



## REASONING WITH HEURISTICS: THEORETICAL EXPLANATIONS AND BEYOND\*

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### INTRODUCTION

Human reasoners often tend to use simple and rapid strategies, *heuristics*, to make inferences. These are adaptative mechanisms of a non-logical nature. In some occasions they are very useful but in other cases they lead subjects to commit systematic *cognitive biases*.

The purpose of this work has been to identify some of the main theoretical proposals on heuristics and cognitive biases in reasoning highlighting the framework of the Dual Process Theories. According to such theoretical perspectives, there are two types of thinking processes. Type 1 that is intuitive, automatic, unconscious, implicit and fast and Type 2 that is reflective, controlled, conscious, explicit and slow.

This work ends with some brief considerations about the relationship between heuristics and cognitive biases and the study of individual differences in reasoning.

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## DUAL-PROCESS THEORY OF REASONING: THE ROOTS

The dual process theories have proved popular in many fields of psychology (see for example Evans, 2018; Frankish & Evans, 2009). In this paper our particular interest is to present the current state of *dual process theories in reasoning*.

Following Evans (2004), the two roots of the modern dual process theories (Evans, 1989; Sloman, 1996; Stanovich & West, 2000) are the "*Dual Process Hypothesis*" (Wason & Evans, 1975) and the "*Two-Factor Theory*" (Evans, 1982). One of the first objective of Wason & Evans was to explain the discrepancy between participants' behavior on a conditional reasoning task and their introspective reports about how they had solved it. According to these authors, the differences reflected "some form of dual processing between behavior and conscious thought" (p. 141). The two-factor theory (Evans, 1982) defended the influence of logical and non-logical factors on reasoning. However, some decades later this author argued that this theory did not offer a real explanation for the underlying cognitive processes.

## THE HEURISTIC-ANALYTIC THEORY: A BRIDGE BETWEEN THE TWO FACTOR THEORY AND THE DUAL PROCESS THEORY

Evans (1984, 1989) extended the previous explanations in the *Heuristic-Analytic Theory* (see Evans, 2004, 2008, 2013, for reviews). The author proposed the origin of reasoning bias via heuristic processes. In this theory, *heuristics* are preconscious and

represent relevant information, retrieve and add knowledge from memory (according to linguistic, semantic and/or pragmatic keys). Then, subjects reason with these personalized representations. Participants might make mistakes if they choose logically irrelevant information or do not take relevant information into account when reasoning about it in a second *analytical* phase.

In a *review* of the Heuristic-Analytic Theory (Evans, 2006, 2007), it is proposed that said errors can occur in the heuristic or analytic process. Therefore, both types of processing, could be influenced by the participants' beliefs, empirical knowledge or experience. In this sense, Stanovich (1999) described the "*fundamental computational bias*" in order to explain the tendency to contextualize the problems with reference to prior knowledge. Evans (2006) presented the "*fundamental heuristic bias*" and the "*fundamental analytic bias*" for explaining the role of Type 1 and Type 2 processing in the causes of cognitive biases. In consequence, Type 1 processing can lead to correct answers and Type 2 to biases depending on the circumstances (Evans, 2007; Evans & Stanovich, 2013).

## DUAL PROCESS THEORY OR DUAL PROCESS THEORIES?

*Dual Process Theory* (Evans & Over, 1996) explains the interaction between processes 1 and 2 in the development of human thinking and both the correct performance and biases are explained.

Following Evans (2019), structurally, there are two main forms of Dual Process Theory (see table). On one hand, some authors have proposed that Type 1 and Type 2 processes operate in *parallel* and

may produce *conflicting answers*, typically describing them as associative and rule-based: the *Parallel-Competitive Processing Model* (Sloman, 1996; Smith & DeCoster, 1999). On the other hand, in the fields of reasoning and decision making, the serial *Default Interventionist Model* (Evans, 2006, 2007; Kahneman, 2011; Kahneman & Frederick, 2002; Stanovich, 1999, 2011), involves the cueing of *default responses* by the heuristic system. This system may or may not be modified by later intervention of the analytic system.

