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Analogy as the Core of Cognition

Few are more stimulating on the subject of how we think than Douglas Hofstadter, who has brought his fertile imagination to a breathtakingly diverse array of intellectual enterprises—from mathematical puzzles to translating Pushkin. In this lively and far-ranging essay, the author of Gödel, Escher, Bach posits that the making of analogies does not grow out of human reasoning ability, but, more fundamentally, stands at the very basis of thought and makes human reasoning possible.

Grand Prelude and Mild Disclaimer

ONCE UPON A TIME, I was invited to speak at an analogy workshop in the legendary city of Sofia in the far-off land of Bulgaria. Having accepted but wavering as to what to say, I finally chose to eschew technicalities and instead to convey a personal perspective on the importance and centrality of analogy-making in cognition. One way I could suggest this perspective is to re-chant a refrain that I've chanted quite oft in the past, to wit:

One should not think of analogy-making as a special variety of *reasoning* (as in the dull and uninspiring phrase "analogical reasoning and problem-solving", a long-standing cliché in the cognitive-science world), for that is to do analogy a terrible disservice. After all, reasoning and problem-

solving have (at least I dearly hope!) been at long last recognized as lying far indeed from the core of human thought. If analogy were merely a special variety of something that in itself lies way out on the peripheries, then it would be but an itty-bitty blip in the broad blue sky of cognition. To me, however, analogy is anything but a bitty blip—rather, it's the very blue that fills the whole sky of cognition—analogy is *everything*, or very nearly so, in my view.

End of oft-chanted refrain. If you don't like it, you won't like what follows.

The thrust of my article is to persuade readers of this unorthodox viewpoint, or failing that, at least to give them a strong whiff of it. In that sense, then, my article shares with Richard Dawkins' eye-opening book *The Selfish Gene* [Dawkins 1976] the quality of trying to make a scientific contribution mostly by suggesting to readers a shift of viewpoint—a new take on familiar phenomena. For Dawkins, the shift was to turn causality on its head, so that the old quip "a chicken is an egg's way of making another egg" might be taken not as a joke but quite seriously. In my case, the shift is to suggest that every concept we have is essentially nothing but a tightly packaged bundle of analogies, and to suggest that all we do when we think is to move fluidly from concept to concept—in other words, to leap from one analogy-bundle to another—and to suggest, lastly, that such concept-to-concept leaps are themselves made via analogical connection, to boot.

This viewpoint may be overly ambitious, and may even—horrors—be somewhat wrong, but I have observed that many good ideas start out by claiming too much territory for themselves, and eventually, when they have received their fair share of attention and respect, the air clears and it emerges that, though still grand, they are not quite so grand and all-encompassing as their proponents first thought. But that's all right. As for me, I just hope that my view finds a few sympathetic readers. That would be a fine start.

Two Riddles

WE BEGIN WITH A COUPLE of simple queries about familiar phenomena: "Why do babies not remember events that happen to them?" and "Why does each new year seem to pass faster than the one before?"

I wouldn't swear that I have the final answer to either one of these queries, but I do have a hunch, and I will here speculate on the basis of that hunch. And thus: the answer to both is basically the same, I would argue, and it has to do with the relentless, lifelong process of *chunking*—taking "small" concepts and

putting them together into bigger and bigger ones, thus recursively building up a giant repertoire of concepts in the mind.

How, then, might chunking provide the clue to these riddles? Well, babies' concepts are simply *too small*. They have no way of framing entire events whatsoever in terms of their novice concepts. It is as if babies were looking at life through a randomly drifting keyhole, and at each moment could make out only the most local aspects of scenes before them. It would be hopeless to try to figure out how a whole room is organized, for instance, given just a keyhole view, even a randomly drifting keyhole view.

Or, to trot out another analogy, life is like a chess game, and babies are like beginners looking at a complex scene on a board, not having the faintest idea how to organize it into higher-level structures. As has been well known for decades, experienced chess players chunk the setup of pieces on the board nearly instantaneously into small dynamic groupings defined by their strategic meanings, and thanks to this automatic, intuitive chunking, they can make good moves nearly instantaneously and also can remember complex chess situations for very long times. Much the same holds for bridge players, who effortlessly remember every bid and every play in a game, and months later can still recite entire games at the drop of a hat.

All of this is due to chunking, and I speculate that babies are to life as novice players are to the games they are learning—they simply lack the experience that allows understanding (or even perceiving) of large structures, and so nothing above a rather low level of abstraction gets perceived at all, let alone remembered in later years. As one grows older, however, one's chunks grow in size and in number, and consequently one automatically starts to perceive and to frame ever larger events and constellations of events; by the time one is nearing one's teen years, complex fragments from life's stream are routinely stored as high-level wholes—and chunks just keep on accreting and becoming more numerous as one lives. Events that a baby or young child could not have possibly perceived as such—events that stretch out over many minutes, hours, days, or even weeks—are effortlessly perceived and stored away as single structures with much internal detail (varying amounts of which can be pulled up and contemplated in retrospect, depending on context). Babies do not have large chunks and simply cannot put things together coherently. Claims by some people that they remember complex events from when they were but a few months old (some even claim to remember being born!) strike me as nothing more than highly deluded wishful thinking.

So much for question number one. As for number two, the answer, or so I

would claim, is very similar. The more we live, the larger our repertoire of concepts becomes, which allows us to gobble up ever larger coherent stretches of life in single mental chunks. As we start seeing life's patterns on higher and higher levels, the lower levels nearly vanish from our perception. This effectively means that seconds, once so salient to our baby selves, nearly vanish from sight, and then minutes go the way of seconds, and soon so do hours, and then days, and then weeks . . .

"Boy, this year sure went by fast!" is so tempting to say because each year is perceived in terms of chunks at a higher, grander, larger level than any year preceding it, and therefore *each passing year contains fewer top-level chunks* than any year preceding it, and so, psychologically, each year seems sparser than any of its predecessors. One might, somewhat facetiously, symbolize the ever-rapider passage of time by citing the famous harmonic series:

$$1 + \frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \frac{1}{5} + \frac{1}{6} + \frac{1}{7} + \frac{1}{8} \dots$$

by which I mean to suggest that one's n th year feels subjectively n times as short as one's first year, or $n/5$ times as short as one's fifth year, and so on. Thus when one is an adult, the years seem to go by about at roughly a constant rate, because—for instance— $(\frac{1}{35})/(\frac{1}{56})$ is very nearly 1. Nonetheless, according to this theory, year 70 would still shoot by twice as fast as year 35 did, and seven times as fast as year 10 did.

But the exact numerical values shown above are not what matter; I just put them in for entertainment value. The more central and more serious idea is simply that relentless mental chunking makes life seem to pass ever faster as one ages, and there is nothing one can do about it. So much for our two riddles.

