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The conceptual and experimental review on human judgment process

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Human judgment researches have the central objective which is to help people improve the accuracy of human judgment and the quality of decision making. Although the attention of human judgment research was to the accuracy of human judgment after the term heuristic had been advocated in the psychological context, it came to shift to human judgment process for examining determinants of the accuracy of human judgment experimentally. Recently, there are, however, various conceptions of human judgment process, called Dual Process Theories, which are subtly different each other. The objective of this research is clarifying how we can examining determinants the accuracy of human judgment. Through this research, several articles on human judgment process were reviewed conceptually and experimentally. It was found that there is a future work to build a methodology to use the conception of human judgment process for examining determinants of the accuracy of human judgment. This research also proposed the dichotomy of human judgment process which is mutually exclusive and clearly defined: a process which is automatic and unconscious and a process which is a reasoning and conscious. The achievement of this study is hoped to further producing methodologies for examining determinants of the accuracy of human judgment.

Keywords: The accuracy of Judgment, Human Judgment Process, Intuition, Heuristic, Dual Process Theory

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Chapter 1 Introduction

Human judgment is a main field of descriptive decision theory, especially in cognitive and social psychology. Researches in this field have been conducted to understand how to make a good judgment and decision. This chapter gives the brief over view of research presented in the current thesis.

1.1 Motivation

Judgment determines decision making. Suppose that a boy is considering which he eats, a pie or pudding which there are. He wants to eat more delicious one. If he predicts that the pudding is more delicious than the pie, he might choose the pudding rather than the pie and eat the pudding. If his prediction is correct, his decision is appropriate, whereas if it is incorrect, his decision is inappropriate. As such, judgment affects decision making, then decision making affects conscious behavior. Therefore, the accuracy of judgment is important because judgment may be the central role in determining the achievement of activity and self fulfillment. In other words, the accuracy of judgment should mainly determine the quality of decision which plays one of the determinant of whether a certain matter succeeds or not.

As his context above, individuals make a judgment and decision on a daily basis. However, since Tversky and Kahneman (1974) advocated the term heuristic, which is a process of human judgment, many researches on human judgment have suggested that the accuracy of human judgment decreases in the various context. The initial researches were summarized by Kahneman, Slovic, and Tversky (1982). Helping people make a better decision is the prime purpose of human judgment research.

It is clear that the possibility of biased judgment should be recognized, and the general question, that is, how well we can make judgment, or how an accurate judgment occurs arises out of the findings. The motivation of the current research also lies in investigating the subjects.

1.2 Objective

As noted in the precedent section, since Tversky and Kahneman (1974) advocated the term heuristic, many researches on human judgment have focused on the accuracy of human judgment. Otherwise, more recently, the attention of human

judgment research changed to how we are making a judgment, and several conceptions to explain human judgment process were proposed by psychologists. The intention is necessary because improving the accuracy of human judgment requires understanding human judgment process.

Stanovich and West (2000) summarized the conceptions, called Dual Process Theories. Because psychologists did present an original Dual Process Theory and did not use existing Dual Process Theories in the own research, it can be predicted that although Dual Process Theories almost agree on the assumption, these may subtly differ each other.

With typical Dual Process Theory, recent human judgment researches have tried to investigate human judgment process with the empirical experiment. It is clear that human judgment process is interpreted variously and difficult to investigate experimentally because of various interpretations of human judgment process. The objective of the current research is clarifying how we can examine determinants of the accuracy of human judgment.

1.3 Contribution

Two following contributions through the current research are done by achieving the objective presented in the preceding section: (1) to further producing methodologies of research on human judgment process and (2) to further throwing light on how to improve the accuracy of human judgment and the quality of decision making.

Summarizing conceptions on human judgment process makes the difficulty of designing empirical experiment on human judgment decrease, whereas reviewing recent experiments on human judgment process lets hidden and possible factors of the accuracy of human judgment be easy to be found. These contribution may cause improvement of the quality of decision support system, user experience design for products and public spaces, and environment for learning and training.

1.4 Terminology

To avoid unnecessary confusion, terms used through out the current thesis are defined in the current section.

