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### *Computers, Conversation, Utilization and Commoditization: the 2008 Herb Abrams Lecture*

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“Computers, Conversation, Utilization and Commoditization”  
The 2008 Herbert Abrams Lecture

Frank Levy<sup>1</sup>

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I want to thank Steven Seltzer and the Brigham radiology community for the opportunity to speak today. The invitation is both an honor and a responsibility. It is an honor to follow the distinguished group of previous Abrams Lecturers: John Wennberg, Marcia Angel, Norman Shumway and Margaret Marshall, to name a few. The responsibility is to say something of interest to radiologists. We will know soon enough how that goes.

When Steven invited me to give the Abrams Lecture, he suggested I talk about the commoditization of radiology. I will talk about commoditization - a term I will define shortly. But as many of you know, commoditization is bound up with other issues facing the profession including the rising cost of imaging and the growing isolation of the radiologist from many medical decisions. I will talk about these issues as well.

My talk is speculative – an attempt to make sense of a number of stories I have collected. I hope the result is sufficiently accurate to stimulate your interest.

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It is a fact of labor economics that the job market can change more quickly than people can change their skills. So it is not surprising that the radiology profession has had its ups and downs. In 1967, Herb Abrams arrived at Harvard Medical School to build a radiology program.

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<sup>1</sup> Department of Urban Studies and Planning, MIT ([flevy@mit.edu](mailto:flevy@mit.edu)). I want to thank Paul Berger, Mick Brown, Howard Forman, Richard Frank, Jon Kolstad, Ramin Khorasani, Stephen Ledbetter, Barbara McNeil, Tom McGuire, Joe Newhouse, Max Rosen, Vijay Rao Christopher Lee Siström, Jon Skinner and Paul Spirn for helpful discussions of the ideas presented here. All errors are mine. This work was supported by a Robert Wood Johnson Foundation Investigator Award.

At the time, the profession was beginning a long upswing with many new ideas and the resources to fund them. As I understand it, Herb's first Brigham office was in the basement. It was a temporary solution while the hospital built his new facilities but the basement was consistent with the rest of the program. Diagnostic radiology and radiation therapy were lumped together. There were no radiology residents.

Eighteen years later, when Herb stepped down as chair, it had become a new world. CT's were in routine use, MRI's were coming into use, and the Brigham Radiology Department was a large, innovative and dynamic organization.

That was 1985. But only eight years later many radiologists thought the profession was doomed. It was the early 1990s and radiologists feared healthcare reform would shift demand away from specialists to general practitioners. But as sometimes happens in financial cycles – we will see about this one –gloom peaked just as a second golden age of radiology was beginning.

This second golden age continued scientific advances and boosted incomes as well. In a talk I gave to radiologists last January, I mentioned that this second golden age had increased the average radiologist's salary to around \$400,000 per year. After the talk, several members of the audience came up to politely suggest that my estimate was too low.

Nonetheless, today's radiologists face professional problems and I want to discuss two of them. One is the potential for the "commoditization" of radiology services. The second is a growth rate of advanced imaging utilization that is unsustainable. Each problem has multiple causes but I want to discuss what I believe is one cause shared in common – the decline in conversation between the radiologist and the ordering clinician. By "conversation", I mean informal consultations – the kind of interchange that happens when an ED doctor walks into

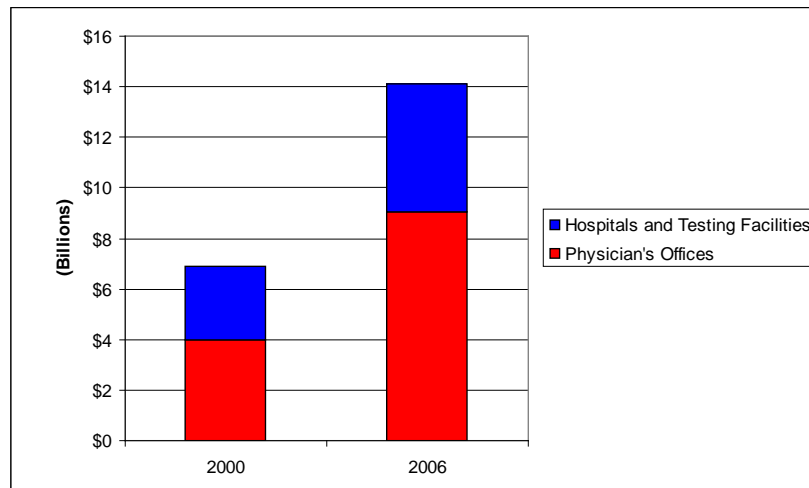
the ED reading room and discusses an image with the radiologist. In the process, the radiologist becomes a more significant part of the medical team.

