

The Invisible Hand Meets the Invisible Gorilla: The Economics and Psychology of Scarce Attention

Summary of a conference held at IDEI, Toulouse School of Economics, September 2011



Executive Summary

Can the psychology of scarce attention help explain why nobody saw the financial crisis coming? And does cognitive science suggest that economists' assumption of rational decisions is fundamentally flawed?

At a recent workshop at the Toulouse School of Economics, researchers described the phenomenon of 'inattention blindness', whereby people looking at a scene fail to see the obvious. 'Seeing' is not a matter of looking at an internal representation of the outside world, but rather depends on an active cognitive process of paying attention to certain things. The structure of the brain, whereby neurons at different levels compete with each other to move up to higher levels of the brain, determines what we pay attention to.

One consequence of this inbuilt scarcity of attention is that attention can be guided by setting appropriate goals and stimuli. This can apply to helping an air traffic controller focus attention by suitable colour coding of visual screen displays – or potentially to helping financial regulators monitor developments in financial markets.

Attention is a key factor, too, in the effectiveness of advertising. Participants in the conference described research indicating that:

- Subliminal advertising and suggestion is ineffective;
- Online advertising does work, with the amounts advertisers pay for slots at different locations on the screen a measure of the value of attention;
- Offline ads are *not* more expensive than online ads, comparing the price of attention, as people spend many more minutes reading a newspaper or magazine than they do reading online;
- Targetted online ads are often *less* effective than generic advertising;
- Junk email could unravel the market for direct email advertising, but the collapse of the market could be averted by a message tax.

Economists at the conference acknowledged the limitations of their conventional rational choice approach to modelling, even though there is as yet little overlap between the science of attention and assumptions about economic decisions. Paradoxically, the kind of models economists use to describe competition might apply better to the non-deliberative competition between neurons taking place in the brain.

Participants included: Tyler Cowen, George Mason University; Martin Eimer, Birkbeck College, University of London; Luis Garicano, LSE; Kia Nobre, University of Oxford; Kevin O'Regan, Lab Psychologie de la Perception, CNRS, Univ. Paris Descartes; Geraint Rees, University College London; David Reiley, Yahoo! Research; Paul Seabright, IDEI – Toulouse School of Economics; Hal Varian, Google.

The conference was organised by Professor Paul Seabright, Toulouse School of Economics. For further information please contact Diane Coyle, diane@enlightenmenteconomics.com

I. Introduction: The Queen and the airplane on the runway

In November 2008, Britain's Queen took advantage of a visit to the London School of Economics to ask a group of its economists – including Professor Luis Garicano – why none of them had predicted the financial crisis.

It was a question many other people have asked too. Since then, there have been numerous criticisms of economics either for its failure to predict the crisis, or for actually playing a part in causing it. Garicano, writing about the meeting at the LSE, said he had told Her Majesty that the crisis had not been completely unforeseen but those economists who had been prescient had not been loud enough in their warnings. A year later he was one of a group of distinguished experts who sent a follow-up letter to the Queen describing the sequence of events and the “psychology of denial” that had gripped the financial world as a whole.¹



Her Majesty the Queen and Professor Luis Garicano, LSE, November 2008. (Courtesy of LSE)

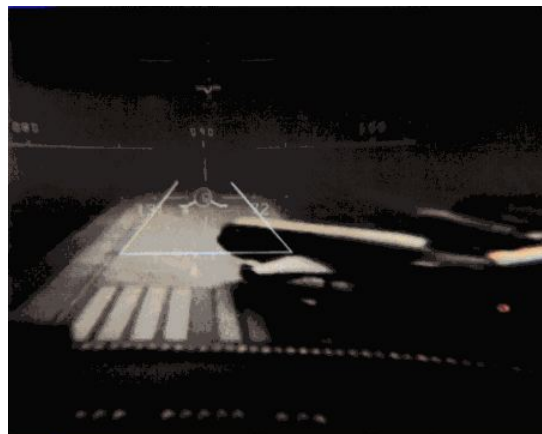
The economics profession has continued to evaluate its own role in the financial catastrophe and subsequent economic crisis. The subject's standard assumptions about how people take decisions and choose to behave have been a particular focus for scrutiny. Did the assumption of rational, self-interested choice, given the available information, in itself contribute to a dreadful misunderstanding on the part of regulators and policy makers about what could happen in the financial markets? Behavioural economics offers several examples of types of financial decision where alternative rules of thumb about behaviour describe typical decisions more accurately. But to address the question systematically, economists will need to learn from the psychology of

¹ <http://www.guardian.co.uk/commentisfree/2008/nov/18/response-credit-crisis-economy-response>
<http://www.guardian.co.uk/uk/2009/jul/26/monarchy-credit-crunch>

individual choice given the constant flow of information in any situation of economic decision-taking.