Judgment: making an opinion which authenticity is unknown

The definition of judgment implies that the content of judgment can be expressed as a proposition, which is true or false. For example, as noted in section 1, if a boy predicts without eating, “The pudding is more delicious than the pie,” the proposition is the content of judgment. In the current thesis, the accuracy of judgment refers the extend of likelihood that the content of judgment is correct.

Logic: a process of judgment which guarantees the truth of the proposition with the presupposition that the bases are true.

It can be thought that logic is one of the way of making judgment. For instance, if knowing the proposition A, a dachshund is one of the dog, and the proposition B, the nose of dog is black, we can obtain the proposition C, the nose of dachshund is black. Logic is important to guarantee the accuracy of judgment because, if all of bases of a logical judgment are true, the logical judgment should be correct.

1.5 Organization and outline

As noted in the current chapter, the objective of the current research is clarifying how we can investigate the accuracy of human judgment, and intended contributions are (1) to further producing methodologies of research on human judgment process and (2) to further throwing light on how to improve the accuracy of human judgment and the quality of decision making. The rest of the current thesis is organized as below.

The next chapter, chapter 2, summarizes advocated conceptions on human judgment process. At first, intuition and heuristic, which were used to explain the characteristic of human judgment before Dual Process Theories had drawn the attention of psychologists, and Dual Process Theories are discussed, and then, the difference of interpretation between noted conceptions is indicated.

In chapter 3, recent experiments which are related to human judgment process are discuss. To grasp what factors psychologists focused on and how they investigated human judgment process, the theoretical framework and methodology of two experimental articles is reviewed. A detail on suggested determinants through the experiment is also mentioned.

Finally, chapter 4 concludes the current thesis and states possible future works. Especially, to clarify subjects which are likely to unsolved and solvable, the problem required to solve for the future human judgment research is discussed.

Chapter 2 Conceptions on human judgment process

In the current chapter, the conceptual review on human judgment process is presented. Intuition, heuristic, and Dual Process Theories are summarized.

2.1 Intuition and heuristic

2.1.1 Intuition

Although intuition is a common word on a daily basis, intuition has been used over time as a term of human judgment process in the academic topic. In Web of Science (Thomson Reuters, n.d.), it was found that there were 608 psychological articles for recent 25 years, which were gathered by the word intuition (the proportion to all of psychological one is 0.23%). However, an article which explained intuition conceptually is a few.

Academically, it is also thought that intuition is a common way to make a judgment. Tversky and Kahneman (1983) argued, “A comprehensive account of human judgment must reflect the tension between compelling logical rules and seductive nonextensional intuitions” (p. 313). There are academic controversies on what intuition is, and the interpretations of intuition by psychologists are different each other. Interpretations of intuition as one of the human judgment process by psychologists is presented below with the definition of logic as mentioned in chapter 1.

Westcott (1968) argued, “It appears that intuition can be said to occur when an individual reaches a conclusion on the basis of less explicit information than is ordinarily required to reach that conclusion” (p. 97). It can be interpreted that a conclusion on the basis of less explicit information means that the reason of the conclusion cannot be explained explicitly. This perspective on intuition excludes the process of logical judgment, for which the reason can be explained explicitly, from the process of intuitive judgment. If less explicit information, which is the basis of a judgment, is not completely implicit, intuition on the perspective is a process of reasoning.

Kahneman and Tversky (1982) argued,

> "The terms intuition and intuitive are used in three senses. First, a judgment is called intuitive if it is reached by an informal and unstructured mode of reasoning, without the use of analytic methods or deliberate calculation. ... Second, a formal rule or fact of nature is called intuitive if it is compatible with our lay model of the world. ... Third, a rule or procedure is said to be part of our repertoire of intuitions when we apply the rule or follow the procedure in our normal conduct" (p. 124).

The first explanation of this perspective excludes logical judgment, which is formal and structured, from intuitive judgment and regards intuition as a process of reasoning. The term, intuitive, in the second explanation means a characteristic of matter as opposed to a process of judgment. The third explanation implies that intuition can be identified by focusing on the familiarity of procedure, and the explanation does not exclude logical judgment from intuitive judgment.

