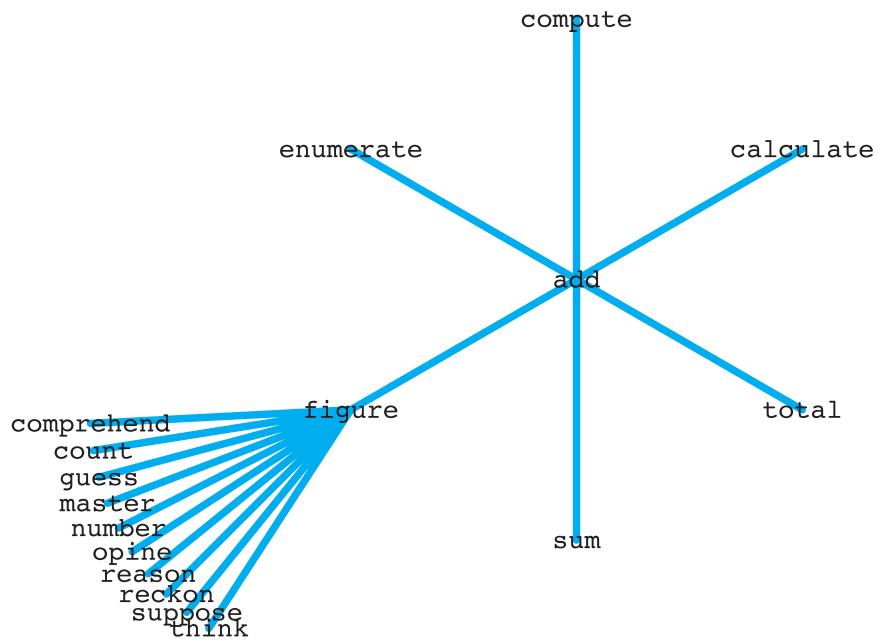


The Gulf between Love and Hate is No Greater than 6

Experiments in Language, Literature, and Mathematics

Jason Zimba



Presentation on the occasion of Bennington College's 75th Anniversary

October 7, 2007

I. The Gulf Between Love and Hate Is No Greater than 6

The word *cup* is synonymous with the word *hold* (as in, “cupping a breast in one’s hand”). Furthermore, the word *hold* is synonymous with the word *imprison* (as in, “the terrorist was being held at an undisclosed location”). But nobody would consider the words *cup* and *imprison* to be synonymous with each other.

Given two words x and y , if x and y are synonymous, then we shall write $x \sim y$. Given two words x and y , we shall define the *gulf* between x and y to be the length of the shortest chain of words $\langle w_1, w_2, \dots, w_n \rangle$ for which

$$\begin{array}{rcc} x & \sim & w_1 \\ & & \\ w_1 & \sim & w_2 \\ & & \\ & & : \\ & & \\ w_{n-1} & \sim & w_n \\ & & \\ w_n & \sim & y. \end{array}$$

For example, the gulf between *cup* and *imprison* is 1:

$$\begin{array}{rcc} \textit{cup} & \sim & \textit{hold} \\ & & \\ \textit{hold} & \sim & \textit{imprison}. \end{array}$$

In the case where x and y are synonymous, or are actually the same word, we shall say that the gulf between them is zero. If there is no finite chain of synonyms whatsoever connecting x to y , then we shall say that the gulf between x and y is infinite.

What is the gulf between *love* (the transitive verb) and *hate* (the transitive verb)? Based on *Webster’s New World Thesaurus*, we can state definitively that the gulf is no greater than six. For *love* is listed as a synonym for *cherish* (page 262), which is listed as a synonym for *treasure* (page 63), which is listed as a synonym for *guard* (page 461), which is listed as a synonym for *tend* (page 192), which is listed as a synonym for *mind* (page 448), which is listed as a synonym for *dislike* (page 278), which is listed as a synonym for *hate* (page 199). Succinctly,

$$\begin{array}{rcc} \textit{love} & \sim & \textit{cherish} \\ \textit{cherish} & \sim & \textit{treasure} \end{array}$$

treasure ~ guard
guard ~ tend
tend ~ mind
mind ~ dislike
dislike ~ hate.