In my talk today, I will first review the problems I have mentioned, I will then explain the link between the problems and conversation. I will talk briefly about why radiologist-clinician conversations have declined and I will discuss possible incentives to reintegrate conversations into practice. I will close with a possible demonstration experiment.

My arguments will draw on two areas of theory. One is economic theory – in particular, the idea that the outcomes we see in the world are not accidents but the result of people responding to the incentives they face. The second area is the structure of information processing by both computers and humans. I will focus on the way that humans parallel-process information through both a cognitive system and an emotional system. The decisions we make reflect the interplay of the two systems. The differences between the systems give rise to developing field of behavioral economics and a finer understanding of the incentives we value.

## II. Overutilization and Commoditization.

To start, I will briefly discuss the two problems I mentioned beginning with the growth of utilization. A recent GAO report gives some perspective. Between 2000 and 2006, Medicare Part B Expenditures for imaging services rose from \$6.9 billion to \$14.1 billion – an aggregate growth of 105 percent.



During the same period, the nation's gross domestic product grew by 14 percent – that is, imaging service payments were growing seven times as fast as the nation's total output.

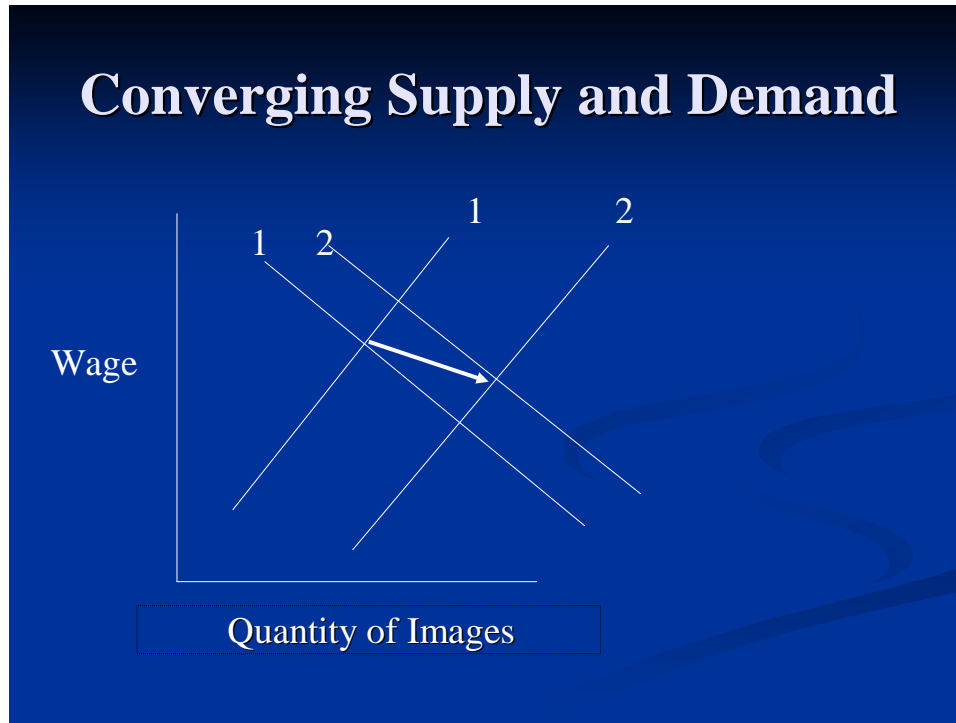
Radiologists are quick to say that much of this growth is due to self-referral by cardiologists and other specialties. That is clearly correct. In the Medicare data, seventy percent of volume growth represents additional billing from physicians' offices – a rough surrogate for self-referral. But this is not the total answer. Fee for service billing that does not come from physicians' offices 76 percent over this period– more than five times as fast as the growth in GDP.

Within the last two weeks another GAO report suggested Medicare utilization trends are now slowing modestly – a result they attribute to the O-P-P-S caps in the Deficit Reduction Act of 2005. Nonetheless, the aggregate data suggests that even if we adjust for self-referral, the volume of imaging is growing too fast to be sustainable.

The second problem I will be discussing is commoditization of radiology. The problem has been summarized in a thoughtful article by Dr. James Borgstede in the June 2008 issue of *Radiology*. As Borgstede says, a commodity is a homogenous good that is bought and sold solely on the basis of price. There is no quality variation to distinguish one producer's product from another. When I teach about commodities to city planning students at MIT, I use the example of Hard Red Wheat #3.

In the case of radiology, the “commodity” is the report dictated by a radiologist sitting in front of a screen. Conversation between radiologist and ordering clinician is not part of the product. As a consequence, the radiologist's location is not an issue.

I mentioned earlier that I would use economic theory where appropriate. To an economist, the emergence of commoditization and resulting price competition suggests the supply of radiologists is starting to outpace demand.