Hogarth (2001) discussed intuition extensively. According to his definition, intuitions "are reached with little apparent effort, and typically without conscious awareness. They involve little or no conscious deliberation" (p. 14). In other words, he defined intuition as an effortless and unconscious process. Additionally, Hogarth (2001) argued as several points about intuition that, first, "our stocks of intuition are largely shaped implicitly by our interactions with our particular environments" (p. 46), second, "we undoubtedly possess instinctive, emotional reactions that operate very much like intuitive processes" (p. 74), and third, intuitions "are initiated automatically without conscious awareness" (p. 98). In the first explanation, it can be thought that intuition is based on what is obtained by implicit learning. The second explanation means that intuition is neither instinctive nor emotional. The third explanation implies that intuition is excluded from a process of reasoning which is in conscious awareness.

Briefly, the perspective of intuition by Hogarth (2001) is largely different from that by Westcott (1968), Kahneman, and Tversky (1982) because the interpretation of intuition only by Hogarth (2001) exclude intuition from a process of reasoning. The current thesis argued that there may be two types of the process of human judgment: first, a process which is automatic and unconscious, argued by Hogarth (2001), and second, a process which is a reasoning and conscious, including in not only the indication of Westcott (1968), Kahneman, and Tversky (1982) but also logic as defined

in chapter 1. It is clear that the two types of human judgment process presented above are mutually exclusive.

2.1.2 Heuristic

As a conception in behavioral science, as opposed to formal science including optimization, the term, heuristic is advocated by Amos Tversky and Daniel Kahneman to explain why biased judgments occur. Tversky and Kahneman (1974) argued, “People rely on a limited number of heuristic principles which reduce the complex tasks of assessing probabilities and predicting values to simpler judgmental operations” (p. 1124). Although they did not define the term heuristic explicitly, their essential account of this conception is that judgments by heuristic are processed “based on data of limited validity” (p. 1124). In Web of Science (Thomson Reuters, n.d.), it was found that there were 1523 psychological articles for recent 25 years, which were gathered by the word heuristic (the proportion to all of psychological one is 0.57%). They advocated three types of heuristic: representativeness, availability, and anchoring and adjustment.

The representativeness heuristic is the process “in which probabilities are evaluated by the degree to which A is representative of B, that is, by the degree to which A resembles B” (p. 1124). For instance, this man is tall (the proposition A) and a tall man is intelligent (the proposition B); therefore, this man is intelligent (the proposition C). By the perspective, the proposition C is generated by the representative heuristic. Through the perspective of two types of process in the precedent section, it can be interpreted that the proposition C is generated by a process which is a reasoning and conscious.

The availability heuristic is the process in which “people assess the frequency of a class or the probability of an event by the ease with which instances or occurrences can be brought to mind” (p. 1127). The availability heuristic may a process which is automatic and unconscious because bringing to mind is recalling rather than reasoning.

The anchoring and adjustment heuristic is the process in which “people make estimates by starting from an initial value that is adjusted to yield the final answer” (p. 1128). Because the final answer is based on an initial value, the anchoring and adjustment heuristic is a process which is a reasoning and unconscious.

They illustrated why human judgment is often biased by using the term heuristic. As noted above, the heuristics can be classified into either a process which is automatic and unconscious or a process which is a reasoning and conscious. Although

interpretations of intuition and heuristic mentioned in the current chapter overlap, it is clear that the dichotomy presented in the current thesis can avoid to overlap two types of human judgment process.

2.2 Dual Process Theories

There is a set of Dual Process Theories which are advocated to explain how we are making judgment by psychologists. Dual Process theories have been applied to investigate human judgment process. In fact, in Web of Science (Thomson Reuters, n.d.), it was found that there were 1570 psychological articles for recent 25 years, which were gathered by the word dual process (the proportion to psychological one is 0.58%). As noted in chapter 1, Stanovich and West (2000) summarized Dual Process Theories, as a set of System 1 and System 2 (see Figure 1 in the next page). They argued, "Although the details and technical properties of these dual-process theories do not always match exactly, nevertheless there are clear family resemblances" (p. 658).

