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The role of Emotion Regulation on the link between False Memory and Decision Making

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ABSTRACT

Current research is based on an experimental two-stage condition. The main objective is to investigate how false memories influence the decision making process, but also the role of emotional regulation in the mentioned relationship. The experiment is based on the DRM paradigm. Participants were aged 18-50 and were divided into two experimental groups.
The study investigates both everyday life decision making strategies and those involving taking risks, according to Prospect Theory. The results show that false memories influence decision making process, especially regarding risky ones, but did not support the moderating role of emotion regulation in decision making process under the condition of false memories. The implications of research highlight both the people's suggestibility and the type of emotional state they should have in order to maintain their trust on false memories.

Keywords: *false memory, decision making process, emotion regulation, risky decisions*

1. INTRODUCTION

From an evolutionary perspective, the process of memorizing information and events, with an emotional impact on people, was an important survival mechanism (recognition of safety stimuli, avoidance of potentially fatal stimuli). When an (emotional) activation occurs in the brain, the situations we pass through and the information we are exposed to are more likely to be encoded, thus helping to strengthen memory. Emotional arousal is activated by the influence of the hippocampus, considered biologically, the neural center of emotions (McGaugh, 2018). The stronger the emotion is, the more pronounced is the trend to focus only on the necessary details for survival and on a more effective emotion regulation, leading to the probability that an event will be remembered in a wrong way, to the formation of false memories (Kaplan, Damme, Levine, & Loftus, 2016).

False memories can be seen as a large accumulation of encoding errors (Newman & Lindsay, 2009). Individuals use mental schemes to categorize information at the time of the encoding of events and that could be an explanation for the formation of false memories. Thus, based on some schematics, people can associate the updated information, assigning them to causes that seem similar but belong to a distinct set of information, previously stored (Webb, Turney, & Dennis, 2016). Emotions represent a combination of affective experiences, behavioral structures and psychological activity, appearing in response to motivational-relevant stimuli. Emotion regulation is seen as a person's ability to change the way they perceive a certain emotion in order to alter their importance. This phenomenon is called reappraisal (Silvers & Moreira, 2017). Emotion regulation also involves changes in the way emotions will be expressed. Emotion regulation strategies are varied and occur either before emotional response (selection/change of situation) or after the occurrence of response (expressive suppression) (Christiansen, Hirsch, Albrecht, & Chavanon, 2019). The person must also be able to implement the emotion regulation strategies (Silvers & Moreira, 2017).

The regulation of emotions has a distinct neurological basis, this process being influenced by a diminished activity in the prefrontal cortex and a weaker connection between this area and the amygdala (Manzoor & Treur, 2013). The decision-making process involves the assessment of the options available to a person, from the perspective of benefits and risks, in order to reach an optimal alternative. Theories that exist in the literature assume that people make rationally and fully knowingly decisions (Whittaker, 2018).

Emotions appear in connection with the decision making process because emotions are associated with the reward and punishment system in the brain, so decisions will be made in accordance with the probability of obtaining rewards (Mitchell, 2011). When a person is in the position of making a decision, based on information from memory, how that information is encoded and its veracity becomes crucial for making reliable decisions (Shadlen & Shohamy, 2016).

Over time, numerous studies have been conducted that highlight the effects of memory on the decision-making process, on the processing limits imposed by short-term memory capacity. Long-term memory is so important that there are doubts that people could make decisions in real life based solely on the present stimuli. Long-term memory affects not only the amount of information that enters the decision process, but also the type of information considered and how it is processed (Lynch, White, & Hutchinson, 1991)

Theories about decision making process, based on a cognitive perspective, assume that decisions derive from the evaluation of future possible outcomes, through cost-benefit analyzes. Some theories considered emotions to be factors that could influence the decision making process, while others consider them a consequence of decision-making process (such as disappointment after a risky decision). It has been found that people make decisions not only based on possible outcomes, but also on the emotions they feel. Lesions of the prefrontal cortex interfere with the normal processing of somatic or emotional signals, but slightly affect other cognitive functions. This deterioration leads to pathological disorders in the ability to make decisions, which can lead to serious problems of daily decision-making (Bechara, 2000).