Analogy, Abstract Categories, and High-level Perception

BEFORE I GO ANY FURTHER, I would like to relate all this to analogy, for to some, the connection may seem tenuous, if not nonexistent. And yet to me, by contrast, analogy does not just lurk darkly here, but is right up there, front and center. I begin with the mundane observation that vision takes an input of millions of retinal dots and gives an output of concepts—often words or phrases, such as "duck," "Victorian house," "funky chair," "Joyce Carol Oates hairdo," or "looks sort of like President Eisenhower." The (visual) perceptual process, in other words, can be thought of as the triggering of mental categories—often standard lexical items—by scenes. Of course high-level

perception can take place through other sensory modalities: we can hear a low rumbling noise and say "helicopter," can sniff something and remark "doctor's office," can taste something and find the words "okra curry" jumping to our tongue, and so on.

In fact, I should stress that the upper echelons of high-level perception totally transcend the normal flavor of the word "perception," for at the highest levels, input modality plays essentially no role. Let me explain. Suppose I read a newspaper article about the violent expulsion of one group of people by another group from some geographical region, and the phrase "ethnic cleansing," nowhere present in the article, pops into my head. What has happened here is a quintessential example of high-level perception—but what was the input medium? Someone might say it was *vision*, since I used my eyes to read the newspaper. But really, was I perceiving ethnic cleansing *visually*? Hardly. Indeed, I might have heard the newspaper article read aloud to me and had the same exact thought pop to mind. Would that mean that I had *aurally* perceived ethnic cleansing? Or else I might be blind and have read the article in braille—in other words, with my fingertips, not my eyes or ears. Would that mean that I had *tactilely* perceived ethnic cleansing? The suggestion is absurd.

The sensory input modality of a complex story is totally irrelevant; all that matters is how it jointly activates a host of interrelated concepts, in such a way that further concepts (e.g., "ethnic cleansing") are automatically accessed and brought up to center stage. Thus "high-level perception" is a kind of misnomer when it reaches the most abstract levels, but I don't know what else to call it, because I see no sharp line separating it from cases of recognizing "French impressionism" in a piece of music heard on the radio or thinking "Art Deco" when looking at a typeface in an advertisement.

The triggering of prior mental categories by some kind of input—whether sensory or more abstract—is, I insist, an act of analogy-making. Why is this? Because whenever a set of incoming stimuli activates one or more mental categories, some amount of slippage must occur (no instance of a category ever being precisely identical to a prior instance). Categories are quintessentially fluid entities; they adapt to a set of incoming stimuli and try to align themselves with it. The process of inexact matching between prior categories and new things being perceived (whether those "things" are physical objects or bite-size events or grand sagas) is analogy-making *par excellence*. How could anyone deny this? After all, it is the mental mapping onto each other of two entities—one old and sound asleep in the recesses of long-term memory, the other new and gaily dancing on the mind's center stage—that in fact differ from each other in a myriad of ways.

The Mental Lexicon: A Vast Storehouse of Triggerable Analogies

WE HUMANS BEGIN LIFE as rather austere analogy-makers—our set of categories is terribly sparse, and each category itself is hardly well-honed. Categories grow sharper and sharper and ever more flexible and subtle as we age, and of course fantastically more numerous. Many of our categories, though by no means all, are named by words or standard phrases shared with other people, and for the time being I will concentrate on those categories—categories that are named by so-called "lexical items." The public labels of such categories—the lexical items themselves—come in many grades, ranging more or less as follows:

- simple words: *chair, clock, cork, cannon, crash, clown, clue, cloak, climber* . . .
- compound words: *armchair, alarm clock, corkscrew, cannonball, skyscraper, station wagon, seapot, salad dressing, schoolbus, jukebox, picket line, horror movie, wheeler-dealer* . . .
- short phrases: *musical chairs, out of order, Christmas tree ornament, nonprofit organization, business hours, foregone conclusion, rush-hour traffic, country-Western music, welcome home, tell me about it, give me a break, and his lovely wife, second rate, swallow your pride* . . .
- longer phrases: *stranded on a desert island; damned if you do, damned if you don't; praise the Lord and pass the ammunition; not in the foreseeable future; to the best of my knowledge; and they lived happily ever after; if it were up to me; haven't seen her since she was knee-high to a grasshopper; you could have knocked me over with a feather; thank you for not smoking; handed to him on a silver platter* . . .

Such lists go on and on virtually forever, and yet the amazing fact is that few people have any inkling of the vastness of their mental lexicons (I owe a major debt here to Joe Becker—see [Becker 1975]). To be sure, most adults use their vast mental lexicons with great virtuosity, but they have stunningly little explicit awareness of what they are doing.

It was Roger Schank, I believe, who pointed out that we often use *proverbs* as what I would call "situation labels," by which I mean that when we perceive

a situation, what often springs to mind, totally unbidden, is some proverb tucked away in our unconscious, and if we are talking to someone, we will quote that proverb, and our listener will in all likelihood understand very clearly how the proverb “fits” the situation—in other words, will effortlessly make the mapping (the *analogy*); to stress what it is that we are talking about here) between the phrase’s meaning and the situation. Thus the following kinds of phrases can easily be used as situation labels:

That’s the pot calling the kettle black if I ever saw it!

It just went in one ear and out the other . . .

Speak of the devil!

When the cat’s away the mice will play!

The Common Core Behind a Lexical Item

I NOW MAKE AN OBSERVATION that, though banal and obvious, needs to be made explicitly nonetheless—namely, things “out there” (objects, situations, whatever) that are labeled by the same lexical item have something, some core, in common; also whatever it is that those things “out there” share is shared with the abstract mental structure that lurks behind the label used for them. Getting to the core of things is, after all, what categories are for. In fact, I would go somewhat further and claim that getting to the core of things is what thinking itself is for—thus once again placing high-level perception front and center in the definition of cognition.

The noun “shadow” offers a good example of the complexity and subtlety of structure that lurks behind not just *some* lexical items, but behind every single one. Note, first of all, the subtle difference between “shadow” and “shade”: we do not speak of cattle seeking *shadow* on a hot day, but *shade*. Many languages do not make this distinction, and thus they offer their native speakers a set of categories that is tuned slightly differently.

In many parts of the world, there are arid zones that lie just to the east of mountain ranges (e.g., the desert in Oregon just to the east of the Cascade mountains); these regions are standardly referred to as the mountain chain’s “rain shadow.”

What does one call the roughly circular patch of green seen underneath a tree after a snowfall? It could clearly be called a “snow shadow”—the region where snow failed to fall, having been blocked by an object.

A young woman who aspires to join her high-school swimming team, but

whose mother was an Olympic swimmer, can be said to be “in the shadow of her mother.” In fact, if she joins the team and competes, she might even be said to be “swimming in the shadow of her mother.” And if she performs less well than her mother did, she will be said to be “overshadowed” by her mother.

