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## **A bat and a ball together cost &dollar;1.10. The bat costs &dollar;.1 more than the ball. How much does the ball cost?**

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**Madeleine Finlay** is a writer based in London Answer to card puzzle: the 10 of spades

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**HIGHLIGHT:** Intuitive ideas about how our mind works have permeated popular culture and shaped everything from economics to advertising. But have we got it all wrong, wonders Madeleine Finlay

HOW much does the ball cost? If you instantly guessed 10 cents, you're in smart company: more than half of students at Harvard University and MIT jumped to the same conclusion. But you'd be wrong - the answer is actually 5 cents.

For years, this puzzle has been held up as the perfect example of the way we think being ruled by two types of mental processes: fast and intuitive, versus slow and analytical. If you arrived at the wrong answer before you had time to really ponder the problem, you might blame it on intuitive thinking leading you to make a snap judgement before slower, rational thinking had kicked in.

This idea that our thoughts can be split into two distinctive camps has become so popular it now influences many areas of everyday life. Marketeers try to tap into our automatic impulses with emotive adverts and special offers, while governments attempt to appeal to our deliberative sides, by doing things like putting calorie counts on menus.

These "nudges" are often based on the assumption that fast, intuitive thinking is likely to get you into trouble, so we need to cultivate the slower kind. The US National Academies of Sciences, Engineering, and Medicine and the World Bank have both issued reports urging decision-makers to use the slower type of thinking to avoid the expensive, or deadly, mistakes of the other form.

But a more complex picture of our mental processes is beginning to emerge. Categorising all our thoughts as one of these two types might in fact be leading us astray on all sorts of policies and practices. Armed with a new understanding of how we make decisions, we could all benefit.

From Descartes's mind-body dualism to Freud's infamous **unconscious** mind, a distinction has long been drawn between the two opposing factions of instinct and conscious reasoning. Yet it wasn't until 1975 that psychologists Michael Posner and Charles Snyder presented the first dual-process model of the mind. In a paper, they described an efficient, automatic thought process that can operate without intention, and an inefficient, conscious process.

However, it was Nobel prizewinner Daniel Kahneman who turned the idea into a popular concept in his 2011 bestseller *Thinking, Fast and Slow*. In it, he describes our mental processes as typically belonging to system 1 or system 2 (see "Ways to think").

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Compare the difference between a joke and a riddle. A good joke is funny without needing to think about exactly why. This taps into system 1. A good riddle, however, requires us to lean on system 2, taking some time and brow-furrowing to get to that moment of satisfaction.

Since the book's publication, the dual-process model of mind has blossomed into one of the most widely accepted ideas in psychology, becoming pervasive in research, with real-world implications. "The popularity of the book is [due to] the intuitive appeal of the two systems," says Kahneman, who is at Princeton University. Those studying topics such as political beliefs, criminal decision-making and lie detection have used the model to investigate the source of our behaviours and beliefs. Research on binge drinking, for example, suggests that this impulsive behaviour is caused by an overactive system 1, which has also been identified as the source of interviewers' false impressions of job applicants. The model has also been at the heart of evidence given to policy-makers about the implicit effects of advertising.

But despite its popularity, it can lead scientists astray. For several years, there was consensus that diagnostic errors were caused by system 1 type reasoning, and clinicians were advised to think more slowly. However, later reviews found that experts are just as likely to make errors when attempting to be systematic and analytical.

Now, spurred on by new evidence from neuroscience and problems reproducing some experimental results linked to the dual-process model, a growing number of psychologists are starting to wonder whether our most complex organ really operates in such a conveniently simple fashion.

"It's such a sticky idea because it makes intuitive sense and resonates with people's experience," says Magda Osman, an experimental psychologist at Queen Mary University of London, "but having a false conception of the mind can be damaging." How we think - or think about thinking - can challenge or entrench our biases, help us avoid mistakes, or cause them.

