Teenagers' Decision Making: Implications for Learning

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Abstract

In this study we investigated high-school students' decision-making using the dual process theory, a prominent framework in cognitive and social psychology for understanding decision-making. Our study pursues two main objectives. The first is a systematic review of the existing literature on dual process theory. For the first part we analyze the theory's explanatory power in human decision-making and critically evaluate the empirical evidence comparing the effectiveness of different cognitive processing systems (i.e., system 1, intuitive; system 2, analytical). Following this critical assessment path, we aim to establish the relative strengths and weaknesses of each system in various decision-making contexts. The second objective involves original research designed to identify which cognitive processing system (system 1 or system 2) leads to superior decision-making outcomes (i.e., decisions whose consequences produce optimal or highly favorable results) for high-school students. The research component consists of experimental studies where participants are presented with decision-making tasks designed to elicit responses predominantly driven by either system 1 or system 2 processing. These tasks vary in complexity, time pressure, or the type of information provided to influence the cognitive system engaged. Statistical methods are used to analyze the data to compare the accuracy, efficiency, and other relevant assessments of decisions made using each system. Based on our investigations, we suggest that system 1 impairs the thinking process generating biased decisions significantly more than system 2. Contrary to some previous studies that show the accuracy of heuristic thinking when determining "good" decision making, our results show the system 1 process did not help improve the thinking process for good decision-making for high school students.

Keywords: dual process theory, decision-making, cognitive systems, high school

"Life is a sum of all your choices," a famous quote by Albert Camus (2006 translation), emphasizes the centrality of judgement and decision-making. Judgement and decision-making are studied in many disciplines, including statistics, economics, politics, philosophy, medicine, and law (Henrizi et al., 2021; Mactavish et al., 2018; Steiger and Kühberger, 2018). Despite the abundance of literature on the topic, judgement and decision-making continue to garner public and media interest because they address phenomena that people experience on a daily basis, from their latest dietary decisions to an excessive stock market trading (Weber, 2009). In 1959, Herbert Simon put forth the classical economic theory, which argued that given enough data, individuals could make decisions that maximize their economic utility. However, research by Kahneman and Tversky (1973) showed that people often disregarded their own financial best interests and bypassed opportunities that could maximize profits, even when they were aware of the advantages of doing so. Dual process theory has provided a new explanation for why people sometimes make irrational choices even when they have all the knowledge, they need to make rational decisions (Kahneman, 2003).

Literature Review

Dual process theory (Kahneman, 2003) contends that two types of mental processing can be used to categorize and understand various human cognition elements, including reasoning, judgement, and decision-making. The idea of "lower" mental processes is related to perceptual and emotional operations like attentional cueing and motor-response preparation. The lower mental processes are portrayed as automatic, experiential, heuristic, implicit, associative, adaptive, unconscious, and reflexive. The term system 1 or type 1 processing is frequently used to describe this type of mental functioning (Evans, 2003). In contrast, the idea of higher mental processes is related to cognitive processes that need a lot of energy, like deductive reasoning and hypothetical thinking (Evans et al., 2008). These processes are controlled, rational, systematic, explicit, rule-based, analytic, conscious, and reflective. The terms system 2 or type 2 are widely used to describe this group of mental operations.

Though the dual process theory has been widely used in multiple fields and has become one of the most influential theories about the human thinking process, which system performs better in the human thinking process remains controversial (Fiedler & von Sydow, 2023). Most dual process theorists support the view that when people are thinking, whether reasoning, making a judgement, or trying to give out a decision, they intuitively use system 1 to process and generate a heuristic answer, and the answer generated by system 1 may be modified and corrected by system 2 (Evans & Stanovich, 2013). However, due to the notion that system 1 is automatic and effortless, people tend to overuse system 1 instead of using system 2, which needs effort, is time-consuming, and requires cognitive control. When the system 1 process result is not corrected by system 2, heuristic biases will occur and eventually lead to a bad decision (Evans et al., 2008; Evans & Stanovich, 2013). Though this default-interventionist model has been supported in some literature (Evans & Stanovich, 2013), other evidence has highlighted the value of system 1 thinking. Gigerenzer and Brighton (2009) argued that heuristics (namely system 1) are effective cognitive techniques that eliminate irrelevant data. Contrary to what is commonly believed, some studies of heuristics have demonstrated that less time, information, and calculation can improve accuracy.