One might say about a man who has had a bout with cancer but has recovered and is now feeling more secure about his health, “He is finally feeling more or less out of the shadow of his cancer.” Along similar lines, many countries in Europe have recovered, to a large extent, from the ravages of World War II, but some might still be said to lie “in the shadow of World War II.”

Another type of shadow cast by World War II (or by any war) lies in the skewed population distribution of any decimated group; that is, one imagines the human population as constituting a kind of flow of myriad tiny entities (individual people) down through the years (like that of photons or snowflakes through space), but long after the war’s end, there are certain “regions” of humanity (e.g., certain ethnic groups) where the flow of births has been greatly reduced, much as if by an “obstacle” (namely, the millions of deaths in prior generations, whose effect continues to reverberate for many decades before gradually fading away, as a group’s population replenishes itself).

There is of course no sharp line between cases where a word like “shadow” is used conventionally and cases where it is used in a novel manner; although “rain shadow” is something of a standard phrase, “snow shadow” (even though it is far easier to see) is less common. And notions like that of “population shadow” mentioned at the end are probably novel to most readers of this article, even though a closely related notion like “in the shadow of the war” is probably not new.

In short, the domain of the word “shadow” is a blurry region in semantic space, as is any human category, and—here I hark back to my initial refrain—that blur is due to the subtleties of mapping situations onto other situations—due, in other words, to the human facility of making analogies. The point is, a concept is a package of analogies.

Complex Lexical Items as Names of Complex Categories

OVER THE NEXT FEW PAGES I will present a potpourri of mental categories (via proxies—namely, their English-language lexical-item representations); I invite you to think, as you consider each item, just what it is that very different exemplars of the category in question tend to have in common. Thus:

- dog
- backlog
- probably
- probab-lee!

I interrupt the list momentarily to comment on the last two entries above, which of course are not nouns. (Who says nouns are the only mental categories? Obviously, verbs represent categories as well—but the same holds true, no less, for adjectives, adverbs, and so forth.) Some situations call forth the word “probably”; most do not. To some situations, the concept behind the word “probably” simply fits, while to most, it does not fit. We learn how to use the word “probably” over the course of years in childhood, until it becomes so ingrained that it never crosses our mind that “probably” is the name that English speakers give to a certain category of situations; it simply is evoked effortlessly and rapidly by those situations, and it is uttered without any conscious thought as to how it applies. It just “seems right” or “sounds right.”

What, then about the word below it: “probab-lee”? This, too, is a lexical item in the minds of most native speakers of contemporary American English—perhaps not often used, perhaps more commonly heard than uttered by readers of this article, but nonetheless, we native speakers of American English all relate to hearing the word “probably” accented on its final rather than its initial syllable, and we all somehow realize the connotations hidden therein, though they may be terribly hard to articulate. I won’t try to articulate them myself, but I would merely point out that this phonetic variant of the word “probably” fits only certain situations and not others (where the “situation” includes, needless to say, not just what is being talked about but also the mood of the speaker, and the speaker’s assessment of the mood of the listener as well). Example: “Are our stupid leaders ever going to learn their lesson?” “Who knows? Maybe they’re doomed to keep on repeating the mistakes of the past.” “Mmm . . . Probab-lee . . .”

My point, with all the phrases cited above, is to bring to your conscious awareness the fact that there are certain situations that one could call “probab-lee! situations,” no less than there are certain situations that are “musical chairs situations” or “speak of the devil situations.” In short, lexical items can be very abstract categories evoked by special classes of situations and not by others. This applies to adjectives, adverbs, prepositions, interjections, short and long phrases, and so on. Thus let me continue my list.

- Come on!
- Go for it!
- It’s about time!
- Well, excuuuuuuuse me!
- Let’s not stand on ceremony!
- without batting an eyelash
- ain’t

Lest the lowest item above seem puzzling, let me point out that the notorious contraction “ain’t,” although it is in a certain sense ungrammatical and improper, is nonetheless used very precisely, like pinpoint bombing, by politicians, reporters, university presidents, and the like, who carefully and deliberately insert it into their speech at well-timed moments when they know their audience almost expects it—it fits the context perfectly. For example, a general trying to justify a bombing raid might say, in describing the series of deadly skirmishes that provoked it, “I’m sorry, but a Sunday picnic it just *ain’t*.” This is just one of many types of “ain’t” situations. We native speakers know them when we hear them, and we likewise have a keen ear for *improper* uses of the word “ain’t” by educated people, even if we ain’t capable of putting our finger on what makes them inappropriate. (Curiously enough, shortly after drafting this paragraph, I came across an article in the *New York Times* about the failure of a test missile to hit its target, and a perfectly straight photo caption started out, “Two out of four goals ain’t bad . . .” As I said above, even the most highly placed sources will use this “ungrammatical” word without batting an eyelash.)

“Suggestions” Imparted on the Soccer Field

AS A NON-NATIVE SPEAKER of Italian watching the 1998 Soccer World Cup on Italian television, I was struck by the repeated occurrence of a certain term in the rapidfire speech of all the commentators: the word *suggerimento* (literally, “suggestion”). They kept on describing players as having given *suggerimenti* to other players. It was clear from the start that a *suggerimento* was not a verbal piece of advice (a suggestion in the most literal sense), but rather some kind of pass from one player to another as they advanced downfield. But what kind of pass was it exactly? By no means were all passes called *suggerimenti*; this term was clearly reserved for events that seemed to have some kind of scoring potential to them, as if one player was wordlessly saying to another, “Here now—take this and go for it!”

But how does a sports announcer unconsciously and effortlessly distinguish *this* kind of pass from other passes that in many ways look terribly similar? When is this kind of nonverbal "suggestion" being given by one player to another? I sensed that this must be a subtle judgment call, that there's no black-and-white line separating *suggerimenti* from mere *passaggi*, but that nonetheless there is a kind of core to the concept of *suggerimento* that all Italian announcers and keen Italian observers of soccer would agree on, and that there are fringes of the category, where some people might feel the word applied and others would not. Such blurriness is the case, of course, with every mental category, ranging from "chair" to "wheeler-dealer" to "pot calling the kettle black," but since *suggerimento* was not in my native language and thus I had been forced to grapple with it explicitly and consciously, it was an excellent example of the view of lexical items that I am herein trying to impart to my readers.

Polysemy and the Nonspherical Shapes of Concepts

IT WOULD BE NAÏVE to imagine that each lexical item defines a perfectly "spherical" region in conceptual space, as pristine as an atomic nucleus surrounded by a spherical electron cloud whose density gradually attenuates with increasing distance from the core. Although the single-nucleus spherical cloud image has some truth to it, a more accurate image of what lies behind a typical lexical item might be that of a molecule with two, three, or more nuclei that share an irregularly shaped electron cloud.

Suggerimento provides a perfect example of such a molecule, with one of its constituent atoms being the notion of a verbal piece of advice, another the notion of prompting on a theater stage, yet a third being the notion of a certain type of downfield soccer pass, and so forth. There is something in common, of course, that these all share, but they are nonetheless distinguishable regions in conceptual space.