One example Osman gives is something she calls the Prince Charming effect, in which we separate automatic thoughts from conscious, intentional ones to absolve - or rescue - ourselves from our mistakes and biases. "If something goes wrong, it saves us and excuses our behaviour," she says. Take the bat-and-ball problem. People tend to feel better if they believe that coming up with the answer of 10 cents was an uncontrollable, **unconscious** response.

Humans have a lot of bad habits. We ignore evidence we dislike, rationalise biases and justify bad decisions

At a personal level, this might seem a minor consideration, but it raises serious questions for society as a whole. "If someone commits a crime and says in court, 'I didn't do it intentionally, I just wasn't thinking. It was an automatic response', we recognise that and we might be inclined to see them as less responsible for their actions," says Osman. "We might even feel that it wasn't really 'them' at all." However, if our minds have more than two clear-cut modes, then deciding when something is intentional and worthy of blame is much more challenging.

David Melnikoff at Yale University agrees. "For over a decade, there was this idea that because stereotyping was a type 1 process it couldn't be consciously accessed." He points to the Implicit Association Test, developed in 1998, in which participants match two target concepts as quickly as possible. Typically, we react faster when pairings are more strongly associated, reflecting participants' implicit attitudes and stereotypes. The test has since been widely used as a way to reveal **unconscious** biases. But in 2014, participants in another experiment were asked to predict the strength of their biases before taking the test. It turned out their guesses were pretty accurate. Our biases aren't as **unconscious** as we would like to believe.

Findings like these have led Osman, Melnikoff and others to question the binary model of our minds. For them, the critical point is that there is little evidence that the features of these two kinds of thinking, such as automatic and quick, or deliberative and conscious, actually go together at all. "This idea is taken as fact, but it's never been tested," says Melnikoff. "Plus, there's reason to suspect that these features aren't correlated. There are plenty of examples where they aren't aligned."

Take language. We deliberately communicate, but in the flow of conversation we don't consciously rehearse what we are going to say or the grammatical rules we need to use. It is intentional and, at the same time, **unconscious**. The same can be said of driving on a familiar route, typing, or playing a well-rehearsed tune on an instrument.

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We can even solve novel problems without being aware of how we do so. "People think that rules can't be processed unconsciously," says Melnikoff. "That isn't true either." Just take a look at the deck of cards, opposite.

You probably guessed intuitively, without needing to cogitate, that the next card should be the 10 of spades. Studies involving puzzles like this show we can process logic and rules in an **unconscious** but effortful manner.

In contrast, think about the bat and ball again. We can also be purposefully trying to solve a puzzle and yet still come up with a compulsive but erroneous response.

### **Unconscious** influence

Other studies are further blurring the boundary between conscious and **unconscious** mental processes. In an experiment in which participants were given an identical-tasting drink containing either glucose or a calorie-free sweetener, those who had consumed sugar perceived a hill to be less steep when asked to estimate its slant. It indicates that on an **unconscious** level, your body is telling you how the world looks based on what it is capable of at that moment, says Simone Schnall at the University of Cambridge, who led the study. "**Unconscious** factors can influence our perception."

To people like Osman and Melnikoff, these examples all point to a bigger question: is it really possible to distinguish between the two systems? In fact, we may be barking up the wrong tree altogether. "There's still debate over many of the features, let alone the categories," says Osman. "Demonstrating that things are **unconscious** or conscious is unbelievably hard. Usually you end up drawing arbitrary distinctions, like how fast 'fast' is." Without good evidence to resolve such difficulties, opponents argue that there is no reason to assume that system 1 and system 2 exist at all.

Yet, Kahneman believes critics have missed the point. "It is a framework and not a theory, which can be used to make sense of phenomenological experience," he says. He argues that his metaphor of system 1 and system 2 can go a long way in describing thinking and aiding understanding of how we think. For him, the bat-and-ball problem is one of the best illustrations. "The number 10 is produced associatively, like  $2+2=4$ . That's clearly system 1. The computation part, where you take away the 10 cents from \$1, calculate the difference and so on, that's very clearly system 2. In that example, there is no ambiguity."

