Language and Thought

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Abstract

The notion that the language we speak impacts the thoughts we think is known as the Whorfian hypothesis. This hypothesis is typically tested by, first, describing two languages that differ systematically on a lexical or grammatical dimension and, second, comparing speakers of the two languages on a cognitive skill that might be expected to depend on that dimension. Whether or not we find support for the Whorfian hypothesis depends on how we define language, how we define thought, and what we take as evidence for "impact." Another, more recent way of testing the hypothesis is to explore patterns of thought in human and nonhuman primates who do not have language—rather than compare cognition in speakers of language 1 versus language 2, we can compare cognition in individuals who have language versus those who do not. We can also explore whether language is special in the impact it has on thought by asking whether other conventional symbol systems shape cognition (e.g., does mental abacus affect thinking beyond numerical calculation? does map reading affect thinking about space more broadly?). If it turns out that the effect language has on thought is special, we need to determine which aspects of language make it special (e.g., do we need to explicitly recognize our behaviors as communicative in order for them to have an effect? do the gestures we produce when we talk shape the way we think?). There is much yet to learn about if, when, and how language shapes thought.

INTRODUCTION

Languages around the globe classify experience in different ways. Building on previous work by Edward Sapir and before him, Franz Boas, Benjamin Lee Whorf popularized the hypothesis that linguistic classifications influence not only how people talk but also how they think. More specifically, Whorf suggested that the relentless use of a particular linguistic categorization might, at some point, also affect how speakers categorize the world even when they are not talking. This view was widely embraced in the 1950s and 1960s, drawing on experimental support from Roger Brown and Eric Lenneberg's studies showing a positive relation between the codability of color terms in English and English-speakers' ability to retain and recognize a given color from an

Emerging Trends in the Social and Behavioral Sciences. Edited by Robert Scott and Stephen Kosslyn.
 ISBN 978-1-118-90077-2.

array. The notion that language can influence thought then went out of fashion, but was revived in a Wenner-Gren Foundation Symposium on linguistic relativity that resulted in an influential volume edited by John Gumperz and Stephen Levinson.

Why would anyone ever come up with the hypothesis that the language we speak not only is a conduit for thought but also shapes thought? Consider a plausible scenario. When recounting an event, speakers of Turkish must indicate whether they themselves actually witnessed the event in order to produce a grammatically correct utterance (they must produce an evidential)—even if they have no need or desire to convey this information to their listener. In contrast, speakers of English have the option of not mentioning whether they actually witnessed the event they are recounting, and they often exercise this option. The important point is that speakers of Turkish do not have the choice. After many years of routinely including whether they witnessed an event in all relevant sentences, Turkish speakers might be particularly likely to note whether events are witnessed, whether or not they are talking—more likely than English speakers. If so, becoming a speaker of Turkish, as opposed to a speaker of English, has the potential to alter how an individual views the world. This is the kind of reasoning that underlies what has come to be known as the Whorfian hypothesis.

FOUNDATIONAL RESEARCH

This provocative hypothesis is most often explored in three steps. First, a dimension is identified along which two languages systematically differ (in the earlier example, Turkish contains obligatory evidentials, English does not). Second, a nonlinguistic skill that might be expected to differ as a function of the linguistic differences in the two languages is identified (Turkish speakers might be expected to notice whether an event had been witnessed more often than English speakers). In the final step, speakers of both languages are tested on both the linguistic and nonlinguistic tasks. The Whorfian hypothesis predicts that there should be a systematic difference between speakers of the two languages.

Evidence for the Whorfian hypothesis has been notoriously difficult to come by, and the claim remains controversial. There are, however, some data supporting the view that the relentless use of particular kinds of talk can influence how speakers categorize the world, not only when talking but also when not talking. For example, John Lucy conducted a linguistic analysis of number marking in two very different languages—English and Yucatec Mayan—and found that the languages differ in how number marking is distributed across different types of objects. English uses plural marking to indicate more than one object for animates (e.g., "ducks") but not for substances (e.g., English speakers do not say "muds" to refer to two puddles of mud). Yucatec uses this same continuum, anchored on one end by animates (which take plural marking) and at the other by substances (which do not). The difference between the two languages is in where on the continuum the line is drawn for implements; that is, in whether implements are categorized along with animates, or along with substances, in terms of number marking. In English, implements take plural marking and thus are treated as animates (e.g., "brooms"). In Yucatec, in contrast, implements do *not* take plural marking and thus are treated as substances.