Often native speakers of a language have a hard time realizing that two notions labeled identically in their language are seen as highly distinct concepts by speakers of other languages. Thus, native speakers of English feel the verb "to know" as a monolithic concept, and are sometimes surprised to find out that in other languages, one verb is used for knowing *facts*, a different verb for knowing *people*, and there may even be a third verb for knowing *how to do things*. When they are first told this, they are able to see the distinction, although it may seem highly finicky and pointless; with practice, however, they build up more refined categories until a moment may come when what once

seemed an unnatural and gratuitous division of mental space now seems to offer a useful contrast between rather distinct notions. And conversely, speakers of a language where all three of these notions are represented by distinct lexical items may find it revelatory, fascinating, and perhaps even elegant to see how they are all subsumed under one umbrella-word in English.

My main point in bringing this up is simply to make explicit the fact that words and concepts are far from being regularly shaped convex regions in mental space; polysemy (the possession of multiple meanings) and metaphors make the regions complex and idiosyncratic. The simplest concepts are like isolated islands in a sea; the next-simplest are like pairs of islands joined by a narrow isthmus; then there are trios with two or three isthmuses having various widths; and so on. *Caveat*: When I say "simplest concepts," I do not mean those concepts that we pick up earliest in life, but in fact quite the contrary. After all, the majority of concepts planted in earliest childhood grow and grow over a lifetime and turn into the most frequently encountered concepts, whose elaborate ramifications and tendrils constitute the highest degree of twistiness! What I mean by "simplest concept" is merely "concept with maximally simple shape"; such a "simple" concept would most likely owe its simplicity precisely to its low frequency, and thus would seem like a sophisticated adult concept, such as "photosynthesis" or "hyperbola."

Conceptual Families and Lexical Rivalry

WALKING DOWN THE CORRIDORS of a building in Italy in which I have worked over several summers, I have been faced innumerable times with an interesting problem in high-level perception that has to be solved in real time—in a couple of seconds at most, usually. That is, how do I greet each person whom I recognize as we approach each other in the hall, and then pass? Here are five sample levels of greeting (there are dozens more, needless to say):

- *Buongiorno!* ("Hello!" or perhaps "Morning.")
- *Salve!* ("Howdy!" or perhaps "How are you.")
- *Buondi!* (Perhaps "Top o' the mornin'" or "How ya doin'?")
- *Ciao!* ("Hi!" or "Hi there!")
- *Come stai?* ("How are you doing?" or perhaps "What's up?")

Each of them conveys a particular level of mutual acquaintance and a particular position along the formality/informality spectrum. And of course it frequently happens that I recognize someone but can't even remember how

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often I've met them before (let alone remember what their name is or what their role is), and so I have to make a decision that somehow will allow me to cover at least two different levels of friendliness (since I'm really not sure how friendly we are!). The choice is incredibly subtle and depends on dozens if not hundreds of variables, all unconsciously felt and all slightly contributing to a "vote" among my neurons, which then allow just one of these terms (or some other term) to come bubbling up out of my dormant Italian mental lexicon.

Consider the following spectrum of phrases all having in a certain sense "the same meaning," but ranging from very vulgar to somewhat incensed to quite restrained to utterly bland:

- He didn't give a flying f***.
- He didn't give a good God damn.
- He didn't give a tinker's damn.
- He didn't give a damn.
- He didn't give a darn.
- He didn't give a hoot.
- He didn't care at all.
- He didn't mind.
- He was indifferent.

For many naive speakers, there are situations that correspond to each of these levels of intensity. To be sure, some speakers might be loath to utter certain of these phrases, but true native-level mastery nonetheless entails a keen awareness of when each of them might be called for in, say, a movie, or simply coming out of the mouth of someone else. After all, a large part of native mastery of a language is deeply knowing how other people use the language, regardless of whether one oneself uses certain phrases. And thus, to reiterate our theme, there are "He didn't give a good God damn situations" and there are situations of a very different sort, which could be called "He didn't care at all situations," and so forth. Each of the above expressions, then, can be thought of as the name of a particular type of situation, but since these categories are much closer to each other than just randomly chosen categories, they constitute potential rivalries that may take place during the ultra-fast high-level perceptual act that underlies speech.

Lexical Blends as a Window onto the Mind

LEXICAL BLENDS, which are astonishingly common though very seldom noticed by speakers or by listeners, reveal precisely this type of unconscious competition among close relatives in the mental lexicon. A lexical blend occurs when a situation evokes two or more lexical items at once and fragments of the various evoked competitors wind up getting magically, sometimes seamlessly, spliced together into the vocalized output stream (see, for example, [Hofstadter & Moser 1989]). Occasionally the speaker catches such an error on its way out and corrects it, though just as often it goes totally unheard by all parties. Thus people make blends of the following sorts:

- word-level blends: mop/broom → brop
- phrase-level blends: easygoing/happy-go-lucky → easy-go-lucky
- sentence-level blends: We'll leave no stone unturned/We'll pull out all the stops → We'll pull no stops unturned.

Blends reveal how much goes on beneath the surface as our brains try to figure out how to label simpler and more complex situations. In a way, what is amazing is that blends are not more common. Somehow, through some kind of cerebral magic, speakers light most of the time upon just one lexical label despite the existence of many potential ones, rather than coming out with a mishmash of several—much as when a good pianist plays the piano, it is very seldom that two keys are struck at once, even though it might seem, a priori, that striking two neighboring keys at once ought to happen very often.

A Lexical Item as One Side of a Perceptual Analogy

AT THE RISK of boring some readers, I shall now continue with my rather arbitrary sampler of lexical items, just to drive the point home that every lexical item that we possess is a mental category, and hence, restating what I earlier claimed, every lexical item, when used in speech (whether received or transmitted), constitutes one side of an analogy being made in real time in the speaker's/listener's mind. I thus urge readers to try on for size the mindset that equates a lexical item with the "name" of a certain blurry set of situations centered on some core. Though this sounds quite orthodox for nouns, it is less so

for verbs, and when applied to many of the following linguistic expressions, it is highly unorthodox:

- slippery slope
- safety net
- shades of . . .
- Been there, done that.
- Forget it!
- It was touch-and-go.
- take a turn for the worse
- Be my guest!
- Make my day!
- Fancy that!
- Put your money where your mouth is!
- I mean, . . .
- Well, . . .
- Don't tell me that . . .
- It's fine to [do X] and all, but . . .
- kind of [+ adj.]
- when it comes to the crunch . . .
- You can't have it both ways!
- . . . *that's* for sure!
- the flip side [of the coin] is . . .
- You had to be there.
- It's high time that . . .
- Whatever!

