THE EFFECT OF INDIVIDUAL'S CHARACTERISTICS OF DECISION MAKING AND JUDGMENT ON STOCK-FLOW PERFORMANCE

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Abstract

Extending the line of research on stock-flow performance we examined the impact of personality characteristics on task performance. It was assumed that the need for cognition, the need for closure and the preference for intuition and deliberation would relate to individual variations in task performance differentiated into the dimensions heuristic reasoning, task effectiveness (number of correct answers) and task efficiency (time needed to perform the task). It was found that the need for closure did not relate to any of the task performance dimensions, while the preference for deliberation related positively with task effectiveness, and the need for cognition positively with task effectiveness and negatively with heuristic reasoning. Although all three constructs possess a rather explicit temporal dimension, the examined needs and preferences appeared not te be correlated with the time needed to perform the stock-flow task. Further research is needed to elaborate on the precise relation between needs and preferences and stock-flow information processing as well as to refine the concept of task effectiveness.

Introduction

People have difficulties performing stock-flow tasks (Booth Sweeney & Sterman, 2000; Cronin, Gonzalez, & Sterman, 2009; Korzilius, Raaijmakers, Rouwette, & Vennix, 2011; Pala & Vennix, 2005; Sterman, 2010). However, research is scarce on how individual's characteristics of decision-making and judgment relate to stock-flow task performance. The current study focuses on three individual characteristics: need for closure, the motivation connected with decision making and judgment (Kruglanski, 1989; Webster & Kruglanski, 1994), need for cognition, the extent to which a person enjoys and engages in effortful cognitive activities (Cacioppo, Petty, & Kao, 1984.), and individual strategy preference for intuition and deliberation (Betsch & Kunz, 2008; Kahneman, 2003). We explore the effect of the these three individual characteristics on task performance differentiated into heuristic reasoning (cf. Cronin et al.; Sterman), task effectiveness, and task efficiency.

Theoretical background

Individual characteristics on decision-making and judgment

Research on stock-flow failure focuses on gaining insight in characteristics of and outcomes of the task performed, precursors of task performance are less often reported. Booth Sweeney and Sterman (2000) do not find any consistent patterns with regard to demographical effects (e.g. prior and current academic field, gender age, region). The participants' prior knowledge of stock-flows (from playing the Beer game, exposing them to systems principles) appears to have no significant effect on the task performance either. In addition, Cronin et al. (2009) do not find clear effects of motivation and feedback presented to participants while performing tasks. Effects of precursors on task performance seem therefore rather indistinct. Remarkably, in this line of research there is much less focus on the relationship of individual's characteristics with task performance. Especially, decision making and judgment characteristics of participants could be important. In this study we focus on the following constructs: the need for cognition, the need for closure, and the preference for intuition and deliberation. These constructs have very good psychometric qualities, measuring individual differences that have been shown to be related to decision-making and judgment (Betsch & Kunz, 2008; Cacioppo et al., 1996; Webster & Kruglanski, 1994). The need for cognition refers to "an individual's tendency to engage in and enjoy effortful cognitive endeavors" (Cacioppo et al., 1984, p. 306). The need for cognition theory assumes a peripheral and central route of information processing. The peripheral route stands for reliance on peripheral cues whereas in the central route the true merits of the information presented are carefully and thoughtfully considered (Petty & Cacioppo, 1986). The need for closure refers to "a desire for definite knowledge on some issue" (Kruglanski & Webster, 1996, p. 263). It is described as an individual's desire for a firm solution as opposed to enduring ambiguity. Kruglanski and Webster state that the motivation towards closure "varies along a continuum anchored at one end with a strong need for closure and at the other end with a strong need to avoid closure" (Kruglanski & Webster, p. 264). The preference for intuition and deliberation resembles decision and judgment based on affect versus cognitions (cf. Betsch & Kunz, 2008, p. 536). In this construct, intuition is seen as part of the tacit, experiential system that is automatic, fast and associative. This system is contrasted with the deliberate, rational system in which thought is slow, deliberate and analytical (Epstein et al., 1996). The construct is connected with the concept of bounded rationality (Kahneman, 2003; cf. Simon, 1955; Tversky & Kahneman, 1981) which means that decision making is not a completely deliberate reasoning process but also includes intuitive and affective components.