Professor Garicano was one of the participants in a recent workshop at the Toulouse School of Economics on the Psychology and Economics of Scarce Attention. The key theme was whether the cognitive scientists' growing understanding of how, given people's limited attention, sense perceptions translate into behaviour offers any lessons for economists seeking to make more realistic assumptions about how perceived information translates into decisions and consumer choices.

A vivid illustration of the potential parallels was offered by an example given by CNRS Research Director Kevin O'Regan of the Institut Paris Descartes de Neurosciences et Cognition, of an airplane crash (in a simulator) due to the pilot's failure to see another aircraft in front of him as he landed. Why did the experienced pilot not see the airplane on the runway? The point was that looking is not the same as seeing; 'inattentional blindness' is commonplace.



From J.K. O'Regan, *Why Red Doesn't Sound Like a Bell*, Oxford University Press (2011) and reproduced courtesy of NASA.

Is this question in fact the same as the Queen's: why did most people not see the impending crash in the financial markets, when the information was available for those who looked carefully? The neuroscientists taking part in the workshop were not convinced the analogy was valid, but the economists thought the evidence presented on the psychology of scarce attention may yet offer them a more fruitful set of assumptions about how people form their preferences, their beliefs and make their decisions. This report sets out the day's debate.

II. The competition for attentional resources

The airplane on the runway – unseen by two out of eight experienced pilots who sat in the flight simulator – is not the only demonstration of inattentive blindness (not seeing something that is there). One of the main causes of traffic accidents is given as ‘looked but failed to see’. Magicians deliberately take advantage of the phenomenon in their illusions and card tricks. The many examples of inattentive blindness and the related phenomenon of change blindness (not noticing changes in a scene) make it apparent that the brain’s internal representations of external reality are rather sparse and sketchy. As Kevin O’Regan has put it: “We can prove that the information available in the brain about the visual field is very sparse, and yet we have the impression of a perfect visual world.”

His answer to this conundrum is that, in order to have the impression of a perfect visual world, all that’s needed inside the head is a recipe or algorithm – such as moving the eyes or shifting the attention – for accessing the outside world. In other words, we use the external world as a memory store. It is a mistake to think of seeing as looking at an internal representation of the outside world; rather, our scarce attentional resources mean we categorise and classify aspects of interest. The potential to turn our attention to different details gives us an impression of seeing everything. But seeing (or perception more generally) is not a passive matter of light falling on the retina and entering the visual system, but rather an active cognitive process, an *experience*.

Given that attention is selective in dealing with the vast amount of sensory information that could be taken in from the outside world, both voluntary and involuntary factors could be involved in making that selection. The architecture of the brain holds the key to understanding the selection mechanisms. Many different areas of the brain deal with visual perception. Each has its own functional specialism, all functioning concurrently and interactively. The system is complicated and more or less hierarchical, and all the senses come into play at the same time. There is a vigorous competition among neurons in the selective process.

The current view on scarce attention is therefore that it emerges from the architecture of the brain. For example in visual processing, information travels from lower to higher levels of the brain. The lower level neurons (in the primary visual cortex) are sensitive to simple features such as edges while the higher level ones are sensitive to objects and categories (such as faces). In addition, the lower level neurons are activated by visual features in specific locations while higher level neurons are not so specific, and the corresponding receptive field (the region of space in which the presence of a stimulus will alter the firing of that neuron) is larger. Both of these mean that

each high level neuron is associated with several low level neurons – the latter are competing with each other in a ‘winner takes all’ contest. There is a loss of information, which is the neural basis of scarce attention.

The Invisible Gorilla



Courtesy of Christopher Chabris

One of the best-known examples of ‘inattention blindness’ – reflected in the name of the book *The Invisible Gorilla* by Christopher Chabris and Dan Simons – concerns what people typically fail to see when set the task of counting passes of a basketball between two teams of players. The book’s title gives a big clue: for about half of people who watch, the gorilla is indeed invisible. You can see how it works here: http://www.youtube.com/watch?v=IGQmdoK_ZfY. There are other examples on the Invisible Gorilla website, <http://www.theinvisiblegorilla.com>, the Simons Lab website, <http://www.simonslab.com/>, and examples of both inattention blindness and change blindness on Kevin O’Regan’s website, <http://www.kevin-oregan.net>.

Chabris, C.F., & Simons, D.J. (2010). *The Invisible Gorilla, and Other Ways Our Intuitions Deceive Us*. New York: Crown.