For example, four years ago, the Brigham ED first offered nighthawk service to local area hospitals. At that time, there was little competition – the biggest problem was that many local hospitals were unfamiliar with teleradiology. Today the market is tougher. Local area hospitals fully accept teleradiology and they know that a number of nighthawk firms are competing for their business. And this competition is not just for night work – several large Boston area hospitals have themselves competed for day work as well.

In theory, the convergence of supply and demand could reflect a rapid increase in the number radiologists. More likely, it reflects a slowing growth of demand due to increased restrictions on imaging and the growing share of images being read by non-radiologists.

This competition for work is not entirely new. Several years ago, one of my students told me about a Minneapolis radiology practice that gave its night work to an established nighthawk firm rather than a large Minneapolis hospital. It feared the hospital might ultimately compete for its daytime customers. That competition for work is slowly becoming a feature of radiology life.

### **III – The Role of Diminishing Conversation**

What role do diminishing conversations play in these problems? A word of personal history. I began to study radiology because I had been studying computerized work and people told me medical images were increasingly read by computers. I soon found that story was wrong, but it was not for lack of aspiration. In the mid- 1960s there were a number of articles with titles like “Automated Computer Analysis of Radiographic Images.”<sup>2</sup> Over time, these efforts were scaled down to today’s Computer Assisted Detection, a sometimes useful but, at least for now, a much less ambitious set of technologies.

There are at least two reasons why computers have difficulty in reading images. One is the large variation that occurs among healthy human structures. You know the aphorism, “A normal patient is one who has not yet been completely worked up.”

Software can sometimes work around this variation as a radiologist does – by analyzing *changes* in an image over time rather than analyzing a single image. Nonetheless, the wide variation in healthy structures makes it hard to establish statistical rules to flag abnormalities.

The second difficulty lies in a fundamental property of information processing: The human mind processes all information in a context, much of which has been previously internalized. When two people bring different contexts to information, they interpret the information differently.

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<sup>2</sup> See P.H. Myers, C.M Nice, and H.C. Becker et al. “Automated computer analysis of radiographic images. *Radiology*. 1964;83:1029–1033.]

I will give two visual examples beginning with a personal story. About 40 years ago, I went up to the top of then new Prudential Center with my two-year-old Goddaughter and her parents. The parents and I were marveling at the view 52 stories below. My Goddaughter was pounding on the glass because she wanted the toy cars and little people she saw just outside the window.

At the time, we thought my Goddaughter was making a cute mistake. Later, I came to understand that based on just the visual information, her interpretation was as plausible as ours. Nothing in the visual information told us we were seeing real cars and people 52 stories down rather than toy cars and ¼ inch people five feet beyond the window. We adults came to our interpretation by imposing a context on the information. Experience had taught us there were no ¼ inch people. My two-year-old Goddaughter had no such constraints.

I believe my second example still holds the record for shortest correspondence. I present the correspondence here in its entirety

The correspondence began with a telegraph consisting of **?** while the reply was a telegraph consisting of **!**

We don't do many telegraphs these days but what would you think if you received a letter consisting only of "??"? If you had a child in college, you would assume the letter was about money. If you were an academic, you would assume it was about an overdue referee report. By itself – taken out of context - the question mark tells you little.

For the record, this particular question mark was written by Victor Hugo. In 1862, Hugo finished *Les Miserables*. Exhausted, he dropped the manuscript off with the publisher and left for vacation. Though Hugo wanted to relax, he also wanted to know how the book was selling



– publication lead times were shorter then - and so he telegraphed “?”to his publisher. The book was a smash hit and so the publisher could telegraph back “!”

Hugo and his publisher each knew what was on the other’s mind – they shared a context. Without shared context, there is no guarantee that a recipient of information will interpret it as the author intended.

My discussions with radiologists and some cardiologists suggest that some medical images are similar to Hugo’s question mark in kind if not in degree. A piece of suggestive evidence occurs in Computer Assisted Detection. It is no accident that the first two CAD applications approved by the FDA were for microcalcifications in mammograms and cancerous nodules in lungs. These are examples where the context is relatively similar across cases and so shapes have relatively unambiguous meanings.

But what about all the other images? It is here, I am told where the loss of conversation can be felt – the inability to share the relevant part of a patient’s history, to know what is new for this patient and what has been present for years, to know what issues have been recently checked. In other words, conversation gives the radiologist a better idea what he or she is looking for and so, in turn, may make the interpretation more useful.