To some extent, the three constructs share commonality. The need for cognition, the need for closure and the preference for intuition and deliberation, here understood as a heuristic versus systematic processing of information, all refer to conditions "under which people process information briefly and superficially and others wherein they do so thoroughly and methodologically" (Kruglanski & Webster, 1996, p. 268). In this context, the adverbs "superficially" versus "methodologically" refer

to the content of the construct, the adverbs "briefly" and "superficially" to its temporal dimension. As a consequence, the three constructs relate conceptually to the dependent variables task effectiveness (content dimension) as well as to task efficiency (time dimension).

An apparent difference between the need for closure and the alternative constructs is the fact that the need for closure theory "does not postulate two qualitatively different modes of information processing" (Kruglanski & Webster, 1996, p. 268). Rather, the inherent difference between brief and thorough processing is seen as "a matter of extent". The need for closure and the need for cognition also differ with respect to the goal people try to accomplish. . For cognitive closure the goal is the desired end state 'to have definite knowledge', while for need for cognition the goal is the process of thinking as such. In line with these differences, the need for closure is generally weakly, and negatively correlated to the need for cognition (Webster & Kruglanski, 1994). As far as we know, the relation between the preference for intuition and deliberation and the other two constructs has not been subject of research.

Task performance: task effectiveness, task efficiency, and heuristics

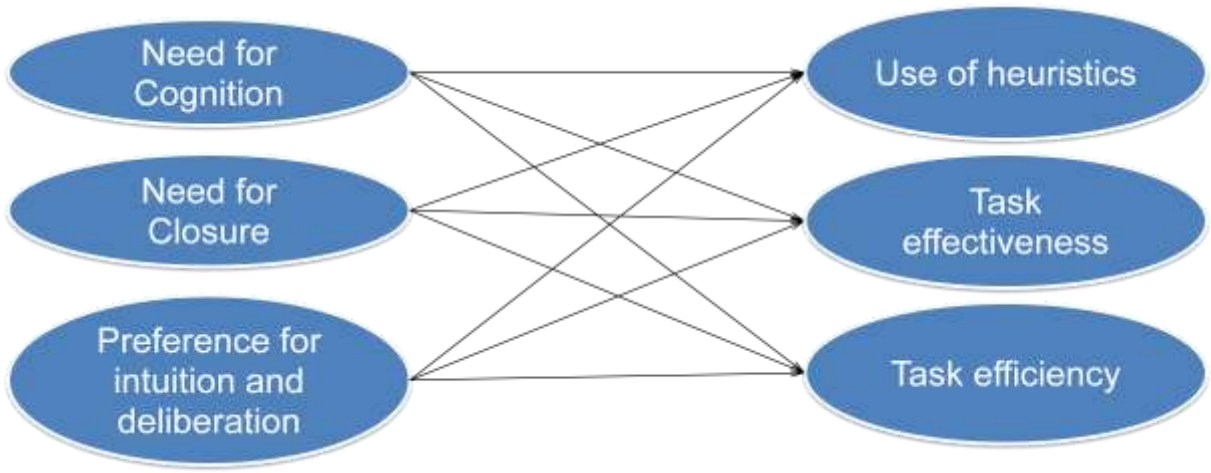
In research on stock-flow performance using the department store or comparable tasks (Brunstein, Gonzalez, & Kanter, 2010; Cronin et al., 2009, Korzilius et al., 2011; Sterman, 2010) the dependent variable is the number of correct answers. This can be considered as a measure of task effectiveness: the degree to which the participant is able to correctly solve the problem. However, this aspect of task performance does not take into account the time it takes to solve the problem. The time needed to perform the task can be regarded as a measure of task efficiency. Although the time needed may be correlated to the number of correct answers, in this exploratory study, we focus on the effect of the individual characteristics on both variables separately.

We also explore the influence of individual characteristics on the use of heuristics. When facing complex problems or incomplete information, people often draw on heuristic reasoning, replacing the original question by a related question that is easier to answer (Kahneman, 2011; Kahneman, Slovic, & Tversky, 1982; Tversky & Kahneman, 1974). In the literature it was assumed that in stock-flow tasks, people often use what is called the correlation heuristic, a form of pattern matching in which people think that the stock resembles the (net)flow (Booth Sweeney & Sterman, 2000; Cronin et al., 2009; Sterman, 2010). By using the so-called think aloud method in the department store task, Korzilius et al. (2011) were able to corroborate the correlation heuristic: participants actually did verbalize their thoughts in terms of the biggest difference between inflow and outflow at a particular point in time, thus expressing the correlation heuristic in words. In general it is to be expected that the use of heuristics is influenced, not only by the complexity of the task presented, but also by personal predispositions, in the form of individual characteristics. In the literature on the need for cognition, need for closure, and the preference for intuition and deliberation, the constructs are in varying degree explicitly linked with forms of heuristic reasoning (Betsch & Kunz, 2008;

Cacioppo et al., 1996; Webster & Kruglanski, 1994). To enable the exploration of this relationship in this study, we assessed the presence of heuristic reasoning..

