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Working memory capacity and cognitive styles in decision-making

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ABSTRACT

Human decision-making is thought to involve the interplay of two distinct information processing systems: a rational (logical) system and an experiential (intuitive) system (Epstein, 1994). Moreover, the ability to engage in rational processing is believed to be constrained by working memory capacity (WMC) (Feldman Barrett, Tugade, & Engle, 2004). Accordingly, preference for rationality, but not preference for experientiality, was expected to mediate the relationship between WMC and performance on cognitive tasks that require logical reasoning. Path analysis using AMOS 18, with data from 269 non-paired twins, confirmed this mediation hypothesis. Higher WMC was predictive of stronger preference for rationality, which, in turn, was predictive of better syllogistic reasoning, lower susceptibility to gambling biases, and lower superstitiousness and categorical thinking. As expected, WMC was unrelated to preference for experiential processing, and higher experientiality predicted poorer performance on the syllogistic reasoning task, higher susceptibility to gambling biases and greater superstitiousness.

1. Introduction

Dual process theories of cognition assume a distinction between two different modes of processing: an intuitive and a rational mode. The intuitive mode is often referred to as the 'default mode' or 'System 1' because it operates constantly, automatically and without conscious control. It involves the activation of memories, affect and emotion, stereotypes and beliefs and relies on cursory analyses of situations, giving it a sense of rapid and effortless thought. The rational mode, 'System 2', is characterised by deliberative thought, analytical, logical, often verbal processing, which is comparatively slow and effortful (for a review of dual process accounts of cognition, see Evans, 2008).

Just as these modes have certain defining characteristics, so too do they perform advantageously in different domains or contexts. For example, intuition that is expressed in situations where an individual has expertise allows them to act quickly, definitively and accurately, their reactions being based on detailed previous learning (Glöckner & Witteman, 2010). Likewise, rational processing can be advantageous in situations where judgment requires analysis or the application of logic, or in the so-called conflicts between the 'heart and head' where reliance on emotions and affect could precipitate an illogical course of behaviour (Epstein, 1994).

In an attempt to understand the conditions under which these modes are utilised and optimised, many experimental tasks reported in the judgment and decision-making and social cognition literature attempt to pit the controlled, rational mode against the automatic, experiential mode. Across these tasks, it has emerged that individuals differ markedly in their application of logic, their susceptibility to cognitive biases and their proneness to faulty beliefs. This differential responding cannot be reduced to differences in cognitive ability alone (e.g., Klaczynski, Gordon, & Fauth, 1997).

1.1. Preferences for rationality and experientiality

A compelling explanation for these differences is that individuals differ in their preferred modes of thinking (Marks, Hine, Blore, & Phillips, 2008; Pacini & Epstein, 1999). Some favour an experiential mode, relying on intuition and feeling confident in following gut feelings and instincts. Some favour a rational mode, are confident in their ability to analyse effectively and enjoy applying logical rules to everyday situations. Others are either confident or uncomfortable with both experiential and rational modes of thinking, indicating that preference for the two modes are independent of each other.

Importantly, these preferences are predictive of a range of behaviour in individuals. Studies using the Rational–Experiential Inventory (REI, Pacini & Epstein, 1999) have consistently found that higher scores in preference for rationality were significantly associated with superior reasoning skills and low susceptibility to cognitive biases, as well as some personality traits such as openness to experience, flexible thinking, and a lack of neurotic traits (Marks et al., 2008; Pacini & Epstein, 1999). In contrast, higher scores in preference for experientiality were associated with poorer reasoning skills and susceptibility to cognitive biases and superstitiousness.

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1.2. The role of working memory capacity

The ability to control attention is strongly related to working memory capacity, WMC (Kane, Bleckley, Conway, & Engle, 2001) and is believed to be a key factor in rational processing (Feldman Barrett, Tugade, & Engle, 2004). It is necessary for maintaining motivation and goal-directedness throughout complex tasks, enabling concentration on relevant (and not irrelevant) stimuli and in inhibiting stereotypical and automatic thinking. Because of the relatively effortful nature of rational processing versus automatic processing, positive feedback in the form of success in tasks is likely to be important in encouraging future rational processing. For individuals with higher WMC more tasks of this type are likely to have successful outcomes, thus making rational processing rewarding, and increasing the likelihood of developing a rational style preference. However, in tasks that demand high proficiency in attentional control, individuals with a lower WMC are likely to have more difficulty and make more errors, and therefore receive more negative feedback than higher WMC individuals. This could result in an aversion to rational processing.

1.3. Rationale, aims and hypotheses of the present study

The present study aimed to clarify the relationship between WMC, cognitive styles and cognitive performance. We measured WMC in a sample of adults, and assessed their preferences for rational and experiential thinking. We further examined performance on a range of cognitions believed to differentially engage rational and experiential cognition: (1) syllogistic reasoning; (2) gambling biases; (3) superstitious thinking; and (4) categorical thinking.