To explain our investigation, the research team first reviewed the contradictory evidence supporting different approaches related to decision-making, then discussed our results, and integrated the literature findings with our own data, which suggest that system 2 is often better for making judgements and decisions.

System 1

The benefits of system 1 thinking have been widely discussed, though it may appear counterintuitive that spending less time on a topic can lead to a better answer (Gigerenzer & Gaissmaier, 2011). Gigerenzer and Gaissmaier (2011) proposed a fast-and-frugal heuristic (i.e., heuristics are simple mental rules or shortcuts people use to make judgments and decisions quickly, especially when information, time, or certainty is limited) thinking approach, which can help people find an optimal solution to a problem quickly and with limited information.

These researchers have proposed the adaptive toolbox theory to show the value of system 1 in judgement and decision-making. The adaptive toolbox theory includes heuristics, heuristic building blocks, and fundamental cognitive abilities (e.g., recognition memory) of the building blocks used in daily decision-making. The building blocks are the three pillars of the adaptive toolbox theory: (a) Search rules to determine search space direction. (b) Search stopping rules to determine when to stop. (c) Develop decision rules to outline the final decision (Gigerenzer et al., 1999, pp. 13–14). Based on these three pillars, the fast-and-frugal heuristic requires basic cognitive skills. In other words, the adaptive toolbox includes both the heuristics that create the desired result and the cognitive processes they necessitate. One example of a heuristic from the adaptive toolbox that has received extensive research is the "recognition heuristic," which involves forming an opinion based on the knowledge that only one of two items is recognized. For example, Goldstein and Gigerenzer (2002) asked Americans and Germans, "Which city, San Diego or San Antonio, has a bigger population?" The correct answer is San Diego. About two-thirds of the Americans accurately stated the correct answer, but all Germans correctly identified the correct answer. In this example, most Germans recognized San Diego (due to its international profile, tourism, or media exposure) but did not recognize San Antonio (a less globally known U.S. city).

Applying the recognition heuristic: "I have heard of San Diego, not San Antonio, so, San Diego must be larger." This led them to the correct answer, even though they had little detailed knowledge of U.S. city sizes. However, for Americans both cities were likely recognized because they are well-known within the U.S. Since the recognition heuristic can only be used when only one of the two is recognized, Americans could not rely on it. Instead, they had to use other knowledge or guesses, which were less accurate. This illustrates the "less-is-more effect": sometimes knowing less (Germans not recognizing San Antonio) can lead to more accurate decisions when a simple heuristic fits the environment's structure.

A second example was developed when researchers asked 50 Turkish and 54 British students to predict the 32 English FA Cup third-round soccer matches. This process produced a similarly unexpected result. The British participants have substantial knowledge regarding English football teams compared to the Turkish participants, who had a limited understanding of them. Nevertheless, the accuracy of Turkish forecasters was comparable to that of their English forecasters, with a success rate of 63% compared to 66% (Goldstein & Gigerenzer, 2002).

The research paradigm adopted by Basehore and Anderson (2016) was similar to that used by Goldstein and Gigerenzer (2002), with the exception that the participants were given the names of two fictitious cities. Basehore and Anderson asked participants to determine which city has a larger population by exposing only one of the two city names before the experiment. The utilization of this particular methodology offered an improvement over Goldstein and Gigerenzer's approach, which is the benefit of experimentally manipulating recognition. These fictitious cities experimental process enabled an unbiased assessment of the influence of familiarity on people's decision-making, devoid of any other potential disparities between the two cities. The recognition heuristic was successful in this experiment as well, predicting the correct response 74% of the time.