Even when things are less clear-cut, argues Kahneman, almost all processes are a mix of both systems, each of which represent a list of characteristics that are likely to apply - but aren't set in stone. For him, counterarguments fail to address the main reason the idea is so popular: we all have experience of two very different ways of coming up with thoughts and making decisions, passive association or active thinking. And because of this intuitive appeal, it is going to be tough to change public acceptance that this is how it is, says Osman, even if researchers are divided on the subject. "There's still a lot of uptake by governments and industry," she says. "It's going to be hard to shift such a popular view."

In the meantime, what most critics and proponents agree on is the need to dispel the "good/bad fallacy". This is the assumption that because system 1 is automatic and **unconscious**, it is error-prone, whereas system 2 is analytic and therefore correct.

"I think this is ridiculous," says Kahneman. "It's a common misunderstanding that system 1 is irrational and system 2 is rational." In fact, he regards the automatic system as the more developed, complex and useful. "System 1 is not a machine for making errors," he says. "It usually functions beautifully." **Unconscious** processing can let us perform well-practised skills more quickly and easily. As Melnikoff puts it, "Don't tell an athlete to think about their swing during a match."

As well as giving our **unconscious** too much of a bad rap, the fallacy increases the risk of us not holding our conscious thinking to account. Humans have a lot of bad habits. We ignore evidence we dislike, rationalise our biases and produce questionable justifications for bad decisions: I only had a small breakfast, so it is fine to have a big slice of cake.

Often, we end up "overthinking". In a recent study looking at deliberation, four cars were described using positive and negative attributes. The terms were 75 per cent positive for the first car, 50 per cent positive for the next two and just 25 per cent positive for the last vehicle. After reading the descriptions, some people

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were told to think about the cars for 4 minutes before choosing their favourite, while others were asked to solve anagrams during that time. When the list of attributes was long - 12 rather than four - the anagram group of "**unconscious** thinkers" consistently made better decisions than those who pondered the information.

This implies it might often be beneficial to delegate more complex matters to the **unconscious**. Similar tests have shown the same with posters, and assessments of job applications and strawberry jam.

If we can't always trust our instincts, but our conscious mind isn't all it's cracked up to be either, how should we think about how we think? According to Osman, no type of reasoning should be consigned to the scrapheap. Our gut feelings and intuitions, as well as our explicit reasoning, have been informed by the evidence around us, even when we aren't consciously aware of it.

Instead, she advises being critical about thinking. This means you should challenge all types of thinking, and not just your instincts, says Osman. "It's useful to look at how well we scrutinise the information available, to what degree we're motivated in making a decision and what our motivations are," she says. "Just saying, 'why do I think that?' or imagining yourself in the opposite position can be useful."

Kahneman agrees it is a good idea to be sceptical, particularly when statistics are involved. "If there's a statistical angle, don't trust yourself." However, he isn't convinced about people trying to "think better". He has hope in other areas though. "When it comes to institutions and organisations making decisions, these are much slower and so there is more room for improvement." This might involve people challenging views during discussions, taking time to review all the evidence between meetings or inviting in people with a fresh perspective. Unfortunately, for most day-to-day choices, measured deliberation just isn't possible.

So if you fell for the bat-and-ball problem, don't beat yourself up about getting it wrong. Next time you might outsmart your own thought processes. Just take a moment and ask whether it is time for a rethink.

*This article appeared in print under the headline "A bat and a ball together cost \$1.10. The bat costs \$1 more than the ball. How much does the ball cost?"*

Ways to think

The bestselling book *Thinking, Fast and Slow* captured the idea that our thought processes relate to two distinct systems **System 1** Jumping to conclusions, quick, automatic, effortless, intuitive, implicit and emotional. **System 2** Slow and demanding, does the mind's heavy lifting. It is deliberate, demanding, analytic, explicit and logical.

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