Time and error as measures of the quantity of attention: an experimental approach

Dino Borie

Université Nice Sophia Antipolis et GREDEG dino.borie@gredeg.cnrs.fr

Pierre Garrouste

Université Nice Sophia Antipolis et GREDEG pierre.garrouste@gredeg.cnrs.fr

Ismaël Rafaï

Université Nice Sophia Antipolis et GREDEG ismael.rafai@gredeg.cnrs.fr

Attention is now considered as an economic resource. Since the famous Simon's sentence, "a wealth of information creates a poverty of attention and a need to allocate that attention efficiently among the overabundance of information sources that might consume it." (Simon, 1971, p. 40), many works attempt to set up models of limited attention, some of them on the basis of perfect rationality (Sims, 2003 ; Ellis, 2014 ; Wiederholt, 2010 ; De Oliveira, 2014), others on the basis of the notion of bounded rationality (Gabaix et Laibson, 2005 ; Gifford, 2005 ; Gabaix et al., 2006). Those works, in themselves very interesting suppose implicitly that the problem of the measure of attention is solved. This is however not the case[1]. In 1938, Hotelling writes "Another thing of limited *quantity* for which the demand exceeds the supply is the attention of people. Attention is desired for a variety of commercial, political, and other purposes, and is obtained with the help of billboards, newspaper, radio, and other advertising. Expropriation of the attention of the general public and its commercial sale and exploitation constitute a lucrative business. From some aspects this business appears to be of a similar character to that of the medieval robber barons, and therefore to be an appropriate subject for prohibition by a state democratically controlled by those from whom their attention is stolen. But attention attracting of some kinds and in some

---

[1] Radner et Rothschild (1975) equate attention and effort, Falkinger (2008) defines attention as the strength of a signal emitted by a producer. For the models of rational inattention, attention is defined by means of a filter.

degree is bound to persist; and where it does, it may appropriately be taxed as a utilization of a limited resource. Taxation of advertising on this basis would be in addition to any taxation imposed for the purpose of diminishing its *quantity* with a view to restoring the property of attention to its rightful owners." (Hotelling, 1938, p. 257, italics added)

In this paper our aim is 1) to define a method that permits to quantify attention that people pay to information when they have to take a decision and 2) to analyze the effects of the complexity of information on the allocation of attention.

Attention can be quantified depending on two complementary dimensions: 1) the quantity of *allocated attention* that is the quantity of attentional resource (the time) that an individual allocates as an input of a decision process[2] and 2) the level of *effective attention* that is revealed by the quality of the decision process (the number of errors made corrected by both the individuals' capabilities and information complexity). We use those two measurement methods and design experiments to quantify attention in this way.

We ran experiments in the LEEN (Laboratoire d'Economie Expérimentale de Nice) in June 2015 with 111 subjects.

Our experimental results show that people are *effectively* less *attentive* when it comes to remove the uncertainty and select the information, rather than when they have to solve more complex calculations. However, our results show the existence of a tradeoff: individuals will limit the amount of attention they consume when the complexity of information makes it more expensive to manage. Finally, the process of attention allocation is subject to learning effect, in the sense that during the experiment, individuals allocate their attention more effectively and achieve the same levels of *effective attention* while *allocating less attention* resources.

---

[2] Camerer et Johnson (2004) use a similar measurement with a 'mouselab' system.

References

Camerer, Colin F., and Eric J. Johnson. 2004. Thinking about attention in games: Backward and forward induction. In I. Brocas and J. D. Carrillo (eds.), *The psychology of economic decisions (vol.2.): Reasons and choices*. Oxford: Oxford University Press : 111-129.

De Oliveira, H. 2014. Axiomatic Foundations for Entropic Costs of Attention, mimeo Northwestern University

Ellis, A. 2014. Foundations for Optimal Inattention, mimeo London School of Economics

Falkinger, J. 2008. Limited Attention as a Scarce Resource in Information-Rich Economics, *The Economic Journal*, 118 (October): 1596–1620

Gabaix, X., Laibson, D. 2005. Bounded Rationality and Directed Cognition, Unpublished Paper,

Gabaix, X., Laibson, Moloche, G., et Weinberg, S. 2006. Costly Information Acquisition: Experimental Analysis of a Bounded Rational Model, *The American Economic Review*, 96(4): 1043-1068

Hotelling, H. 1938. The general welfare in relation to problems of taxation and of railway and utility rates. *Econometrica*, 6(3): 242-269.

Gifford, S. 2005. Limited Attention as the Bound on Rationality, *Contributions to Theoretical Economics*, 5(1): 1-40

Radner, R., et Rothschild, M.1975. On the Allocation of Effort, *Journal of Economic Theory*, vol. 10(3): 358-376

Simon, Herbert A. 1971. Designing Organizations for an Information-Rich World. In Martin Greenberger (Ed.), *Computers, Communication, and the Public Interest*. Baltimore, MD.: The Johns Hopkins Press : 37-72

Sims, C.A. 2003. Implications of rational inattention, *Journal of Monetary Economics*, 50(3): 665–690

Wiederholt,M .2010. Rational Inattention, in Durlauf, S. N. et Blume, L. E. (eds) *The New Palgrave Dictionary of Economics*, Palgrave Macmillan, Basingstoke