As an explanation, they argued "System 1 is characterized as automatic, largely unconscious, and relatively undemanding of computational capacity" (p. 658), System 1 "conjoins properties of automaticity and heuristic processing as these constructs have been variously discussed in the literature" (p. 658), "System 2 conjoins the various characteristics that have been viewed as typifying controlled processing" (p. 658), and "System 2 encompasses the processes of analytic intelligence that have traditionally been studied by information processing theorists trying to uncover the computational components underlying intelligence" (p. 658). It can be interpreted that the interpretation of a set of System 1 and 2 is similar to the dichotomy presented in the current thesis. However, the explanation of a set of System 1 and 2 is complicated, and it cannot be thought that a set of System 1 and 2 is clearly defined. They referred to heuristic processing as System 1 processing. Nevertheless, the conception heuristic by Tversky and Kahneman (1974) and System 2 also seems to overlap.

2.3 Summary

Representative conceptions, human judgment process, intuition, heuristic, and Dual Process Theories, especially a set of System 1 and 2 are summarized. What the terms intuition and heuristic used by psychologists have implied overlap each other. Dual Process Theories are exactly different and may be used for explanations with the unclear definition. The dichotomy of human judgment process is presented by the

current research: (1) a process which is automatic and unconscious and (2) a process which is a reasoning and conscious. The explanation of a set of System 1 and 2 by Stanovich and West (2000) is similar to the dichotomy presented by the current research and vaguer then the dichotomy.

	System 1	System 2
Dual-Process Theories:		
Sloman (1996)	associative system	rule-based system
Evans (1984; 1989)	heuristic processing	analytic processing
Evans & Over (1996)	tacit thought processes	explicit thought processes
Reber (1993)	implicit cognition	explicit learning
Levinson (1995)	interactional intelligence	analytic intelligence
Epstein (1994)	experimental system	rational system
Pollock (1991)	quick and inflexible modules	intellection
Hammond (1996)	intuitive cognition	analytical cognition
Klein (1998)	recognition-primed decisions	rational choice strategy
Johnson-Laird (1953)	implicit inferences	explicit inferences
Shiffrin & Schneider (1977)	automatic processing	controlled processing
Posner & Snyder (1975)	automatic activation	conscious processing system
Properties:	associative	rule-based
	holistic	analytic
	automatic	controlled
	relatively undemanding of cognitive capacity	demanding of cognitive capacity
	relatively fast	relatively slow
	acquisition by biology, exposure, and personal experience	acquisition by cultural and formal tuition
Task Construal:	highly contextualized	decontextualized
	personalized	depersonalized
	conversational and socialized	asocial
Type of Intelligence Indexed:	interactional (conversational implicature)	analytic (psychometric IQ)

Figure 2.1

The terms for the two systems used by a variety of theories and the properties of dual-process theories of reasoning (Source: Stanovich & West; 2000, p. 659).

Chapter 3 Experiments on human judgment process

In chapter 3, the theoretical framework, methodology, and significantly suggested hypotheses in two experimental articles by Alter, Oppenheimer, Epley, and Eyre (2007) and by Thompson, Prowse Turner, and Pennycook (2011) are discussed. Although all of experimental work on human judgment are not presented, the chapter 3 focuses on how of human judgment process investigated empirically and emphasize the results.

3.1 Theoretical frameworks and methodologies

Alter, Oppenheimer, Epley, and Eyre (2007) and Thompson, Prowse Turner, and Pennycook (2011) investigated determinants of intervention of System 2 to human judgment process, rather than determinants of the accuracy of human judgment. Although, after the term heuristic had been advocated by Tversky and Kahneman (1974), experiments on human judgment focused on the accuracy of human judgment, the objective of recent experimental works on human judgment is to investigate Dual Process Theory or human judgment process.

As an explanation of Dual Process Theory, Alter, Oppenheimer, Epley, and Eyre (2007) argued “System 1 processes that are quick, intuitive, and effortless and System 2 processes that are slow, analytical, and deliberate that occasionally correct the output of System 1” (p. 569), whereas, Thompson, Prowse Turner, and Pennycook (2011) argued “automatic Type 1 processes give rise to a highly contextualised representation of the problem and attendant judgments that may or may not be analysed extensively by more deliberate, decontextualised Type 2 processes” (p. 108). These explanation noted the feature of Dual Process Theory. However, they are difficult to be interpreted as the definition of Dual Process Theory because what they referred to as Dual Process Theories is unclear.