The Whorfian question then is—does this linguistic marking affect the way speakers of these languages categorize implements on nonlinguistic tasks? To address this question, we can give speakers of both languages a nonlinguistic task (a picture recall task), and note whether they pay attention to changes in the number of objects. As expected, English and Yucatec speakers perform identically on objects at the two ends of the continuum. Both English and Yucatec speakers notice when the number of *animates* in the picture changes (i.e., they correctly say this is not the picture they saw when the number of animate objects varies from the original); moreover, speakers of both languages fail to notice when the number of *substances* in the picture changes (they accept as correct pictures in which the number of substances varies from the original). The crucial question, of course, concerns *implements*—and here the speakers differ. As one would predict from the way their languages pattern, English speakers notice when the number of implements in the picture changes (thereby treating implements in the same way as they treat animates), whereas Yucatec speakers do not notice changes in the number of implements (thereby treating implements in the same way as they treat substances). The way speakers of English versus Yucatec mark number in their respective languages thus has a subtle, but measurable, effect on how they categorize objects even when they are not talking—an effect of language on thought.

The Whorfian hypothesis has been explored in a wide variety of domains, with some studies finding evidence to support the hypothesis and others finding no evidence in support of the claim. The domains are chosen because, in each case, a property, event, or relationship within the domain is encoded differently in different languages. Examples of domains that have been explored are perceiving differences between colors; classifying objects according to their spatial relationship; classifying and remembering motion events; or placing objects in spatial arrangements according to different frames of reference.

CUTTING-EDGE RESEARCH

Whether language has an impact on thought depends, of course, on how we define language, how we define thought, and what we take to be the criterion for "having an impact on."

Defining Language

In terms of how we define language, languages differ in the lexical items or the grammatical devices they offer their speakers. For example, languages vary systematically in the number of lexical color terms they use to label the hues in the color spectrum. Although there may be universal constraints on how the color spectrum is partitioned as a function of the number of color terms a language has, the particular labels a language offers could potentially affect how speakers of that language perceive color. As another example, how number-marking devices are used across different object types in English versus Yucatan is a difference across languages at the grammatical level, as is the presence of evidentials in Turkish and not in English. One important distinction that is relevant to grammatical devices is that they can either be obligatory or optional (lexical items are never obligatory). For example, whether or not English speakers want to indicate the number of dogs they are describing, they are forced by their language to produce either the singular (*dog*) or the plural (*dogs*) form of the noun, thereby indicating whether they are talking about one versus more than one dog—number marking is obligatory on nouns for animates in English. Linguistic devices that are obligatory and deeply embedded within the fabric of the speaker's language might be expected to have a more pervasive impact on thought than linguistic devices that are optional.

Recent research has explored the impact of a third type of linguistic category—spatial metaphor—on thought (Dolscheid, Shayan, Majid, & Casasanto, 2013). Dutch speakers (similar to English speakers) describe musical pitches as *high* (*hoog*) or *low* (*laag*); Farsi speakers describe the same pitches as *thin* (*nāzok*) and *thick* (*koloft*). Do these metaphors influence how Dutch and Farsi speakers perceive pitch on a nonlinguistic task? In a height-interference task, participants see lines of varying heights while listening to tones of different pitches; in a thickness-interference task, the lines vary in thickness. After each tone, participants must sing back the pitch they heard. In both tasks, the information conveyed in the lines is irrelevant but potentially distracting. If metaphors influence pitch perception, Dutch speakers' pitch estimates should be more affected by irrelevant height information than thickness information, whereas Farsi speakers' pitch estimates should be more affected by irrelevant thickness information than height information. This is precisely what happens—Dutch and Farsi speakers' performance on the nonlinguistic pitch reproduction task mirrors the different types of metaphors used to describe pitch in the two languages. Even linguistic properties that are optional can have an impact on our thinking.