On page 1,118 of the Fourth Edition of *The American Heritage Dictionary of the English Language*, the following appears as definition number six for the word *mind* (transitive verb): “**6a.** To care about; to be concerned about. **6b.** To object to; dislike.” In grouping together these two senses, the lexicographers have located for us the exact site of the affinity between *love* and *hate*. It is here, precisely here, within the bipartite sixth definition of the word *mind*, where our language records the torture that is caring for someone.

If the gulf that separates *love* and *hate* can be bridged, then might any two words whatsoever be connected by a long enough chain of synonyms? Or are there concepts in our language so definitively different, so unblurrable at their edges, that their respective shades of meaning never overlap, even as their synonyms, and the synonyms of their synonyms, ripple outwards through the dictionary? If such an unbridgeable gulf were to exist, would we find only antonyms on opposite sides of it? Or would we discover a new kind of relationship between words, a relationship more profound than simple antonymy or synonymy, a relationship of total irrelevance? Given any dictionary and any thesaurus, there exists a third book, one that sets down, against each word, the strangers to it: its xenonyms. I cannot help but observe that Borges has produced this work.

Jason Zimba
June 14, 2007
Pownal, Vermont

What you just heard is something I wrote a few months ago. The piece actually started a year earlier, as a word puzzle, of all things—making word puzzles is a hobby of mine. This particular puzzle was inspired by “change-a-words,” which you find in the 99-cent puzzle books sold in supermarket checkout aisles. In change-a-words, you begin with a word—*palm*, say—and you have to get to another word—*hand*, say—by changing one letter at a time. We can get from *palm* to *hand* like so:

palm, balm, bald, band, hand.

This game is really about finding nearest neighbors. The “nearest neighbors” of the starting word *palm* are all of the four-letter words that differ from *palm* by a single letter. It so happens that *palm*’s nearest neighbors are *balm*, *calm*, *pale*, *pall*, *palp*, and *pals*.

By analogy, I wondered what the nearest neighbors of *love* and *hate* were—not in the sense of changing one letter at a time, but in the sense of moving away by one degree of meaning. Could we “change-a-word” from *love* to *hate* like this?

I tried it for a few minutes, but I decided that finding the solution would probably involve consulting a thesaurus, which meant that this was not a very fun sort of puzzle. It was also not at all clear that one *could* get from *love* to *hate* by any finite chain of synonyms. One might hunt around in the thesaurus for hours looking for a chain that didn’t even exist. So I dropped the question.

A few months later, I picked up the *love-hate* puzzle again. Still unwilling to consult the thesaurus that stood within arm’s reach on my shelf, I reflected instead about synonymy itself. Synonymy is a relation that holds between certain pairs of words. A given pair of words may be related by synonymy, or not related by synonymy, as the case may be. *Cup* and *hold* are so related; *salt* and *helpfulness* are not.

Synonymy is a relation between words, but there are relations between all kinds of objects, such as relations of kinship between family members. *Jeb Bush* stands in a relation of “unclehood” to *Jenna Bush*, for example.

Mathematicians classify relations according to whether they are *reflexive*, *symmetric*, or *transitive*, or perhaps some combination of these things (or perhaps none of these things). To begin with the first of these terms, a particular relation is said to be *reflexive* when objects always stand in the relationship to themselves.

An example of a reflexive relation would be the relation between people having the same birth weight. My daughter Abigail weighed 8 pounds 10 ounces at birth. That “relates” her to a little boy baby I found on the web, who also weighed 8 pounds 10 ounces at birth, and whose picture is in your packet. Abigail, as it turns out, is not “related” to me; I weighed 8 pounds 8 ounces at birth. But Abigail *is* related to herself, because she and herself share the same birth weight. The birth weight relation is



~



~



reflexive



~



symmetric



~



transitive



~



~



~



reflexive. Synonymy is arguably a reflexive relation—we may as well consider a word to be synonymous with itself.