As possible factors of System 2 intervention, Alter, Oppenheimer, Epley, and Eyre (2007) predicted “experienced difficulty or disfluency would function as a signal that a simple and intuitive judgment was insufficient and that more elaborate cognitive processing would be necessary, thereby increasing System 2 processing” (p. 570). On the other hand, Thompson, Prowse Turner, and Pennycook (2011) hypothesized “the

Feeling of Rightness (FOR) that accompanies Type 1 processing should signal whether the current output suffices or whether additional Type 2 processes are needed" (p. 109). In other words, Alter, Oppenheimer, Epley, and Eyre (2007) attributed System 2 intervention to experienced difficulty and disfluency, whereas Thompson, Prowse Turner, and Pennycook (2011) attributed System 2 intervention to the Feeling of Rightness. In addition, on determinants of the Feeling of Rightness, Thompson, Prowse Turner, and Pennycook (2011) argued,

> "We identified three variables that might play a similar role in reasoning judgements; one was a task-independent variable called *answer fluency* which was tested in all four experiments. In addition, we examined two task-specific variables, namely the probability that a conclusion is accepted as valid (Experiments 1 and 2) and the presence or absence of competing responses (Experiments 3)" (p. 111).

They regarded the Feeling of Rightness as an intermediate variable and attributed System 2 intervention to three variables: answer fluency, accepting a given conclusion, and the presence of competing responses.

The explanation of Dual Process Theory by Alter, Oppenheimer, Epley, and Eyre (2007) includes what was implied on the methodology. The interpretation implies that if a judgment was made more correct, it would be by System 2 intervention. On the other hand, Thompson, Prowse Turner, and Pennycook (2011) asked participants to make a judgment with System 1 at first, then a final judgment with System 2. They also explained, "In all four experiments, we measured FORs across a series of trials and used this to predict rethinking times, answer changes, and the probability of giving a normatively correct answer" (p. 111). Briefly, they regarded rethinking times, answer changes, and the probability of giving a normatively correct answer as the indication of System 2 intervention. The argument implies that if rethinking times are long, answer is changed, or the accuracy of judgment is high, it would be by System 2 intervention.

Although Dual Process Theories are for explanations on human judgment process, they regarded features on the result or output of judgment as the indication of System 2 intervention. In other words, even though the regarded indication of System 2 intervention implied strong one, it might be caused by manipulations or the difference of condition on the experiment. It is clear that the conception did not play a significant role of the paradigm to support the methodology of the empirical researches.

3.2 Experimental works

For the independent variable, experienced difficulty and disfluency, Alter, Oppenheimer, Epley, and Eyre (2007) mainly manipulated "disfluency in this experiment by printing the questions in either a difficult-to-read font (disfluent condition) or an easy-to-read font (fluent condition)" (p. 570). They suggested that the accuracy of judgment for Cognitive Reflection Test (proposed by Frederick, 2005) more increased in the disfluent condition than in the fluent condition. In detail, they showed that "a separate sample of 13 participants rated (on a 5-point scale) the disfluent font (M = 3.08, *SD* = 0.76) as being more difficult to read than the fluent font (*M* = 1.54, *SD* = 0.87), *t(12)* = 3.55, *p* < .01" (p. 570), that "participants answered more items on the CRT correctly in the disfluent font condition (*M* = 2.45, *SD* = 0.64) than in the fluent font condition (*M* = 1.90, *SD* = 0.89), *t(38)* = 2.25, *p* = .03" (p. 570), that "Whereas 90% of participants in the fluent condition answered at least one question incorrectly, only 35% did so in the disfluent condition," χ square (1, *N* = 40) = 12.91, *p* < .001 (p. 570), and that "participants in the fluent condition provided the incorrect and intuitive response more often (23% of responses) than did participants in the disfluent condition (10% of responses), *Z* = 1.96, *p* = .05" (p. 570).

Thompson, Prowse Turner, and Pennycook (2011) manipulated for the function of the dual system. They explained that participants "were told to give the answer that was their first instinct or gut feeling" (p. 110). As a manipulation check, they asked "them to indicate whether or not they had, indeed, done so for each trial" (p. 110). On manipulation to system 2 response, they explained, "To measure Type 2 engagement, participants were allowed as much time as needed to produce a final answer to the problems" (p. 110). Significant results of their experiment are in experiment 3 and 4. In experiment 3, they used the task "to study base-rate neglect (Kahneman & Tversky, 1973) in which participants are presented with two pieces of information, namely, the prior probability (base rate) that an individual belongs to one of two categories and a personality description of a particular individual" (p. 124) (see Figure 3.1 in the page 13), adapted from De Neys and Glumicic (2008). Thompson, Prowse Turner, and Pennycook (2011) explained as following: "(1) A few of the individuals' names were changed to make them more gender neutral; (2) Two versions of each problem were created by switching the large and small base rate numbers so that the same personality description could be presented in both the congruent and incongruent conditions; and (3) Instead of asking participants to make a binary choice of two categories" (p. 125).