First, it was hypothesised that WMC would be positively associated with preference for rationality. In line with Feldman Barrett et al. (2004), those individuals with a higher WMC were expected to have a greater capacity for rational processing than those with lower WMC, resulting in individuals with a higher WMC more often preferring a rational mode of cognition.

Second, preference for rationality was expected to be associated with better reasoning on a syllogistic reasoning task, and better choice of strategies in gambling tasks. Individuals who are high on rationality should attend to the reasoning tasks more and enjoy the reasoning tasks more than those low on rationality. Preference for rationality should also be negatively related to superstitious beliefs and categorical thinking (Epstein, Pacini, Denes-Raj, & Heier, 1996). Highly rational thinkers should be less likely to attribute events to non-rational causes thereby being less superstitious than individuals low in rationality. They should also be more aware of alternatives in problem solving and thereby be more flexible thinkers than those who are low in rationality (Pacini & Epstein, 1999).

Third, it was expected that the hypothesised relationships between WMC and each of the four dependent measures outlined above would be mediated by preference for rationality. WMC should affect whether people prefer to act in the rational mode, and their performance on these tasks is affected by their level of preference for rational cognition (e.g., Marks et al., 2008).

Fourth, we predicted that preference for experientiality would not mediate the relationship between WMC and the four outcome variables. Individuals' preference for experientiality has been consistently found to be independent of preference for rationality (e.g., Epstein et al., 1996; Marks et al., 2008). It was expected that it would also be independent of WMC, because differences in the ability to control attention should not be a limiting factor in the automatic mode (Evans, 2008).

Finally, in line with past studies, higher preference for experientiality was expected to be associated with poorer performance on the reasoning tasks, more susceptibility to biases in gambling strategies, and greater superstitiousness (Epstein et al., 1996; Klaczynski, 2001; Marks et al., 2008). People who have a high preference for experiential processing can rely on snap judgments and decisions that in some cases are optimal, but it is believed that stereotypical and rigid thinking can result from a failure to take different perspectives and process contextual stimuli more deeply (Feldman Barrett et al., 2004). Intuitions are often associated with strong feelings, and the perceiver often has confidence in judgments that are not logically justifiable (Feldman Barrett et al., 2004). This can lead individuals to ignore other alternatives and anomalies to past experiences and make decisions based only on preconceptions and not on all the current, relevant, available, information and ultimately hinder their reasoning.

2. Method

2.1. Participants

Participants for the current study were a portion of a larger sample involved in a behaviour genetics study and recruited by the Australian Twin Registry (ATR). To ensure independence of observations for the current study, only one twin from each pair was selected – the first twin listed by participant code in the ATR database. Thirty-one cases were excluded due to excessive missing data (>12%), leaving 269 participants comprising 84 males with a mean age of 35.9 years ($SD = 6.1$) and 185 females, with a mean age of 37.1 years ($SD = 6.2$). Participants' education levels were as follows: 10.2% had completed 4 years or less of high school, 17.6% had completed 6 years of high school, 38.2% had completed an undergraduate degree or equivalent, and 34% had completed a postgraduate degree.

2.2. Measures

All instruments were converted to HTML format and amalgamated into an on-line assessment battery as follows. All reliabilities reported below (Cronbach's α) were obtained with the current sample.

2.2.1. Working memory span tasks

Two memory span tasks were used to assess working memory capacity. The first task was an operation-word span task adapted from Web-Ospan (Graf, Lin, & Kinshuk, 2005). Participants responded 'true' or 'false' to 40 simple mathematical operations (e.g., $6/3 + 1 = 5$). Immediately following each arithmetic operation, participants were presented with a to-be-remembered word for 800 ms (common monosyllabic English words). Each trial consisted of between two and six operation/word presentations, after which they were asked to recall and type the words in their order of presentation. There were ten trials overall; two of each of 2, 3, 4, 5 or 6 operation/word pairs (maximum score of 40 correct).

The second task was a sentence–letter span task (adapted from Kane et al., 2004). Participants were presented with either logical or illogical sentences (instead of mathematical operations) that they responded to by ticking a box saying either 'makes sense' or 'doesn't make sense' (e.g., I was eating spaghetti under the blue news. *Answer = doesn't make sense*). After responding, they viewed a to-be-remembered letter for 800 ms. As with the first task, there were 10 randomly presented trials overall that consisted of two each of 2, 3, 4, 5, and 6 pairings of sentence/letters (maximum score of 40). Each correct item was scored 1 (out of a possible 40). After standardization, the two tasks were averaged to give a total WMC score ($\alpha = .80$).