Cardiologists, for example, argue that they are equipped to read their patients’ images because they have this contextual information about their patients – something radiologists lack.<sup>3</sup>

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<sup>3</sup> There is a limit to this argument: Experiments have shown that knowing a patient too well can lead a doctor to use unwarranted optimism in talking to the patient See Botond Koszegi, “Emotional Agency”, *Quarterly Journal of Economics*, 121 (February 2006), pp. 121-155, and Marcus Alexander and Nicholas A. Christakis, “Bias and asymmetric loss in expert forecasts: A study of physician prognostic behavior with respect to patient survival,” *Journal of Health Economics*, 27 (2008), pp. 1095-1108.. A radiologist discussing detailed information about a patient would seem less subject to this bias.

At the same time, conversations let the ordering clinician get a better sense of whether another image (or even the first image) is likely to provide useful information. This is potentially a modest brake on utilization.

It goes without saying that these conversations are most effective if they occur between clinicians and radiologists who have worked together long enough to trust each other. As a colorectal surgeon told me this summer, “The thing that drives me crazy is talking over the phone to some guy I don’t know half-way around the world. Or some guy I don’t know across town, for that matter,”

What I am telling you is based on stories I have been told – I haven’t yet encountered experiments in the literature that verify the importance of this kind of informal learning in radiology. But the stories are consistent with the benefits of collaboration in other parts of healthcare<sup>4</sup>. They are also consistent with descriptions of informal learning in other settings.

For example, Jack Whalen and Erik Vinkhuyzen of P-A-R-C – what used to be Xerox PARC – analyzed the role of informal learning in a Xerox service center.<sup>5</sup> In the center, calls would be fielded by customer service operators who would either suggest a solution or, if they were stumped, would dispatch a technician.

Because a technician visit is expensive, Xerox wanted their customer service operators to solve as many problems as possible over the phone. To improve the operators’ performance,

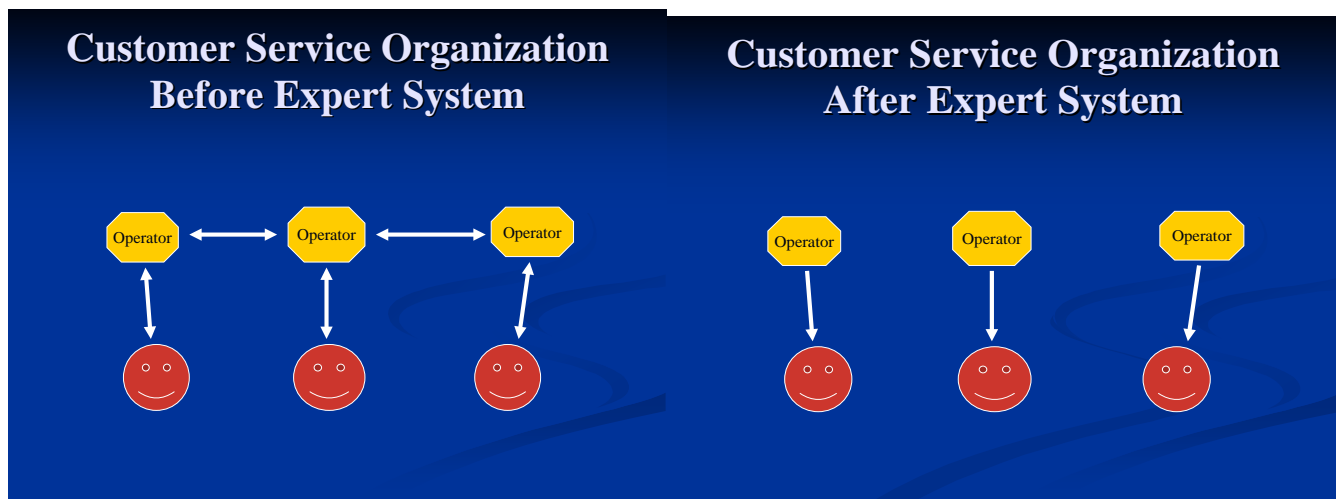
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<sup>4</sup> Some of these findings are summarized in Charles Hecksher, et. al., “Collaboration and the Quality of Healthcare Delivery,” working paper, Center for Workplace Transformation, Rutgers University, dated April 17, 2008.

<sup>5</sup> Erik Vinkhuyzen and Jack Whalen, “Technology and expertise in work practice::The case of service technicians,” in *Orders of Ordinary Action*, Stephen Hester and David Francis, eds., Aldershot, Hampshire: Ashgate Publishing. Paper also available at <http://www2.parc.com/csl/members/jwhalen/>

Xerox constructed expert system software and required each operator to use it on most of their calls.