Why Red Doesn’t Sound Like A Bell: Understanding the Feel of Consciousness by J Kevin O’Regan (Oxford University Press, 2011)

The role of selective attention, according to Kia Nobre of the University of Oxford, is to process and integrate this neuronal competition in order to enable people to take appropriate actions. Some things capture our attention involuntarily, while we are able to control other factors. Her research concerns the deliberate focusing of attention. Some areas of the brain lie at the interface of perception and action. For example, the areas involved in moving the eyes are also used to focus attention on something even if the eyes are not moving. Experimental results point to the brain’s ability to insert top-down or anticipatory biases in the stream of perceptual information. These can take a number of forms and come from many sources, including goals and expectations, and perhaps also long-term memory. Another way to express this is to say that the brain constantly constructs a forward-looking model of the world as it processes the different areas of neuron activity, extracting regularities and building predictions. To the extent that long-term memory shapes the top-down biases,

training and habit may be able to affect people's ability to direct their attention.

Attention can also be grabbed in involuntary ways, too. Examples include sudden movements or 'abrupt onsets', or by irrelevant visual features (demonstrated by experiments which for example ask the subjects to focus on shape and distract them with irrelevant colour differences). The 'grabbiness' of different items is the bottom-up factor affecting the competition between nerve cells and, according to Geraint Rees of University College, London, the bottom-up and top-down influences interact. We will deploy our attention voluntarily (mediated through one part of the brain's attention network) and also respond to unexpected events (mediated through another part).

Martin Eimer of Birkbeck College, University of London, asked what we mean by scarce cognitive resources? The many examples such as invisible gorillas and card tricks mean the idea that attention is limited has become a self-evident fact for neuroscientists and psychologists. The phenomenon is taken for granted, and their experiments focus on understanding the mechanisms of how cognitive systems cope. But in fact a model of scarcity is implicit. There are two traditional well-known models or metaphors of the coping mechanisms in psychology. Broadbent's 1958 filter theory assumes that there is a channel of limited capacity in a linear processing mechanism. This was always seen as self-evident too, although it is obviously a version of the information processing model popular in communication theory in the 1950s.

An alternative, influential model was proposed by Daniel Kahneman in his 1973 book *Attention and Effort*. This model accounts for scarce attention by postulating an independent supply of general-purpose "resources", "energy", or "capacity" that can be selectively allocated to different tasks or activities, but is in short supply. This is a circular definition - attention is scarce because attentional resources are limited - nor is it clear how to measure the 'resource requirements' of a task; but nevertheless this model has had a strong intuitive appeal.

So the traditional models of scarce attention involved metaphors concerning the engine or mechanism of the brain, and alternatively the fuel or energy for the brain. As we've seen, the current thinking portrays vigorous competitions between neurons to climb the hierarchy of the brain's architecture. Both bottom-up factors related to the salience or 'grabbiness' of a perceptual stimulus and top-down factors such as expectations or motivations will bias the outcome of the competition for neural domination. Experimental results from psychology labs have demonstrated that it is usually the top-down factors that determine scarce attention. In order to overcome problems linked to inattentional blindness - such as flying into another aircraft - it is therefore important to understand the top-down biases, especially

as they will often be unconscious ones. For example, effective top-down attentional goals are usually concrete and simple – they refer to one specific colour, shape or object – and this has important implications for the design of safe and useful communication interfaces. Visualisations can make a big difference. For example, colour coding of flights at different altitudes can make it easier for an air traffic controller to focus attention appropriately. Scarce attention is strongly affected by implicit expectations and prior knowledge about context thanks previous experience. Again, this has clear practical implications.

III. Cognitive science and economics

Perhaps it has direct lessons for economics too: for instance, finding appropriate visualizations of financial market data to help alert the authorities to future crises is an active area of research, one stimulated by the 2010 ‘flash crash’.² There seems obvious scope for applying the lessons from psychology about how to direct attention effectively.

The economists were also the interested in broader lessons for the assumptions made about decision taking in economic models, as the lack of realism of the conventional assumption of optimising behaviour became ever clearer. Ailsa Roell cited, as just one recent example, the research by Shai Danziger of Ben Gurion University and colleagues into more than 1000 parole decisions by eight Israeli judges over ten months: the best predictor of whether parole would be granted was whether the judge had just had a meal break.³

As the evidence of non-optimal decision-making from other human sciences mounts, this re-evaluation in economics will clearly continue.