Consider the teen-ager's favorite rejoinder, "Whatever!" If one were to try to capture its meaning—its range of applicability—one might paraphrase it somewhat along these lines: "You think such and so, and I disagree, but let's just agree to disagree and move on . . ." It takes a good number of years before one has acquired the various pieces of cognitive equipment that underpin the proper usage of such a phrase (which again ties in with the fact that one cannot remember events from one's babyhood).

High-Level Mental Chunks That Lack Labels

ALTHOUGH LONG STOCK PHRASES like "Put your money where your mouth is!" might seem to stretch the notion of mental chunking to the

limit, that's hardly the case. Indeed, such phrases lie closer to the beginning than to the end of the story, for each one of us also remembers many thousands of events in our personal lives that are so large and so idiosyncratic that no one has ever given them a name and no one ever will, and yet they nonetheless are sharp memories and are revealed for the mental categories they are by the fact that they are summoned up cleanly and clearly by certain situations that take place later, often many years later. Thus take this one simple mental chunk, from my own personal, usually dormant repertoire:

that time I spent an hour or two hoping that my old friend Robert, whom I hadn't seen in two years but who was supposed to arrive from Germany by train sometime during that summer day in the little Danish fishing village of Frederikssund (which in a series of letters he and I had mutually picked out on maps, and in which I had just arrived early that morning after driving all night from Stockholm), might spot me as I lurked way out at the furthest tip of the very long pier, rather than merely bumping into me at random as we both walked around exploring the stores and streets and parks of this unknown hamlet

As its length suggests, this is a very detailed personal memory from many years ago (and indeed, I have merely sketched it for readers here—I could write pages about it), and might at first seem to be nothing at all like a *mental category*. And yet, how else can one explain the fact that the image of myself standing at pier's end tingling with unrealistic hope jumped instantly to mind some fifteen years later as I was idly seeking to rearrange the eight letters in the last name of Janet Kolodner, a new acquaintance, in such a way that they would spell a genuine English word? Without success, I had tried dozens of fairly "obvious" pathways, such as "rendlook," "leodronk," and "ondorkle," when out of the blue it occurred to me that the initial consonant cluster "kn," with its cleverly silent "k," might be the key to success, and I started excitedly trying this "brilliant idea." However, after exploring this strategy for a while, I realized, to my chagrin, that no matter how lovely it would be if the silent "k" were to yield a solution, the probabilities for such a clever coup were rapidly diminishing. And at the precise instant that this realization hit, the Frederikssund-pier image came swooshing up out of memory, an image to which I had devoted not even a split second of thought for many years.

There was, of course, a perfectly logical reason behind this sudden resurfacing—namely, a strong and rich analogy in which the mundane idea of merely walking around the fishing village mapped onto the mundane explo-

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ration of “rendlook” and cousins, in which the “romantic” idea of lingering way out at the tip of the pier mapped onto the “romantic” hope for an anagram beginning with the tricky “kn” cluster, and in which the growing recognition of the likelihood of failure of the more unlikely, more “romantic” strategies was the common core that bound the two otherwise remote events together.

The Central Cognitive Loop

ABSTRACT REMINDINGS of this sort have been noted here and there in the cognitive-science literature, and some attempts have been made to explain them (e.g., Roger Schank’s *Dynamic Memory* [Schank 1982]), but their starring role in the phenomenon of cognition has not, to my knowledge, been claimed. It is my purpose to stake that claim.

To make the claim more explicit, I must posit that such a large-scale memory chunk can be thought of as being stored in long-term memory as a “node”—that is, something that can be retrieved as a relatively discrete and separable whole, or to put it metaphorically, something that can be pulled like a fish out of the deep, dark brine of dormant memory. Once this “fish” has been pulled out, it is thrown in the “bucket” of short-term memory (often called “working memory”), where it is available for scrutiny.

Scrutiny consists in the act of “unpacking” the node to some degree, which means that inside it are found other nodes linked together by some fabric of relationships, and this process of unpacking can then be continued recursively, given that the contents of unpacked nodes themselves are placed in short-term memory as well, and hence are themselves subject to more detailed scrutiny, if so desired. (I suppose one could extend the fishing analogy by imagining that smaller fish are found in the stomach of the first fish caught, as it is “cleaned”—and so forth, recursively. But that fanciful and somewhat gory image is not crucial to my story.)

Thus, if it is placed under scrutiny, inside the “Frederikssund pier” node can be found nodes for the exchange of letters that preceded Robert’s and my Danish reunion, for Frederikssund itself, for my Stockholm drive, for Robert’s train trip, for a few of the town’s streets and shops, for the pier, for my growing disappointment, and so on. Not all of these will be placed into short-term memory each time the event as a whole is recalled, nor will the inner structure of those nodes that *are* placed there necessarily be looked into, although it is quite possible that *some* of their inner structure will be examined.

Thus the unpacking process of this kind of high-level unlabeled node

(such as the “Frederikssund-pier” node or the “Kolodner anagram” node) can fill short-term memory with a large number of interrelated structures. It must be stressed, however, that the unpacking process is highly context-dependent (i.e., sensitive to what concepts have been recently activated), and hence will yield a somewhat different filling-up of short-term memory on each occasion that the same high-level node is pulled up out of the ocean of long-term memory.

Once there are structures in short-term memory, then the perceptual process can be directed at any of them (this is, in fact, the kind of high-level perception that forms the core of the Copycat and Tabletop models of analogy-making—see [Hofstadter & FARG 1995]), the upshot of which will be the activation—thanks to analogy—of further nodes in long-term memory, which in turn causes new “fish” to be pulled out of that brine and placed into short-term memory’s bucket. What we have described is, in short, the following *central cognitive loop*:

A long-term memory node is accessed, transferred to short-term memory and there unpacked to some degree, which yields new structures to be perceived, and the high-level perceptual act activates yet further nodes, which are then in turn accessed, transferred, unpacked, etc., etc.

An Illustration of the Central Cognitive Loop in Action

THE FOREGOING may seem too abstract and vague, and so to make the ideas more concrete, I now will present a dialogue most of which actually took place, but some of which has been added on, so as to make some points emerge a little more clearly. The fact, however, that it all sounds perfectly normal is what matters—it certainly could pass for spontaneous cognition in the minds of two speakers. The dialogue exemplifies all the processes so far described, and—at least to my mind—shows how these processes are what drives thought. So here is the dialogue.

A and B are walking by a church when A looks up and notices that on the steeple, there are some objects that look like emergency-warning sirens attached to the base of the cross.

A: Hey, fancy that! Shades of “Praise the Lord and pass the ammunition!”

B: What do you mean?

A: Well, it's kind of amusing to me. On the one hand, the cross implies a belief in protection by the Lord, but on the other hand, the sirens suggest the need for a backup system, some kind of safety net. I mean, it's fine to believe in divine protection and all, but when it really comes to the crunch, religious people's true colors emerge . . .

B: Well, sooner safe than sorry, no?