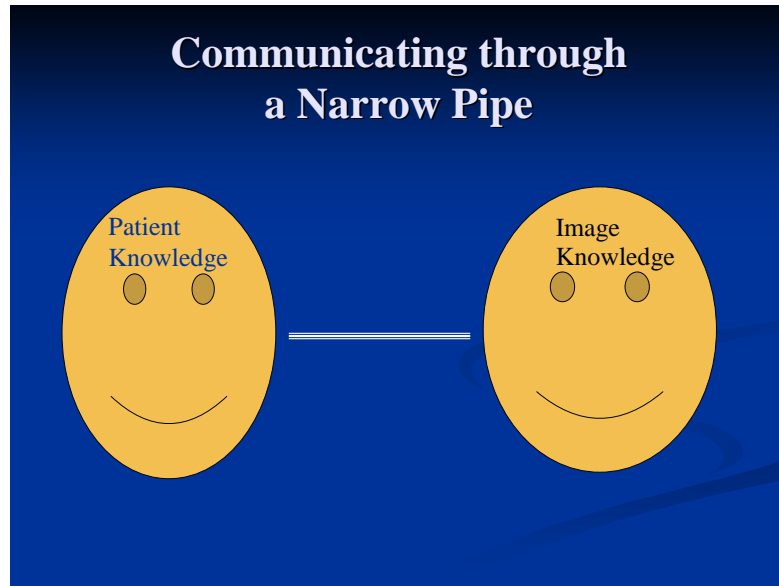
In practice, the use of expert system software reduced two kinds of informal learning. It cut down on contact **AMONG** customer service operators – that is, both explicit conversation and informal contact when one operator would overhear another solve a problem. More germane for our subject, the software also cut down on the unstructured opening conversation between an operator and a customer.



Before the software was installed, these opening conversations helped clarify the problem definition. Now the opening conversations were used for the more narrow purpose of getting the information required by the software's front end. Both sources of informal learning were important and over time, the fraction of calls solved by the customer service operators actually fell rather than rising.

I can summarize these kinds of stories using a diagram adapted from a lovely book on cognition called *The User Illusion* by Tor Norrestrand.<sup>6</sup> (SLIDE)

<sup>6</sup> Tor Norrestrand, *The User Illusion*, (paperback edition) Penguin Books, 1999.



The diagram illustrates two people, each with extensive information about different parts of a problem, trying to communicate through a narrow pipe. There is no ability to communicate through gestures or tone of voice – little back-and-forth opportunity to correct misunderstanding. Because the pipe is narrow, some parts of the information don't make it. The loss of information can affect the quality of the solution.

The new order entry tools – with decision support - reinsert some of this lost information into clinician decisions. The tools are a big step in the right direction. But they address utilization – not the distancing of the radiologist from medical decisions. And I will argue later that increased conversations can reinforce what the tools attempt to do.

To summarize to this point: A number of radiologists have told me that the way to fight commoditization is to restore the “value added” in the service they offer. From what I can tell, much of that value added occurs through conversations between the radiologist and the ordering clinician. Used in appropriate situations, the conversations can improve the value of an image. Conversations can also modestly ease overutilization by identifying when an image is not called for.

### III. Why Did the Conversations Decline?

From what I gather, commoditization is the last act of a three act play. The first act occurred in the pre-digital age. When clinicians wanted to see an image they had ordered, the quickest route was to walk down to the radiology reading room. The clinician and the radiologist in the same room offered a natural venue for discussing the case.

The play's second act occurred when images became digitized. The ordering clinicians could now see the image on their own terminals – there was no need to go to the reading room. And at least some radiologists welcomed the change. With a few exceptions, radiologists knew they were being reimbursed largely according to the number of cases read. Less time on conversation meant more time to read cases. But as we now see, the process had unintended consequences. It legitimated reading without much conversation. In the process, it distanced the radiologist from the center of medical decisions.

This unintended consequence began to level the playing field between local radiologists and teleradiologists. The result is the commoditization and price competition we discussed earlier. This may be less of a story at the major academic centers. But even here, I am told digitization caused radiologist-clinician conversations to decline over time.

In terms of economic theory, the current situation involves two overlapping ideas. One is an incentive problem first laid out for economists in an elegant article by Bengt Holmstrom and Paul Milgrom.<sup>7</sup> The radiologist's job (and many other doctors' jobs) consists of multiple tasks some of which are easily measured and some of which are not. It is easy to measure the number of cases read. It is harder to measure whether time spent in consultation clarifies a case or clarifies the Red Sox playoff chances.. If you want to relate pay to output you are forced to

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<sup>7</sup> Bengt Holmstrom and Paul Milgrom, , Multitask principal-Agent Analyses: Incentive Contracts, Asset Ownership and Job Design, *Journal of Law, Economics and Organization*, VII, spring 1991, pp. 24-52.

base pay on the parts of output you can measure. The result is the skewed system we currently have.

The situation is similar to the objection you hear about MCAS tests for Massachusetts elementary and high school students. The MCAS tests are currently the only measure of school performance. MCAS critics argue that as a result, teachers spend all their time teaching to the MCAS while art, civics and other untested subjects get squeezed out.