In the context of naturalistic situations, making effective judgments and decisions becomes more difficult. Uneven and erratic factors can affect people's logical thinking and forecasts about current situations (Wang et al., 2022). In our study the research team members believed that additional data was required to establish precise findings regarding the interaction among relevant variables. However, it is often surprising how well system 1 (fast-and-frugal heuristics) works in real life (Wang et al., 2022). For example, a patient with acute vestibular syndrome (a condition characterized by vertigo, nausea, and a shaky gait) can be scanned with a magnetic resonance imaging (MRI) machine to help doctors determine if patients have suffered from a stroke. Despite being a highly effective diagnostic instrument, MRI is notably expensive. The clinical decision rule HINTS (head impulse, nystagmus type, test of skew) is another method for the diagnosis of stroke. If these tests indicate abnormalities in eye movements, then a stroke could be diagnosed. Contrary to MRI screening methods, the HINTS test is much more cost-effective and less burdensome. According to Newman-Toker et al. (2013), HINTS, which uses system 1 thinking, was more accurate in identifying strokes than an MRI.

One more real-world application of heuristics is picking the optimal course of action in the context of financial decision-making. It is true that deciding how to spend retirement savings is a multifaceted process, as there are many unknown factors that can have disastrous consequences. However, people can also consider using a heuristic known as 1/N strategy or rule. This naive diversification strategy entails putting the same amount of money into each of N different funds (Hafenbrädl et al., 2016). Interestingly, a study by De Miguel et al. (2009) compared the 1/N strategy with several much more complicated models, including the mean-variance portfolio, for which Harry Markowitz was awarded the Nobel Prize (1990) in economics. However, none of the 14 intricate models they evaluated were able to outperform the simple 1/N strategy (De Miguel et al., 2009). This is likely due to the fact that sophisticated models assign significant value to historical stock market performance indicators. However, most of the historical data are "noise" in the data and its underlying structure, leading to the production of unnecessary information and skewed models (Hafenbrädl et al., 2016). In this case, the use of heuristics can effectively help investors avoid the overuse of irrelevant information, potentially helping them make more optimal decisions.

In conclusion, the benefits of system 1 can be seen in both literal situations (e.g., determining which city has a larger population) and real-life situations (e.g., medical diagnosis and financial decision-making). Despite the evidence pointing to system 1's usefulness, educators should proceed with caution when relying on the results it produces, as there are still major disagreements about where and how to acquire these heuristics, and which ones are the most effective when applied to a given problem (Otworowska et al., 2017).

System 2 Thinking

Despite the abundance of evidence demonstrating system 1's efficacy, advocates of system 2's superiority have maintained that system 1 is associated with many logical fallacies and cognitive biases that undermine probability theories and rational thought (Fiedler & von Sydow, 2023). Our research team identified several studies that deeply investigated several biases, including: the representativeness heuristic (Basehore & Anderson, 2016), framing effect (Steiger & Kühberger, 2018), loss aversion (Sokol-Hessner and Rutledge, 2019), and the anchoring-and-adjustment heuristic (Henrizi, et al., 2021). These biases serve to demonstrate how the limitations of system 1 reinforce the significance of system 2.

One of the most common fallacies of system 1 is the representativeness heuristic (Basehore & Anderson, 2016), which ignores base-rate information, and shows the probability of specific events based on a given assumption (Fiedler & von Sydow, 2023). When seeking the best solution under uncertainty, Bayesian decision theory is considered to be the best approach for rational inference (Johnson & Tubau, 2015). Bayes' theorem requires people to weigh the probabilities and likelihood of the two hypotheses. To identify the optimum solution under Bayes' theorem, one must consider the essential facts: the relative probabilities that the hypothesis would happen under the given probability (Johnson & Tubau, 2015). However, if people rely solely on system 1 processing, they are likely to overlook this foundational data. In another study participants were asked to read a narrative description of a person, the participants were divided into two groups, informing one group that 70% of the description was relevant to a lawyer and the other group was told that 70% of the description was relevant to an engineer. On average, all participants guessed that the narrator was an engineer with a 90% probability, these results strongly suggested that people who used system 1 processing overlooked the base-rate data despite its clear presentation (Kahneman, 2003; Kahneman & Tversky, 1973).

System 1 can also generate the framing effect, when situational factors like the description used, or irrelevant information affect decisions. Using an Asian disease problem, Kahneman and Tversky (1981) demonstrated the framing effect (Tversky et al., 1982). They gave two groups of participants the same summary of an Asian disease problem but framed the solution differently. For example: Frame 1 (gain) was described in terms of survival (e.g., 250 people will be saved); Frame 2 (loss) was described in terms of death (e.g., 450 people will die). Though both solutions had the same loss and gain probability, 72% of participants chose the one with the gain. In a meta-analysis study by Steiger and Kühberger (2018), the researchers found 81 experimental findings that supported the existence of framing effects in judgment and decision-making. They claimed that the framing effect had a significant impact on people's evaluations.