A: Sure, but isn't a cross wrapped in danger sirens kind of hypocritical? I mean, why don't religious people put their money where their mouth is? If they really believe in God's benevolence, if they really have the courage of their own convictions, then how come it doesn't suffice to speak softly—why do they need to carry a big stick as well? Put it this way: Either you're a believer, or you ain't.

B: That's a bit black-and-white, isn't it?

A: Of course! As it should be! You can't have it both ways. Somehow this reminds me of when I had to leave my bags in a hotel in Italy for a few days, and the hotel people stored them in a tiny little chapel that was part of the hotel. A friend joked, "Well, this way they'll be protected." But why is such a remark so clearly a joke, even to religious people? Aren't churches houses of God? Shouldn't a *sacred* place be a *safer* place?

B: Yes, but being sacred doesn't make churches immune to disaster. We've all heard so often of churches whose roofs collapse on the assembled parishioners . . .

A: Exactly. And then pious people always say, "The Lord works in mysterious ways . . . It's beyond our comprehension." Well, how they can continue to believe after such an event is beyond *my* comprehension, that's for sure.

B: You're talking about people who claim to believe but in some sense act as if they don't really believe, deep down. But then there's the flip side of the coin: people who claim *not* to believe but act in a way as if they *do*. The reverse type of hypocrite, in short.

A: Do you have an example in mind?

B: Yes—Niels Bohr, the great Danish physicist. I once read that in his house there was a horseshoe hanging over one door, and someone asked him, "What's this all about?" Bohr answered, "Well, horseshoes are supposed to bring good luck, so we put it up there." The friend then said, "Come now—surely you don't *believe* it brings good luck

do you?" Bohr laughed and said, "Of course not!" And then he added, "But they say it works even if you *don't* believe in it."

A: I see your point—in a way Bohr's remark is the flip side of "Praise the Lord and pass the ammunition." In the trench-warfare case, you have a believer whose actions reveal deep doubts about their proclaimed belief, and in the Bohr case, you have a skeptic whose actions reveal that he may doubt his own skepticism. But that cross with the sirens—I just can't believe that they would wrap them around the cross, of all things—that's the height of irony! I mean, it's like some priest who's going into a dangerous area of town and doesn't just carry a handgun along in case of need, but in fact a *cross* that doubles as a handgun.

B: You've made the irony rather clear, I agree. But tell me—would you propose that the Pope, simply because he's a big-time believer in God, should travel through the world's cities without any protection? Would you propose that true believers, if they are to be self-consistent, shouldn't put locks on their churches?

A: Well, won't God take care of his flock? Especially the Pope?

B: It's not that simple.

A: Come on—if God doesn't look after the Pope, who *does* he look after?

B: Come on, yourself! They crucified Jesus, didn't they? If anyone should have had divine immunity, it was Jesus—but he didn't. And yet that in itself doesn't mean that Jesus wasn't God's son.

This exchange illustrates all of the themes so far presented. In the first place, it shows A and B using ordinary words—bite-size lexical items such as "cross," "sirens," "bags," "hotel," "when," "people," and dozens more—nouns, verbs, adjectives, adverbs, prepositions, and so forth. Nothing unusual here, of course, except that readers are being exhorted to picture each of these words as the tip of an iceberg that hides myriad hidden analogies—namely, the analogies that collectively allowed the category to come into being in the first place in the speaker's or listener's or reader's mind.

In the second place, the dialogue shows a good number of the shorter phrases cited in lists above being used in realistic situations—smallish stock phrases such as "Fancy that," "kind of," "I mean," "ain't," "that's for sure," and many more. These phrases are used by speakers because they meet the rhetorical needs of the particular context, and when perceived by listeners they activate familiar rhetorical-context categories.

In the third place, the dialogue illustrates high-level perception—the retrieval of high-level labels for perceptions—such as A's opening statement, in which the lexical item "Praise the Lord and pass the ammunition" is the effortlessly evoked label for a church cross with warning sirens attached to it. In fact, all through the dialogue, the participants use large lexical items to label situations that are being categorized in real time in their minds. Thus we hear "backup system," "safety net," "when it really comes to the crunch," "flip side of the coin," "put your money where your mouth is," "sooner safe than sorry," "speak softly and carry a big stick," "black-and-white," and many more.

In the fourth place, we have large-scale reminders. First there is the shift from the cross-wrapped-in-sirens scene to the suitcases-left-in-hotel-chapel situation, then the shift to the collapsing-churches scenario, after which comes the shift, mediated by a kind of conceptual reversal, to Niels Bohr's horseshoe-that-works-despite-skepticism (probably an apocryphal story, by the way). Following that image comes a different kind of shift—an analogy where a given, known scenario is compared with a spontaneously concocted hypothetical scenario—thus, for instance, the cross-wrapped-in-sirens scene is compared with a hypothetical cross/handgun blend. This is swiftly followed by a trio of further concocted analogues: first the Pope traveling without protection, then churches that are left unlocked, and finally God not even taking care of his own son.

The Central Cognitive Loop in Isolation and in Interaction

THE BROAD-STROKE PATHWAY meandering through the limitless space of potential ideas during the hypothetical conversation of A and B is due to various actual scenes or imagined scenarios being reperceived, in light of recently activated concepts, in novel fashions and thereby triggering dormant memories, which are then fished up from dormancy to center stage (i.e., short-term memory), where, partially unpacked, they are in turn subjected to the exact same context-dependent reperception process. Around and around in such a loop, alternating between fishing in long-term memory and unpacking and reperceiving in short-term memory, rolls the process of cognition.

Note that what I have just described is not problem-solving, which has traditionally played such a large role in modeling of thought and been tightly linked with "analogical reasoning"; no, everyday thought is not problem-solving or anything that resembles it at all; rather, it is a nonrandom stroll through long-term memory, mediated by high-level perception (which is simply, to echo myself, another name for analogv-making).

To be sure, thought does not generally take place in a sealed-off vat or an isolation chamber; most of the time, external events are constantly impinging on us. Therefore the purely self-driven flow that the "central loop" would suggest is just half of the story—it is the contribution from within one's private cognitive system. The other half—the contribution from outside—comes from inanimate objects impinging on one's senses (skyscrapers and sunsets and splashes, for instance), from animate agents seen mostly as objects (mosquitos that one swats at, people that one tries not to bang into as one hastens down a crowded sidewalk), or from other cognitive agents (conversations with friends, articles read in the paper, e-mail messages, scenes in movies, and so on).

This buzzing, booming confusion in which one is immersed most of the time tends to obscure the constant running of the private inner loop—but when one retreats into solitude, when one starts to ponder or daydream, when one tries to close oneself off from these external impingements and to be internally driven, that is when the above-positd "central loop of cognition" assumes the dominant role.

Goal-Drivenness and the Central Loop

WHERE DO GOALS enter this picture? How does the deeply goal-driven nature of human thought emerge from what might seem to be the randomness of the posited central loop? The answer resides in the enormously biased nature of each individual's perception.

