The Deep History of Information Technologies: a Cognitive Perspective

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Introduction

Cognition constrains and influences human cultural productions, among which are information technologies. Information technologies, because of and through their intensive use, can be expected to reflect human cognition particularly well.

Cognitive approaches to information technologies have the potential of informing both cognitive science and historical disciplines. Beyond high ecological validity, we demonstrate the relevance of real-world data in testing and informing theories about how the mind works, through four different case studies and contexts: how we represent the world and space around us (Riggsby), how we represent more abstract -number- concepts (Chrisomalis), how we optimize written characters for our visual system (Miton), and coinage to minimize possible errors (Morin). Discussion and moderation will be assured by Valeria Giardino, a philosopher whose main research topic is reasoning with diagrams and the role of cognitive artifacts in improving thought.

Size ordering as a cognitive principle for numerical systems

Stephen Chrisomalis

Size ordering can be defined as the property comparing the size (length) of a numeral phrase with the quantity being expressed. In a fully size-ordered numerical system, each number is equal or greater in length to all those lower than it. Size-ordering thus makes it possible to get a rough idea of a numerical magnitude simply by looking at the length of the numerical phrase. Systems like the Indo-Arabic (Western) numerals, or tallying systems, are well size-ordered - e.g., 1000 is longer than 999. Other numerical systems, such as the Roman numerals or the Chinese numerals are less size-ordered - IX is longer than X. An index of size-ordering is developed and evaluated using comparative data from twelve cross-culturally attested notations.

Much of the cognitive literature on numerical notation evaluates features such as conciseness or extent (Chrisomalis 2010, Beller and Bender 2008), or their utility for arithmetic (Zhang and Norman 1995). Size-ordering, despite being relatively neglected, is important, because it interacts with a number of cognitive mechanisms known in numerical cognition, such as the mapping of number concepts onto physical space and the approximate number sense (Feigenson et al. 2004, Lakoff and Núñez 2000). It is demonstrated that diachronic changes in known numerical notations that improve properties such as conciseness can reduce size ordering.

Wayfinding, directional indicators and land-surveying in Ancient Rome

Andrew M. Riggsby

It has been influentially argued that Classical Antiquity lacked the technology of mapping and that that absence reflects a failure to develop "survey"-type (multi-dimensional, allocentric) cognitive models (Brodersen 2003). By contrast, this paper argues that even descriptions of literal routes (egocentric itineraries) can demonstrate the use of survey-type modeling.

Ancient Roman land-surveyors recorded the boundaries of individual parcels by a variety of methods, but in most contexts the official version was verbal—a list of landmarks. However, examination of actual instances of such descriptions shows a number of techniques that allocentrically overlay the route descriptions with survey information, including references to multiple external orientation schemes and to hypothetical other travelers, and

characterization of whole spaces. The nature of these devices is not uniform across examples, as is typical of the family-resemblance that characterizes other Roman information technologies (Riggsby 2019). The evidence from land-surveying thus undercuts the claim from the mapping argument of a lack of cognitive complexity, and it is more consistent with current understanding of the connections between different types of spatial knowledge organization (Kim & Bock 2020).

Writing systems and graphic complexity

Helena Miton

A writing system is a graphic code, i.e., a system of standardized pairings between symbols and meanings in which symbols take the form of images that can endure. The visual character of writing implies that written characters have to fit constraints of the human visual system (Dehaene, 2010; Teriman & Kessler, 2011). One aspect of this optimization lies in the graphic complexity of written characters. Using computational methods derived from Pelli et al. (2006) over a large and diverse dataset (over 47 000 characters, from 133 scripts), we answer three central questions about the complexity of written characters and the evolution of writing: What determines character complexity? Can we find traces of evolutionary change in character complexity? Is complexity distributed in a way that facilitates character recognition? Our study suggests that character complexity depends primarily on which linguistic unit the characters encode, and that there is little evidence of evolutionary change in character complexity. Additionally, for an individual character, the half which is encountered first while reading tends to be more complex than that which is encountered last.

Optimal denomination signalling in currencies

Olivier Morin

Human language categories broadly satisfy an informativeness-simplicity trade-off. Kinship or colour categories, for instance, tend to be structured in such a way that the most relevant and frequently mentioned categories (e.g., close vs. remote kin) are encoded in more precise ways, by narrower terms (Regier et al., 2015). Thus far this hypothesis has mainly been tested with linguistic data, neglecting visual symbols. In two studies, Pavlek et al. (Pavlek et al. 2019, 2020) showed that coin designs also satisfy such an informativeness-simplicity trade-off. Higher denomination coins being more valuable than low-denomination coins, the symbols minted on these high-value coins should be more distinctive, to minimise the cost of mistaking one coin for another. On low-denomination coins, keeping the same symbols for distinct coins may occasion confusion but is cognitively efficient, since it limits the number of symbols to be learnt, without occasioning costly mistakes. We predicted and found that modern coinage worldwide is more likely to display distinctive graphic designs on pairs of coins with large differences in value. More surprisingly, this observation is also true of currencies of the ancient Mediterranean (c. 600 to 33 BCE). Olivier Morin will discuss the reasons for this convergence between two otherwise massively different types of monetary systems, and reflect on the nature of coinage as an information technology from antiquity to our days.

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