Can psychology and cognitive science draw anything from economics? For the economists taking part in the workshop, the models of optimising competition for scarce resources used in economics have an obvious applicability to these descriptions of competing neurons in the way the brain focuses attention. Lionel Robbins classic definition of economics (in his book is *An Essay on the Nature and Significance of Economic Science*) is: “Economics is the science which studies human behaviour as a relationship between given ends and scarce means which have alternative uses.” It seems evident that the brain will use energy as efficiently as possible, so there is an objective function analogous to, say, the firm maximising profits. The architecture of the brain creates certain constraints on the ways neurons behave. Luis Garicano said: “Can we think of the brain making the same choices

² <http://www.treasury.gov/initiatives/Pages/ofr.aspx>

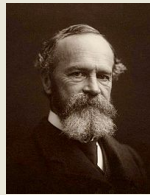
<http://www.lbl.gov/cs/html/CIFT-LBL-report.pdf>

³ <http://www.pnas.org/content/early/2011/03/29/1018033108.short>

automatically as we assume an individual does consciously? It has limited capacity and has to select between activities. Nothing we've heard today would reject this model of the brain as an optimisation tool." While neurons are obviously not optimising agents, he suggested natural selection could be thought of as having optimised the neuronal architecture subject to energy constraints.

However, the cognitive scientists resisted the analogy. As Geraint Rees put it, "There is an emerging enormous chasm between our two conceptions of attention. My problem is how the brain works and how that affects awareness. There is complex information coming in but a limited range of effectors, for example, we only have two hands. Attention as a limited resource in that sense is very different from economics, which is more about decision making and how people choose to spend their time." What's more, Martin Eimer added, optimality is not the relevant criterion for modelling brain processes; the relevant criterion is good enough for behavioural success.

What is attention?



(Wikimedia)

Several of the speakers at the workshop started their discussion of the phenomenon of attention with reference to William James, whose 1890 classic *The Principles of Psychology* contains descriptions or definitions of attention that are still frequently cited: 'Millions of items of the outward order are present to my senses which never properly enter into my experience. Why? Because they have no *interest* for me. *My experience is what I agree to attend to.*' And: 'Everyone knows what attention is. It is the taking possession by the mind in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought...It implies withdrawal from some things in order to deal effectively with others, and is a condition which has a real opposite in the confused, dazed, scatterbrained state.'

James divides attention into different kinds in three ways:

- It can apply to either objects (via the senses), or ideas (via the intellect);
- It can be immediate, or derived from an association with some other immediately interesting thing (also called 'apperceptive' attention);
- It can be passive/reflex and involuntary, or active and voluntary.

William James – and workshop speaker Kia Nobre – also cited Hermann Von Helmholtz for his research on voluntary attention, showing that attention could be deliberately focussed.

William James, (1890). *Principles of Psychology*. New York: Holt. Chapter XI Attention

Available at <http://psychclassics.yorku.ca/James/Principles/prin11.htm>

Hermann Von Helmholtz (1896) *Handbuch der Physiologischen Optik*, described in:

<http://www.sfu.ca/~rwright/PDF/Wright%20&%20Ward%20CIEP%2094.pdf>

IV. Advertising and the decision to purchase

One area of economics where attention is a key factor is in advertising. Do we pay enough attention to ads to alter our purchasing choices – does advertising work? Or is our spending affected *without* our realising it?

We've seen that attention is a limited and valuable resource, but that people generally are not aware just how limited it is. At the same time, though, although we over-estimate our capacity to pay attention, many people nevertheless believe that advertisers can manipulate them – in particular, through subliminal advertising campaigns. Christopher Chabris of Union College reported that (in a representative sample of 1500 US adults) 77 per cent believed they were being manipulated subliminally by ads. There were no significant variations in this strong belief among different social and demographic groups.

Advertisers seem to believe subliminal messages work too. One recent example was the presidential primary campaign of Mick Huckabee, which used a video of the candidate in front of a bookshelf. The shelves in the background formed a symbolic cross, no doubt to plant in viewers' minds a firm impression of his religious commitment.



YouTube

According to Chabris, though, there is no evidence that subliminal ads ever work; we can't be unconsciously manipulated. The idea of their effectiveness dates from a 1973 book, *Subliminal Seduction* by Wilson Brian Key. It reports experimental results that differ so much between the treatment and control groups as to be implausible. Other studies purporting to show evidence of subliminal suggestion often rely on experiments consisting of so few people that one person acting differently would eliminate the result.

These claims about unconscious manipulation can be headline-grabbing. One example is supposed 'subliminal priming' of people to race by showing them stereotypically black and white names. When

subsequently shown the 'invisible gorilla video, "Only 45% of the participants exposed to the White names noticed the gorilla. But 70% of the participants who saw the Black names noticed the gorilla."⁴

However, the results of small sample experiments of this kind have so far appeared to be difficult to replicate in larger samples. Other methodological problems include researchers discarding the results of 'pilot' experiments if they don't agree with the more dramatic finding, or stopping the experiment when it has reached the 'right' result even though continuing might indicate the opposite.

