Reformulating the Sapir-Whorf Hypothesis: Discourse, Interaction, and Distributed Cognition

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The position that the structure of a language has an impact on the cognition of its speakers is a venerable, if controversial, one in both linguistics and anthropology (see Gumperz and Levinson 1996 and Lucy 1992 for recent overviews). Over the last 60 years, a wide range of theories about the relationship between language and thought have been developed and disputed. The theories that posit some shaping or determining effect of language on thought are typically grouped under the rubric of linguistic relativity theories, or more popularly, the Sapir-Whorf Hypothesis (SWH).

Interestingly, the long-standing controversy over linguistic relativity has been only modestly impacted by two significant developments in our modern understandings of language and cognition – namely, the now commonplace position that both language and cognition are fundamentally interactional and socially-situated practices that cannot be reduced to isolated, abstract knowledge structures.

The goal of this paper is to make use of these reconceptualizations of language and cognition to recast linguistic relativity in a way that responds to modern concerns with discourse and interaction. I seek to do this by bringing into conjunction two distinct but complementary streams of research: first, the anthropological tradition of ethnographic research on discourse and interaction. And second, the emerging body of work by cognitive anthropologists and cognitive scientists on socially-situated cognition and cognition-in-interaction. Informed by these two traditions, I propose a reformulation of the SWH that ascribes the impact of language on thought to the patterning of the concrete discursive practices that mediate and constitute those distributed cognitive processes that arise via social interaction.

I will begin with a brief review of the dominant conceptions of language and cognition in linguistic relativity research, focusing on the structural and non-interactional perspective the majority of this work takes. I will then discuss the theoretical bases and antecedents of the present paper. Finally, I turn to a case study of engineering students engaged in collaborative problem-solving, to examine the relationship between communicative and group-level cognitive activity in a concrete empirical context.

The work in recent years on linguistic relativity by scholars such as John Lucy (1992, 1996) and Stephen Levinson (1996) represents a significant leap in theoretical sophistication and empirical rigor in comparison to earlier work. From the perspective I take here, however, there are important continuities between early and modern approaches.

In particular, both early and modern approaches overwhelmingly analyze language in terms of the semantic properties and organization of a language's lexicon and morphosyntax. Consequently, theoretical and empirical attention has focused on the cognitive effects of the organization and semantic properties of color terms, kinship terms, and ethnobiological taxonomies, and on obligatory morphosyntactic categories such as noun and numeral classifiers, tense, and aspect. In these traditions, then, language is typically understood in terms of abstract structure, and not as discourse.

The dominant conception of cognition operative in both these traditions is similarly divorced from concerns with practice and interaction. In most work on linguistic relativity, cognition emerges as a process of categorization of objects of perception. This process is effectively theorized as being carried out by isolated individuals outside of real-life contexts of task-performance or social action. And although the linguistic and mental structures of interest are assumed to be replicated in the minds of all speakers of a given language, the existence of a community of speakers and of interactions between them has been of little theoretical or empirical importance.

Since the 1970s, of course, the insufficiency of viewing language solely as mental structure has become increasingly clear. Theoretical and empirical work in several research traditions, including the ethnography of speaking (Bauman and Sherzer 1989 [1974]), conversation analysis (Ochs et al. 1996), and sociolinguistics have shown that interaction, context, performance, and culture are all essential to understanding the full significance and functioning of language (Duranti and Goodwin 1992). Similarly, starting in the 1980s, the socially-situated and culturally-contextualized nature of cognition has become apparent (Lave 1988, Rogoff and Lave 1984). And since the 1990s, the significant role of interaction between individuals, and between individuals and their environment, in *real-life* cognition (Agre 1997, A.Clark 1997, Hutchins 1995, Varela et al. 1993) has also become clear.

The reformulation of linguistic relativity that I propose rests on the two theoretical shifts just indicated: first, from a concern with grammar to a concern with discourse in the context of face-to-face interaction; and second, from individual, isolated cognition, to socially-distributed cognition among a group of individuals.

I trust that the basic conceptual and empirical issues implicated in the first shift, from grammar to discourse and interaction, will be familiar, so I will focus here on a discussion of the second shift, from individuated to distributed cognition.

