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EMPIRICAL STUDIES IN PSYCHOLOGY

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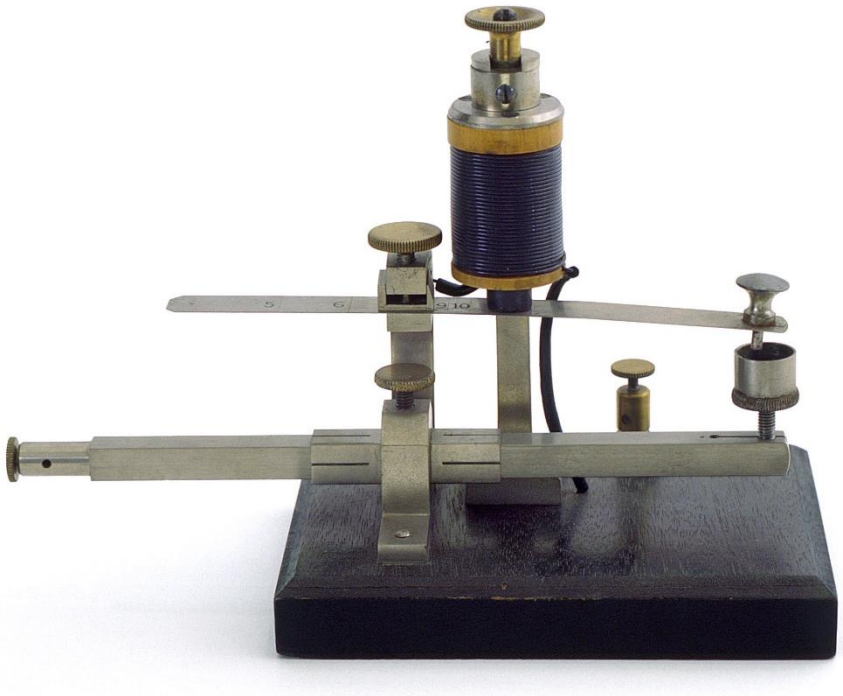

INSTITUTE OF PSYCHOLOGY
LABORATORY FOR EXPERIMENTAL PSYCHOLOGY
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Institute of Psychology, Faculty of Philosophy, University of Belgrade

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Does Time Pressure Make Us Illogical?

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Abstract

Hybrid models of reasoning posit the concept of logical intuitions that are based on highly automatized mindware, that is – knowledge about mathematical, logical, and probabilistic principles. The aim of the present study was to investigate precisely when logical intuitions activate. To this end, we have conducted an experimental study and employed the two-response paradigm which allowed for delineating intuitive from deliberative answers on cognitive reflection test. We also registered participants intelligence, mindware and executive functions in order to use these known correlates to pinpoint the logical intuitions timeframe. The results indicate that logical intuitions activate in the first 250 ms after participants have read the task.

Keywords: dual process theories, logical intuitions; mindware; executive functions; intelligence

Introduction

Dual process theories pertain to a group of cognitive processing models based on the idea that human reasoning operates by two types of processes – the Type 1 and the Type 2 processes (Wason & Evans, 1974) which are also labelled intuitive and deliberative processes. Intuitive processes are automatic, associative, fast, high-capacity, and do not engage working memory. Deliberative processes are intentional, slow, low-capacity, and engage working memory, i.e., controlled attention (Evans, 2019; Evans & Stanovich, 2013; Pennycook, 2017). In order to describe the interaction between these processes, different dual processing models have been proposed, and the latest type are the hybrid models (e.g., the Three-stage Model by Pennycook et al., 2015). These models are serial in that they describe the activation of two types of processes as sequential – during reasoning, intuitive processes are activated first, and deliberative processes take part later if certain conditions are satisfied (Pennycook et al., 2015). So, in the initial stages of reasoning, multiple intuitive processes are activated in parallel, and these intuitions take at least two forms – heuristic and logical intuitions (De Neys, 2012). Heuristic intuitions are based on experience (e.g., stereotypes), while logical intuitions are based on highly automated mindware – knowledge of logical, probabilistic, and mathematical principles that are necessary to solve any reasoning task (Perkins, 1995). However, when this knowledge is adopted to such an extent that it is automated, it can be used intuitively (Burič & Konradova, 2021). When heuristic and logical intuitions cue different answers, i.e., when there is a conflict, if one detects this conflict, Type 2 or deliberative processes can be activated (De Neys, 2017). Therefore, in order to detect the conflict and/or give a correct answer, one does not have to engage in cognitively expensive deliberative processing, as multiple intuitions, or a logical intuition will suffice, respectively. Apart from the mindware they are based on (Burič & Šrol, 2020), logical intuitions are also positively correlated to cognitive abilities (Thompson et al., 2018). The findings pointing to the existence of logical intuitions, as well as the findings on the correlates of this construct, are not numerous, but are consistent. However, it was not previously addressed when logical intuitions activate, apart from the fact that they are generated before Type 2 processing. Therefore, the aim of the present study was to pinpoint the timeframe in which logical intuitions give outputs. To this end, we conducted an experimental study and employed the two-response paradigm (Thompson et al. 2011), a procedure in which participants are presented with the same reasoning tasks twice – once with a strict time limit to capture intuitive response, and then with unlimited time so that deliberative processing can take part. In the present study, the time limitations were calculated by data driven approach, and not by using data from different sample of participants. Further, total of six strict time limits were used, and previous research findings regarding correlates of logical intuitions, were used to pinpoint in which one of the multiple restricted time conditions logical intuitions activate.