The second term. A relation is said to be *symmetric* if x 's being related to y equally implies that y is related to x . The order of the objects is irrelevant in a symmetric relation. The relation of synonymy is symmetric, for if Word x is a synonym of Word y , then Word y is also a synonym of Word x . The birth weight relation is also symmetric, for if Baby x has the same birth weight as Baby y , then Baby y obviously has the same birth weight as Baby x .

The unclehood relation, however, is not symmetric, because Jeb is Jenna's uncle, but the reverse is not true.

Finally, a relation is said to be *transitive* if, whenever x is related to y , and y is related to z , it follows that x is related to z . The birth weight relation is transitive, for if Baby Abigail is related to little Micah, and little Micah is related to little Nicole, then Abigail will in fact be related to Nicole.

Synonymy is not a transitive relation, for as we have seen, *cup* is synonymous with *hold*, and *hold* is synonymous with *imprison*, but *cup* is not synonymous with *imprison*. This is important for the *love/hate* question. Because if synonymy were transitive, then a chain of synonyms of any length whatsoever would necessarily have synonyms at its endpoints. The gulf between *love* and *hate* would therefore be infinite. But the lack of transitivity in the relation of synonymy leaves the question open.

With thoughts like these running through my head, I thought the *love/hate* word puzzle would make a nice article for a recreational math journal. (Yes, there is such a thing as a recreational math journal.) I would highlight some of the interesting computational and linguistic aspects of the relation of synonymy.

But as I began writing, I found that instead of symbols, definitions, and theorems, prose kept coming out. It seemed I was having difficulty regarding *hatred* as a solely mathematical object. In the genre in which I was working, the path starting at *love*, pivoting on *mind*, and ending at *hate*, should have been a harmless sequence of vertices in a graph; instead, it read to me like an emotional collapse: benevolence descending through care into anger.¹

In the end, I tore down the mathematical scaffolding and wrote the paragraphs with which I began this lecture. So what started as a puzzle, and tried to be a mathematics paper, ended up as something less easy to categorize.

The linguistic questions posed in the piece are not rhetorical, by the way. Do xenonyms exist? I cannot say; I have not explored the linkages in my thesaurus very far. The next word I add to my data might be the one that bridges all of the islands of meaning into a single connected network. This would mean that xenonyms do not exist.

¹ This, I should say parenthetically, was during a difficult time in my life. I had finally succeeded—the verb is excessive—in relocating my parents from their home in Michigan to a nursing home at the edge of this campus. This—let me tell you—I minded.

I suspect they do exist, though. Borges noted the “happy conjunction” of corporeal and ethereal adjectives in Shakespeare’s phrase, “a malignant and turbaned turk;” and Borges himself used similarly heterogeneous combinations of modifiers in his writings. We may one day prove mathematically that *malignant* and *turbaned* are, in fact, xenonyms—in which case, we could attribute to Borges the discovery of this feature of our language. (My solitude is gladdened by this elegant hope.)

Although it doesn’t come across in the piece itself, writing it was actually an experiment: specifically, an attempt to investigate one element of Borges’s craft. In Borges, the stories are intensely emotional, and this has always impressed me, because these emotions so often unfold within a context of abstract intellectual concerns, even mathematical concerns. Actually, the emotions *derive* from those concerns. The Librarians in *The Library of Babel* clamber over a hexagonal latticework like so many Escheresque ants, and their melancholy *derives* from the vastness of the mathematical problem they inhabit.

I thought I might better understand what Borges was up to here, and what challenges he surmounted as an artist, if I attempted the same challenge (in my own humble way). A quasimathematical reflection on love, hate, caring, and minding, presented the opportunity.

