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Forum

The mystery of the brain–culture interface

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Nature and culture work together to shape who we are. We are embedded in culture and are profoundly influenced by what those around us say and do. The interface between minds occurs at the level of explicit metacognition, which is at the top of our brain's control hierarchy. But how do our brains do this?

The mental world atop the information processing hierarchy

Nature–nurture interactions are continually being debated. Although genetic processes affecting the brain are being studied with some success, we are still far from understanding how the cultural environment shapes the brain. So, how can we best investigate the mechanisms that enable the far-reaching effects of culture on what we perceive, feel, think, and do?

The now widely used predictive processing framework, which has been useful in explaining cognitive processes, could be the start of a fruitful path forward [1]. The central idea is that the brain uses both expectations (priors) and experience (evidence) to update models of the world. As shown in Figure 1, we presume that there is a bottom level of ancient and forever unconscious cognitive processes and a top level of later-evolved conscious processes. There is two-way traffic between them. Signals from below enable top-down control to intervene in the event of a problem. Perhaps we have pressed the wrong key while typing. This is likely to result in a change of strategy (e.g., slowing down).

But where is the top of this predictive hierarchy? Not in the individual's brain. The top is other people and the culture created by other brains [2]. At this top level, we can enter a mental world where we exchange ideas with other brains [3]. Here we can look for the effects of a vast range of priors that are set by other minds over many generations (i.e., our culture). For instance, in our culture, we have a strong expectation that people will not jump the queue and we get angry at people who do. But how does a prior like this get into the brain? How is it possible for individual brains/minds to interact with this world? We need to know because the answer will help us understand some of today's most difficult problems. Why do some groups, influenced by cultural pressure, vehemently oppose vaccination? Why do people have no idea how to persuade governments to take effective climate-change mitigation measures?

The importance of explicit metacognition

Only at the top level of the processing hierarchy do we have full access to the mental world as represented in our culture. Fortunately, there is an active research area that sheds light on this top level by exploring explicit metacognition [4]. Explicit metacognition is our human superpower. It draws on the slow and deliberate monitoring of high-level cognitive processes, thus enabling us to reflect on and justify our behaviour to others [5]. This conscious monitoring and reflecting, though not immune to error, underpins self-awareness. It allows us to gauge the quality and intensity of our feelings and to share such information with others. At the same time, it acts as a portal for outside cultural influences. We already know which brain region is involved in this form of metacognition: the frontal pole (BA10 [6]), a region that emerged late in evolution [7].

The most important tool that has advanced this work is not so much brain imaging as signal detection theory (SDT). Using SDT, we can estimate the sensitivity of our unconscious perceptual processes and separate them from the top-down biases that influence the outcomes of those processes. In a classic paradigm, participants try to detect a target under uncertainty. Some people may be overcautious and often report a target when there is none. Others may have the opposite bias and risk missing a target. By asking each person to rate their confidence in their decision, we can get an estimate of their bias. In past experiments, the bias has often been assumed to originate from within the individual brain, based on its prior experience or its current state of expectation. However, we can use the same method to study biases that originate from outside sources. For example, people might be instructed that missing a signal would result in a highly dangerous outcome. This will trigger a prior, which, because the task is difficult, will inevitably increase the number of false alarms.

How do instructions get into the brain?

Studying simple instructions given by an experimenter might help us to eventually understand how cultural priors operate. There are hints about the neural mechanisms involved when we compare what happens when a task is done with or without explicit instructions. We can consider, for example, a multiplayer game where participants are asked to invest in a common good. In these games, free riders can arise who do not invest but benefit from the investment of others.

What happens when you need to find out on your own how trustworthy your partners are? It is virtually impossible to predict how they will behave, that is, your prior expectations are very imprecise. You have no choice but to carefully track their behaviour. In a brain-imaging experiment, this was reflected in the activity of the striatum, as it signals your prediction errors while tracking the behaviour of others [8]. In another