Summarizing, in this study we explore the effect of the individual characteristics on decision-making and judgment: need for cognition, need for closure, and preference for intuition and deliberation on stock-flow task performance, in terms of task effectiveness, task efficiency, and use of heuristics (see Figure 1).

Figure 1. Conceptual model: effect of individual characteristics on stock-flow task performance



Method

Participants

Participants were 115 second year bachelor students of Business Administration of Radboud University Nijmegen in the Netherlands, following a Management game course. Students were told that as part of the course a short exercise on decision making had to be performed. Participation was compulsory and a reward was given to the best scoring participants. There were 53 (46%) female and 62 (54%) male participants. Their mean age was 20.6 (range 19-27, SD = 1.41). Three quarters of the students (n = 87, 76%) had as prior high school profile Economics and Society, the majority (n = 111, 97%) had the Dutch nationality, and 4 students (3%) had played the Beer game before. The participants filled out a questionnaire and subsequently performed a stock-flow task.

Procedure and materials questionnaire

The questionnaire was filled out by the participants during the first lecture of the course after some introductory remarks. It took about 15 minutes to complete the questionnaire.

All participants completed a questionnaire consisting of a number of background variables (e.g. age, gender, prior high school profile) and three 7-point Likert scales with answers ranging from

"very strongly disagree" to "very strongly agree". Some items were negatively formulated to avoid response set.

Need for cognition (Cacioppo et al., 1984) is the extent to which people enjoy thinking and learning. The need for cognition consists of 18 items, example item "I would prefer complex to simple problems".

Need for closure is the desire for clear, definite, or unambiguous knowledge that will guide perception and action (Vermeir & Van Kenhove, 2005). Need for closure consists of 25 items divided over five subscales: Need for structure (5 items), example item: "I find that a well-ordered life with regular hours suits my temperament"; Need for predictability (5 items), example item: "I don't like situations that are uncertain"; Need for decisiveness (5 items), example item: "When I go shopping, I have difficulty deciding exactly what it is that I want"; Intolerance for ambiguity (5 items), example item: "I dislike it when a person's statement is unclear to me"; Closed-mindedness (5 items), example item: "Even after I've made up my mind about something, I am always eager to consider a different opinion".

Preference for intuition and deliberation consists of 18 items equally split over two independent subscales: Preference for intuition (9 items), is an individual's preference for intuition as decision making that uses affect as a decision criterion, example item: "I listen carefully to my deepest feelings". The preference for deliberation (9 items) is decision making using explicit evaluations, beliefs, and reasons, example item: "Before making decisions, I first think them through".

Internal consistency in terms of Cronbach's alpha of the scales was acceptable (i.e. higher than .60; Hair, Black, Babin, & Anderson, 2010, p. 92; see Table 1) except for the need for closure subscales: Need for decisiveness ($\alpha = .59$) and closed-mindedness ($\alpha = .39$). These two subscales were not used in the research. After recoding negatively formulated items, mean composite scales were calculated for all scales. For all scales, high scores indicate that participants possessed the characteristic to a greater extent.

Procedure stock-flow task

In line with existing research (e.g. Cronin et al., 2009; Pala & Vennix, 2005) an English version of the department store task was used. In addition, to examine whether there were task context effects, we developed an alternative stock-flow task we refer to as the bank task. For the Business administration students in the sample we deemed inflows and outflows of a bank more salient and familiar than the flows of people into and out of a store (see Cronin et al., p. 121). We closely followed the format of the department store task regarding the lay-out, number of words, and the wording of the four questions.

