When bottom-up meets top-down

Studying the intriguing question of how words or pictures are encoded, processed and stored has been a long-standing problem in cognition. Both the written word *frog*, and a picture of the animal, can lead to an observer to say /frog/, or otherwise to the association that frogs leap, croak, need water, etc. Two different types of account have been formulated to explain word and picture processing: multiple-semantic-system approaches, [e.g. different systems for word ('logogen') and picture ('imagen') processing], and common-semantic-system approaches (e.g. single-code models).

A recent study reported two experiments that looked at the effects of semantic and contextual factors, as well as perceptual familiarity, on word and picture recognition[1]. The aim was to obtain, using ERPs, a detailed electrophysiological picture using an elegant and complex design of how the brain responds to words and pictures as a function of meaning, context and novelty. At a general level, the study seemed to lend support to the single-code model, as both words and pictures showed a similar time course and gave rise to an enhanced negativity about 300–500 ms after stimulus presentation (N400).

However, at a more detailed level, remarkable differences between word and picture processing appeared. In the frontal region, as early as 100 ms (N1) and 200 ms (P1) after stimulus presentation, picture processing but not word processing started to be affected by semantic factors, but only when the participants were led to expect one particular picture. The second experiment suggested that this difference could be attributed to a perceptual effect only, namely stimulus uncertainty or 'perceptual predictability', to use the authors' term – this semantic effect on picture processing disappeared after visual familiarization with the items. The very elaborate data set used in this study make it unlikely that a single, amodal semantic system model can account for the electrophysiological findings. Instead, a specificity model based on spatially distinct regions of the brain and different patterns of activation seems more convincing at this stage. Refreshingly, the authors' conclusion that top-down and bottom-up processes are integrated at around 100 ms should be taken as encouragement to study similar problems again, rather than as being the final answer.

1 Federmeier, K.D. and Kutas, M. (2001) Meaning and modality: influences of context, semantic memory organization, and perceptual predictability on picture processing. *J. Exp. Psychol. Learn. Mem. Cognit.* 27, 202–224

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In Brief

Two new face illusions

The perception of human faces is different from that of other shapes: it has long been known that specialized mechanisms exist in the human visual system that, on the one hand, permit us to categorize and remember faces with remarkable accuracy, but that, on the other hand, necessarily involve heuristics that can lead to mistaken perceptions. Recently, two new illusions involving face perception have been discovered. The 'Bogart illusion', discovered by Pawan Sinha [*Perception* (2000) 29, 1005–1008], works best with a black-and-white photograph of someone looking sideways: if a negative of the image is made, the face seems to look in the opposite direction! This illusion shows that we have a specialized, modular mechanism for the socially crucial task of detecting gaze direction, which works on the assumption that the dark area is the iris. The knowledge that the iris is light instead of dark in a negative makes little or no difference: the illusion is cognitively impenetrable. The second illusion, the multiple faces phenomenon, discovered by Maria Lúcia de Bustamente Simas [*Perception* (2000) 29, 1393–1396], can be experienced by fixating off the edge of a

photograph in such a way that the blind spot falls on the nose (for example, by covering the right eye and looking at a point 10 cm to the right of the nose, with the photo about 40 cm away). After about a minute, many observers experience strange phenomena, such as seeing expression changes or a rapid succession of other, sometimes unfamiliar, faces. According to the author, this phenomenon demonstrates the workings of the inferotemporal cortex, where long-term memory traces of faces are stored. *MW*

Probing *Mus silicium*

A nervous system rapidly learns to recognize spoken words, performing correctly for previously unheard examples and speakers. Scientists probe the system (composed of several hundred neurons arranged in two layers) while exposing it to various sounds and performing extracellular recordings on individual cells. Others struggle to gain a global understanding of the mechanism behind its remarkable performance, but two scientists already know the system's secret… because they created it! John Hopfield and Carlos Brody constructed the artificial neural network (playfully dubbed *Mus silicium* or the sand mouse) to embody a new, robust and biologically plausible principle for categorizing temporal patterns. Instead of publishing it in the traditional way, they announced a contest: could their colleagues deduce the principle by using a traditional anatomical description and physiological experiments on the artificial system? A first paper [Hopfield, J.J. and Brody, C. (2000) *Proc. Natl. Acad. Sci. U. S. A.* 97, 13919–13924] described the anatomy and physiology of their system; in addition, a web site (http://str.princeton.edu/mus/Organism/) was set up to which contestants could upload sound 'stimuli' and then download the 'response' of any individual neuron. Three months later, after the contest deadline, Hopfield and

Brody published the answer [*Proc. Natl. Acad. Sci. U. S. A.* (2001) 98, 1282–1287]. The principle, which might be applicable to many different types of temporal sequence learning, is based on the synchrony of neurons with varying decay rates that respond to different features. *MW*

ANTS in space?