They showed that rethinking time was shorter for the congruent (M = 13.46 s, sd = .80) than the incongruent (M = 17.89 s, sd = 1.1) items, "$t(63) = 5.25$, $p < .001$" (p. 129), and that the degree of answer change was smaller for the congruent (M = 12.33, sd = 1.64) than the incongruent (M = 19.67, sd = 2.01) items, "$t(63) = 3.51$, $p = .001$" (p. 129). In experiment 4, they used the task of qualified syllogisms (see Figure 3.2 in the page 13). The former task in Figure 3.2 is consistent with the Min heuristic (advocated by Chater & Oaksford, 1999), whereas the latter task inconsistent with the Min heuristic. On the example presented in Figure 3.2, Thompson, Prowse Turner, and Pennycook (2011) noted that,

> "the conclusion above is consistent with the min heuristic, because the quantifier of the conclusion, ''some'' is the same as the least informative premise (Some of the nurses are magicians). In contrast, the conclusion below violates the min heuristic, because the conclusion is less informative than either of the premises. Logically, both conclusions have the same status, in that they are consistent with, but not necessitated by, the premises" (p. 131).

They showed that rethinking time was "lower for min" (M = 13.61 s, sd = 1.1) than non-min (M = 17.71 s, sd = 1.3) conclusions, $t(63) = 6.18$, $p < .001$ (p. 133), that the probability of answer change was "lower for min" (M = .17, sd = 0.2) than non-min (M = .27, sd = 0.2) conclusions, $t(63) = 3.38$, $p = .001$ (p. 133), that "for the invalid problems, reasoners were more accurate for the Non-min problems (.42 vs. .15, $t(63) = 6.10$, $p < .001$)" (p. 133), and that "for the valid problems, where accepting the conclusion produces correct answers, reasoners were more accurate with the min (.91) than the non-min (.64) conclusions, $t(63) = 6.64$, $p < .001$" (p. 133).

Once again, Alter, Oppenheimer, Epley, and Eyre (2007) suggested that the accuracy of judgment for Cognitive Reflection Test more increased in the disfluent condition than in the fluent condition, whereas Thompson, Prowse Turner, and Pennycook (2011) suggested that the length of rethinking time and the probability of answer change more decreased in the congruent condition than in the incongruent condition and that length of rethinking time, the probability of answer change, and the accuracy of judgment for the invalid problem more decreased and the accuracy of judgment for the valid problem more increased with the Min conclusion than with the non-Min conclusion.

In a study 1000 people were tested. Among the participants, there were 3 nurses and 997 doctors. Paul is a randomly chosen participant of this study. Paul is 34 years old. He lives in a beautiful home in a posh suburb. He is well spoken and very interested in politics. He invests a lot of time in his career.

What is the probability that Paul is a doctor?

Figure 3.1

The example of the task to study base-rate neglect
(Source: Thompson, Prowse Turner, & Pennycook; 2012, p. 124).

Some of the nurses are magicians.
All of the winemakers are nurses.
Therefore, some of the magicians are winemakers.

None of the nurses are magicians.
Some of the winemakers are nurses.
Therefore, some of the magicians are not winemakers.

Figure 3.2

The example of quantified syllogisms
(Source: Thompson, Prowse Turner, & Pennycook; 2012, p. 131).

3.3 Summary

Although experiments on human judgment focused on the accuracy of human judgment after the term heuristic had been advocated, the objective of recent experimental works on human judgment is to investigate Dual Process Theory or human judgment process. The current chapter presented two experimental articles by Alter, Oppenheimer, Epley, and Eyre (2007) and Thompson, Prowse Turner, and Pennycook (2011).