The second economics idea lurking in the background is an older problem in economic policy - the potential mismatch between the number of policy goals and the number of policy tools. The classic example today, God help us, is the position of the Federal Reserve. In normal times, the Fed has two competing goals: to control inflation and to maintain economic growth. And in normal times, they have one tool – the size of the money supply. Maintaining growth requires a larger money supply. Controlling inflation requires a smaller money supply – an obvious tension. Today's bail-out plan is, of course a second tool created because these are not normal times.

If we think of radiologists and ordering clinicians as responding only to financial incentives, we likely face a similar mismatch. We could set a higher rate per case to compensate for discussion time. But a higher rate would increase the opportunity cost of having conversations and radiologists would have incentives to game the system. Alternatively, one could put a radiologist on salary that was totally unrelated to the number of cases read, but that would threaten overall productivity,

If we have two goals – to maintain productivity and to reestablish useful conversations – a single financial incentive may not be enough to do the job. But, in fact, financial incentives may not be the only instrument we have.

#### IV– A Framework for Possible Solutions

At the beginning of this talk, I noted that the field of behavioral economics is slowly changing the traditional economist’s view about the way people make decisions. I want to use ideas from behavioral economics to analyze the clinician’s decision to order an image. I will then consider how these ideas might help to restore some conversation into the clinician-radiologist relationship. But before doing any of that, I will first discuss a different problem – the problem of ordering lunch.

The problem’s structure comes from a 1981 Thomas Schelling essay, “The Intimate Contest for Self Command”<sup>8</sup>. It is ten o’clock in the morning and you are thinking about what you will have for lunch. You know you should lose some weight and so you focus your thoughts on a spinach salad with a vinaigrette dressing. You maintain that focus until you actually enter the cafeteria at which point you hear the macaroni and cheese calling out to you. You know the rest of the story.

The medical version of this story comes from H. Gilbert Welch’s book, *Should I be Tested for Cancer?*<sup>9</sup> Welch writes:

“Consider what happens at my hospital’s weekly medical conference where the medical staff reviews the case of a specific patient. One doctor tells the patient’s story, stopping at critical junctures to ask the other doctors’ opinions. The basic questions are “What diagnoses would you consider given the information and what would you do next?”

Welch continues:

“Almost all doctors would agree that indiscriminate testing is not in a patient’s best interest. And in an educational forum, with many trainees in attendance, senior staff tend

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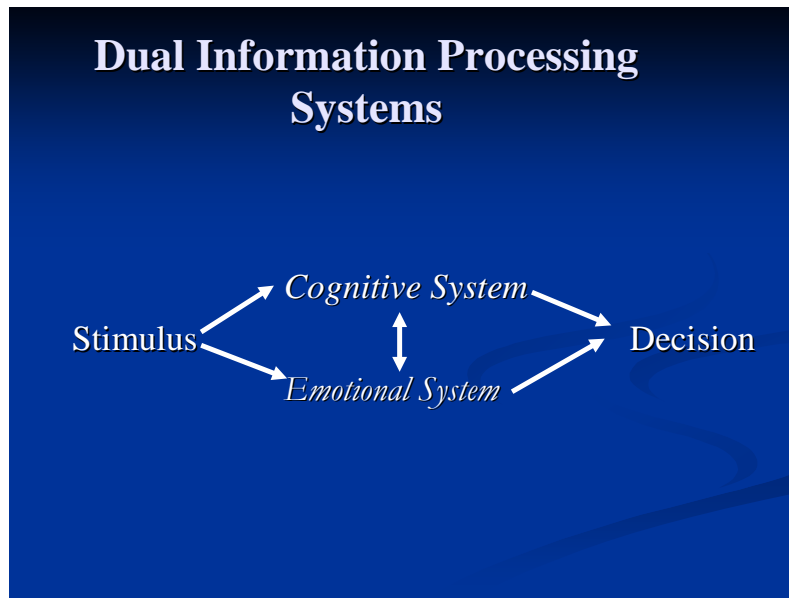
<sup>8</sup> Thomas Schelling, “The Intimate Contest for Self-Command”, *The Public Interest*, Volume 60, Summer 1980.

<sup>9</sup> H. Gilbert Welch, *Should I be Tested for Cancer? Maybe not and Here’s Why*, University of California Press, 2004.

to be quite parsimonious in the tests they suggest. Occasionally, however, someone will point out the charade: in the real world, most of us order more tests.” Welch (pp. 118-119)

Both the lunch decision and the testing decision fall under the heading of “**being of two minds**”. And, in fact, increasing evidence suggest that we are of two minds: a cognitive processing system which processes information more or less “rationally” and an emotional processing system that processes information in a context of emotional memories – crude representations of past experiences that have made strong impressions on us.