This in any case is the *personal* meaning behind my piece’s final sentence: “Borges has produced this work.” The *surface* meaning is that a book of xenonyms, which I vainly invent in the climax of the piece, in fact already lies on a dusty shelf in some corner of Borges’s Total Library. In expressing, redundantly, this idea, I am merely a Librarian, drifting through the latticework, running my index finger listlessly along the spines of books.

II. Autosummary

As I was working on this lecture, I discovered a sensational feature in Microsoft Word: the Autosummary. Go to the Tools menu and select Autosummarize. Microsoft Word will summarize your document.

In the spirit of “experiments in language, literature, and mathematics,” I took several texts and dumped them into Microsoft Word, to see what would happen when I Autosummarized them.

It had been my ambition to write Borgesian flights of fancy about all these—parodies of literary criticism comparing Austen’s *Pride and Prejudice* to the infinitely richer Autosummary of it; absurd attempts to generate exact copies of the original works by a fanatically close reading of the summaries; and so on. But we don’t have to overdo the Borges to enjoy the Autosummaries—they are actually pretty interesting to look at all by themselves.

The Autosummaries do come out looking like modernist poetry, which means that they are best looked at on the page, not read aloud. So I’ll give you a few minutes to look them over. There are four examples in your packet. If people have comments on these, we can talk about them at the end.

The Open Boat

by Stephen Crane

The captain shook his head. Then the oiler rowed. There comes another man!"

"Why, certainly it's a boat."

Well, that must be the life-boat. Isn't that a boat?"

"Where? No, that's no boat."

In a low voice the correspondent addressed the captain. Later the correspondent spoke into the bottom of the boat.

The boat was headed for the beach. The men were silent. "All right, captain," said the cook.

"Come to the boat! Come to the boat!"

"Come to the boat," called the captain.

"All right, captain." The correspondent said: "Go."

Selected chapters from *Pride and Prejudice*

By Jane Austen

Chapter 1

Mr. Bennet made no answer.

"Bingley."

my little Lizzy."

Chapter 2

Bingley. Mrs. Bennet said only,
to Mr. Bingley."

Chapter 3

Mrs. Bennet was quite disconcerted.
Lady Lucas
daughters.

Elizabeth Bennet had been obliged, by the scarcity of gentlemen,
said Mr. Darcy, looking at the eldest Miss Bennet.

"Oh! to young ladies who are slighted by other men. Mr. Darcy walked off; and
family. Jane
Elizabeth felt Jane's pleasure. found Mr. Bennet still up. Mr. Bennet protested against
Darcy.

Chapter 4

When Jane and Elizabeth were alone, the former, who had been
time. *me* never. "Dear Lizzy!"

"Oh! Mr. Bingley
Bingley was endeared to
strength of Darcy's regard, Bingley had the firmest reliance, and
In understanding, Darcy
Bingley was by no means deficient, but Darcy
Bingley was
Bingley had never met with more

Chapter 13

Mrs. Bennet's eyes sparkled. to see Mr. Bingley. "Dear Sir,--

If you should have
"WILLIAM COLLINS"

sensible man, sir?"

Mr. Bennet indeed said

Chapter 14

Lady Catherine de Bourgh's
Catherine. Lady Catherine was
Lady Catherine
the ladies at court."

ladies. Lydia exclaimed.

Chapter 15

Miss Bennet's lovely face
Mr. Collins had only to change from Jane to Elizabeth--and it
Elizabeth, equally next to Jane in birth and beauty, succeeded
discomposed Mr. Bennet exceedingly. Bingley was the principal spokesman, and Miss Bennet the
Mr. Darcy corroborated it with

Chapter 23

Elizabeth was sitting with her mother and sisters, reflecting on
daughter.

daughter!

happiest of men.

Chapter 56

Darcy mentioned his letter.
letter.

loveliest Elizabeth!

Darcy affection

The United States of America

State of the Union Address

January 23, 2007

President George W. Bush

(Applause.)

