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# Commentary on Edmund Rolls: 'Emotion and reason in human decision-making'

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**Abstract**
In his paper Emotion and reasoning in human decision-making (Economics Discussion Papers, No 2019-8) Edmund Rolls points out that multiple and independent types of reinforcement exist in the human brain, and that they cannot be reduced to a common currency. The present commentary introduces non-specialist readers to this wide variety of reinforcers, each of which carries equal biological value. The evolutionary forces under-writing them reveal much about the causes of our apparently irrational choices – which is why it is important for economists to acquaint themselves with such things.

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Edmund Rolls (2019) discusses two brain systems. The first is an evolutionarily old, emotion-based system "with many rewards and punishers, all of which cannot be simultaneously optimized" (p. 1). The second involves reasoning, in which the human brain is less naturally adept than is widely assumed. I will focus my commentary mainly on the first system, and in particular on the "many rewards and punishers" – that is, on the *variety* of positive and negative reinforcers that influence human decision-making.

Rolls makes the important point that "each reward is represented by its own computationally independent though distributed subpopulation of neurons so that each type of reward is separate from the other rewards, and each can be a goal for a separate action" (p. 6). Moreover, he states that these multiple and independent types of reinforcement cannot be reduced to a common currency, such as points or dollars. What occurs instead is that the qualitatively different reinforcers are quantified on approximately equal scales, so that each of them will be given its due in the long term: "If food reward were to *always* be much stronger than other rewards, then the animal's genes would not survive, for it would never drink water, reproduce, etc." (p. 10, emphasis added).

This is well-established. The obvious implication is that anyone wanting to understand the contribution of the emotional brain to economic decision-making needs to acquaint themselves with the *diversity* of negative and positive reinforcers that exist in nature. This is because they are of equal biological value, and all will contribute in some way to economic decision-making. Rolls makes general observations about the range of relevant variables in the closing sections of his paper, concerning intrasexual selection, kin altruism and the like, but he makes little attempt to provide a comprehensive guide. This commentary is a step in that direction, although, given space constraints, it can only be indicative.

There are several nomenclatures in this field, which refer to the same things by different names. One crucial distinction must be dispensed with at the outset. Some scientists designate as 'rewards' and 'punishers' the *external objects* that deliver pleasurable and unpleasurable reinforcement; others reserve these terms for the *feelings* themselves. For example, if you escape a predator by climbing a tree, is your elevated perch the reward, or is it the feeling of safety? The feeling seems to be the self-evident answer, but behaviourism (a psychological school which eschews variables that cannot be observed directly) demands that the perch be regarded as the reward. The problem with the latter approach is that it emphasises the (highly variable) means to obtain biological ends rather than the (invariant) ends themselves. There are, after all, many ways to achieve the feeling of safety.

Although behaviourism has lost its grip on mental science, its influence is still apparent in the terminological usage of neuroscientists of a certain age. To be clear, therefore, in this commentary, the terms 'reward' and 'punisher' refer to the *innate varieties of feeling* that exist in the human brain, not to the infinite number of things in the world that may become associated with them and thereby attain motivational power. This enables us to see the wood for the trees. For example, it explains how something as inherently valueless as gold bullion becomes pivotal in world economics. To paraphrase Bill Clinton: it is not the gold, stupid, it's the power that it bestows.

Much that is apparently irrational in behaviour, including economic behaviour, can only be understood in this light. We go to extreme lengths to attain and avoid things that have no intrinsic value because of their *affective* value. Here, affective value is the proximal motivator. Affect is subjective, but it is nevertheless biologically caused, because affective values (the varieties of hedonic feeling) reflect underlying biological *needs*. That is where feelings come from, in terms of their distal causes, but we agents have scant knowledge of our real needs.

For example, as Rolls points out, sweet tastes are attractive to us because they generally characterise foods with high energy content, even though most people know nothing of this underlying fact. The nub of the matter is that agents are attracted to or repelled by objects because of the *feelings* they generate, even in the absence of any explicit understanding of the biological imperatives (such as energy balance) that underpin those feelings. To provide another commonplace example, people usually copulate because it feels good, not because they understand or even endorse the underlying imperative to reproduce. Evolutionary forces, by contrast, attach pleasure to sexual activity because – on average -- it massively increases the chances of reproductive success. The 'irrational' outcome is that individual agents indulge in all manner of sexual activities which are pleasurable to them (the proximal cause) even if those activities have no chance of achieving reproductive success (the distal cause).

