Journal of European Psychology Students, 2013,
First Work in Progress Special Edition, 9-15

efpsa journal of european psychology students

(In)accurate Intuition: Fast Reasoning in Decision Making

Michalina Andrzejewska, *University of Gdansk, Poland*
Dilara Berkay, *Dogus University, Turkey*
Sophie Dreesmann, *VU University Amsterdam, Netherlands*
Jonas Haslbeck, *University of Graz, Austria*
Daisy Mechelmans, *University of Leuven, Belgium*
Sarah Furlan, *University of Padova, Italy*

Received: 11.05.2013 | Accepted: 01.08.2013

abstract

Dual-process theories postulate a distinction between fast, automatic, intuitive and error-prone (Type 1) versus slow, controlled, deliberate and analytic (Type 2) processes. When less time is available, performance is predicted to be based on low-effort Type 1 processes, which leads to an increase in biases. Using variations of the gambler's fallacy task with or without time pressure, we will test whether Type 1 processes are indeed more error-prone than Type 2 processes and how this discrepancy is modulated by individual differences in impulsivity and cognitive abilities. It is hypothesized that i) people with high expertise levels will perform equally well both under and without time pressure; and ii) people higher on cognitive abilities will perform equally well under time pressure and without time pressure, unlike those with lower cognitive abilities.

Keywords: decision-making, dual-process theories, fast reasoning, individual differences

Throughout life, humans experience circumstances requiring them to make decisions involving probability information. These circumstances often require quick responding and the outcomes of these decisions can have life changing consequences. For this reason, studying the processes underlying decision-making behaviour is of great importance.

Correspondence

Dilara Berkay
dilara.berkay@yahoo.com

Decision-making has been subject to many empirical studies. Central to the entire empirical investigation of reasoning and decision-making processes are traditional dual-process theories (Evans, 2011), to which researchers have shown an increased interest over the last four decades (e.g., Kahneman & Frederick, 2002; Sloman, 1996; Stanovich, 1999).

Dual-process accounts posit two autonomous and competing reasoning processes: one process is automatically accessible, largely unconscious and often

inaccurate (Type 1), the second process is analytical, rational and leads to accurate outcomes (Type 2) (Evans, 2011; Kahneman, 2003; Stanovich, 1999). The first associative mode encompasses effortless, rapid and strongly contextualised processes, whereas the second one operates in an effortful, sequential and slow way (Evans & Curtis-Holmes, 2005). Type 2 processes monitor and revise the output of the heuristic system. In the literature, the speed of processing characteristic for two systems has been presented as an important distinguishing factor (ibid). The slower, deliberate Type 2 processes rely on time- and resource-consuming serial operations and are constrained by the limited capacity of central working memory. The functioning of these processes correlates with individual differences in cognitive abilities. Conversely, Type 1 processes do not demand executive working memory resources and operate implicitly and in parallel (De Neys, 2006). The literature posits that heuristic processes, activated immediately when engaging in reasoning tasks, might lead to biased outcomes, unless the analytical system intervenes (Evans, 2006).

The strong association between intuitive processes and biased reasoning has been underpinned over the years. The line of thought employed in empirical studies on decision-making postulates that people, when faced with tasks requiring them to make quick decisions, will respond inaccurately (Evans & Curtis-Holmes, 2005; Gillard, Van Dooren, Schaeken, & Verschaffel, 2009). This postulation follows from the idea that time pressure inhibits the Type 2 processes which are slow, sequential, accurate and analytical by nature, and leaves the Type 1 processes intact, which are thought to produce biased decisions. Thus, when people reason under time pressure, they fall prey to biases and the level of correct reasoning decreases.

The introduction of time constraints in reasoning tasks has been commonly used in empirical studies as a method to partial out rational processing and to examine default heuristic processing (Evans & Curtis-Holmes, 2005; Roberts & Newton, 2001). For instance, in a study by Evans and Holmes (2005) it was found that time pressure caused a decrease in logically correct answers in a syllogistic reasoning task, which provided support for the dual-process theories. Similarly, in another study, the effect of time constraint on reasoning tasks - conjunction fallacy problems - was examined (De Neys, 2006). As the results revealed, participants who solved the problems correctly needed more time than those whose inferences were incorrect, pointing to the idea that analytical reasoning and Type 2 processes require time.

Contrary to the line of evidence, which shows that time pressure decreases logical responses, some other studies did not support this proposition. In a study by Dijksterhuis (2004), participants presented with a decision problem were asked either to make a decision immediately after they were given the problem, or they were given some time to think before they reported their choice. The results revealed that performance of participants in both conditions did not differ. Thus, contrary to the predictions of dual-process theories, time pressure did not affect performance in the judgment task.