A recent study examined the connection between memory and different stimuli that may be affected by false feedback. The results showed that the false feedback given to participants from the evoked memories resulted in the increase of diffuse memories and the decrease of faith for their pre-established associations. Intriguingly, the study showed that the decision making preference of the participants (experimental group) was altered by the false feedback, not the actual feedback addressed to the second group (control group) (Wang, Otgaar, Smeets, Howe, & Zhou, 2019).

False memories are considered to be easily confused with those that present the real situation. Studies found that individuals were more confident to assert that the objects they remember (wrongly) are, in fact, older information – these are false memories – and less confident when they have to associate correctly encoded information in the past as belonging to a past stimulus – real memories. Subjects were persuaded to mistakenly recall information presented above (they were presented with an axe in a sequence of images, and then read a description of the same object, now illustrated as another tool) (Loftus, Donders, Hoffman & Schooler, 1989).

Another similar study also claims that people would invest considerable amounts of money on such decisions (Weingardt, Toland, & Loftus, 1994). It is found that people tend to misidentify false information as real, but also vice versa, to classify true information as false, leading to a certain effect called truth bias (Peter & Koch, 2016).

A first objective of the study is to research how the formation of false memories influences the decision-making process in the control group and experimental group. We assume that there will be differences between the experimental group and those of the control group in terms of decision-making process, since the participants of the control group were not induced false memories. Another objective is to investigate the contribution of emotion regulation and the strategies people use in emotionally challenging situations, on the formation of false memories in the decision-making process. A third objective aims to investigate how the formation of false memories influences the process of taking risky decisions. The study aims to present an experiment, objectively evaluated using the scales for measuring previously operationalized variables. Thus, the study will compare the final results of the two

groups, depending on the application of the experimental condition.

H1: *False memory will influence the decision-making process in the experimental group*.

H2: *Emotion regulation mediates the relation between false memory and decision-making process.*

H3: T*he experimental group will have a smaller percent of frequencies of taking risky decisions than the control group.*

2. METHODOLOGY

Participants

The study was carried out on 34 participants, who were selected from the population of Bucharest, as part of a convenience sample. They were between the ages of 18 and 50 (M= 25.88; SD= 11.42). Respondents received informed consent in on-line format before engaging in the completion of questionnaires, giving their consent through the answers given. The 34 participants were divided into two groups through random sampling. Thus, there is an experimental group consisting of 17 participants and a control group consisting also of 17 participants. According to the G-power program (Faul, Erdfelder, Lang, & Buchner, 2007) a minimum number of 30 participants is recommended as subjects in this experimental research in order to have an average effect size.

Intruments

Emotion Regulation. The Emotion Regulation Questionnaire (ERQ) (Gross & John, 2003) measures two types of emotion regulation strategies: cognition reassessment and affective suppression. It was developed by James Gross and Oliver John, and the measurement is done using the likert scale (1= strong disagreement; 4= neutral; 7= strong agreement), with 10 items, 6 of them measuring the reassessment of cognitions, and 4 affective suppression ("When I feel positive emotions I take care not to express them").

Decision Making. The Decision-Making Questionnaire (self-report) measures decision-making strategies (French, West, Elander and Wildin, 1993). Through a likert scale (1= very rare or never; 6= very frequent or always), with 21 items that build 7 distinct dimensions ("Are you relying on your first instinct when you make a decision?").

Procedure

The data were collected through questionnaires measuring the two concepts investigated, decision making, as a dependent variable and emotion regulation, as mediator, but also through an experimental condition, to test the formation of false memories, the independent variable. The tools were administered in an on-line form, participants having access to all the details aimed at completing them. The average time to complete the two questionnaires was 10 minutes. Participants were placed in a room, where they were given the experimental condition for the implementation of false memories, according to the cognitive paradigm Deese-Roediger-Mcdermott Task (DRM; Pardilla-Delgado & Payne, 2017).

Each respondent in the experimental and control groups was asked to watch a Power Point presentation showing 15 words at a distance of 0.5 seconds, according to the mentioned paradigm. The attached words were taken from the study by Pardilla-Delgado and Payne (2017), based on the fact that they are easy to understand as and have a high probability of memorizing and recognition, some of them being part of single semantic family but the exact methodology for their selection is not specified, which can be considered a limitation.

Thus, only 7 sets of words were used instead of 15, in order to be compatible with the availability of participants. After viewing the 15 words, in the current research, participants were asked to write the words they remember on a sheet of paper, this being the first stage of the experiment, namely the free recall task.