Defining Thought

In terms of how we define thought, researchers explore the impact language has on how we perceive the world, as well as its effect on how we categorize, recall, reason about, or learn about the world. For example, we can ask whether the frame of reference that a speaker's language habitually uses has an impact on how quickly the speaker can learn different spatial arrangements of objects (Haun, Rapold, Call, Janzen, & Levinson, 2006). Although most languages allow for a variety of frames of reference, they often make heavy use of only one. Dutch speakers rely primarily on a relative frame of reference that makes use of the speaker's point of view to describe small-scale spatial arrangements (in English, "*the bird is to the right of the house*"; to the right of the house as it is seen by the speaker). In contrast, speakers of Haj||om, a Khoisan hunter-gatherer community in Nambia, rely primarily on an absolute frame of reference that makes use of cardinal directions (in English, "*The bird is to the north of the house*"; north of the house does not depend on where the speaker is). The question is whether 7- to 11-year-old children (the age when the relevant spatial terms are typically acquired) and adults differ in how quickly they learn about different spatial arrangements when given feedback with minimal verbal instructions. Participants are positioned in front of table 1 and watch the experimenter place a target under one of five cups; the participants then shift their position 180° to face table 2 where an identical arrangement of five cups is displayed. The participant's job is to find the target hidden under one of the cups on table 2, under two different conditions: egocentric condition in which the target's position on table 2 can be identified using the participant's viewpoint (e.g., it is to the participant's left on both tables); and geocentric condition in which the target's position on table 2 can be identified using a cardinal direction (e.g., it is in the northwestern corner of the display on both tables). Dutch speakers, both children and adults, perform better in the egocentric than the geocentric condition, whereas Haj||hom speakers, both children and adults, show the reverse pattern. The preferred linguistic frame of reference in Dutch versus Haj||hom thus predicts how well speakers of these languages do on a nonlinguistic spatial relational learning task. This is an important result as it suggests that the language we speak can influence how easy it is to learn a new, nonlinguistic task.

Defining Impact

In terms of the type of effects that language can have on thought, there are at least two central issues. First, does the effect that a linguistic property might have on thought depend on the amount of experience the speaker has with the linguistic property? If so, then we might expect that habitual use of a linguistic property over a lifetime would lead to effects that are difficult, if not impossible, to reverse. Perhaps, surprisingly, there is no evidence that the effect of language on thought depends on the duration of linguistic experience. In fact, many studies explicitly manipulate language by teaching people new words, constructions, or metaphors and then explore the impact of that newly learned language on thought—precisely in order to demonstrate that it is language (as opposed to some other aspect of experience) that is producing the effect—in other words, to show that language is playing a causal role in shaping thought.

As an example, in the studies of pitch perception, Dutch speakers are given training during which they complete sentences about pitch relationships using Farsi-like thickness metaphors or, as a control, familiar height metaphors. Both groups then participate in the thickness-interference task. The Dutch speakers who used their familiar height metaphors during training, not surprisingly, perform as Dutch speakers do on the nonlinguistic pitch production tasks. But the Dutch speakers who used thickness metaphors perform as Farsi speakers do after only 20 min of training. A study of this type clearly implicates language as a causal agent of change, but it also suggests that experience with language need not be lifelong and that lifelong experience with language can be overridden in a relatively short period of time. Of course, we do not know how long the training effects will last—presumably Dutch speakers will return to their pre-training state at some point. The short-term nature of the effect suggests that language is not having its impact by changing, replacing, or altering the perceptual apparatus that underlies thought. Moreover, the study puts into bold relief speakers who are fluent in more than one language—under what conditions will language 1 versus language 2 have an impact on a bilingual's thinking?

Another question that this study raises is how malleable cognition is. Are there constraints on the effects that language can have on thought? This question can be addressed by training Dutch speakers to use a "reverse Farsi" mapping in which low frequencies are associated with "thin" and high frequencies with "thick," a pattern not known to be conventionalized in any language. Interestingly, it turns out to be harder for Dutch speakers to learn the reversed thickness metaphors than the Farsi-like thickness metaphor. But more relevant to the point here, even after learning the reversed metaphors, those metaphors do not have an impact on the Dutch speakers' performance on the nonlinguistic pitch reproduction task. The effect of line thickness on pitch reproduction is greater in Dutch speakers who learned the Farsi-like metaphors than in Dutch speakers who learned the reverse-Farsi metaphors. These findings suggest that learning a linguistic metaphor may be modulating the strength of a preexisting mental metaphor, rather than creating a totally new one.