Each person, as life progresses, develops a set of high-level concepts that they tend to favor, and their perception is continually seeking to cast the world in terms of those concepts. The perceptual process is thus far from neutral or random, but rather it seeks, whenever possible, to employ high-level concepts that one is used to, that one believes in, that one is comfortable with, that are one's pet themes. If the current perception of a situation leads one into a state of cognitive dissonance, then one goes back and searches for a new way to perceive it. Thus the avoidance of mental discomfort—the avoidance of cognitive dissonance—constitutes a powerful internal force that helps to channel the central loop in what amounts to a strongly goal-driven manner.

The Whorf-Sapir Hypothesis: Language and the Central Loop

THE VIEWPOINT I have been proposing here—in most ways quite unrevolutionary!—can be rephrased in terms of "perceptual attractors," which are long-term mental loci that are zoomed into when situations are encoun-

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tered (see [Kanerva 1988]). We all have many thousands of such attractors in our dormant memories, only a tiny fraction of which are accessed when we encounter a new situation. Where do such attractors come from? How public are they? Do they have explicit labels? Here I list three main types:

- standard lexical items (words, names, phrases, proverbs, etc.) provided to a vast public through a shared linguistic environment;
- shared vicarious experiences provided to a vast public through the media (e.g., places, personages, and events of small and large scale in books, movies, television shows, and so on), the smaller of which have explicit linguistic labels, the more complex of which have none;
- unique personal memories, lacking any fixed linguistic labels (such chunks are generally very large and complex, like the Fred-erikssund memory discussed above, or even far larger events, such as a favorite high-school class, a year spent in a special city, a protracted divorce, and so on)

Since a sizable fraction of one's personal repertoire of perceptual chunks is provided from without, by one's language and culture, this means that inevitably language and culture exert powerful, even irresistible, channeling influences on how one frames events. (This position is related to the "memé's-eye view" of the nature of thought, as put forth in numerous venues, most recently in [Blackmore 1999].)

Consider, for instance, such words as "backlog," "burnout," "micromanaging," and "underachiever," all of which are commonplace in today's America. I chose these particular words because I suspect that what they designate can be found not only here and now, but as well in distant cultures and epochs, quite in contrast to such culturally and temporally bound terms as "soap opera," "mini-series," "couch potato," "news anchor," "hit-and-run driver," and so forth, which owe their existence to recent technological developments. So consider the first set of words. We Americans living at the millennium's cusp perceive backlogs of all sorts permeating our lives—but we do so because the word is there, warmly inviting us to see them. But back in, say, Johann Sebastian Bach's day, were there backlogs—or more precisely, were backlogs perceived? For that matter, did Bach ever experience burnout? Well, most likely he did—but did he *know* that he did? Or did some of his Latin pupils strike him as being underachievers? Could he see this quality without being given the label? Or, moving further afield, do Australian aborigines resent it when their

relatives micromanage their lives? Of course, I could have chosen hundreds of other terms that have arisen only recently in our century, yet which designate aspects of life that were always around to be perceived but which, for one reason or another, aroused little interest, and hence were neglected or overlooked.

My point is simple: we are prepared to see, and we see easily, things for which our language and culture hand us ready-made labels. When those labels are lacking, even though the phenomena may be all around us, we may quite easily fail to see them at all. The perceptual attractors that we each possess (some coming from without, some coming from within, some on the scale of mere words, some on a much grander scale) are the filters through which we scan and sort reality, and thereby they determine what we perceive on high and low levels.

Although this sounds like an obvious tautology, that part of it that concerns words is in fact a nontrivial proposition, which, under the controversial banner of "Sapir-Whorf hypothesis," has been heatedly debated, and to a large extent rejected, over the course of the twentieth century. I myself was once most disdainful of this hypothesis, but over time came to realize how deeply human thought—even my own!—is channeled by habit and thus, in the last accounting, by the repertoire of mental chunks (i.e., perceptual attractors) that are available to the thinker. I now think that it is high time for the Sapir-Whorf hypothesis to be reinstated, at least in its milder forms.

Language, Brains, and "Just Adding Water"

THE USUAL GOAL of communication is, of course, to set up "the same thought" in the receiver's brain as is currently taking place in the sender's brain. The mode by which such replication is attempted is essentially a drastic compression of the complex symbolic dance occurring in the sender's brain into a temporal chain of sounds or a string of visual signs, which are then absorbed by the receiver's brain, where, by something like the reverse of said compression—a process that I will here term "just adding water"—a new symbolic dance is launched in the second brain. The human brain at one end drains the water out to produce "powdered food for thought," and the one at the other end adds the water back, to produce full-fledged food for thought.

Take, for instance, the paragraph given a few pages back:

that time I spent an hour or two hoping that my old friend Robert, whom I hadn't seen in two years but who was supposed to arrive from Germany by train sometime during that summer day in the little Danish fishing village of

Frederikssund (which in a series of letters he and I had mutually picked out on maps, and in which I had just arrived early that morning after driving all night from Stockholm), might spot me as I lurked way out at the furthest tip of the very long pier, rather than merely bumping into me at random as we both walked around exploring the stores and streets and parks of this unknown hamlet

Obviously, this set of black marks on a white background is not similar to the time I spent in Frederikssund, nor is any part of it similar to a pier, a drive from Stockholm, a body of water, or dashed hopes. And yet these marks triggered in your brain a symbolic dance so vivid that you saw, in your mind's eye, a fishing village, two young friends, their joyful anticipation of a semi-random reunion, a pier stretching far out into a gulf, a barely visible person anxiously pacing at its tip, and so on. A never-before-danced dance inside your brain, launched by a unique set of squiggly shapes, makes you feel almost as if you had been there; had I spelled it out with another page or two of intricate black-on-white patterns, it would feel all the more vivid. This is a wonderful kind of transportation of ideas between totally different media—uprooting ideas from one garden and replanting them in a garden never even imagined before, where they flourish beautifully.

Transportation

IN HIS BOOK *The Poetics of Translation* [Barnstone 1993], poet and translator Willis Barnstone has a section called "The Parable of the Greek Moving Van," where he points out that on the side of all Greek moving vans is written the word μεταφορα (phonetically *metaphora* and semantically "transportation"). He then observes:

To come to Greece and find that even the moving vans run around under the sun and smog of greater Athens with advertisements for transportation, for metaphor, and ultimately with signs for TRANSLATION should convince us that every motor truck hauling goods from one place to another, every perceived *metamorphosis* of a word or phrase within or between languages, every decipherment and interpretation of a text, every role by each actor in the cast, every adaptation of a script by a director of opera, film, theater, ballet, pantomime, indeed every perception of movement and change, in the street or on our tongues, on the page or in our ears, leads us directly to the art and activity of translation.