A number of economists questioned why subliminal manipulation would matter even if it were true – why does it matter that so many people cannot see the gorilla? Jean Tirole suggested there could be good reasons to care, for example if there are externalities in the advertising that damage the viewer, or if the effects differed for people with different educational qualifications. Yet although many of us are sure that our attention is being unconsciously manipulated, and Chabris suggests that we would like to believe that tiny causes can have big effects, the reality is that small stimuli only have small effects.

What about everyday advertising, which seeks to attract attention and shape people's choices without being secretive about it? The issue of the effectiveness of advertising has become more acute as a growing amount of both media and spending move online. Advertisers are having to consider where they can most effectively reach consumers, while consumers are faced with new types of advertising and, increasingly, 'information overload'. Online ads generate plentiful data, and economic research is beginning to address some of these issues.

Clicks on ads online account for 98% of Google's revenues. Hal Varian, Chief Scientist at Google, said that the position of an ad on the screen determines how frequently people click on it. The choice of placement is partly cultural – depending for example on whether people read left to right in the relevant language – and partly evolves as a result of Google learning from users' and advertisers' choices over time. The number of clicks is determined by

Ad position x ad quality

Advertisers have to bid for their placement in an auction, and their bids reflect the value of each position. Each chooses their bid, and Google ranks the advertisers by their bid multiplied by their click-

⁴<http://www.stanford.edu/group/gender/cgi-bin/wordpressblog/2011/07/the-continued-dehumanization-of-blacks/>

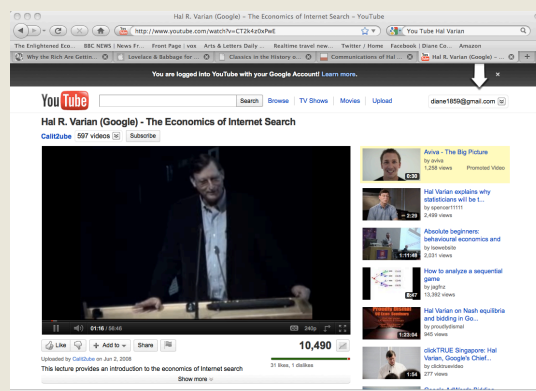
through rate. In other words, they are in effect ranked by their expected revenue, because while advertisers really want to pay for clicks, what Google has to sell is impressions (the number of times the ad is displayed). The positioning of each ad on the online page is therefore determined by the value to each advertiser of the position they end up with; and the difference between their bids is a measure of the *value of attention*. If people were equally likely to click on any ad on the page, advertisers would not be willing to bid more to be placed at the top of the page.

Online versus offline advertising

The conventional wisdom about the increasing commercial pressure on both the newspaper and the broadcasting industries is that their revenues are being undermined by both consumers' unwillingness to pay for anything online and by far lower revenues for online than for offline advertising. Google's chief economist Hal Varian argues that it's wrong to claim offline ads are vastly more expensive, however, because the relevant comparison is the *price of attention*, not the price of the ad itself.

Offline readers generate 88% of newspapers' ad revenue in the US, and spend an average 24 minutes a day reading the paper. Online readers generate 12% of ad revenue and spend just 1.2 minutes a day reading. Offline advertising is therefore cheaper per minute of reading as, compared to online reading, it gets 20 times the attention for 7 times the cost. The reason seems to be that online reading is done at work, offline at home. That makes the real challenge for newspapers getting people to spend longer reading them online, Varian concludes.

Similarly, the cost per thousand views (CPM) for a TV ad is \$10 compared to a cost per impression of just \$1 on You Tube. But there are 20 ads per hour on TV, so TV advertisers pay 20 cents for an hour of viewer attention. You Tube viewers see one ad impression every four minutes, so You Tube advertisers pay a not dissimilar 15 cents for an hour of attention.



David Reiley, Principal Research Scientist at Yahoo! Research, pointed out that there is surprisingly little evidence that advertising works. Most of the evidence presented by the advertising industry suffers from sample selection bias, for example looking at the travel purchase decisions of people who are already visiting holiday websites; or failing to distinguish between causation and correlation as when noting that sales increase when there is more spending on advertising – in December, in the run up to Christmas.

Field experiments offer a way to overcome these biases. Reiley described the results of an experiment looking at over a million customers who purchased from a large US retailer and were also users of Yahoo! The customers were randomly assigned to treatment and control groups. Looking at data for each individual on ad exposure and weekly purchases at this retailer, both online and in stores, showed statistically and economically significant impacts of the advertising on sales. The effect persisted for weeks after the end of an advertising campaign, and the total effect on revenues exceeded the retailer's expenditure on advertising. An advertising campaign costing \$25,000 brought additional sales over two weeks of \$83,000 (plus or minus \$70,000 – the confidence interval is wide because retail sales data show great variability). After five weeks, a \$33,000 ad campaign is estimated to have increased sales by \$250,000 plus or minus \$190,000. About a quarter of the uplift was due to an increased number of purchases, and about three quarters due to an increase in the amount of each transaction.