The second issue that we have to consider when defining what counts as having an impact on thought is whether language is covertly or overtly deployed in the task. Dan Slobin introduced the notion of "thinking for speaking"—we shape our thoughts to fit the words we are about to utter. However, the classic Whorfian effect involves carrying linguistic structure over to a nonlinguistic task; for example, carrying the linguistic metaphor used to describe pitch over to a nonlinguistic task in which pitch is perceived and reproduced. But even though no words are actually spoken in the task, participants could be covertly recruiting words on the task. The traditional way to explore this possibility is to give participants a verbal-interference task. If the effect of line height on pitch reproduction is driven by covertly labeling the lines, then the effect should diminish when participants are required to rehearse letter strings (for later recognition) simply because rehearsing prevents them from covert line labeling. Verbal interference, in fact, has no effect on pitch perception and reproduction, suggesting that, in this case, the speaker's language is having an indirect impact on thought—the language influences the way the stimuli are processed even when no language (covert or overt) is involved.

KEY ISSUES FOR FUTURE RESEARCH

Traditionally, when researchers examine the impact of language on thought, they compare speakers of two distinct languages that vary systematically in how a particular type of event is encoded; that is, they compare the impact of two different languages on how speakers of each language think. A different, more recent approach to the question is to remove language entirely and examine the impact of having a language (any language) versus not having a language. This approach allows us to explore default patterns present in the absence of language, and to identify ideas that require language to develop and flourish. Three types of studies illustrate this approach.

Animals without Language

Studying animals that do not have human language is an excellent way to explore how far thought can progress without language, and to observe default patterns of thought that might influence the impact language can have. As an example, orangutans (Pongo pygmaeus), gorillas (Gorilla gorilla), bonobos (Pan paniscus), and chimpanzees (Pan troglodytes) are tested on a modified version of the frame of reference task described earlier (the object-centered and geocentric conditions are collapsed, and the task requires only that the animals act on their interpretation of the training bias, not that they learn an abstract rule). All of the great apes prefer to process spatial relations using environmental cues rather than egocentric cues, suggesting that the default pattern for interpreting spatial arrangements is not in relation to the self, but rather in relation to environmental cues. This apparently inherited bias toward allocentric coding of spatial relations can be overridden by language (e.g., the egocentric patterns found in English and Dutch). Overriding the bias might, however, come at a cost; for example, an egocentric system might be mastered later in development than an allocentric system, and might continue to present difficulties even in adulthood (e.g., difficulties distinguishing left from right). By examining animals that do not use human language, we see not only that language can have an impact on how we interpret spatial arrangements but also that its impact must be interpreted in the context of default biases that we all bring to the table.

HUMANS WITHOUT LANGUAGE

All cognitively intact humans, when exposed to a model for a particular language, acquire that language. But under some circumstances, a human child is exposed to an inaccessible language model. For example, deaf children with profound hearing losses and no access to cochlear implants are typically unable to take advantage of the spoken language model that surrounds them. If these children are born to hearing parents (as most deaf children are), they are also not likely to be exposed to a model of a sign language. The children thus lack any conventional language. Under these circumstances, children typically use gestures, called *homesigns*, to communicate with the hearing individuals in their worlds. We can thus ask, first, whether homesigners encode a particular notion in their gestures and, if not, whether the children display evidence of having this notion on a nonlinguistic task. The absence of language for a particular notion, combined with poor performance on a nonlinguistic test tapping the notion, would suggest that the notion is difficult to develop without language.

Take, for example, deaf children living in Istanbul whose hearing losses prevented them from acquiring speech and whose hearing parents had not exposed them to sign language (Gentner, Özyürek, Gürcanli, & Goldin-Meadow, 2013). Although the children use homesign to encode directional relations—the direction a figure moves toward or away from a ground (e.g., *box came here*), they do not use homesign to encode spatial relationships—the relation between a figure and a ground (e.g., *box came on top of the truck*). Moreover, when tested on a spatial mapping task, homesigners perform significantly worse than hearing Turkish children who are matched to the deaf children on another cognitive task. The absence of spatial language thus goes hand in hand with poor performance on the nonlinguistic spatial task, pointing to the importance of spatial language in thinking about space.