I pack my mental goods down into tight, neat bundles, I load them as carefully as I can into the *metaphora* truck of language, it drives from my brain to yours, and then you unpack. What a metaphor for communication! And yet it has often been said that all communication, all language, is metaphorical. Since I believe that metaphor and analogy are the same phenomenon, it would follow that I believe that all communication is via analogy. Indeed, I would describe communication this way: taking an intricate dance that can be danced in one and only one medium, and then, despite the intimacy of the marriage of that dance to that medium, making a radically new dance that is intimately married to a radically different medium, and in just the same way as the first dance was to its medium.

Trans-sportation

TO MAKE THIS ALL a little more concrete, let us consider taking a complex dance done in the medium of *the sport of basketball* and trans-sporting that dance into the rather different medium of *the sport of soccer*. Indeed, imagine taking the most enthralling basketball game you ever watched—perhaps a championship game you saw on television—and giving a videotape of that game to a "soccer choreographer," who will now stage all the details of an artificial soccer game that is in some sense analogous to your basketball game. Of course this could be done in many ways, some conservative and some daring.

Some choreographers, citing irreconcilable differences between the two sports (for instance, the difference in the number of players per team, the lack of any counterpart to a goalie in basketball, the low frequency of scoring in soccer relative to basketball, and on and on), might severely bend the rules of soccer, creating a game with only five players on a team, taking away the goalies, vastly reducing the size of the field (and the goals), and so forth, thus effectively creating a hybrid soccer-basketball game that looks very much like basketball, only it is played on grass and involves propelling the ball with the lower rather than the upper limbs. When one watched the reenactment of one's favorite basketball game in this artificial medium, one would not have the sense of watching a soccer game but of watching a very distorted basketball game.

Other choreographers, more willing to go out on a limb, would retain the normal rules of soccer but would attempt to stage a game whose every play *felt* like a particular play of the original basketball game, even though eleven players were retained on a side, even though the goals remained huge compared to baskets, even though there were still goalies, even though the goals might be

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coming a little too thick and fast, and so forth. There would be plays that would be essentially like slam-dunks while at the same time looking every bit like normal soccer plays. In such a case, one would feel one was watching a genuine soccer game—perhaps a peculiar one in some ways, but nonetheless genuine. In the ideal case, one could have the two counterpart games running on side-by-side television screens, and a “neutral” commentator using only terms that apply to both sports could be effectively heard as describing either of the games.

Anything in between these two extreme philosophies of “trans-sportation” can also be imagined—and just such a bizarre scenario is what I think everyday communication is actually like. Two brains are, in general, far more unlike than are the sports of soccer and basketball—and yet our society is predicated on mutual comprehensibility mediated by language.

Winding Up: On Associationism and the Cartesian Theater

THE CRUX OF this essay is the claim that thinking (at least when isolated from external influences) is a series of leaps involving high-level perception, activation of concepts in long-term memory, transfer to short-term memory, partial and context-dependent unpacking of chunks, and then further high-level perception, and so forth.

This may sound like no more than the age-old idea of associationism—that we think by jumping associatively from one thing to another. If that’s all it came down to, my thesis would certainly be a sterile and vapid noncontribution to cognitive science. But the mechanisms I posit are more specific, and in particular they depend on the the transfer of tightly packed mental chunks from the dormant area of long-term memory into the active area of short-term memory, and on their being unpacked on arrival, and then scrutinized. Both transfer and perception are crucial, and in that respect, my thesis departs significantly from associationism.

Some readers, such as the author of *Consciousness Explained* [Dennett 1991], might feel they detect in this theory of thinking an insidious residue of the so-called “Cartesian theater”—a hypothetical theater in which an “inner eye” watches as various images go parading by on a “mental screen,” and becomes “aware” or “conscious” of such imagery. Such a notion of thinking leads very easily down the slippery slope of nested homunculi, and thus to an infinite regress concerning the site of consciousness.

I would gladly plead guilty to the accusation of positing a “screen” upon which are “projected” certain representations dredged up from long-term memory, and I would also plead guilty to the accusation of positing an “inner

eye” that scans that screen and upon it posts further representational structures, which trigger a descent via analogy into the dormant depths of long-term memory. I would insist, however, that the label “perception,” as applied to what the “inner eye” does, be sharply distinguished from visual or any other kind of sensory perception, since in general it involves no sensory modality in any normal sense of the term (recall the perception of “ethnic cleansing” in a newspaper story). The nature of such abstract or high-level perceptual processing has been sketched out in work done by my students and myself over the years (see [Hofstadter & FARG, 1995]), and I will not attempt to describe it here. Clearly, since it has been implemented as a computer program (at least to a first approximation), such a model does not succumb to snagging on the fatal hook of infinite regress.

To those who would scoff at the very notion of any “inner screen” involved in cognition, I would point to the large body of work of perceptual psychologist Anne Treisman [e.g., Treisman 1988], which in my view establishes beyond any doubt the existence of temporary perceptual structures created on the fly in working memory (she calls them “object files”)—a stark contrast to the connectionist-style thesis that all cognition takes place in long-term memory, and that it consists merely of simultaneous *conceptual activations* (possibly with attached temporal phases, so as to handle the “binding problem”) without any type of transfer to, or structure-building in, a distinct working area. Although this more distributed view of the essence of cognition might appeal to opponents of the Cartesian theater, it does not seem to me that it comes anywhere close to allowing the richness of thought that back-and-forth flow between long-term and short-term memory would allow.

I hope that my speculative portrayal of analogy as the lifeblood, so to speak, of human thinking, despite being highly ambitious and perhaps somewhat overreaching, strikes a resonant chord in those who study cognition. My most optimistic vision would be that the whole field of cognitive science suddenly woke up to the centrality of analogy, that all sides suddenly saw eye to eye on topics that had formerly divided them most bitterly, and naturally—in-deed, it goes without saying—that they lived happily ever after. Whatever.

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Revolutionary New Insoles Combine Five Forms of Pseudoscience

FROM THE ONION

If it sounds like science, it must be science—or so it sometimes seems in our tech-crazy, jargon-loving commercial culture. But as the pseudoscience writers at the pseudonewspaper The Onion ("America's Finest News Source") have figured out, the line between real and ersatz can get awfully blurry.

MASSILLON, OH—Stressed and sore-footed Americans everywhere are clamoring for the exciting new MagnaSoles shoe inserts, which stimulate and soothe the wearer's feet using no fewer than five forms of pseudoscience.

"What makes MagnaSoles different from other insoles is the way it harnesses the power of magnetism to properly align the biomagnetic field around your foot," said Dr. Arthur Bluni, the pseudoscientist who developed the product for Massillon-based Integrated Products. "Its patented Magna-Grid design, which features more than 200 isometrically aligned Contour Points™, actually soothes while it heals, restoring the foot's natural bio-flow."

"MagnaSoles is not just a shoe insert," Bluni continued, "it's a total foot-rejuvenation system."

According to scientific-sounding literature trumpeting the new insoles, the

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