The concept of distributed cognition arises from the observation that real-life cognition is rarely, if ever, a process bounded by the skull. Instead, real-life cognition involves interaction with other individuals, and with semiotic artifacts such as texts and maps. Research in distributed cognition therefore seeks to rethink the basic unit of cognition, expanding it beyond the brain to encompass the whole body, useful physical artifacts and technologies, and ultimately, groups of people. Among other things, then, distributed cognition concerns itself with the cognitive states and processes that can be ascribed to groups of interacting individuals (A.Clark 1997, Hutchins 1995).

What is meant, though, by a group-level cognitive state or process? An example can help here. In an early study of distributed cognition, Ed Hutchins examined the functioning of a navigation team aboard a naval vessel. The task of the navigation team is to keep track of the location of the vessel. It did this by taking measurements of the orientation of the vessel relative to visible landmarks. Using these data, a plotter triangulates the position of the vessel on a detailed navigational chart, a process known as 'taking a fix'.

This process involves several individuals: two bearing-takers make and call out bearing measurements to another individual who records the information in a log. A fourth individual takes the information from the log and plots it on the navigational chart, and a supervisor manages the timing of the entire process. All of these individuals are involved in the flow of information that makes the fix possible, and the cognitive processing for the task is distributed among them. Working together, the navigational team is able to answer the basic question: 'where are we?'. Taking a fix in this way, then, is an example of a distributed cognitive process, a cognitive process that is fundamentally dependent on the interaction and contributions of multiple individuals.

Returning now to discourse, it will be readily appreciated that in the collaborative work of the navigation team, communicative interaction is crucial. Members of the group share information with one another, check their understanding and seek clarifications, and dispute and agree on interpretations by using speech and writing. Language enables members of the group to share aspects of their own cognitive processes with others, as well as to gain access to those of others. The result of this language-mediated interaction is not merely an aggregate of isolated individual cognitive processes but the emergence of a network of cognitive activity that supports group-level cognitive processes.

The inspiration for my present argument, and one contained in Hutchins' own work, is the idea that the characteristics of distributed cognitive activity that emerge through the interactions of a group depend in part on the nature of the communication that constitutes those interactions. From this perspective, then, the Whorfian concern regarding the impact of language on thought can be reformulated as an interest in the impact of discourse and discursive practices on processes of distributed cognition.

This reframing of linguistic relativity falls under the rubric of what John Lucy has called *discursive relativity*.

> Any investigation of the relation between language and thought must also cope with [differences in patterns of use] in natural languages. The question is whether patterns of use have an impact on thought either directly or by amplifying or channeling any effects due to linguistic structure. We can call this the hypothesis of *discursive relativity*, a relativity stemming from diversity in the *functional* (or goal-oriented) configuration of language means in the course of (inter)action. (Lucy 1996, 52)

Perhaps the first scholar to suggest a discourse approach to the linguistic relativity problem was Dell Hymes. In a series of papers in the 1960s (Hymes 1961, 1966), Hymes proposed that while language structure may be important for questions of linguistic relativity, language use should be of even greater importance.

It was not until the late 1980s, however, that Hymes' ideas were further developed by the linguistic anthropologists who formulated the discourse-centered approach to culture (DCAC). These scholars argued that rather than looking for causal influences of language on culture, researchers should instead seek to understand how discourse, especially verbally artistic discourse, serves to create and shape both language and culture (Sherzer 1987). From this perspective, grammar and culture provide resources and impose constraints that favor certain discourse forms and processes, which reflexively affect grammar and culture.

Interestingly, the DCAC tradition largely elides the question of cognition and reframes the SWH as referring to the relationship between language and culture. I am inclined to believe that one reason for this is the difficulty in marrying a concern with discourse with the conceptions of cognition as the abstract mental structure and symbol processing of individuals that were until recently completely dominant in research on cognition. The concept of 'culture', on the other hand, provides a way of talking about meaning and knowledge that does not privilege individuals.