The neuroscience evidence for this dual-system model has been developed by Joseph LeDoux, among others – his experiments were the hard evidence behind Daniel Goelman’s *Emotional Intelligence*. An excellent behavioral economics survey of the dual-system model is an unpublished paper by George Lowenstein and Ted O’Donoghue entitled “*Animal Spirits*”.<sup>10</sup>



<sup>10</sup> See, for example, LeDoux’s excellent book, *The Emotional Brain* (paperback edition), Simon and Schuster, 1998. Daniel Goelman, *Emotional Intelligence*, Bantam Books, 1995, George Lowenstein and Ted O’Donoghue, “Animal Spirits: Affective and Deliberative Processes in Economic Behavior”, paper can be downloaded from O’Donoghue’s website, <http://people.cornell.edu/pages/edo1/papers.html>.



This slide, adapted from Lowenstein and O'Donoghue, summarizes the argument. The pull between the two systems is something we experience every day. We have to remind ourselves that the picture of the woman and cute children on the car salesman's desk does not mean the car salesman is an honest man – those people in the picture may not even be his family. Similarly, coming home from a bad day at work, we have to force ourselves to speak gently when our four-year-old knocks over his milk at the dinner table, something we would usually laugh off.

I believe the dual-system model is a useful way to understand the clinician's decision to order an image. The rational system frames the ordering decision in expected value terms – the expected value of any additional information versus the certain cost of the scan itself. You can modify this a little – the clinician doesn't actually pay the cost of the scan - not doing the test could increase the chance of malpractice litigation. But the rational calculation still says a clinician usually will not order a scan she believes is highly likely to confirm what she already knows.

A behavioral economist would shift the ground substantially by pointing to Richard Thaler's concept of regret – the feelings of guilt and responsibility that can arise when one acknowledges, ex post, that one has made a wrong choice.<sup>11</sup> In the field of finance, behavioral economists use regret to explain why people hold onto a losing stock for too long. Selling the stock acknowledges that there will be no turnaround and that buying the stock was a mistake.

As I understand it, physicians are champions of regret. The fear of missing something important has been inculcated in you in medical school - perhaps in Montessori school. (I also understand that surgeons are a little easier on this score. Economists are certainly easier.) The

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<sup>11</sup> Richard H. Thaler, "Toward a Positive Theory of Consumer Choice", reprinted in Thaler, *Quasi Rational Economics*, Russell Sage Foundation, New York, 1994.

result is a strong emotional motivation. Think again about a clinician deciding whether to order a test. If he orders a test that he thinks is probably unnecessary, he is likely to have wasted money. But if he doesn't order a test and misses something the test might have revealed, his feelings of regret, working through the emotional system will impose a psychic cost that could outweigh the wasted money of the unnecessary test.

Note that the clinician is still doing an expected value calculation. But he is now balancing emotional as well as financial variables. To complete the calculation, he must consider not only the psychic cost of regret but the probability that regret will occur.

How does a clinician estimate that probability – the probability that his initial diagnosis is wrong? Drawing on psychology, behavioral economics has established parts of the answer. To begin with, individuals attach too much probability of repeating salient or vivid events.

To update an example posed by Richard Nisbett and Lee Ross<sup>12</sup>, suppose you want to buy a compact car and you have narrowed your choice to a Toyota Camry and a Honda Accord. You read the *Consumers Reports* car owners' survey where the consensus is that the Accord is somewhat better. The next day at work you talk to a colleague who tells you that his brother-in-law recently purchased an Accord and it is a piece of junk.

The cognitive system evaluates this story for what it is: the equivalent of one more reader filling out a survey for *Consumer Reports*. But this is a story about a particular person told to you by a colleague. The emotional system sees this vivid information as more meaningful than one more data point. As a result, the story will weigh more heavily in your decision than its information warrants.

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<sup>12</sup> Richard E. Nisbett and Lee Ross, *Human Inference, Strategies and Shortcomings of Social Judgment*, Prentice Hall, 1980.

Several years ago, an attending ED radiologist expressed the same idea to me when he scoffed at a CT order. As he said, “The doctor doesn’t need this CT – he knows what the problem is. But these doctors are like gamblers – it’s the few times they hit that keep them coming back.”

Go back for a minute to the new generation of order entry tools. In the terms we are developing, their decision-support information works through the cognitive system. Given the power of vivid incidents, it would be nice to have stimuli working through the emotional system as well. Richard Thaler speaks to this idea when he points out that a clinician who gets a second opinion is dividing responsibility for the decision and so sharing the potential regret. In our problem, advice to avoid a scan that arises in a conversation with a radiologist (or a peer physician) is likely to have more impact than decision support information alone. The linking of decision support with prompts for peer-to-peer consultation is a step in this direction.