Most of the effect of online ads on sales occurred through physical sales in the stores, however. Consistent with this was a second experiment showing the effect of the ad campaigns was greatest for people living within 2 miles of a store.

Measuring click-throughs is not a good indicator of the effectiveness of advertising, therefore. But using an experimental method means there is no need to rely on a specific assumption about how exactly people's behaviour responds to ads; all that matters is that they spend more in the end.⁵

The advertising industry will be reassured by this evidence, but less so by evidence presented at the workshop suggesting that personalising online ads is often less effective than sending generic messages. The tailoring of ads to the individual according to their browsing behaviour – known in the industry as 'dynamic retargeting' – is the focus of enormous hope among advertisers for greater effectiveness thanks to the relevance of the ads displayed to the individual. For example,

⁵ <http://www.davidreiley.com/papers/DoesRetailAdvertisingWork.html>

social networking sites are keen to accumulate enough information about individual users to sell targeted ad slots. Advertising agencies are keen to promote the technique. But evidence from data from an online experiment, presented by Anja Lambrecht of London Business School, showed that a generic ad was more likely to induce a consumer to purchase than a specific one, increasing the probability of conversion by 60%.

The experimental data were provided by a travel firm that tracked consumers who visited their website and the hotels they looked at. When the consumers visited external websites that the travel firm advertised on, the travel firm randomized whether they used dynamic retargeting, showing an ad for the hotel the consumer had previously browsed, or showing a generic brand ad for the travel firm. The only people for whom the specific ad was more effective were those who had already visited a review website to search within a specific product category. Lambrecht suggested that this distinction may indicate that many consumers do not start out with well-defined preferences, and use the search process to refine their preferences. But if they already know enough about what they want to buy to visit a review site, they can be presumed to have already reasonably fixed preferences. The lesson for the advertising industry is that greater effectiveness will require greater insight than they have at present into consumers' decision-making, needing to know how firmly their preferences are already fixed, and consequently what level of detail a targeted ad needs to provide to be effective.⁶

V. Coping with information overload in business

Firms involve many people required to work together for a common purpose. Assuming they do all really share a common purpose rather than having different aims (an assumption that is not made in an important branch of the economics literature), what is the effect of the existence of cognitive costs on the organisation? People have to share information, co-ordinate with each other, make decisions and communicate them, with limited amounts of time and energy. What does this mean for the organisation?

Introducing this session, Luis Garicano said there are some well-known examples of situations where the decisions taken were the minimum needed to avert an immediate crisis. For example, in a recent comment⁷ on the Eurozone crisis, the former US Treasury Secretary Larry Summers – no stranger to having to take difficult decisions in complicated situations – quoted Winston Churchill's criticism of the:

⁶ *When Does Retargeting Work? Timing Information Specificity* by Anja Lambrecht and Catherine Tucker, <http://ssrn.com/abstract=1795105>

⁷ <http://www.ft.com/cms/s/2/5eaa83dc-dfca-11e0-b1db-00144feabdc0.html#axzz1b8GJl7y>

“Want of foresight, unwillingness to act when action would be simple and effective, lack of clear thinking, confusion of counsel until the emergency comes, until self-preservation strikes its jarring gong – these are features which constitute the endless repetition of history.”

How can organisations overcome the limitations of the ‘bounded rationality’, the fatigue, and the multiple demands for attention decision makers face? A classic text on the question by Kenneth Arrow argues that an organisation can hold more information than any individual, but to do so it will need to develop special codes, and to economise on information costs through a hierarchical structure (analogous to a hub-and-spoke transport network).

Information congestion: the problem of spam

Is there too much junk email and if so can anything be done about it? While for the advertiser the cost of sending a spam email is negligible, so that even a very low response rate makes it profitable, what about the demands the spam makes on the scarce resource of consumers’ attention? Simon Anderson of the University of Virginia considered the question as the same kind of problem as overuse of a scarce but unpriced natural resource – over-fishing is often given as an example of a common property resource problem. What light does this shed on the impact of spam?