The biological forces underwriting our natural kinds of feeling therefore reveal the causes of our apparently irrational choices. That is why it is important for economists to acquaint themselves with such things.

As I have said, different scientists call the same things by different names. This is not because there is much controversy about the existence of the things themselves. The different terminologies reflect different ways of describing and understanding them. Thus, what one scientist calls 'play' others call 'social dominance' or 'territorial aggression'; what one calls 'seeking' others call 'foraging' or 'wanting'; what one calls 'panic' others call 'separation distress' or 'protest'. The varying terminologies also reflect different ways of *classifying* these things. In affective neuroscience, the differences arise mainly from the variety of methodologies that are employed. Some scientists (like Paul Ekman) classify the natural kinds of feeling on the basis of facial expressions, others (like Lisa Feldman Barrett) on the basis of factor analyses of verbal reports,[1] still others (like Jaak Panksepp) on the basis of electrical stimulation of brain circuits (Ekman, 1992, Barrett, 2017, Panksepp, 1998). To avoid confusion, I will follow Panksepp's taxonomy here; but readers must be aware that it is not a universal currency.

Panksepp focused mainly on mammals, because it turns out that electrical and/or chemical stimulation of the relevant brain circuits produces almost identical affects in all mammals. This applies to humans, too, of course. Readers will be surprised to hear that we share basic affective circuitry with our favourite pets -- which may in fact be *why* they are our favourite pets. The fact that all mammals share this circuitry reveals that it is at least 200 million years old, since that is when the first mammals evolved.

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[1] A method which inevitably leads her to the conclusion that there *are* no natural kinds of feelings, beyond 'pleasure' and 'unpleasure'.

On the basis of his extensive research findings, Panksepp divided mammal feelings into three broad categories: '**homeostatic**', '**sensory**' and '**emotional**' ones. The name given to his first category is problematical because *all* affects are homeostatic. What Panksepp had in mind when he used this term was the affects that regulate vital bodily needs. So, let's start with those. They enable me to say a bit more about the function of homeostasis in general.

Homeostasis is brought about by innate *resistance to deviation from desired biological states*. Deviations *away* from desired states are felt as unpleasurable and shifts which return the organism back *towards* them are pleasurable. In computational neuroscience, such deviations are conceptualised as 'error' signals (see Solms & Friston, 2018). Once the desired state (the homeostatic settling point) is regained, the relevant feeling is resolved. Unpleasurable feelings or 'punishers' therefore represent *demands for work* – to correct homeostatic errors -- and pleasurable feelings are the 'rewards' that are obtained in consequence of such work (when it is successful).

This mechanism provides the hedonic *valence* that is the keynote of all affectivity. In addition to valence, each affect has a categorical *quality* of its own. For example, hunger feels different from fatigue feels different from suffocation, etc. The quality of the unpleasure identifies the category of underlying biological need (for nutrients, sleep, oxygen, etc.) that requires attention, which in turn dictates the type of behavioural work that is demanded.

Organisms are equipped with both *innate* and *acquired* modes of behavioural response to homeostatic demands. The innate responses are called reflexes and instincts. In computational neuroscience, they are described as 'prior predictions' (i.e., action programmes that are predicted by natural selection to resolve homeostatic errors). These programmes only rise to the level of consciousness when *uncertainty* prevails. This is the primary function of feeling: it enables organisms to make *voluntary* behavioural choices in *unpredicted* situations (see Damasio, 2018). Feeling thus provides real-time feedback on the success or failure of trial-and-error solutions to novel problems. This bestows enormous adaptive advantages on species which are so equipped.