The second stage of the experimental condition was carried out only by the participants of the experimental group. According to the paradigm, the passage of time between the two experimental conditions is essential to the implementation and fixation of false memories. Thus, the time allotted to the implementation of false memories was predetermined at 30 minutes, before caring out the next task. The control group has not been subject to the implementation of these false memories, so that they can differentiate whether there are indeed effects of false memories on the decision-making process. Thus, in the second stage, the recognition of words (recognition task), the participants were presented with a series of 162 words, on a separate sheet, in order for the participants to recognize and identify the words presented in the first stage and then to write them down on another sheet of paper. Of these 162 words, only 15 form false memories derived from the words of the first stage. These words will then be attached in the final section of the annexes, together with the 15 words originally presented (Annex 1).

Finally, the two questionnaires were administrated in on-line format. First, they had to complete the questionnaire for determining emotion regulation strategies, namely ERQ. Secondly, the instrument for assessing the decision-making process was applied. Also, there were introduced by us,

three separate items which assessed the process of taking risky decisions. The construction of the questions was based on the Prospect Theory of Kahneman and Tversky (Kahneman & Tversky, 1992). The questions raised concerned decision making at risk on the basis of three words. These three key words, such as "sleep", "doctor" and "needle" were chosen according to the DRM paradigm, as they are part of the 15 words that form false memories and represent words from the lexical family of those used in the memorizing stage and implicitly the recall stage. They are also often found and used in the common language of participants, so their implementation is facilitated. Prospect Theory can be summed up by the utility amounts of some results weighed by their likelihood of happening. In the context of the present study, the items built on this reasoning were in the form: "Did the word "sleep" appear in the word list?", as the answer variants being: "YES (earn 450 RON for sure)" and "No (you have 50% chance of winning 1000 RON and 50% chance of not winning anything)". In classical theory there are two phases: that of framing and that of valuing. In the valuing phase the decision-making person evaluates each possibility and chooses accordingly (Kahneman & Tversky, 1992).

Statistical approach

The "Frequencies" procedure from the SPSS program (IBM Corp., 2011) was applied to determine the frequency of each word presented in the first stage of the experiment, recalled by the participants later on paper. The same procedure was also used to determine the frequency of each word in the second stage, the recognition stage, for the 15 words that make up the false memories.

The same statistical procedure was also applied in order to determine the percentage frequency of the words recalled and recognized in the two samples of the experimental condition. This procedure was also applied to determine the percentage frequency of risky decisions that participants had to choose.

The Pearson linear correlation procedure, from the SPSS program (IBM Corp., 2011), was applied to see if there is an association between the formation of false memories (independent variable) and risky decisions (dependent variable) in the experimental group. The same procedure was applied to see if there is a statistically significant correlation between the words presented in the first stage of the experimental condition and the risky decisions for the control group. We also applied the statistical mediation procedure using the PROCCES 2.16.3 software (Hayes, 2013), where the mediator is represented by the variable emotion regulation.

3. RESULTS

The means for each group included in the research were obtained, in terms of the final results for the variable emotion regulation and for that of the decision-making process. Thus, the experimental group obtained an average M = 41.35 and a standard deviation SD = 6.44, for the total score of emotion regulation. The lowest total score recorded was 31, and the highest was 53. At the level of the decision-making process variable, the experimental group obtained a mean of M = 85.35 and a standard deviation SD = 6.10. The lowest total score was 73, and the highest was 94.

Table 1 - *Descriptive statistics of the experimental group*

	N	Minimum	Maximum	Mean	Std. Deviation
Emotional regulation	17	31	53	41.35	6.44
Decision making	17	73	94	85.35	6.10

For the total score of the variable emotion regulation the control group obtained a mean of M = 41.76 and a standard deviation SD = 7.25. The lowest score obtained in this questionnaire was 31, and the highest was 61. For the questionnaire regarding the decision-making process, a mean of M = 83.47 and a standard deviation SD = 6.91 were obtained. Also, the lowest total score was 73 and the highest was 94.