In the neo-Whorfian research of the 1990s, the notion of discursive relativity was further developed by several scholars, including Dan Slobin (1996), John Haviland (1996), John Gumperz (1996), and Herbert Clark (1996). Of this collection, Herbert Clark's work on the achievement of joint attention in interaction, a process he calls coordination, stands out in its emphasis on a unit of analysis – the conversing pair – that at least implicitly challenges the assumptions of individuated cognition

However, with the exception of Clark's work, and possibly that of the discourse-centered approach to culture, work on discursive relativity has remained committed to an individuated model of cognition. It is only with Ed Hutchins' development of the concept of distributed cognition that the question of linguistic relativity with respect to units of cognition other than individuals receives significant attention.

> When cognitive activities are distributed across social space, the language or languages used by task performers to communicate are almost certain to serve as structuring resources, and the structure of language will affect the cognitive properties of the group even if they do not affect the cognitive properties of individuals in the group. (Hutchins 1995, p232)

Interestingly, Hutchins himself ultimately does not examine in depth how the "structure of language" employed by the navigation team in his study affects its cognitive properties. Instead, he turns to computer simulations of groups of communicating individuals that he uses to explore how differently-connected networks of individuals with abstractly parameterized levels of 'persuasiveness' yield groups with different group decision-making properties. This approach certainly serves to buttress the theoretical plausibility of the general claim he is making – namely that patterns of communication affect patterns of distributed cognition – but it does not address how this abstract formulation is grounded in actual communicative interactions. Thus, while recognizing the importance of language in affecting the properties of distributed cognitive systems, Hutchins ultimately does not pursue the empirical question in the direction that - at least for a linguistic anthropologist – it seems to lead.

I now wish to shift to an empirical discussion of the ideas presented thus far. To do so, I turn to a study I carried out on collaborative problem-solving interactions among engineering students. Here I will look at two interactions in which groups of students are working together to solve textbook problems assigned to them in their introductory physics course.

Students in courses like these are often encouraged by their professors to work on homework problems in groups. In fact, at the university at which this research was carried out, the physics department provides a space with large tables where students can meet to work on problems together. The data I analyze here were obtained by videotaping interactions at these tables.

In homework, the students' task is to develop and implement a computational strategy that yields a computational trajectory – in other words, a series of algebraic and arithmetic calculations – that leads to the correct answer.

In examining the interactions of these two groups I seek to relate certain observable features of their group-level cognitive processes to observable patterns in their communicative activity. Broadly speaking, I shall be focusing on how the interactants in the two different groups communicate about their computational activities, and how this in turn affects the ways in which the groups generate and evaluate computational trajectories.

The first interaction involves two students; here two features of the interaction are of interest. First, notice that there are three distinct sequences of interaction, which follow periods of extended silence during which each student works by himself on the problem. Second, notice that each sequence is initiated by an explicit request for information, namely, the completed answer that the other person has obtained. And third, notice that when the two students find that their answers are divergent, they work their way back to the point in the calculational trajectory at which their calculational steps diverged. And, after reaching the point of divergence, they resume their individual calculational work.