Here-and-now problem solving takes place in short-term ('working') memory. The new predictions acquired in this way ('posterior predictions') are then consolidated into long-term cortical memory systems, whence they are iteratively revised ('reconsolidated') on the basis of ongoing prediction-error-correction, which demands multiple cycles of memory updating (i.e., learning from experience). In this way, the most successful acquired predictions are gradually[2] automatized into sub-cortical 'non-declarative' memory systems, whereafter they become stereotyped and behave much like reflexes and instincts. Non-declarative predictions are executed *unconsciously*. Odd as it may seem, this is the ideal state of memory, since non-declarative predictions are generalisable over large temporal and spatial scales, and they require less mental work -- and therefore less (biologically dangerous) delay.

[2] Consolidation into some non-declarative memory systems is not gradual. Everything here depends on the category of affect concerned. For example, fear-conditioning requires just a single exposure. Attachment bonding, by contrast, takes roughly six months. The biological reasons for this difference should be obvious.

Panksepp's second category of affect – the 'sensory' type -- behaves in much the same way as his first 'homeostatic' category, except that it concerns *external* rather than internal sources of error. I do not need to say much more about this category of needs. Typical examples are pain, surprise and disgust. Here, too, organisms are equipped with innate predictions (e.g., withdraw from a painful stimulus, orientate toward a surprising one, retch up a disgusting one), all of which must become elaborated through learning from experience. This involves not only learning *which objects* are painful, surprising, disgusting, etc., but also *what else can be done* other than withdrawal, orienting, retching, etc.

Most of the examples of affective decision-making provided in Rolls's article concern homeostatic and sensory affects of the kind I have just described. However, in my opinion, these categories of feeling are the least relevant for macroeconomics. The third category – 'emotional' affects – is far more important. Emotional feelings announce the biological needs which regulate *social* behaviour. Humans are woefully underprepared in this respect in comparison with other mammals, mainly for the reason that, since we began planting crops and husbanding animals (a mere 12,000 years ago), we have developed social formations that are quite unlike those for which the mammalian brain was evolutionarily prepared. These biologically unpredicted formations arose primarily from the establishment of large and permanent settlements, which gave rise to complex forms of property holding. It behoves economists to familiarise themselves with the natural kinds of emotional need that underpin the artificial regulatory systems that we humans have sought to impose on them.

I do not have space here for more than a mere listing of the seven basic emotional needs. For a more comprehensive discussion and a review of the vast evidential basis for the facts I am about to briefly summarise, see Panksepp's (1998) book, which is, however, rather technical. A more accessible version is Panksepp & Biven (2012), which was written for mental health practitioners. The capitalised terms are Panksepp's:

- SEEKING. We need to engage with and *explore* the world -- since all our biological appetites (including internal needs like hunger and thirst) can only be met there.[3] This is a *foraging* instinct. It is felt as interest, curiosity and the like. Kent Berridge (1996) calls it 'wanting'.
- LUST. We need to find *sexual* partners – since we need (as a species) to reproduce. This instinct is sexually dimorphic, on average, but male and female circuitry exists in both genders. This need is felt as sexual arousal, which is quite different from love (see the two 'attachment' needs, below) with which it needs to be reconciled.
- FEAR. We need to *escape* dangerous situations. The instinctual predictions for this emotional need are freezing and fleeing. This provides a good example of the learning principle mentioned above: we need to learn *what objects* to fear and *what else to do* in dangerous situations, other than freeze and flee. To be frozen by anxiety is hardly the

[3] The fact that we can only meet our needs by engaging with others is why life is difficult. You cannot successfully copulate with yourself, attach to yourself, etc, although this does not stop us from trying! (The phenomenon of 'narcissism' arises from these simple facts.)

most adaptive response in most danger situations. Here, as with all emotional needs, we also have to reconcile fear with our other needs (e.g., the next one in this list).

- RAGE. We need to *destroy* frustrating objects (i.e., things that get between us and the objects of our many homeostatic needs). This is called 'hot' aggression, which is distinguished from 'cold' aggression (also known as 'predatory' aggression, which is triggered by the SEEKING circuit mentioned above). It is also distinguished from 'dominance' behaviour (which is discussed under PLAY below).
- PANIC-GRIEF. We mammals need to *attach* to caregivers (i.e., to those who look after us). Separation from attachment figures is felt (acutely) not as fear but as *panic*, and loss of them is felt (chronically) as *despair.* Although parental caregivers provide the prototype attachment figures, the same need operates throughout life. (This circuit, like SEEKING, is highly prone to promoting addictive behaviour.)
- CARE. We need to *nurture* others, especially our offspring. This is the so-called 'maternal instinct', but it exists (to varying degrees) in both genders.
- PLAY. We literally *need* to play. This is not as frivolous as it appears; play is the medium through which social hierarchies are formed ('pecking order') and in-group and out-group boundaries are maintained.