Table 2 - *Descriptive statistics of the control group*

	N	Minimum	Maximum	Mean	Std. Deviation
Emotion regulation	17	31	61	41.76	7.25
Decision making	17	73	94	83.47	6.91

For the experimental group, the following frequencies were obtained for the words used in the first stage of the experimental condition, the one in which the participants recalled the visualized stimuli. Thus, the words "hospital" and "patient" have been 100% recalled. The words "table", "armchair", "fireplace" and "candy" were recalled in a similar proportion (82%); "thread" (88%); "pain" (59%); "nose" and "flavor" (65%); "cigarette" (77%); "bed" and "cool" (71%); "dream" (53%); "taste" (30%); "warm" (59%).

For the control group, the following word frequencies were obtained: “hospital” and "patient" (94%); "armchair" and "candy" (59%); "table" (65%); "thread" (41%); "pain" (71%); "nose" (41%); "flavor", "taste" and "coolness" (35%); "cigarette" (58.8%); "fireplace" and "warm" (53%); "bed" (65%).

For the second test, the word recognition test, performed exclusively at the level of the experimental group, the following frequencies were obtained of words that formed false memories. Thus, the words "chair", "tobacco", "fire" and "sewing" were not recognized by any participant. The words "sofa", "office", "cold", "sweet" and "doctor" were recognized in a proportion of 12%; "Smell", "needle" and "smoke" (18%); "heat" (30%); "ash" and "sick" (6%).

The results of the Pearson linear correlation analysis show a statistically insignificant negative correlation ($r = -.13$; $p > .05$) between false memories ($M = 1.53$; $SD = 2.24$) and risky decisions ($M = .76$; $SD = .83$) at the level of the experimental group.

Table 3 - *Correlation between false memories and risky decisions (experimental group)*

Variables	1	2
1. False memories	-	
2. Decision making	-.13	-

The results of the second Pearson linear correlation analysis show a statistically insignificant negative correlation ($r = -.46$; $p > .05$) between false memories ($M = 9.12$; $SD = 3.16$) and risky decisions ($M = .76$; $SD = .66$) at the control group level.

Table 4 - *Correlation between false memories and risky decisions (control group)*

Variables	1	2
1. Word encoding	-	
2. Risky decisions	-.46	-

In the experimental group, 41% of participants did not take any risky decisions after inducing false memories. Another proportion of 47% of participants made a single risky decision, and another 5.9% of those in the group, two risky decisions, respectively three risky decisions.

In the control group, 35% of participants did not make any risky decisions after the first test of the experiment.

Another proportion of 53% of participants made a single risky decision, and 12% of them made two risky decisions.

Regarding the words mentioned in the questions from the questionnaire for risky decisions, the participants did not take the risky decision in proportion of 53% and assumed this decision, in proportion of 47%, for the word "sleep". For the word "doctor", 18% of the participants took the risky decision, and 82% did not take this decision. Similarly, for the word "needle", they took the risky decision in proportion of 12%, and those who did not take the risky decision accounted for 88%.

Following the mediation analysis, the role of mediator of emotion regulation in the relationship between false memories (independent variable) and the decision-making process (dependent variable) was tested. According to the analysis, the formation of false memories does not have a statistically significant effect on emotion regulation (b = .45, p > .05, CI95% = -1.12 - .60). False memories do not have a statistically significant effect on decision making (b = 1.10, p > .05, CI95% = -.18 - 2.38) and emotion regulation does not have a significant effect on decision making either (b = .35, p > .05, CI95% = -.09 - .80). The effect of false memories on decision making through emotion regulation (indirect effect) is statistically insignificant (b = .16, p > .05, CI95% = -.82 – 1.26). Thus, emotion regulation does not mediate the relationship between false memories and decision making.

Based on linear regression indicators, false memories explain 2% of the variance of emotion regulation (R2 = .02, p> .05). False memories and emotion regulation explain 34% of the variance of decisions (R2 = .34, p> .05).