<u>Interaction 1</u>: 2 participants (A and B)

```
B: what did you get for 4.61? A.
A: u:hm, actually I went for a vector on that one.
B: you did?
A: yeah.
B: what did you get?
A: negative twenty I, minus two J, minus 56 K.
B: hm. that's a little bit different than what i have.
A: what'd you get?
B: u:h, i got=i got a really big number for that. i got
   negative what. two hundred? i
A: well, what was your, what was your, force vector?
B: u::hm
A: ten twenty ten? (.) ten negative twenty ten?
B: ten negative twenty negative ten.
A: i got two, negative two, negative one.
(3.0)
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((fifteen minutes of discussion of other problems and silent
   working elapse))

B: yeah, what've you been getting for your, for your vector
   on, on 461 A?
(7.0) ((shuffles among papers))
A: uh, negative 200, negative 20, negative 80.
B: yep. that's what i'm getting. we:ll, hold on. negative
   80? (3.0) ah=woop uh=u=hah, you're sure negative 80 is
   right? are you sure it shouldn't be negative 360?
(3.0)
A: uhm, its K, so its, yu:::h

((they resume silent work for another ten minutes))

B: did you get it?
A: yeah.
B: good job. that's good timing.
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A basic observation about this interaction shows that the cognitive functioning of this pair of students, as a group, involves the fruitful intersection of two processes. First, the two students carry out individual computational work that results in distinct computational trajectories. And second, they *compare* their two calculational trajectories, and note the similarities and differences between them. This distributed cognitive process depends on a particular pattern of communicative interaction: namely, periods of communication about the problem, alternating with periods during which they *do not* communicate about the problem, but work separately.

With these observations kept in mind, we are now going to look at a second interaction, this time involving three students. This group has already attempted to develop and implement several strategies without success, and the data segment begins with yetanother attempt. At this point, notice in particular the very different way in which the students in this group handle communication about the problem they are all working on. Noteice too that each step of the computational trajectory is narrated by the individual performing the calculation, so that every member of the group has significant access to the calculation while it is being performed. Consequently, the other members of the group can offer criticism, suggest alternative courses of action, and provide information at almost any point in the progress of the calculation.

<u>Interaction 2</u>: 3 participants (A, B, and C)

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B: alright we know energy is gonna be Q squared over 2C,
   right?
C: I (?), Q squared over C. oh yeah, 2C, sorry.
B: =U is equal to Q squared over 2C, a:nd
A: =oh yeah, oh c'mon, this=this can't be that easy.
B: you have to multiply it by the dielectric constant.
A: it's one half QV?
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B: and we have Q here. right? so this is gonna be, 4.38 E to
   minus six squared over two times the capacitance
C: but we don't have capacitance.
B: hold on, give me half a second.
C: it's Q over V.
B: it's Q over V. right? (1.0) and this Q cancels out with
   that one, so this is gonna be, uh, 4.38 E to the minus
   six V, over 2. okay? is equal to U. and we need to find
   out what V is. and V, i-a:::h
A: V equals Q over C.
B: and V is equal to Q over C, right?
C: u:h, that's not gonna help us any.
B: go::d=bless=america.
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By continuously narrating the calculations underway, the members of this group produce a distributed cognitive process with particular characteristics. First, they make it possible for all of them to attend to and participate in a single calculation. And second, the calculation is evaluated and criticized by the group while it is being carried out.

As groups, then, the first and second set of students differ significantly in the way that they generate and evaluate computational trajectories. The first group generated two distinct and complete trajectories that could then be compared for points of divergence, and each trajectory evaluated for possible weaknesses at these points of divergence. The second group, on the other hand, generated a single calculational trajectory, and weaknesses in the calculational trajectory were identified by the participants as the calculation was narrated.

The different characteristics of the distributed cognitive processes in these two groups are critically dependent on the patterns of communicative interaction that emerge within the groups. In the first group, the pattern of alternating periods of silent work was followed by communication about the problem, allowing the students to generate complete and distinct computational trajectories. These students only gave each other access to their computational trajectories for evaluation after they had been completed. And this provision and denial of access was constituted through language, namely, the retrospective narration of the completed calculations in the former case, and silence, in the latter.

In the second group, on the other hand, the practice of continuously narrating a single computation resulted in the generation of a single computational trajectory in which each step could be negotiated by the entire group. This group could not rely on the comparison of distinct computational trajectories, since the way they communicated about the problem essentially precluded more than one trajectory. Similarly, the first group could not collaborate in each computational step as it was carried out, since their pattern of communication precluded mutual access to their calculations. In short, by communicating in particular ways, each group produced different patterns of distributed cognition.

In this paper I have sought to make two points. First, I have argued that the basic spirit of the Sapir-Whorf hypothesis, the concern with the impact of language and thought, can be given a new expression in the present, responding to the fact that our understandings of language and thought have shifted significantly since the time of Whorf and Sapir. I argued that a suitably responsive reformulation of the Sapir-Whorf Hypothesis centrally involves a concern with how concrete discursive practice impacts processes of distributed cognition.