The generic theoretical framework has recently been challenged by an influential dual-process approach to reasoning and decision-making: fuzzy-trace theory (Reyna, 2012; Reyna & Brainerd, 1995, 2011). Instead of defending the traditional dichotomy between the smart and accurate consideration (normative Type 2) and the unreliable, intuitive emotionality (heuristic Type 1), the fuzzy-trace model raised the value of gist-based intuition, which, according to this approach, is advanced. Fuzzy-trace theory focuses on mental representations, referring to the way people perceive information. This theory posits two types of separate representations, working roughly in parallel, namely: verbatim representations and gist-based representations (Reyna & Brainerd, 2011). Verbatim representations of information are exact and quantitative. By referring to the literal format of problems, they span their precise, superficial form. On the other hand, gist representations convey the personal interpretation of problems, catching their essential meaning. They appear to be imprecise and qualitative (ibid.). The fundamental

construct in this account, gist, – also named fuzzy trace – is grounded on essential meaning and lies in the intersection of meaning and intuition (Reyna, 2012). According to this theory, intuition is not a primitive, mindless construct but instead is advanced and captures understanding (ibid). According to this model, healthy individuals rely more on fast and effective gist-based mode of processing than on verbatim-based analysis (Reyna, 2012). Empirical studies provided evidence that gist is tightly related to expertise. For instance, Ashby, Ennis and Spiering (2007) showed that experts rely more on gist than novices (Reyna & Brainerd, 2011).

Fuzzy-trace theory takes intuition as its fundamental construct. The described model assigns positive connotations to intuition, presented as an imprecise mode of processing based on gist, and posits that this kind of fast, fuzzy reasoning is an advanced form of thinking. According to fuzzy-trace theory, non-analytical, automatic processes are smart and optimal – ergo compatible with laws of probability and rules of mathematics. In the current study, these assumptions of the fuzzy-trace theory and those of the traditional dual-process theories will be tested using the gambler's fallacy (Kahneman & Tversky, 1972; Tune, 1964).

The gambler's fallacy refers to the belief that the probability of an event is lowered when that event has recently occurred, even though the probability of the event is objectively known to be independent from one trial to the next. In the study, two different versions of the gambler's fallacy task (standard gambling task vs. everyday-life context task) will be used. All participants will respond to both versions, either under time pressure or without time pressure, depending on the group they will be assigned to.

In coherence with the fuzzy-trace theory (Reyna, 2012; Reyna & Brainerd, 1995), we predict that judgment and decision-making under time pressure may be also intuitively accurate in gambling tasks in which probability ratios are clearly explained. However, some individual differences related to expertise, cognitive abilities and personality traits might be crucial to identify a cut-off point for time constraint, under which performance either worsens or improves.

The answer to the question whether people with higher levels of expertise in statistics will perform equally well under time pressure and without time pressure will be sought. It will be further investigated whether the rate of correct reasoning in gambler's fallacy questions will be equal under time pressure and without time pressure in a group of people with higher cognitive abilities, as predicted.

Method

Participants

For the present study, undergraduate students and recent graduates will be recruited from Austria, Belgium, the Netherlands, Turkey and Poland.

Materials

The study will be conducted through an online survey, which will be translated and assessed in Austria, Belgium (Dutch part, Flanders), The Netherlands, Turkey and Poland. Limesurvey, which is a free-access online survey software, will be used to run the study. To assess probability judgment, the gambler's fallacy task (West, Toplak, & Stanovich, 2008) will be used.

To investigate individual differences in cognitive abilities and personality traits, additional scales will be included in the survey. Raven's Advanced Progressive Matrices (R-APM) (Arthur & Day, 1994) will be used to assess general cognitive abilities. The non-verbal feature of this scale will provide a unique validity given the heterogeneity of the sample. The Cognitive Reflection Test (Frederick, 2005) will be used to test whether cognitive inhibition might be a predictor of performance both with and without time pressure. For assessing

impulsiveness traits, the self-report measure Barratt Impulsiveness Scale (BIS; Patton, Stanford, & Barratt, 1995) will be used. More specifically, the short 15-item form will be included in the study. The BIS-15 has been found to be a reliable and valid measure (Spinella, 2007), and, to shorten test duration, translations of BIS-15 will be used as a final test examining individual differences.