(Applause.) (Applause.)

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(Applause.)

Spreading opportunity and hope in America also requires public schools that give children the knowledge and character they need in life. (Applause.) (Applause.) The No Child Left Behind Act has worked for America's children -- and I ask Congress to reauthorize this good law. (Applause.)

(Applause.) (Applause.) But many Americans cannot afford a health insurance policy.

Single Americans with health insurance will pay no income or payroll taxes on \$7,500 of their income. (Applause.)

(Applause.) We need to help small businesses through Association Health Plans. (Applause.) (Applause.) (Applause.) (Applause.)

Extending hope and opportunity in our country requires an immigration system worthy of America -- with laws that are fair and borders that are secure. (Applause.) (Applause.)

(Applause.) (Applause.) (Applause.)

Extending hope and opportunity depends on a stable supply of energy that keeps America's economy running and America's environment clean. (Applause.) (Applause.) Tonight, I ask Congress to join me in pursuing a great goal. (Applause.) (Applause.) (Applause.) (Applause.)

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(Applause.)

(Applause.)

In 2005, the people of Afghanistan defied the terrorists and elected a democratic legislature. (Applause.)

(Applause.) (Applause.)

(Applause.) The people of Iraq want to live in peace, and now it's time for their government to act. If American forces step back before Baghdad is secure, the Iraqi government would be overrun by extremists on all sides. (Applause.)

(Applause.)

(Applause.) (Applause.) In Iraq, multinational forces are operating under a mandate from the United Nations. We're working with Jordan and Saudi Arabia and Egypt and the Gulf States to increase support for Iraq's government.

(Applause.) (Applause.) (Applause.)

(Applause.)

(Applause.) (Applause.)

(Applause.)

(Applause.)

Julie represents the great enterprising spirit of America. (Applause.)

(Applause.)

The Outline of Science: A Plain Story Simply Told

By J. Arthur Thomson (1861-1933)

TO MAN

Animal Intelligence

conservative animals. Brute man

[Illustration: 1. 4. man. Man's Pedigree

Tentative Men

Neanderthal Man. HEIDELBERG MAN

Primitive Men

(7) Palaeolithic men

The animal lives

animals themselves.

simpler animals.

shore-animals. animal behaviour.

animal's.

light.

light.

sun.

III. Math and Things

What are we trying to do when we teach mathematics here? I am embarrassed to admit that I do not know. But over the past year, my growing sense has been that what we do with math at Bennington should help our students develop into the kinds of thinkers and doers who can take up the many challenges we will all face in the coming decades. I am glad to report that no fewer than thirty of our students are now getting involved in this conversation, as part of a course(?) I'm convening this term called "Why Math? What Math?"

As the weeks go by this term, I have been asking myself what from mathematics is so powerful that perhaps everyone here should get it. By everyone I mean not just students, but everyone, from the dance faculty to the librarians and the deans. So far, I have a short list of things—and the list had better be short—and in my thoughts I refer to them as Thing 1, Thing 2, and so on, like in Dr. Seuss. Here I'll talk about just two of the Things:

Thing 1: The eagerness to draw diagrams when working on a complex problem.

Thing 1 is not really about math abilities, as we usually understand them. Obviously, no "math" is required in order to be eager to draw a diagram! It doesn't even matter if the diagram is very good. Everybody *can* draw a diagram. The point is that some people *do* draw them. I want to know how to make more of those people.

Having Thing 1 is also not the same as knowing or understanding a body of content. Nor is it like having a skill, because skills are what you call on to help you in specific, stereotyped situations, such as academic exams or drawing a patient's blood. Having Thing 1 is more akin to having *powers* of a certain kind, powers which you display whenever you're in a tight spot, like Wolverine, when he lowers his arms and reveals those adamantium claws.