Table 5 – *Mediation model (experimental group)*

				95% C.I. (a)				
Type	Effect	Estimate	SE	Lower	Upper	B	z	p
Indirect	False memories ⇒ Emotion regulation ⇒ Decision making	.16	.25	.34	.65	.06	.61	.54
Component	False memories ⇒ Emotion regulation	.45	.69	-.90	1.80	.16	.65	.52
	Emotion regulation ⇒ Decision making	.35	.19	-.02	.72	.37	1.84	.07
Direct	False memories⇒ Decision making	1.10	.54	.04	2.16	.40	2.03	.04
Total	False memories⇒ Decision making	1.26	.61	.07	2.44	.46	2.08	.04

Note. (a) Confidence intervals computed with method: Standard (Delta method)

4. DISCUSSION

The study claimed that false memories influence the decision-making process in the experimental group, but this hypothesis is not supported by the results obtained, being insignificant. In their study, authors Wang, Otgaar, Smeets, Howe and Zhou (2019) support that memories guide elections in a decision-making task. Then, manipulating these memories in the experimental group (using false feedback before making decisions that could lead them to make money) would result in a change in decision preferences to get rewards. Participants' ability to remember decreased significantly after receiving false feedback. Significant correlations were obtained between decision making and false memories, contrary to our current study. The study (Wang et. Al., 2019) showed that past

experiences feedback on memories can change reward-based decision making, while our study showed that there is no significant correlation between the two variables used to conduct the experiment.

Previous studies have also analyzed the role that memory structure and activation play in decision-making (Morewedge & Kahneman, 2010). The authors explain how three features of associative memory, namely associative coherence, attribute substitution, and processing fluency, give rise to prejudices and intuitive judgments, such as decision-making in risky situations. This article highlights both the ability of the memory system to create complex judgments and its role as a source of judgment errors.

The second hypothesis of the study is not supported by the results. The mediating effect of emotion regulation on the relationship between false memories and the decision-making process is not statistically significant. This lack of statistical significance may be caused by a possible lack of statistical power. Also, the data entered in the mediation relationship differ in numerical format, as the dependent variable is counted by the number of the false memories formed, while the mediator and the independent variable are counted on a likert scale, so there is an incompatibility at the measurement level.

Our results show differences between the percent of frequencies obtained between the two groups, supporting

our third hypothesis. Individuals in the control group risked more in choosing decisions that assumed a hypothetical win or lose situation, compared to the experimental group. Based on the frequencies obtained, the control group made several risky decisions, as they based their decision only on their authentic memories, after viewing the presentation of the words. Instead, the experimental group had difficulty making risky decisions because they were affected by false memories, which prevented them from being sure of what they remembered. Thus, the difference between the number of risky decisions in the two groups was insignificant, rather small.

Other recent research has shown that particular memories can largely lead to risky decisions. (Bornstein, Khaw, Shohamy & Daw, 2017; Ludvig, Madan & Spetch 2015). These studies claim that false memories (false feedback in these cases) have a certain influence when a person makes a risk-based decision. The hypotheses of these studies are not in accordance with the hypotheses supported in the related research, but the differences between the results and the correlations of the two experimental researches can be observed.

Observations

In the two groups included in the experimental study, participants updated in the smallest proportion the word "taste", being one of the last words presented in the slides they viewed, so that the phenomenon of forgetting specific to short term memory can occur. This statement is based on the theory formulated by H. Ebbinghaus in 1885 and is based on the process and factors that intervene in oblivion (Ebbinghaus, 2013). As the control group was not subjected to the second part of the experiment, only the experimental group was affected by the establishment of false memories. Words that have been recognized on the sheet as false memories are part of the lexical families of the words originally presented. Also, these words are part of the basic vocabulary of the participants, being words used in current speech and known by the reference population, according to the statements made by Pardilla-Delgado and Payne (2017).

For both groups, the word “sleep” was the one that the participants risked the most, which may suggest its familiarity, sleep being an essential activity in the life of any person, being also found in the basic vocabulary.

Also, from the point of view of emotion regulation, it is possible that the fatigue or lack of energy that the subjects could feel when participating in the experiment, may interfere with the memorization of words, especially with the aforementioned word. Because the participants failed to adjust their potential fatigue state, it facilitated the fixation in memory of the false memory (in the case of the experimental group) or of the word itself, by projecting the state on the word (in the case of the control group). The emotional state of the participants during the experiment is decisive for the way they formulate their decisions, a statement supported by other specialized studies, as in the experiment conducted by Manzoor and Treur (2015).