The participants arrived in teams at the experimentation rooms. All members of one team performed the same task, 53% (n = 61) the department store task, and 47% (n = 54) the bank task. Participants were randomly assigned to either the verbal (think aloud) (43%, n = 50) or the written

condition (57%, n = 65). From each team two or three members performed the think aloud protocol on an individual basis. The participants in the written condition did the task in one room at detached seats under surveillance of an assistant. They were told that they had to do the task individually and were thus not allowed to talk to each other. The other instructions were the same as in the think aloud condition. Contrary to the think aloud condition, this condition was not videotaped. Both tasks were pre-tested by two university lecturers and two Master students. The data were collected in 2010.

Materials and measures stock-flow task

We transcribed the video tapes of the think aloud protocols and focused on the reasoning used for answering question 3 and 4 (Q3 and Q4). A qualitative, iterative approach was followed: in the search for key phrases the first author moved back and forth between the transcriptions, coming up with a preliminary categorization of reasoning strategies. Next, the third author independently coded the 44 protocols (due to technical shortcomings six of the fifty recordings could not be used) so that the interrater reliability could be assessed. Regarding the allocation of the participants there was 83% agreement about the reasoning strategies (reasoning types) used for Q3 and Q4, Cohen's kappa was .73. Any differences were subsequently settled by consent. The final classification was used to operationalize the heuristic reasoning concept, variable Heuristic. Heuristic has three categories based on the reasoning in both Q3 and Q4: a non-heuristic mode of reasoning (value = 0), a heuristic mode of reasoning[1] (value = 1), or a combination, a heuristic as well as a non-heuristic mode of reasoning (value = 0.5).

We also established if the answers of the four questions were correct or incorrect. In line with previous research (e.g. Cronin et al., 2009) we considered answers to all questions correct if they were within 1 minute of the correct response. In addition, we assessed the total Number of correct answers (theoretical range 0-4; see Table 1). As it appeared in previous research (Korzilius et al., 2011) that there were no task context effects and no difference between the verbal and written condition we pooled the data.

The video tapes were also used to determine the time needed by the participants to come up with the answers on question three and four (Q3 and Q4), using the beginning of the task as the starting point for measurement (variable Time in seconds).

Statistical analyses

IBM SPSS Statistics (Version 19) was used to conduct the statistical analyses. We calculated descriptive statistics and Pearson and Spearman correlations to describe the variables and to study interrelationships. To control whether the assumption of normality was met, one-sample Kolmogorov–Smirnov tests were conducted. Also, assumptions of multicollinearity and homoscedasticity were

[1] Heuristic reasoning considers either inflow or outflow, or inflow-outflow differences (net flow) at a specific point in time.

tested. We conducted linear regression analyses to test the effects on the metric dependent variables and (multinomial) logistic regression for the ordinal and dichotomous dependent variables.

Results

Frequency distributions of the independent variables showed that the mean scores of the participants were relatively high on preference for deliberation and need for cognition (see Table 1). All independent variables were normally distributed (Kolmogorov–Smirnov tests, *p*s > .05). Regarding the stock-flow task it appeared that out of 44 participants 12 used a non-heuristic mode of reasoning, 5 used a combination of non-heuristic and heuristic reasoning, and 27 used heuristic reasoning. Mean time needed to complete Q3 and Q4 was 5 minutes and 17 seconds. Mean Number of correct answers was just above 2. Time in seconds was normally distributed, Number of correct answers was not (Kolmogorov–Smirnov tests Z = 0.63, $p = .82$; Z = 4.42, $p < .001$, respectively).

Table 1. Reliability figures of scales and descriptives statistics of measures

Measure	Cronbach' s alpha	*n*	*M*	*SD*
Need for cognition	.83	112	4.68	0.60
Need for structure	.80	112	4.27	1.14
Need for predictability	.77	112	3.86	0.97
Intolerance for ambiguity	.64	112	4.61	0.74
Preference for deliberation	.78	112	5.05	0.69
Preference for intuition	.81	112	4.53	0.76
Heuristics [a]	-	44	0.67	0.44
Number of correct answers	-	115	2.23	0.80
Time in seconds	-	31	317	139

Note. [a] Ordinal variable with values 0, 0.5, and 1 (see text); *Mdn* = 1.

Bivariate intercorrelations (see Table 2) showed that higher Need for cognition was related to higher Number of correct answers and the use of a non-heuristic mode of reasoning, respectively. Preference for deliberation was also positively correlated to Number of correct answers. A non-heuristic mode of reasoning was associated with more correct answers. Time in seconds appeared not to be correlated to any other variable. There also were a number of significant intercorrelations between the independent variables.