Inspired by the accomplishments of social insects, and perhaps disappointed by the failures of conventional robots, NASA is planning to send a swarm of miniature spacecraft to explore the Asteroid Belt. The collective intelligence of the swarm – to be composed of hundreds of tiny, independent spacecraft called ANTS ('Autonomous Nano Technology Swarm') – will be based on that of earthbound species, such as ants and wasps. After traveling to the Asteroid Belt, the ANTS will assume different roles: some will act as rulers, others as messengers, but most will be workers. Each worker will carry a single instrument, such as a magnetometer or a gamma-ray sensor, and will perform a single specified task. The collective nature of the swarm is supposed to make the system robust: the loss of a few spacecraft will not cripple the mission. By performing their tasks individually but later swapping knowledge, the ANTS will behave as a single, extended organism, more intelligent that the sum of its parts. Perhaps the real challenge is whether the same be said of the NASA research group… *MW*

Plum take-away

After years of hiding plums behind screens on a Puerto Rican island, researchers have concluded that untrained rhesus monkeys are remarkably good at subtraction (Sulkowski, G.M. and Hauser, M.D. (2001) *Cognition* 79, 239-262]. The researchers wander the island till they spot a lone monkey then, when they are sure the monkey is watching, set up an experimental stage. Different numbers of food and non-food items are placed on two platforms which are then covered. Next, the experimenters very obviously pocket a number of items from one or both of the platforms, leaving a greater number of food items at one location. When free to approach the stage, the monkeys almost invariably head for the platform with more food items. Previous work from the same group established that the monkeys were capable of spontaneous addition and also demonstrated that their abilities are limited to operations on small numbers of items (fewer than four). *HJB*

Topping the science charts

Fancy yourself as the next Carl Sagan or Stephen Hawking? If you have ambitions to join the ranks of bestselling science authors then concentrate on getting a catchy title and compelling personality rather than influential content. Bruce Lewenstein, a professor at Cornell University, presented findings to the annual meeting of the American Association for the Advancement of Science (San Franciso, 15–20 February, 2001) which demonstrated that books that fell into a category of 'influential' because of their content, often did not make it into the category of 'important in public culture'. Although a few books did manage to succeed on both counts (e.g. Hawking's *A Brief History of Time*), Lewenstein suggested that 'an author's style and personality and the presence he or she brings to a bestselling book are generally the main factors in making it a bestseller'. A tempting title also helps –anything involving sex or space is a pretty safe bet! *HJB*

Perfect pitch

Babies might be born with 'perfect pitch', according to new research from the University of Wisconsin-Madison (Annual meeting of the American Association for the Advancement of Science, San Fransico, 15–20 February, 2001). The ability to recognize a musical note without a reference point is rare even amongst trained musicians. However, studies on babies suggest that we are all born with the ability but lose it as we get older. Jenny Saffran and colleagues play babies a sequence of tones followed by segments from the sequence. Some of the segments, however, differ in absolute pitch from the original tones. The rationale is that if the segments are perceived as novel, the babies will attend to them, whereas if they are recognized as familiar the babies will be bored with them. Babies responded by attending to changes in absolute pitch, whereas adult subjects did not. Saffran suggests that perfect pitch might be useful in infancy as it allows flexibility in language learning – tonal languages such as Vietnamese or Thai might be easier to learn if you have absolute pitch. However, once a language is learnt, and if it does not require perfect pitch, then the ability can be superfluous and recognizing relative pitch might be more useful. In fact, Saffran points out 'absolute pitch is too fine a form of categorization. If that's all we knew we couldn't generalize any of the sounds we hear. We wouldn't understand that the word *cup* spoken by a man and a woman was the same word.' *HJB*

Sociable computing

Studying images on a computer screen is not considered by most people to be the most sociable of activities. Computers, however, are about to be used to encourage effective social interaction, as reported in *The Guardian* on Tuesday 20th February. Simon Baron-Cohen, co-director of the Autism Research Centre at Cambridge University, is producing an interactive CD to improve the capacity of people with autism to identify emotions. They will be able to study facial expressions that would be present in normal life for no more than a fleeting moment. Using the CD, these expressions may be viewed for any length of time and repeatedly. Baron-Cohen and his colleagues are building up a database of over 1000 words describing emotions, each of which will have matching child and adult photographs of the associated facial expression. Emotions will be classified according to the age groups in which they are commonly found, so that the computer can provide appropriate examples. The words will also have corresponding sounds, to aid the process of identifying emotion from tone of voice. A more detailed description of the project, along with some sample expressions is available at //www.autismsoftware.co.uk. *DPB*

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