A lot is known about each of these emotional needs and their underlying chemistries. Given space constraints, however, I will say more about only the last one, to illustrate some general points and to demonstrate the relevance of such things for macroeconomics.

People are often surprised to learn that play is a biological need, but all juvenile mammals engage in vigorous rough-and-tumble play. If they are deprived of their quota on any one day, they will try to make it up the next day – as if by rebound. We all know what rough-and-tumble play is, although the form it takes varies slightly from one mammal species to another. The play session starts with an 'invitation' posture or gesture; then, if the invitation is accepted, the game is on. The one animal exuberantly chases the other, which then stops and rolls onto its back; then they wrestle or tickle each other, taking turns to be on top -- accompanied by peals of laughter, or the equivalent mammal vocalization, depending on the species (even rats 'laugh')[4]; then they are back on their feet again, chasing each other in the reverse direction. The associated feeling state is equally universal: it is called fun.

Children just love to play. However, empirically, the majority of play episodes end in tears. This provides an important clue as to what play is all about, biologically speaking; it is about finding the limits of what is socially tolerable, acceptable, permissible. When play is no longer fun for your playmate, often because they decide you are not being 'fair', they won't play anymore. Their limit has then been reached. The marking of such limits is very important for the formation and maintenance of stable social groups. And the survival of a group is important for the survival of each member of that group in social species, such as ours.

A very important criterion in this respect is dominance. In any play situation, one of the participants takes the lead role and the other is submissive. This is fun for both parties, so long

[4] See https://www.youtube.com/watch?v=j-admRGFVNM

as the dominant one does not insist on calling the shots (being on top) all the time. The maximum acceptable ratio seems to be about 60:40. The ‘60:40 rule’ states that the submissive playmate continues playing so long as they are given sufficient opportunities to take the lead role.

This reveals a second, related function of play, namely the establishment of social hierarchies – a pecking order. Rough and tumble play accordingly gives way (from puberty onwards) to more organised and frankly competitive games. Of course, play is not limited to games of the rough-and-tumble variety. We humans engage in pretend play, in which the participants try out different social roles (e.g., Mother/Baby, Teacher/Pupil, Doctor/Patient, Cop/Robber, Cowboy/Indian, King of the Castle/Dirty Rascal – note the ever-present hierarchies). We do not know what goes on in the imagination of other mammals while playing, but we may confidently hypothesise that they too are trying out different social roles, and thereby learning what they can get away with.

This suggests the deeper biological function of play. It requires you (it teaches you) to take account of the feelings of others. If you don’t, they will refuse to play with you, and then you will be deprived of the enormous pleasure it yields. The bully might get to keep all the toys, but he will be deprived of all the fun. This, it seems, is why play evolved (and why so much pleasure attaches to it): it promotes viable social formations. It is, in a word, a major vehicle for developing empathy.[5]

Play episodes come to an abrupt end when they lose their ‘as if’ quality. If you lock your little sister up and throw away the key, then not only have you broken the 60:40 rule but you also are no longer playing the game of Cops and Robbers; instead you are simply imprisoning your sister. In other words, what is governing your mutual behaviour now is fear or rage rather than play. The same applies to the other games enumerated above. ‘Doctor Doctor’ is a game until it becomes real sex; then it is governed by lust rather than play.

These observations reveal the innate homeostatic values of the play instinct. It is ‘good’ to compete and to win, but not all the time; it is ‘bad’ to think only of yourself and to disregard the needs of others.