The mediation between emotion regulation, false memories and the decision-making process is statistically insignificant, rejecting our second research hypothesis. This result can be justified by the literature that emphasizes that efforts are made by people to control emotionally charged experiences, so that the effects of the emotionally charged experiences, so that the effects of the decision-making process can be mediated by emotion regulation strategies (Miclea, Heilman, Crișan, Hauser & Miu, 2010), a variable that was not effectively integrated into this study because no positive or negative emotional context was created for participants.

Theoretical and practical implications

This experimental research consists in a particular relevance and in this regard, trying to clarify how false memories are involved in decision making, this study try to bring more knowledge through the experimental method approached.

A theoretical implication is the possibility to study the risky behaviors of people and the way they appreciate the value of a sum of money that is guaranteed to them compared to a sum of money with chances of only half percent for them to take. Based on this information, a practical implication would be how certain marketing companies can use the investment decision-making strategies of their aimed public.

Another practical implication is the way that false memories of others can be used for personal gain, based on people’s suggestibility and what type of emotional state they should have in order to maintain their trust on those memories.

Limitatios and future directions

Current research has some important limitations. The research design was based on a convenience sample. Thus, the results can be generalized to the reference population only under certain conditions. The sample consists mainly of students, with an average level of education, which makes the representativeness of the general population limited. In addition, the associations were measured also based on self-reported data, which are likely to be a frequent source of methodological bias. Another limitations refers to lack of control of confuounded variables such as participants' emotional state, time of day, ambience, lack of attention, fatigue, noise. The mediator and the independent variable could not experimentally be manipulated in order to assume a possible causality. This design was used without pre-test, and this aspect can change the results obtained, so we can not generalize the all the implications.

From a theoretical point of view, it is essential to determine the explanatory mechanisms associated with the investigated relationship, not just the mere existence of the relationship between these variables. Therefore, future research may consist in providing an explanatory mechanism for the relationship between false memory and decision making.

Another limitation was based on the participants' learning stlye, this aspect being neglected. In the current study, only a visual method was used to facilitate the memorization of words, and an auditory instrument was needed, similar to the original experiment. Another limitation of the study is the lack of an objective investigation of the phenomenon of false memory formation, through biological testing, so that the phenomenon is more concretely understood, as it appears in other specialized studies (Jou et al., 2016).

Another important limitation regarding the theoretical level is the lack of specific studies on the investigated topic, which leads to a prophylactic interpretation of the results due to gaps in the literature. The current study can be replicated, taking into account the shortcomings in the literature, thus leading to the enrichment of scientific knowledge and the possibility of obtaining other results, which support the mentioned hypotheses.

Given the theoretical and methodological limitations presented, many future directions can be considered. Future studies could take into account the importance of emotiona regulation in terms of memory or decision making, but also a thorough and objective research of the process of forming false memories per se, through assessments of biological changes in the body. Subjecting participants to an emotionally charged context, concretely measuring the two identified emotion regulation strategies, relating to them when making decisions, and to neural activations is a study of the future.

Also, we recommend a study replication in order to improve the experimental conditions in terms of the time allocated to the production of false memories. We have allocated a relatively short period of time for the formation of false memories, but to benefit from stronger evidence it it recommend to allocate a whole day between the two experimental conditions.

Conlusions

Consequently, the current research started from the two proposed objectives, under which false memory is a predictor for decision making and emotion regulation mediates the mentioned relationship. Based on the obvious results, the first objective is confirmed. This finding is consistent with previous studies and provides additional insights about forming the false memories and their potential consequences (Redish & Mizumori, 2015). Few studies have approached this topic. Thus, the current study will bring more knowledge through the experimental method. This research claims that emotion regulation had an insignificant mediating effect on the relationship between false memory and decision making. The Deese-Roediger-Mcdermott (DRM) Task cognitive paradigm (Pardilla-Delgado & Payne, 2017) was used in order to perform the experiment. The results show that implemented false memories to the participants in the experimental group had an influence on the risky decisions they made. In control group, there was an insignificant difference, the subjects not being affected by the false memories. Thus, we can assume that people do not largely rely on false memories, but rather have a rational decision-making process, especially when they have to make a risky decision. In other words, these results largely depend on the representations of memory, whether they are more general and less specific or whether they have a high degree of specificity (Redish & Mizumori, 2015). According to the literature and observations based on the current study, although there is a risk of forming false memories, people are often guided by those that prove to be true, based on accumulated information or logical reasoning, which they support judgments in various aspects of life.

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