A different approach is the proposal of Thompson (2009); Thompson et al. (2011). The authors examined people's *metacognitive intuitions* using a *two response paradigm* (participants asked to give a quick intuitive answer without reflection; after, they are asked to think about the problem again without time limit and with the opportunity to change the initial answer). They observed that the *feeling of rightness* (FOR) can modulate the option to change the initial answer. Concretely, the lower the initial FOR, the more time people will take rethinking the answer and change it. The faster the initial response, the higher the FOR (see table).

Some of the main Dual-Process Theories in the Psychology of Reasoning.

| AUTHOR                                   | THEORY  | KEY IDEA   |
|--|---|--|
| EVANS (1984, 1989)                       | Heuristic-Analytic Theory                     | Heuristic and analytic processes.<br>Bias only in heuristic phase.   |
| EVANS & OVER (1996)                      | Dual Process Theory                           | Interaction between processes 1 and 2 in the development of human thinking.  |
| SLOMAN (1996)                            | Parallel-Competitive Processing Model         | Two reasoning process operate <i>at the same time</i> and in direct <i>competition</i> with one another.<br>Parallel activation of two types of intuitive responses: heuristic and logical answers.  |
| EVANS (2003); (2010)                     | Two Minds Theory                              | Two minds in one brain.<br>OLD intuitive mind, NEW reflective mind.  |
| EVANS (2006)                             | Heuristic-Analytic Theory-Revised Version     | Heuristic and analytic processes.<br>Both processes can lead to bias.  |
| EVANS (2007)<br>EVANS & STANOVICH (2013) | Default Interventionist Model                 | One process is the default but can be overridden by a second process. Type 1 processes produce intuitive heuristic answer. After this, <i>only sometimes</i> might be followed by a deliberative slow Type 2 processes. Both processes can lead to bias. Subject as a <i>cognitive miser</i> who try to minimize cognitive effort. |
| THOMPSON (2009); THOMPSON ET AL. (2011)  | Dual Process Theory-Metacognitive Perspective | Metacognitive feelings.<br>Two response paradigm.  |
| STANOVICH (2009, 2012)                   | Tri-Process Theory                            | Processes: Autonomous, Reflective (thinking dispositions), Algorithmic (cognitive capacity)  |

Some of the main Dual-Process Theories in the Psychology of Reasoning (continued).

|  |                                       |   |
|--|---------------------------------------|---|
| <p>BAGO &amp; DE NEYS (2017, 2020); DE NEYS (2018); DE NEYS &amp; PENNYCOOK (2019)</p> | <p>Hybrid Models</p>                  | <p>Multiple Type 1 processes can provide intuitive cues.</p> <p>Intuitive reasoning is determined by the absolute and relative strength of competing intuitions.</p> <p>Bias “blind spot”: biased people don’t realize that their system 1 answer is logically questionable.</p>        |
| <p>PENNYCOOK (2018); PENNYCOOK, FUGELSANG &amp; KOEHLER (2015)</p>                     | <p>Three-Stage Dual Process Model</p> | <p>Multiple type 1 processes may be cued by a stimulus (stage 1), leading for potential conflict detection (stage 2). If successful, conflict detection leads to Type 2 processing (stage 3).</p> <p>TYPE 1-Intuitive. TYPE 2: Functions: rationalization and cognitive decoupling.</p> |

What factors can trigger the activation of type 1 and type 2 processes? On one hand, according to Stanovich (2011) different situations can activate a heuristic response, such as: (1) when a person lacks the “mindware” (necessary knowledge) to solve the task; (2) when the subject fail to see the need to engage Type 2 reasoning or (3) when he lacks the cognitive capacity to solve the task by reasoning. On the other hand, ¿what variables could modulate the probability of intervention of Type 2 reasoning? The Stanovich’s research program highlights the “cognitive decoupling”, as a key factor to reason hypothetically, to abstract the relevant features and disregard the context and experiential knowledge.

Numerous empirical studies reveal that the tendency to think analytically has very important consequences both in experimental laboratory tasks and in everyday situations.