We don’t always like to recognize that humans, like other mammals, naturally form social hierarchies with clear rules. (The rules governing primate behaviour are remarkably complex.) The structure of families, clans, armies, even nations – almost any social group – is undeniably hierarchical and territorial; and this has been so throughout human history. The higher the social status of an individual within the group, the greater the access that individual has to the resources in the territory the group controls. This observation is not a matter of personal preference; it is a matter of fact. If we do not face such facts, we cannot begin to deal with them. The fact that emotional needs exist does not mean we have no control over them -- that we are obliged to bow before ‘the law of the jungle’; but we ignore these needs at our peril.

It is easy to see how play, in particular, gives rise to social rules. Rules regulate group behaviour, and thereby protect us from the excesses of our instinctual needs. It is also easy to

[5] The development of empathy is therefore by no means an automatic process, as the ‘mirror neuron’ theory might suggest. Empathy is not a reflex; it is a developmental achievement.

see how social rules encourage complex forms of communication, and therefore how they contribute to the emergence of symbolic thought. The 'as if' quality of play suggests that it might even be a biological precursor of thinking in general (i.e., virtual action versus real action).

All that remains to be said here is that what most distinguishes the human brain from that of our closest mammal relatives is our highly developed capacity to inhibit instinctual responses, which is what enables us to think our way through the problems that evolution could not have predicted. For this, we rely heavily on the part of our brain anatomy that distinguishes us humans most, namely cortex, and especially prefrontal cortex, which has overarching access to all other brain regions. This superstructure – our evolutionary pride and joy – is conventionally divided into ventromesial and dorsolateral components. Ventromesial prefrontal cortex, more than any other brain structure, inhibits the outputs of the affective systems I have summarised here. This means that it inhibits both the feelings in question and the behaviours they give rise to. Not acting ('free won't') enables dorsolateral prefrontal cortex to engage in thinking. That is, ventromesial prefrontal inhibition enables dorsolateral prefrontal cortex to run virtual scenarios 'in the mind's eye' – i.e., in working memory, as described above. Action in imagination rather than action in the world is what thinking is all about. For obvious reasons, it saves lives.

The fundamental contribution of cortex to the processes described here is therefore an inhibitory one: cortex delays subcortical action tendencies and enables us to 'hold needs in mind'. It thereby facilitates viable solutions to the many real-world problems that evolution could not predict, such as how to regulate permanent settlements and all that flows from them. This flexibility bestows considerable adaptive advantages. It does so by inhibiting automatic action tendencies, and by stabilising our intentionality in working memory, while we think (and feel) our way through life's problems.

I hope this brief commentary gives readers a sense, at least, of the complexities covered by Rolls's laconic statement that the emotional decision-making system entails "many rewards and punishers, all of which cannot be simultaneously optimized". Readers wanting a more comprehensive treatment of these issues should look out for my forthcoming book (Solms, in press)!

# References

Barrett, L. F. (2017). *How Emotions Are Made: The Secret Life of the Brain*. Boston: Houghton Mifflin Harcourt.

Berridge, K. (1996). Food Reward: Brain Substrates of Wanting and Liking. *Neuroscience and Biobehavioral Reviews*, 20: 1–25. https://www.ncbi.nlm.nih.gov/pubmed/8622814

Damasio, A. (2018). *The Strange Order of Things: Life, Feeling and the Making of Cultures*. New York: Pantheon.

Ekman, P. (1992). An Argument for Basic Emotions, *Cognition and Emotion*, 6: 169–200. https://www.tandfonline.com/doi/abs/10.1080/02699939208411068

Panksepp, J. (1998). *Affective Neuroscience: The Foundations of Human and Animal Emotions*. New York: Oxford University Press.

Panksepp, J. & Biven, L. (2012). *The Archaeology of Mind: Neuroevolutionary Origins of Human Emotions*. New York: WW Norton.

Rolls, E. T. (2019). Emotion and reasoning in human decision-making. Economics Discussion Papers, No 2019-8, Kiel Institute for the World Economy. http://www.economics-ejournal.org/economics/discussionpapers/2019-8

Solms, M. (in press). *The Hidden Spring: A Journey to the Source of Consciousness*. London: Profile Books.

Solms, M. & Friston, K. (2018). How and Why Consciousness Arises: Some Considerations from Physics and Physiology. *Journal of Consciousness Studies*, 25: 202–238. https://www.ingentaconnect.com/content/imp/jcs/2018/00000025/f0020005/art00009