Although a spammer can send 10 billion emails a day at virtually no cost, people receive so many junk emails that the spam is likely to crowd out valid advertising they might have found useful. The failure of spam to take account of the scarcity of attention, and therefore of the true impact on consumers of each unwanted message, means that the bad ads drive out the good. Just as the noise level at a party can rise unbearably when one or two people start shouting, once a minority of advertisers start to spam consumers, other advertisers are compelled to send more emails in an effort to gain attention. In the extreme, the market for direct email advertising could unravel, in a version of the classic ‘market for lemons’ problem that affects other markets with similar externalities, such as second hand car sales and insurance.

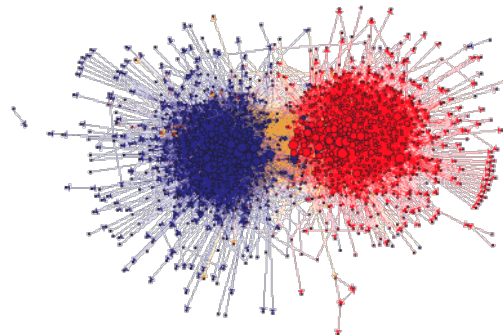
One solution to email congestion is to enable people to opt out of receiving unwanted messages, but not only might they opt out of advertising that would in fact be useful, this also puts the cost of adjusting onto the consumer. Increasing the cost of sending emails, via a message tax, would raise the average quality of direct emails sent and reduce the demands on consumers’ attention. But taxes will prevent delivery of some emails consumers would value, and may be difficult to enforce. An alternative market mechanism for pricing the scarce resource of attention was proposed by Marshall Van Alstyne. The ‘Attention Bond’ allows each recipient of emails to define the price that senders must pay to deliver their message.

Information Congestion, Simon P Anderson & André de Palma,
<http://www.virginia.edu/economics/workshops/papers/anderson/inoRANDo8111owith%2ofigs.pdf>
An Economic Response to Unsolicited Communication, Theodore Loder, Marshall Van Alstyne, and Rick Wash, http://www.idei.fr/iast_conf_vanalstyne.php

The fact that cognitive processing is costly in terms of time and energy suggests it should be possible to test hypotheses about how people will allocate their time, taking advantage of the growing availability of computerised data on activity inside firms. For instance, what does the time top executives spend on activities talking to people outside their firm indicate about their priorities relative to those of the firm? The evidence so far suggests that it is more productive for executives to spend their time within the firm rather than outside it, and they allocate more time to outside activities, to their own benefit, where corporate governance is weak.⁸

Another example, presented at the workshop by Ignacio Palacios-Huerta, uses email data to analyze communication patterns within a large Spanish retailer. Communication patterns within the firm should reflect the priorities of the organization, and agents should therefore allocate more time to writing email to colleagues they consider more 'important'. Measuring 'importance' using the same ranking algorithm as used by Google to rank web pages, the actual impact factor of each executive measured via actual email traffic was strongly correlated with that executive's formal rank in the corporation, his salary, and his probability of being either dismissed or promoted.⁹

The information revolution has potentially contradictory effects: it can help people communicate in more meaningful and productive ways; or it can fragment people into distinct groups. One well-known example of this is this mapping of links between Republican and Democrat bloggers in the United States.



Adamic, L. A., and Glance, N. 2005. *The political blogosphere and the 2004 U.S. election: divided they blog*. In LinkKDD '05: Proceedings of the 3rd international workshop on Link discovery, 36-43. New York, NY, USA: ACM Press.

⁸ *Organizational Economics with Cognitive Costs*, Luis Garicano and Andrea Prat
London School of Economics December 2010;
<http://www.econ.lse.ac.uk/staff/prat/papers/organizations.pdf>

⁹ Palacios-Huerta, Ignacio and Andrea Prat. Measuring the Impact Factor of Agents within an Organization Using Communication Patterns. CEPR Discussion Paper 8040, 2010.

Similarly, greater information diversity can enhance productivity but information overload will reduce it. More information will be better when the 'gains from trade' of information exchange outweigh the additional communications and cognitive costs of maintaining a network. Marshall van Alstyne of Boston University presented empirical research evaluating the productivity of employees in an executive recruitment firm. Using their emails, accounting data on their involvement in specific project teams, and surveys of their IT use and information sharing, it was possible to assess whether access to information enabled the employees to multitask more effectively. The data indicated increased productivity in multitasking, with diminishing marginal returns. In addition, recruiters whose network contacts have heterogeneous knowledge – an even distribution of expertise over many project types – are less productive on average but more productive when juggling diverse multi-tasking portfolios.¹⁰

VI Assessing online influence

How do online dynamics shape people's influence? This underlying question was addressed in different ways by two speakers, Sanjeev Goyal of Cambridge University and Tyler Cowen of George Mason University and the blog marginalrevolution.com.