Second, I have illustrated how this reformulated Whorfian concern might play out by taking it into a specific empirical context, that of collaborative problem-solving by engineering students. In this context, I have argued that specific patterns of communicative activity support, and in part constitute, specific processes of distributed cognition. In particular, I have argued that continuous concurrent narration of collaborative computational work produces a single calculational trajectory within a group, which can be continuously negotiated and evaluated by all members of the group. In contrast, the pattern of periodic and retrospective narration produces multiple streams of computational work that are evaluated by mutual comparison. In this specific context, the above are some of the ways in which language influences thought.

In conclusion, then, I see the contribution of this paper as two-fold: first, it introduces an approach to cognition into the extant tradition of research on discursive relativity –an approach which I believe has the capacity to significantly widen our understanding of how language and thought interact. And second, it introduces into the research on distributed cognition a discussion of how specific patterns of communication and specific discourse practices produce different distributed cognitive processes in interacting groups.

Appendix 1

The following discussion is meant as a response to the very interesting and spirited interchange that followed the paper, which was presented essentially as it is found above. My thanks to the several conference participants who made insightful comments.

For those accustomed to treating cognition as an intrinsically individual process, and one that takes place exclusively in a single brain, it can be troubling to entertain the notion of cognition as a process that can be associated with a *group* of individuals, or with human individuals and the artifacts with which they interact. As one conference participant remarked, does it make sense to treat a student and a reference book he or she is using as a 'cognitive group' that exhibits 'group-level' cognitive processes? There is, after all, the participant continued, no cognitive activity going on in the book itself. Similar comments could be made about groups of individuals: while there is certainly cognitive processing being carried out by each of the individuals, where is one to locate cognitive processing that can be ascribed to the group? There is, after all, no 'group brain', some might argue, in which cognitive processing could take place.

Let us examine these issues one at a time. First, in the case of the student and the book, the objection appears to rest on a definition of cognition that excludes as cognition whatever role the book might play in the cognitive activity involved in the interaction of the student and the book. I suggest that this definition ultimately depends on an identification of cognition with neural activity. By making such a definition, one in effect stipulates from the outset that brains (and perhaps peripheral neural structures) are the only sites of cognitive activity.

Researchers in distributed cognition ultimately reject this definition, and instead posit that cognition should be identified with chains of semiosis. Semiosis can involve an abundance of sign-bearing substrates on which, and through which, signs may be constituted and propagated. A neural network is but one such substrate, though certainly a very important one. Books are another important semiotic substrate, and texts are an important kind of sign. Proponents of distributed cognition argue that *chains of semiosis* should be considered in their entirety and not arbitrarily segmented to only include neurally-based semiosis. In the case of the student and the book, the chains of semiosis include both the text on the page (one form of sign), the reading of the text (a complex sign-interpretation process that yields neurally-based signs), and understanding the text (a yet more complex sign creation and transformation process). This complete chain of semiosis involves a group (the student and the book), which can *together*, for example, quote the numerical value of π to 20 decimal places. Neither the student by him or herself, nor the book by itself, can do so. In short, the student-book pair exhibits different cognitive properties than does either sub-unit in isolation. In this example, each sub-unit contributes in very different ways to the cognitive capacities of the unit, and in particular, the book clearly does not display any neural activity. If, however, we identify cognition with flows of meaning in the world (i.e. with chains of semiosis), the book is a participant in the system of distributed cognition that encompassed the student and the text he or she reads.

It is possible to respond to disquiet about referring to interacting individuals as displaying group-level cognitive processes along similar lines. In addition, however, it is useful to make reference to concepts of *emergent organization* (McClamrock 1995). Briefly, emergent organization refers to relational properties or processes that can be observed to arise among interacting sets of entities, but which cannot be found in any single entity. A traffic jam furnishes a clear example of this phenomenon.One cannot locate the traffic jam, or even a portion of the traffic jam, in in any particular car.Inspection of any single automobile in a traffic jam will fail to identify or diagnose a traffic jam; only taking into account the relationships of multiple automobiles with respect to one another allows one to identify a traffic jam. Indeed, it is only through these multiple relationships that a traffic jam is constituted; traffic jams are intrincically group-level processes. It is not necessary, however, that there be any ancillary psysical basis for this group-level process to supplement the individual physical processes of location and movement.

Similarly, I argue that processes of distributed cognition, which I see as an intrinsically emergent phenomenon, need no ancillary basis (such as a 'group brain') for their existence. Distributed cognition emerges through the interactions of individual cognitive processes, and produces a process which is not merely the sum of individual cognitive processes, just as a traffic jam is not simply the sum of automobile trajectories.

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