Thing 1 should probably be an important focus of education in the very early grades. But as that appears not to be the case, we have to ask how we can best work with the students who come through the educational system we have today. These students often lack the confidence to pick up a piece of chalk and make a mark. Teachers of drawing, painting, and writing know all kinds of strategies for getting students to spoil the clean sheet of paper and spill that first drop of ink. I believe these strategies will prove valuable in teaching mathematics at Bennington. I believe these *teachers* will prove valuable in teaching mathematics at Bennington.

Thing 2: Estimating orders of magnitude

A colleague of mine told me recently about a research study he'd read that noted that the number of elementary and secondary teachers in the U.S. is 3.1 million. It could hardly be otherwise. The human life span is on the order of 72 years, meaning

that children up to age 18 will comprise on the order of a fourth of the U.S. population, that is, on the order of 75 million people. With a class size on the order of 25 students, you're going to need on the order of 3 million teachers.

What I just did is called making an order of magnitude estimate. Physicists make tremendous use of this technique, Enrico Fermi having been famous for his ability to estimate anything to within an order of magnitude. Last spring I taught the technique to twenty-five “non-math-students” in my Rediscovering Math class. As an illustration, I stood at the board and right there on the spot estimated the number of gallons of gasoline consumed in the United States every day, using only common knowledge. The calculation went like this:

$$(100 \text{ million people driving each day}) \times (100 \text{ miles driven}) \div (20 \text{ miles per gal.}) = 500 \text{ million gal. per day}$$

Many of the students were aghast. “But how do you *know*,” they said, “that 100 million people drive every day?” Well, it can't very well be 10 million, because that's only 3% of the population, and can you really think that only 3% of the population of the United States drives a car every day?

At the other extreme, I know it's not a billion people either, because there aren't even that many Americans.

So, 100 million it is.

As for the daily distance, you could argue for an average of 10 miles per day, but my own commute is 20 miles per day, and don't forget that we have to take commercial transportation into account. In that light, 10 miles a day just isn't reasonable.

At the other extreme, the average distance can't be 1000 miles either, because it takes all of a day just to drive that far.

So, it's not 10 miles, and it's not 1000 miles, which means it's 100 miles.

Well, there was enough skepticism about all of my reckless assertions that I went to the web later to dig up a more careful estimate. The official government estimate at <http://www.eia.doe.gov/neic/quickfacts/quickoil.html> is 384.7 million gallons per day. We got the order of magnitude dead-on.

Anyone *can* reason like this, but very few people do—probably because in the current educational landscape, you have to be a graduate student in physics, or a management consultant, before anyone teaches you the technique.

Thing 1 and Thing 2 should be much more common than they are, and in general I think that we as educators should aim for a world in which virtually everyone in America is vastly more comfortable using mathematics than they are now. How many people can sketch a graph of a relationship, not only when specifically asked to do so in school, but also unprompted and with confidence as a way of attacking a problem at work?

Last year, I was talking to publishers about my manuscript on Newton's Laws of Motion, and you can bet that I went into that process with order of magnitude estimates in hand for how many copies my book would sell, how much revenue it would generate for the publisher, and what I should be asking for in terms of an advance and royalties. It shouldn't take a Ph.D. in theoretical physics to approach life this way. But the K-12 system and the colleges are not producing citizens who can use math powerfully for their own ends.

Like Borges's characters, we inhabit a mathematical problem. But we cannot afford to respond with suicidal melancholy. We need to achieve—and for more than just a few of us—what John Dewey described as a “widening spread and a deepening hold of the scientific habit of mind.” As J. Arthur Thomson said it in his book *The Outline of Science*, in a passage that somehow didn't make it into the Autosummary, “Life is not for science, but science for life. And even greater than science, is the individual development of the scientific way of looking at things.”

To foster that development on a large scale is the challenge for math and science at Bennington as it looks towards its next 75 years.

Thank you.

The Gulf between Love and Hate is No Greater than 6
Experiments in Language, Literature, and Mathematics

By Jason Zimba

Autosummary by Microsoft Word

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