Number is another domain in which we can explore cognition in humans without language. The exact quantities to which words such as "seven," "eight," and "nine" refer seem so basic it is hard to imagine that we might need the word "seven" to have the concept seven. But evidence from the Mundurukú and Pirahã, Amazonian people in rural Brazil whose languages do not contain words for exact numbers larger than five (the Mundurukú) or any exact number words at all (the Pirahã), suggests that language, particularly the numeral list in a count routine, may be importantly involved in the ability to represent the exact cardinal values of large sets (the Mundurukú and Pirahã can match sets containing small numbers of objects, <4, but not sets containing large numbers of objects). However, the difficulties the Amazonians have with large exact numbers might stem not from the absence of relevant words in their language, but from the absence of culturally supported contexts in which large exact number must be encoded (they do not typically need to be exact when dealing with large numbers of things). We can turn to homesigners who lack a linguistic model for number but who live in the numerate culture of Nicaragua to disentangle these possibilities (Spaepen, Coppola, Spelke, Carey, & Goldin-Meadow, 2010). These homesigners are unable to learn Spanish and have no access to Nicaraguan Sign Language. They have no congenital cognitive deficits and perform as well as hearing siblings and friends on tasks testing mental rotation skills; they hold jobs, make money, and interact socially with hearing friends and family but do not know one another; none attends school regularly.

Unlike the Pirahã and Mundurukú who do not use their fingers to communicate or reason about number, the homesigners communicate about number using gesture. However, they do not produce gestures that accurately represent the cardinal values of sets containing more than three items—that is, they do not display an understanding of large exact numbers in their homemade language. Moreover, when asked to make the number of items in a second set match the number of items in a target set, they are unable to do so reliably for sets containing more than three items—that is, they do not display an understanding of large exact numbers in a nonlinguistic task. These findings suggest that a language model for exact large numbers may be essential to develop representations of large exact numbers that are flexible and generalize across domains.

Humans Before Learning Language

A third way to explore the impact of language on thought is to examine children before and after they begin to acquire language. For example, even before infants begin to speak, novel words guide their attention to objects and highlight commonalities and differences among those objects. Hearing a word when presented with a set of objects encourages 6-month-old infants to recognize commonalities across the objects (e.g., that they are all dinosaurs), whereas hearing a tone does not. Conversely, labeling two objects with distinct words (e.g., *ball, duck*) makes it easier for 10-month-old infants to keep track of the unique identifies of the objects than if the objects are not labeled. Language invites children to make different types of generalizations in a situation than they would make without language.

Particular kinds of words influence how children reason about a situation. For example, English-learning children perform significantly better on a spatial mapping task (the same task used to study homesigners) when the experimenter uses spatial relational words (*top, middle, bottom*) during the task. Moreover, when brought back to the laboratory several days later, the children continue to show improved performance even though no spatial terms are used the second time around, suggesting that hearing spatial language can invite specific spatial encodings that are then retained over time. Interestingly, older children (5½–7 years) perform well on this task even when *not* provided with overt spatial language, suggesting that, with repeated exposure as a child grows, the spatial representations invited by language can become habitual encodings. These results confirm the findings on homesigners, who lack linguistically encoded spatial relations and who are commensurately disadvantaged on the spatial mapping task.

One additional question that looking at language learners can help us address is when in development a particular linguistic construction begins to have an effect on thought. For example, 7- to 11-year-old Dutch-speaking children display the same egocentric pattern that adult Dutch speakers display on nonlinguistic tasks. In contrast, 4-year-old Dutch-speaking children display the default allocentric pattern found in nonhuman primates. Somewhere between ages 4 and 8 years, children's nonlinguistic cognition starts being influenced by the language they have been speaking for years. We see a similar effect in Yucatec-speaking children. Before 8–9 years, children categorize objects in the picture recall task described earlier according to the English language pattern (i.e., implements are treated in the same way as animates, with a focus on their form rather than their substance); this pattern thus appears to be the default. After 8–9 years, Yucatec-speaking children begin to display the same pattern that adult Yucatec speakers display on the nonlinguistic picture recall task. Future research is needed to determine whether this age period is special in terms of when grammatical constructions begin to have an impact on nonlinguistic thought and, if so, why. What else might be going in a child's world that would heighten the impact that language has on thought?