Method

Participants

Sample consisted of 195 participants. Participants were recruited via Facebook advertisement and data were collected online.

Design and variables

The study consisted of an experimental and correlational part. The experimental part followed a 2 (CRT response time condition: limited, unlimited; within subjects) x 6 (group: time limited to 250, 500, 750, 1000, 1250, 1500ms; between subjects) factorial design. In the correlational part the measures of executive functions (updating, shifting, inhibition; Miyake et al., 2000), intelligence and mindware were used as predictors of the number of correct responses on CRT in both limited and unlimited time conditions.

Materials

Materials used in this study consisted of: CRT (8 tasks; Damnjanović et al., 2019) presented in a multiple choice form – correct, heuristic and the most common atypical answer (Damnjanović et al, 2019; Ilić & Damnjanović, 2021); executive functions battery (Živanović, 2019); short Raven's progressive matrices (RPM; Živanović, 2019); 21 mathematical problems (developed for the purposes of this study); CRT reading speed test comprising the total of 40 sentences (5 sentences per CRT task, matched in length (both letters and words) and structure with the particular CRT task).

Procedure

Study procedure was as follows: (1) all participants read 40 sentences in a randomized order to measure CRT reading speed; (2) solved CRT within a strict time limit calculated, for each CRT task separately, as the mean reading speed for 5 sentences corresponding to that particular CRT + 250-1500ms; (3) solved 21 mathematical problems to measure mindware; (4) following the two response paradigm (Thompson et al. 2011), all participants completed CRT again, but in unlimited time condition, (5) and solved 3-back task, Stroop task, Local-global task and short Raven's progressive matrices.

Results

ANOVA revealed differences in the number of correct answers (accuracy) between limited and unlimited time conditions ($F(1, 192) = 270.858.$, $p < .001$). No differences in accuracy between 6 groups in restricted conditions were observed ($F(5, 187) = 0.177$, $p = .971$).

Results of regression analyses predicting accuracy in both limited and unlimited condition are presented in Table 1. The mindware predicted accuracy in both restricted and unrestricted CRT tasks. Regression analyses for each group separately revealed that the only significant model predicting accuracy in different limited time conditions (i.e. groups) was the 250 ms condition model – accuracy was positively predicted by scores on stroop (inhibition), local-global (shifting) and mindware.

The two-response paradigm allows for registering patterns of participants' answers which take four forms: correct-correct, correct-incorrect, incorrect-correct, and incorrect-incorrect. 32% of the times participants failed to solve a CRT task regardless of time restriction condition. However, in 34% of correct trials in unlimited time condition, half were preceded by correct answers given with a strict time limit.

Table 1. Results of regression analyses where CRT accuracy was predicted by executive functions, intelligence, and mindware measures.

Factor	Condition	R^2	*p*	β (** – p < .01)				
				3-back	Stroop	Local-global	RPM	Mindware
CRT response time condition	Limited	.074	0.012	-0.007	0.134	0.034	0.063	0.221**
	Unlimited	.371	<.001	-0.008	0.053	0.025	0.039	0.600**
Group (time limited to)	250ms	.430	0.001	0.113	0.368*	0.306*	0.051	0.380*
	500ms	.341	0.082	0.084	-0.312	-0.054	0.408	0
	750ms	.179	0.286	-0.279	0.018	-0.198	0.24	0.144
	1000ms	.147	0.476	-0.159	0.172	-0.087	0.083	0.348
	1250ms	.229	0.297	0.174	0.07	0.149	-0.449	0.632*
	1500ms	.150	0.601	-0.078	0.108	0.122	0.497	-0.629

Discussion

In order to pinpoint the timeframe in which logical intuitions, a concept introduced in hybrid models of dual processing, activate and give outputs, we conducted an experimental study in which we imposed participants with strict time limits for solving a CRT task. In line with the findings supporting the hybrid models of reasoning (e.g., Burič & Šrol, 2020), we registered that participants are indeed capable of intuitively solving reasoning tasks correctly – half of the participants who correctly solved a task in unlimited time condition also gave correct answer in the limited time condition. Next, although we registered significant difference between the accuracy in limited and unlimited time conditions, we did not register a significant difference between groups – all participants solved statistically the same number of tasks in limited time condition regardless of the time allowed. Further, we conducted multiple regression analyses which revealed that accuracy in both restricted and unrestricted conditions can be predicted by mindware. This is expected as we need mindware to solve any task, but an automated mindware is necessary for logical intuitive reasoning (Burič & Konradova, 2021). Finally, to examine in which timeframe logical intuitions are active, we conducted six multiple regressions with accuracies in CRT for each group as dependent variables and mindware, progressive Raven's

matrices scores, and scores on executive functions tasks as predictors. The only statistically significant model was registered in the 250ms time limit condition. Since logical intuitions are known to correlate with cognitive abilities, and mindware, the results point to a conclusion that the first 250ms are probably the point in time when logical intuitions are already activated and give outputs. This conclusion takes into account that intuitions might be activated even during task reading. Further improvements of methodology are needed to pinpoint the exact time, and not the timeframe, of logical intuitions. The present study also has some other limitations. The small sample by group might have led to registering some random effects. Also, the fact that we also registered that mindware was significant predictor of accuracy in 1250ms condition, and the fact that there were many missing values (participants didn't have time to provide an answer) indicate that procedure for measuring participants' reading speed might have not been precise enough. Namely, it is possible that participants read tasks slower than texts of the same length. Future studies should address these problems.

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