Tversky and Kahneman's (1981) experiments provided evidence of how the wording of a question, and the presence of extraneous data, can influence participants' final choices. These findings further demonstrated another fallacy associated with system 1 thinking: loss aversion, the fear or pain of losing is felt more intently than the pleasure of an equivalent gain (Trippas et al., 2013). Due to the utilization of system 1 in cognitive processes and the influence of emotional elements, individuals may demonstrate a tendency towards loss aversion. This means that although losses and gains have the same amount, individuals who exhibit loss aversion are more concerned with losses than with gains (Sokol-Hessner & Rutledge 2019).

The anchoring-and-adjustment heuristic, which contends that once a judgement is made, any further adjustment is negligible, is another system 1 error. System 2 users are much more likely to adjust their judgements based on new information received, because it requires a lot more effort. In contrast, system 1 thinkers may overlook new information that can help them alter their initial judgements while focusing solely on the initial information, but this can help them save more energy. In this practice, people are more likely to use system 1 and will only make a little adjustment to the judgement. For example, after playing the roulette wheel, the number shown on the roulette wheel will significantly bias people's later judgement of the total number of countries in Africa, even though these two cases have no relevance to each other (Fiedler & von Sydow, 2023).

Furthermore, the anchoring-and-adjustment heuristic can also affect judgement in financial decisions, for example, audit judgements. The audit judgements require high cognitive ability and involve four main stages. The auditor needs to:

1. Form an analysis of the data provided by clients and form their expectations.
2. Define the possible deviations from their expectations.
3. Run the deviations on the computer.
4. Complete an analysis of the deviations.

The first stage is the most important part. The auditor needs to gather information about the field they need to audit, then analyze how reliable the data is and form an expectation of the client's data (Mactavish et al., 2018). This expectation requires the auditor to have a solid understanding of clients and industries. To form a clear expectation, the auditor must use independent and professional judgements without being influenced by unaudited data. However, if the auditor has an anchoring-and-adjustment heuristic connected to the unaudited data, they may neglect the statistics rules and the information they gathered (Henrizi et al., 2021).

Though there is reliable evidence that system 1's heuristic biases impair people's judgement and decision-making, the strategy to demonstrate system 1's failure is still criticized (McDowell & Jacobs, 2017). First, biased processing does not always cause erroneous judgements. Instead, people often make false decisions due to a small and biased sample of information (an environmental factor). For example, in the engineering problem, those who chose engineer have proof in the description. Further, incorrect judgement may not be caused by system 1. However, it can also be argued that people may make bad decisions in these artificial settings (McDowell & Jacobs, 2017).

Connection of the Literature to This Study

The question of whether system 1 could produce an optimal result still remains controversial. Based on current literature, many studies have examined the impact of system 1 thinking on the questions' outcomes, without incorporating the questions that yielded positive and negative findings for joint analysis (Da Silva, 2023). Thus, our research team conducted our investigations in an attempt to fill this gap and test whether and under what circumstances system 1 impairs people's performance or boosts people's performance. Previously conducted research questions, suggested that individuals in a particular scenario tend to rely on fast-and-frugal heuristics. Another type of question in the research suggested that individuals' decision-making abilities would be compromised by the use of system 1 thinking, when presented with a particular phrasing or task. Thus, by putting these two types of questions in the same questionnaire and comparing the average scores of participants who use the different systems, we can analyze whether and/or when system 1 boosts or impairs the thinking process. The team chose the most representative scenarios; (some have been reviewed above) to test people's thinking. Our study focused on high school students' thinking and reasoning performance when using system 1 and/or system 2. The research team established questions that show the value of heuristics thinking, which is taking the best heuristic and the fastest and most frugal heuristics. Question types that show the deficit of system 1 processing were also included, which are representative of heuristics and loss aversion.

