can present an action from the point of view of the agent (*The boy opened the door*), the object-affected alone (*The door opened*), or the object-affected without identifying the agent (*The door was opened*). Speakers can also identify the same referent in a variety of ways (e.g. *the dog, the scavenger, the spaniel, our family pet*), depending on the perspective chosen on each occasion [61]. The extensive layering in language vocabularies might have evolved in part for just this purpose. Very young children recognize and make use of alternate perspectives on objects [62–65] and on events [66]. Finally, children also understand early on that language reflects the speaker's intentions about how to view objects [67]. (For further questions, see Box 2.)

Box 2. Questions for future research

- According to findings on children's ability to discriminate among sounds, children begin to focus their attention on the sounds of the specific language around them between 10–14 months, but their ability to make other discriminations is not lost (consider bilingual and multilingual acquisition in childhood). Children's conceptual discriminations might follow a similar path. They might at first be able to notice all sorts of distinctions and later narrow-in on those actually marked in the language they hear. To what extent does this parallel hold?
- Languages differ in their typology or structure – the meanings, grammatical options, and patterns used in words and constructions. To what extent do these reflect cognitive distinctions already present for young children? Do children also learn to make further distinctions from (adult) speakers of the language? Which grammatical distinctions have a conceptual basis already in place when children start to learn them?
- In language acquisition, comprehension is generally ahead of production. Still, researchers rarely check on whether children really understand specific terms, or whether they are just making reasonable pragmatic inferences about what speakers probably mean. How can researchers examine these alternatives, and document more carefully when young children are *coping* versus *understanding* the linguistic forms used?
- Findings from cognitive development and comparative psychology suggest that language might help establish connections for vision, touch and sound, for example, among categories. To what extent might the acquisition of a language itself account for different patterns and rates of cognitive and linguistic development in children? To what extent might such connections be affected by the amount of language children hear addressed to them?

Summary

When children start to acquire language, they build first on categories that have already discriminated. The conceptual representations they set up in their first year for objects, relations, properties and events provide a broad cognitive basis onto which they can map words from child-directed speech. This speech draws their attention to specific categories and properties of those categories. It also draws their attention to grammatical distinctions not yet represented. In acquiring a language, children must eventually attend to all the distinctions relevant in that language. This includes the ability to take different perspectives on the same event or the same object. But as linguistic representations capture only certain aspects of cognitive representations, both types of representation remain crucial, not only during language acquisition, but also on other occasions when children and adults alike need to draw on non-linguistic as well as, or instead of, linguistic categories.

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