Where possible, the translated and culturally-adapted versions of each scale to our languages will be used in the study. For the ones where this is not possible, translated and back-translated versions will be included in the survey.

At the end of the study participants will be asked about their previous education in statistics and their subjective assessment of their expertise in it. Finally, demographic characteristics like age, sex, education, and gambling habits will be asked.

Procedure

At the beginning of the study, participants will be randomly assigned to the 'Time pressure' or 'No time pressure' condition. Afterwards, all participants will read the gambler's fallacy questions either with or without time pressure. Time limits will be determined by adding 5 seconds to the time necessary to read the question and response options (Evans, Handley, & Bacon, 2009). Reading time will be calculated separately for each language in accordance with reading speed standards. After completing the gambler's fallacy task, participants will answer R-AMP, CRT, and BIS 15.

Analyses

Responses to the problems will be analysed with mixed logit models (Generalized Linear Mixed Models) for binomially distributed outcomes (Agresti, 2007; Bates & Sarkar, 2007), since the responses given to the problems will be categorized as correct or incorrect. GLMM have the great advantage of including random effects as a predictor and they describe an outcome as the linear combination of fixed effects and conditional random effects associated with subjects and items (Jaeger, 2008). Predictors of reasoning performance will be first investigated descriptively through nonparametric correlations. Ordinal logistic regressions (Agresti, 2007) will be performed accordingly.

Ethics

The present research pertains to cognitive psychology and as such does not involve much risk. However, in order to protect participants' interests, request for ethical approval was issued towards a standing research ethics committee in Padova University for ethical approval. Since not all members of the research team were students of or had an affiliation with a university this year, universal approval was sought. As this was an online study, the request for additional protective steps was issued by the ethical committee, with the purpose of ensuring that children would not be able to reach the survey. To satisfy this request, the survey was made password-protected. To illustrate, all participants received an email with an individually generated code in it, and were asked to enter this password when accessing the survey.

Practical

Since the present study is run independently, we encountered several obstacles. Most importantly, due to a lack of funding, the full version of the software (Qualtrics) that we originally intended to utilize could not be purchased. Even though a free trial version of the software was available, this version was not preferred as it limited the amount of information that could be gathered. In order to deal with this problem, researchers with full access to this software were contacted. However, since the institutions were not willing to make their resources available to an external study, it has not been possible to acquire the full version, which forced us to use a freely available online survey software.

Another challenge faced while conducting the international study was to establish a smooth communication between the group members, given that it was not always possible to meet in person. However, this problem was tackled through using the means of communication available on the Internet. In addition to this, setting dates for the online meetings appeared to be problematic. In order to keep the whole research team and the members that were unable to attend updated, and to keep clear track of deadlines and agreements, everything that was discussed during the meetings was shared with the whole team afterwards by using Dropbox and GoogleDocs.

Current Status of Project

During the European Summer School we had early discussions about the scales used in the present research. Thereafter, focus has been put on familiarizing with critical issues in literature and conducting a profound investigation of the theoretical background. While working on reviewing and describing literature, we translated the tools into our native languages and strived to gain ethical approval from the University of Padova. In order to test the adequacy of the chosen research instruments and test experimental conditions, pilot studies have been undertaken. The statistical analyses of the pilot data allowed us to finalize the research design. Furthermore, feedback received from the participants uncovered potential problems with data collection in the main survey. The observation that many respondents dropped out before they reached the end of the study led us to the decision to shorten the survey by discarding one scale, the Berlin Numeracy Test. Having solved minor issues that arose and having determined the final version of the experiment, we are currently in the data collection phase.

Prospective Discussion

Current research will provide insights into decision-making processes based on information expressed in probabilities. It is envisaged that a better understanding of the effect of time pressure on the accuracy in decision-making will be obtained. A moderating effect of individual differences in expertise and cognitive abilities on performance on the gambler's fallacy task is expected to be found. This will provide valuable information about judgments people often have to make in daily life. An additional aim is to shed light on cultural differences, if any do exist. There are some barriers that might have an effect on current research, such as the heterogeneity of the sample. Future research can extend current research by studying whether the moderating individual differences also exert this influence on induced risk taking, as this has been found under time pressure (Chandler & Pronin, 2012). A full disclosure of the current study is foreseen for September 2013. The whole research team will be present in Cambridge in August 2013 to work together on the analyses and writing the article. However, follow-up studies might be needed to answer all research questions in detail.

This manuscript is part of the Work in Progress special edition of JEPS and was developed under a research project of EFPSA's Junior Researcher Programme cohort of 2012-2013.

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