Is Language Special?

Language is a codified system shared across members of a community. One question for future research is whether other codified systems also have an impact on thought. Consider, for example, mental abacus, a system for performing rapid and precise arithmetic by manipulating a mental representation of a physical abacus (Frank & Barner, 2011). Mental abacus is represented in visual working memory and, as such, is a nonlinguistic format for exact numerical computation, one that has an impact on thinking (mental arithmetic). A question for future research is whether becoming an expert in mental abacus confers skills in mental arithmetic that extend beyond the abacus (and is analogous to asking whether the effects that language has on thought extend beyond linguistic tasks). As a second example, consider the influence that maps, another nonlinguistic codified system, have on the development of spatial cognition (Uttal, 2000). Maps provide a perspective on spatial information that differs in important ways from the perspective gained from direct experience navigating in the world and, as such, have the potential to shape our abstract concepts of space.

If it turns out that the impact language has on thought is in some respects unique, we will need to determine which aspects of language make it special. For example, we can ask whether a linguistic system needs to be shared across users to have an impact on cognition. Homesign is relevant here in that each homesigner has his or her own system of regularities, but the regularities are not shared across homesigners. Does using a consistent pattern found only in one's own system have the same impact on thought as using patterns shared across individuals within a community? Finally, we can ask whether a system needs to be explicitly recognized as a system in order for it to have an impact on thought. The spontaneous gestures that accompany speech are relevant here. Co-speech gesture is not recognized as a system unto itself (and, in fact, cannot easily be interpreted without the speech it accompanies). We know that the language we speak does not completely constrain thought even when we are talking simply because the gestures we produce along with speech can convey ideas not found in that speech. The question for future research is whether co-speech gesture not only reflects thinking but also alters thinking.

CONCLUSION

Language is surely a conduit for thought and, as such, shapes the thoughts we express; for example, we routinely express, and therefore must think about, evidentials when we are speaking Turkish, but not when we are speaking English. Importantly, however, language does not completely constrain our thoughts even when we are talking; for example, we can express ideas in our co-speech gestures that go beyond the ideas expressed in speech. Language is not thought.

But language can have an impact on thought when we use it and even when we do not use it. However, many language and thought effects disappear under conditions of verbal interference (i.e., when participants are forced to produce irrelevant words), suggesting that even though language is not used overtly in these instances, it is drawn on covertly. This is an interesting effect in and of itself, as it underscores the fact that we often recruit language "under the radar" when the task does not demand it, particularly when (as Lila Gleitman has hypothesized) the situation is ambiguous. Finally, it is worth noting that history is recorded in language. Our communal memories—the memories we hand down to future generations—are therefore influenced by the language we speak, which may be the most pervasive effect that our language has on how we think.

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SUSAN GOLDIN-MEADOW SHORT BIOGRAPHY

Susan Goldin-Meadow A year spent at the Piagetian Institute in Geneva while an undergraduate at Smith College piqued Susan Goldin-Meadow's interest in the relation between language and thought. She has explored these interests through gesture: (i) The home-made gestures profoundly deaf children create when not exposed to sign language, called *homesigns*. Homesign offers us insight into the skills that children themselves bring to language learning, and into the linguistic properties that conventional sign languages are likely to have had at the earliest stages of their creation (*The resilience of language,* NY: Psychology Press, 2003). (ii) The gestures hearing speakers spontaneously produce when they talk. These gestures not only reflect a speaker's thoughts (often thoughts speakers do not know they have) but also play a role in changing the speaker's thoughts (*Hearing gesture,* Cambridge, MA: Harvard University Press, 2003). Goldin-Meadow got her PhD from the University of Pennsylvania under the direction of Rochel Gelman and Lila Gleitman. She then moved to the University of Chicago where she is currently the Bearsdley Ruml Distinguished Service Professor. She is the founding Editor of *Language Learning and Development*, former President of the *International Society for Gesture Studies* and the *Cognitive Development Society*, and a member of the *American Academy for Arts and Sciences*.

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