Social networks affect behaviour, which prompts the question of whether the *structure* of networks matters in itself. Goyal reported on his work looking at the relationship between the actual structure of the network and the beliefs that people have about it. And do their beliefs also vary depending on their location in the network, such as how connected or peripheral they are?¹¹

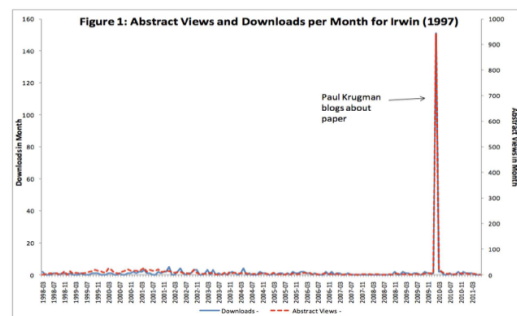
The results of an experiment which assigned participants randomly to different locations in a fixed network suggest that there are biases in people's beliefs. In particular, people *underestimate* the average number of connections of the people making up the social network. This may be linked to the 'Dunbar number': anthropologist Robin Dunbar suggested based on his analysis of a range of groups and settlements through history, that there is a cognitive limit to the size of an effective organisation or community, putting 200 as the upper bound.¹² The finding that the perceived average size of social networks is much less than the actual mean is therefore interesting.

¹⁰ *Information, Technology and Information Worker Productivity*, Sinan Aral, Erik Brynjolfsson and Marshall Van Alstyne.

¹¹ Sanjeev Goyal, http://www.econ.cam.ac.uk/faculty/goyal/selected_articles.htm

¹² Dunbar, R.I.M. (June 1992). "Neocortex size as a constraint on group size in primates". *Journal of Human Evolution* 22 (6): 469–493. [doi:10.1016/0047-2484\(92\)90081-J](https://doi.org/10.1016/0047-2484(92)90081-J)

Tyler Cowen drew on his own experience as co-founder of marginalrevolution.com and a recent World Bank working paper by David McKenzie and Berk Ozler to argue that blogs have become the main way the world now interacts with the economics profession.¹³ For example, the World Bank authors demonstrate a dramatic increase in the number of abstract views and downloads when a working paper is cited by a prominent blog (see the figure for an illustration). Indeed, citation in a blog has the same impact in terms of number of views as a paper being in the top 50 titles on RepEc, the portal for research papers in economics.



From McKenzie and Özler, *The Impact of Economics Blogs*, p. 39

Cowen argued that the growing importance of blogging in economics means that ideas and results are now evaluated very quickly; and also that it changes the character of what success means in the academic profession. As the wider readership of blogs tends to prefer either posts that confirm their opinions, or that present surprising new facts, economists providing this kind of material are thriving at the expense of, say, economic theorists or papers about methodology.

However, his verdict on the importance of blogging for economic research was challenged by Roland Bénabou of Princeton University, who cited an 'ironic' paper by Tatu Westling linking a country's economic growth to average penis size, which was widely discussed on a number of blogs including the freakonomics blog. The paper had subsequently been downloaded 175,000 times but that was no measure of its actual impact as a piece of economic research. Similarly, the replies to many blog posts were often rants by people who were simply looking for confirmation of their prior views, while many blogs suffered from a focus on surprising results that subsequently turned out to be wrong, or manufactured controversies. Cowen replied that the impact of blogs on the broader public

¹³ D. McKenzie and B Ozler, *The Impact of Economics Blogs*, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1921739
<http://www.freakonomics.com/2011/07/15/for-economic-growth-does-penis-size-matter-more-than-political-system/>

understanding of economics mattered, as well as the impact of economic research on the state of knowledge within the profession. As he pointed out, prior to the existence of the blogosphere, most economics working papers had zero public impact.

VII Conclusions

It would be an overstatement to say the workshop delivered a consensus between the economists and cognitive scientists as to what they could learn from each other; but there was agreement that the two disciplines overlap, and further inter-disciplinary conversation would be fruitful. Cecilia Heyes of Oxford University summed it up by saying that the psychology and neuroscience were concerned with instant reactions and actions in response to seeing and other perceptual stimuli, whereas economics looked at slower decisions involving deliberation. There is a direct area of overlap including subjects such as the design of online ads or user interfaces. One obvious – and perhaps urgent – application is researching the design of how financial market information is presented.

There was general interest in the paradox that rational choice economic models did not always work well at the higher levels of decision-making, but might have some applicability to the non-deliberative processes taking place in the brain. However, there was greater enthusiasm for disciplinary exchange amongst the economists. Tyler Cowen spoke for many of the economists present in saying: “I don’t agree that the economics approach is all that different – you think we’re different but we don’t think we are.” But as Drazen Prelec of MIT noted, it’s economists who know that their present approach has such limitations that they need to change it.

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