Alter, Oppenheimer, Epley, and Eyre (2007) suggested that the accuracy of judgment for Cognitive Reflection Test more increased in the disfluent condition than in the fluent condition, whereas Thompson, Prowse Turner, and Pennycook (2011) suggested that the length of rethinking time and the probability of answer change more decreased for the base-rate problem in the congruent condition than in the incongruent condition and that length of rethinking time, the probability of answer change, and the accuracy of judgment for the invalid quantified syllogisms reasoning problem more decreased and the accuracy of judgment for the valid syllogisms reasoning problem more increased with the Min conclusion than with the non-Min conclusion.

Their empirical research investigated determinants of intervention of System 2 to human judgment process, rather than determinants of the accuracy of human judgment. The methodology of Alter, Oppenheimer, Epley, and Eyre (2007) implies that a judgment is made more correct, it would be by System 2 intervention, whereas the methodology of Thompson, Prowse Turner, and Pennycook (2011) implies if rethinking times are long, answer is changed, or the accuracy of judgment is high, it would be by System 2 intervention.

However, there is the difficulty to construct the methodology. Although Dual Process Theories were for the explanation of human judgment process, they regarded features on the result or output of judgment as the indication of System 2 intervention. In other words, even though the regarded indication of System 2 intervention implied strong System 2 intervention, it might be caused by manipulations or the difference of condition on the experiment. It is clear that the conception Dual Process Theory did not play a significant role of the paradigm to support the methodology of empirical research. Fortunately, from the perspective that determinants of the accuracy of human judgment is intended, their finding would further to progress the investigation of determinants of the accuracy of human judgment.

Chapter 4 Conclusion and future work

Through the current research, current issues on both the conception and experiment of human judgment process was presented. The conclusion of the current thesis and future works in researches on the accuracy of human judgment is presented.

4.1 Conclusion

In chapter 2, conceptual controversies on intuition, heuristic, and a set of System 1 and 2 were presented. What the terms intuition and heuristic used by psychologists have implied overlap each other. Dual Process Theories are exactly different, and, in fact, as noted in chapter 3, one of Dual Process Theories, a set of System 1 and 2 is used for explanations with the unclear definition. The current research produced the mutually exclusive and clear dichotomy of human judgment process.

(1) A process which is automatic and unconscious

(2) A process which is a reasoning and conscious

In chapter 3, two empirical researches were presented. Earlier experiments on human judgment focused on the accuracy of human judgment, whereas the objective of recent experimental works on human judgment is to examine Dual Process Theory or human judgment process. Recent findings seem to further progressing the investigation of determinants of the accuracy of judgment. However, the researches did not produce any significantly suggestion on Dual Process Theory because although Dual Process Theories were for explanations on human judgment process, they regarded features on the result or output of judgment as the indication of System 2 intervention.

The objective of the current research is to clarify how we can examine determinants of the accuracy of human judgment. From the perspective, following conclusion was found.

(1) There is a future work to build a methodology to use the conception of human judgment process for examining determinants of the accuracy of human judgment.

(2) The dichotomy of human judgment process presented by the current research may be able to used to examine determinants of the accuracy of human judgment experimentally.

The two conclusions was valuable because the absence of the methodology may be caused by the ambiguity of conceptual definition. The definition of conception related to human judgment process should be observable. The dichotomy based on the perspective of whether it is a reasoning, which is a process of judgment based on some propositions, is the key for understanding the accuracy of judgment because if a reasoning caused biased judgment, it would be by the illogicality of reasoning.

4.2 Contribution

As noted in Chapter 1, intended contributions in the current research were following.

(1) to further producing methodologies of research on human judgment process

(2) to further throwing light on how to improve the accuracy of human judgment and the quality of decision making

The current research proposed a future work to examine determinants of the accuracy of human judgment. The proposed dichotomy by the current research is similar to and clearer than existing Dual Process Theories. It was intended that the simple and clear dichotomy allows researches to be capable to examine the feature of each human judgment process.

4.3 Future work

It can be thought that the future work of review such as the current research is the further investigation of recent controversies on novel conceptions and experiments indirectly related to the accuracy of human judgment, especially quantitative judgment such as risk evaluation. Through such works, there is the possibility that the academic understanding on the relation between human judgment process and determinants of the accuracy of human judgment would come to deeper.

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