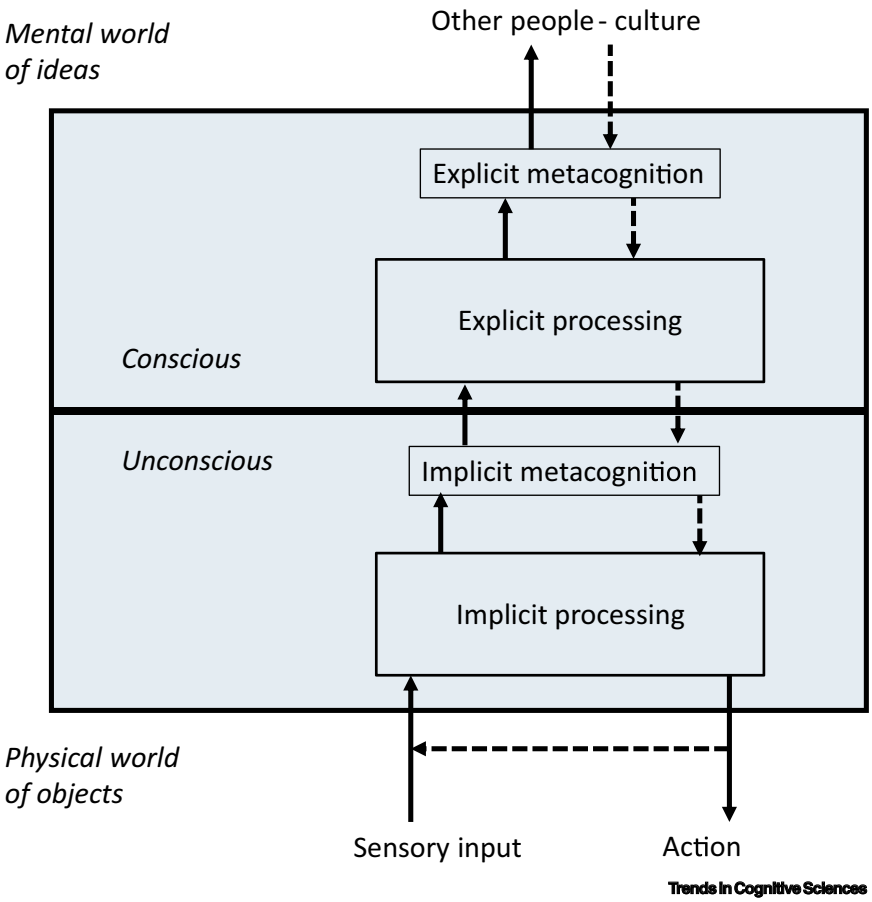

Figure 1. The brain–culture interface. The figure shows a much-simplified model of brain function where the hierarchy is represented with just two levels. At the top level we have processes that we can reflect upon. They are part of our conscious experience. At the bottom level are all the processes that occur without any awareness. The figure also sketches out what we currently believe about communication within the hierarchy. We suggest that, for each level of processing, there is a 'minder' which we have labelled metacognition. It is via these minders that messages emerge (bottom-up) giving information about the functioning of the lower-level processes. At the same time, signals can be sent (top-down) to alter the functioning of the lower-level processes. As the figure shows, we believe that these metacognitive processes occur at the unconscious as well as the conscious level.

experiment, participants were told in advance how trustworthy their partners were. In this case, they had a very precise prior belief and saved effort by not tracking their partners' behaviour. Here signals of prediction errors were no longer detectable in the striatum [9].

A belief, inserted from outside, can indeed trump your own inner experience. If this were an example of a cultural effect on the brain, how would it work? Let us accept the idea that top-down control is driven by the relative precision of the priors (precision control, see, e.g., [10]). In the absence of instructions, your prior belief has low precision, and so you must consider the behavioural evidence, which has higher precision. Because instructions increase the precision of your prior belief, you no longer consider the behavioural evidence, which now has lower precision than your belief. It is unclear how the balance of priors and evidence shifts and how this affects brain processes. A fascinating question is whether cultural priors can extend their influence all the way down the processing hierarchy, perhaps even to the deeply unconscious processes.

How does culture get into the brain?

Building on this type of work, we can glimpse a roadmap for exploring how culture enters the brain. Our guess is that culture has its effects by altering the precision of prior beliefs at the point where explicit metacognition emerges. The priors at the top of the hierarchy concern complex abstract concepts (e.g., freedom, loyalty, and climate change). In contrast to priors at the bottom of the hierarchy, these high-level priors cannot easily be learned by trial and error [11]. But we can get rough estimates of the precision of such priors from what other people tell us. We may get even better estimates from studying works of art and literature, since this reflects the experience of many people over time, increasing the precision of complex priors. As a result, they are likely to dwarf subjective experience. It is still another question how accurately precision estimates can map and keep pace with cultural changes, whether for good or bad.

Shifts and turns between priors and evidence hint at some intriguing parallels to the interplay between nature and nurture. We have identified a possible entry point for culture into the brain and sketched out a possible cognitive mechanism. However, we admit that we have not got much further than hand-waving, and we have little understanding of how the mechanism is implemented at the neural level. This will undoubtedly change in the next 25 years.

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References

1. Friston, K. (2005) A theory of cortical responses. *Philos. Trans. R. Soc. B* 360, 815–836
2. Roepstorff, A. and Frith, C. (2004) What's at the top in the top-down control of action? Script-sharing and 'top-top' control of action in cognitive experiments. *Psychol. Res.* 68, 189–198
3. Heyes, C. *et al.* (2020) Knowing ourselves together: the cultural origins of metacognition. *Trends Cogn. Sci.* 24, 349–362
4. Fleming, S.M. (2021) Know Thyself: The Science of Self-Awareness. Basic Books
5. Frith, C.D. (2012) The role of metacognition in human social interactions. *Philos. Trans. R. Soc. Lond. Ser. B Biol. Sci.* 367, 2213–2223
6. Fleming, S.M. *et al.* (2010) Relating introspective accuracy to individual differences in brain structure. *Science* 329, 1541–1543
7. Semendeferi, K. *et al.* (2001) Prefrontal cortex in humans and apes: a comparative study of area 10. *Am. J. Phys. Anthropol.* 114, 224–241
8. King-Casas, B. *et al.* (2005) Getting to know you: reputation and trust in a two-person economic exchange. *Science* 308, 78–83
9. Delgado, M.R. *et al.* (2005) Perceptions of moral character modulate the neural systems of reward during the trust game. *Nat. Neurosci.* 8, 1611–1618
10. Limanowski, J. (2021) Precision control for a flexible body representation. *Neurosci. Biobehav. Rev.* 134, 104401
11. Yon, D. and Frith, C.D. (2021) Precision and the Bayesian brain. *Curr. Biol.* 31, R1026–R1032