If conversation is unavailable, a second best emotional stimulus may be detailed profiling information: data showing a clinician how he or she performs vis-à-vis colleagues in the same situation. I emphasize - **in the same situation**. Otherwise, a clinician can dismiss profiling information by assuming colleagues have a different case mix. If that problem can be overcome, profiling information has the virtue of comparing the clinician to other real people rather than abstract statistics. This gives it some of the same emotional stimulus that comes from the story of the brother-in-law’s Accord.

A third aspect of behavioral economics – the last one I will discuss – is proximity. Here the new order entry systems shine. The more proximate the stimulus, the better it activates the emotional system and so the greater its weight in decisions. As Lowenstein and O’Donoghue write:

“Proximity can be defined on many dimensions – geographic, temporal, visual, social and so forth. Thus, for example, a tasty morsel is more likely to evoke hunger to the extent that it is nearby, immediately attainable, visible, or being consumed by someone else (in close proximity). Likewise, a person who makes you angry is more likely to evoke anger to the extent that he is geographically close (or likely to be soon) or visible. (p. 10)

In the context of ordering a scan, the concept of proximity says that while it may be necessary to explain profiling data in staff meetings, the data should also be presented at the moment the image is being ordered – something an order entry system can already do.

To this point, I have applied behavioral economics and the dual system model to the clinician’s decision to order an image. I believe similar ideas can be applied to both the clinician’s and the radiologist’s decisions to initiate a conversation. This is the subject of the last section of my talk.

## **V – Applying the Framework**

Let me begin this last section with two points:

- The future of commoditization is uncertain.
- If commoditization does slow, it will be because of experiments demonstrating the value of reintegrating radiologists into medical decisions.

My first point easily leads to economist-speak- “On the one hand..., On the other hand...” But uncertainty is more realistic than technological determinism that predicts commoditization is inevitable. You will recall how, a decade ago, there were technological predictions that web-based retailing would doom brick and mortar stores. For the record, in both 1990 - before the web - and in 2007, about 5 percent of all employed persons worked in

sales occupations. Salespeople maintained their presence in part because human interaction is better than text on a web page to convey many kinds of information.

My second point is just common sense. Given the state of the economy, healthcare spending will come under increasing financial pressure. Because of the pressure, in-house radiologists cannot simply assert their superiority over teleradiologists. If the value added is real – if regular conversations between radiologists and clinicians improve outcomes - it should be possible for experiments to demonstrate that fact.

I do not claim such experiments will be easy, but I want to sketch what one such an experiment might look like. **(SLIDE)**

At the outset, we know many images are too routine to need conversation. It follows that a first requirement for an experiment will be a set of criteria that can flag cases where a conversation might be useful – something like the ACR criteria for appropriate imaging.

If such criteria can be developed, the next step would involve programming the criteria on an order entry system - Percipio or one of its competitors. The order entry system would flag an image order where a conversation may be useful. The radiologist would also receive the flag and so and could initiate a conversation if the clinician failed to do so.

We have seen that to achieve maximum impact, this flag should be proximate and vivid. The flag is already proximate by being part of the order entry system. Its vividness can be increased by coupling it with profiling information of the kind described above – that is, “This is the rate at which you initiate conversations in this situation and this is average rate for your colleagues.”

The experiment would then involve two groups of clinicians: one group working with standard order entry software and the other working with order entry software augmented by the conversation flag.

The last element of an experiment – perhaps the hardest – involves establishing metrics for evaluation. One criterion is the number of ordered scans that are judged to be inappropriate or unnecessary. This presumably would be determined through expert panels. The harder question is judging whether conversations result in better information from images. In essence, we are asking whether the conversation changed what the clinician was intending to do. This would require recording clinical responses before and after the conversation. That task is arduous but not impossible. It is my understanding that other hospitals are doing this kind of data collection for assessing other diagnostic procedures.

At this point, you may be asking why - in the pressured busy world of hospitals - anyone would buy into this experiment? I can suggest several motivations.

From the clinician's perspective, the motivation is avoidance of regret. The flag is a warning that without conversation, the clinician may be missing something important.

The radiologist has to consider regret as well but radiologists have a second motivation: the threat of continued commoditization. If conversations with clinicians are really so cumbersome and useless, there is little value added from in-house radiologists and commoditization will continue to expand.

In sum, I have suggested an example of evidence-based medicine where the evidence does not come cheap. There is, however, one point to note.

In most cases involving evidence based medicine, lack of evidence results maintaining the status quo. In this case, lack of evidence will result in the continued growth of

commoditization, further isolating the radiologist from medical decisions. This result may not do patients, clinicians or radiologists any good at all.

Thank you.

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