Table 2. Intercorrelations between measures

	Heuristic[a]	Number of correct answers	Time in seconds[b]	Need for cognition	Need for structure	Need for predictability	Intolerance for ambiguity	Preference for deliberation
Number of correct answers	-.60**							
Time in seconds	.06	-.04						
Need for cognition	-.37*	.27**	-.13					
Need for structure	.12	.04	.16	-.06				
Need for predictability	.02	-.07	-.14	-.29**	.43**			
Intolerance for ambiguity	-.09	.02	.02	-.08	.28**	.47**		
Preference for deliberation	-.19	.24*	-.02	.33**	.50**	.28**	.22*	
Preference for intuition	.20	-.09	.06	-.00	-.17	-.26**	-.06	-.15

Note. $N = 112$, [a] $n = 44$ [b] $n = 31$. Correlations are Pearson correlations, except for correlations with the ordinal variable Heuristic, with values 0, 0.5, and 1, which are Spearman´s correlations. *$p < .05$; **$p < .01$ (2-tailed)

Multivariate testing of the effects on the three dependent variables yielded the following. First, a multinomial logistic regression model with Heuristic as dependent variable was not significant ($\chi^2(12, n = 44) = 15.86, p = .20$). However, the Need for cognition was a significant predictor ($\chi^2(2, n = 44) = 9.20, p = < .05$; R^2 Nagelkerke = .20). A follow-up analysis with only Need for cognition as independent variable was significant ($\chi^2(2, n = 44) = 7.86, p < .05$). It appeared that for each unit increase in Need for cognition, the odds of belonging to the category non-heuristic mode of reasoning relative to a heuristic mode of reasoning would be expected to increase by a factor of 4.61. For the category combination, the odds ratio was 8.34. Second, as the dependent variable Number of correct answers was not normally distributed, we conducted a logistic regression with a dichotomous operationalization (2 or fewer correct answers vs. 3 or 4 correct answers). This showed a statistically significant model ($\chi^2(6, n = 112) = 16.07, p < .05$; R^2 Nagelkerke = .21), with Preference for deliberation as significant predictor ($b = 1.04, p < .05$, *odds ratio* = 2.82). This means that for each unit increase in Preference for deliberation, with all other variables held constant, the odds for giving a higher number of correct answers in the stock-flow task would be expected to increase by a factor of 2.82. Third, and finally, the regression model with Time in seconds as dependent variable was not significant ($F < 1$).

Conclusion and discussion

In this study a relationship was expected between individual's characteristics of decision-making and judgment and stock-flow task performance. More precisely, it was assumed that the constructs the need for cognition, the need for closure and the preference for intuition and deliberation, would affect stock-flow task performance differentiated into heuristic reasoning, task effectiveness (number of correct answers) and task efficiency (time needed for task). This assumption was based on the observation that all three constructs refer to conditions under which people process information briefly and superficially and others wherein they do so thoroughly and methodologically (cf. Kruglanski & Webster, 1996). The constructs therefore refer conceptually not only to the content of information processing but also to the time dimension of this process. Remarkably, only the content dimension was evidenced by the data. That is, participants high in need for cognition are less often involved in heuristic reasoning than those low in this need. The preference for deliberation appeared the predictor of the number of correct answers. Conversely, the sub scales of the need for closure did not affect task effectiveness. Participants low in the need for closure were not more successful in analyzing the information of the store/bank task than those high in the need for closure. The fact that Webster and Kruglanski (1994) observed that the empirical correlation between the two constructs, the need for cognition and the need for closure, was rather low, may play a part of the explanation, but has nevertheless been further elaborated upon in relation to stock-flow information processing.

Further elaboration is also needed with regard to one of the dependent variables, the time needed to solve the task. The concept of time efficiency showed no correlation with any of the constructs or subscales examined, despite the fact that the three constructs all possess a rather explicit temporal dimension. Especially the construct need for closure is inherently temporal. However, in this exploratory study, needs and preferences are not converted in a corresponding use of time. Of course, the character and the modest scope of our research in terms of sample size does not allow for far-reaching conclusions. Besides, at a conceptual level, one has also to take into consideration the relatively gross character of the time efficiency variable. This variable measures not only the time used to answer question three and four, but includes also the time used for the first two questions. Refining this variable, for example by distinguishing between the time needed to answer questions one and two on the one hand, and the time consumed while performing the second part of the task on the other hand, might enhance future research and lead to more precise results.

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