Different experimental investigations from the heuristics and biases literature displayed that the likelihood of activation of Type 2 reasoning, is related to factors such as: *the experimental instructions*, *the time available* or *the individual differences in cognitive ability* and *rational thinking dispositions*. In real life scenarios, analytic thinking allows to differentiate, for example, “fake news” from real news (see Pennycook & Rand, 2019). Also, the reflective practice and cognitive bias awareness may also help doctors, psychologists, etc. to improve their diagnostic accuracy (see for example Royce et al., 2019).

Nevertheless, people often evaluate evidence and test hypotheses in a manner biased by prior knowledge and beliefs (*belief bias*), opinions and attitudes (*myside bias*), or even for their religious or paranormal beliefs (for example, Baron, 2020; Pennycook et al., 2012; Yilmaz, 2021).

Human reasoners show consistent differences when they reason and some of them are more susceptible to biases than others. The study of individual differences is one of the main topics in the current psychology of reasoning (De Neys & Bonnefon, 2013). In a set of experimental investigations, Stanovich and his research group observed that individual differences can in part be predicted by psychological dispositions and cognitive ability. Let’s see in the next section some recent considerations around this topic.

## HEURISTICS, COGNITIVE BIASES AND INDIVIDUAL DIFFERENCES

The late 1990s, Stanovich's research group program analyzed the relation between individual differences in reasoning and cognitive biases. In general terms the findings show that the tendency to override various cognitive biases was correlated with the individual differences in cognitive ability and thinking dispositions (see Stanovich, West & Toplak, 2016, for a review of the results).

Nevertheless there was an "outlier bias" that did not correlated with cognitive capacity or thinking dispositions: the *Myside Bias*. It occurs when the subject's belief is a conviction (or "distal belief", that cannot be directly verified by experience). This bias "that divide us" (Stanovich, 2021a), embody our values and it is related to the own prior opinions, attitudes, emotional commitment or ego preoccupation. It derives from our general worldviews or, in political terms, from our ideologies (Pennycook & Rand, 2019; Stanovich, 2021a). Related to this question, see Evans (2021); Goel (2022); Stanovich (2021b), for recent analysis of the rationality debate and the Dual Process Theory.

In this sense, political science studies showed that *cognitive sophistication* (high cognitive ability, high educational level, knowledge level, political awareness, personal dispositions, etc.), not only do not reduce myside bias but increase it. Stanovich (2021a) analyzed the sociopolitical implications of myside bias and studied how to delete this error, which is particularly strong in "cognitive elites".

In order to avoid this peculiar bias, we must train cognitive decoupling (suppress automatic response and enabling hypothetical reasoning). Moreover we must practice the perspective switching. This is very important and “allow us to conceptualize the world in new ways” (Stanovich, 2021a, p. 161). Recent debiasing studies also suggest that a short training can debias performance at an intuitive level (see for example, Boissin et al., 2021, 2022).

### THE DUAL PROCESS THEORIES: SOME OPEN QUESTIONS

Some key questions around the Dual Process Theories are the following: (1) What make us think?; (2) How intuitive and analytic processes operate?; (3) How is the type of interaction between both processes, sequential or parallel? (4) Which are the key factors that determine the intervention of type 2 processes? The *cognitive ability?*, the *rational thinking dispositions?*, the *instructions*, the *time available?*... (5) Is reasoning the implementation of concrete beliefs, abstract structures or something else?

### CONCLUSIONS

\* To investigate the origins and underlying mechanisms of heuristics and cognitive biases may serve to find better ways to predict their occurrence. This has important consequences on many practical levels and daily-life situations.

\* There are gaps in the literature (Pennycook, 2018), so there is still much work to be done.

\* There is a strong need to re-think some of the fundamental assumptions of the original Dual Process Theory (De Neys, 2018; Frey & De Neys, 2022).

\* More research is needed to understand how the types of thought work (Evans, 2018).

\* In general terms, the existence of dual processes or systems of thought is “one of the most widespread and influential theoretical ideas in contemporary cognitive psychology” (Rhodes et al., 2020, p. 185).

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