Methodology

The objective of this study was to assess the degree to which system 1 processing characterized as fast, heuristic-based thinking (i.e., using simple mental shortcuts or rules of thumb to make judgments and decisions quickly) is associated with detrimental and/or constructive factors on individual decision-making. More specifically, the study tested two hypotheses. Hypothesis 1 stated that the majority of students would choose to use system 1 thinking or system 2 thinking to answer all of the questions. Hypothesis 2 stated that students who choose system 1 to respond to all of the questions would more likely cause more impairment than enhancement in cognitive responses than students who chose system 2 for all of their responses.

To assess this issue, 42 students from an AS-level (equivalent to AP-level) psychology course were enrolled in the study using a random number table to guarantee unbiased selection. The study was undertaken in a controlled atmosphere, namely an 80-square-meter classroom in Shenzhen College of International Education (SCIE), which kept the test conditions uniform for all participants.

Variables

The independent variable was the type of thinking process that the participants used. If participants used less than two minutes to resolve questions, we inferred they used their fast-thinking process, as it takes very little time to resolve the question. If participants used more than two minutes, we inferred they used the slow thinking process. The dependent variable was the score the participant received in the question, operationalized by calculating the total scores for participants.

Experimental Procedures

Our experimental study was designed as a laboratory experiment in an artificial situation. We presented participants with questionnaires and our subjects completed them. By analyzing the results, we were able to test the effectiveness of system 1 and system 2. The room temperature has been controlled at 23 degrees (Celsius), and the two sets of experiments both took place at 10:45 and lasted for 15 minutes each.

Experiment Method and Design

To test our hypotheses that one of the systems, either system 1 or system 2, would preferentially be used by teenagers in decision making; and students who chose system 1 would cause more impairment than enhancement than students who chose system 2 responses, we provided participants with two types of determining questions using online questioners. We used the WenJuanXing website (2025) to send out a link to the participants to complete this experiment. We implemented three questions based on our review of other studies. We generated one question that was based on recognition heuristics, fast-and-frugal heuristics; the correct or accurate answer should indicate that missing knowledge can be used to draw accurate conclusions. The second type of questions were based on the results from studies that indicated system 1 thinking would lead to inaccurate decisions, based on system 1 issues (e.g., loss aversion and base rate neglect).

The question that tested the recognition heuristics was comparing the two American cities' population sizes. The question was, “Which has the smaller population, San Diego or San Antonio?” The key to the recognition heuristic is to only recognize one option out of two and choose the option that a student recognized most. As the participants were all Chinese students, we could presumably predict they had little knowledge about the American city populations, just like the German participants in the original experiment. In this instance, the recognition heuristic can be tested like the original experiment. If there were notable improvements in the performance of participants who employed the system 1 method in this question, it would lead the team to infer that system 1 enhances cognitive processing.

In the second set of two questions, we concentrated on bias in the representativeness of a heuristic strategy for decision making. In the first of these two questions that tested representativeness heuristics, we presented the participants with a probability question. By telling the participants that “a dice has 4 red faces and 2 green faces” and letting them choose the rolling sequence that has the most possibility in coming up. Three sequences included: 1. RGRRRR; 2. GRGRRR; 3. GRRRRR. The second choice contains all the possibilities, so most likely the participants will choose the second one if they neglect the base rate and rely on system 1 thinking. The correct answer is 1, since with increasing rolling numbers, the possibility of rolling a full sequence actually decreases. In this scenario, if a substantial number of participants who employ system 1 opt for the second option, it may be inferred that system 1 exhibits a deficiency in the process of decision-making.

The final question aimed to test loss aversion, which puts the participants in a position to choose whether to leave the door or not. "Suppose you are on a game show and you are given the choice of three doors. Behind one door is a car, behind the others, goats. You pick a door, say, Number 1, and the host, who knows what is behind the doors, opens another door, say Number 3, which has a goat. He then says to you, "Do you want to switch to door Number 2?" "Is it to your advantage to switch your choice?" Though the correct answer is to choose to change the option if the participants really have a thorough thinking on this question and calculate the probabilities. If the participants rely on system 1 process their decision-making process may be defaulted, and they are likely to be affected by loss aversion.

In this scenario, people who employ system 1 thinking and use intuitive decision-making might be affected by loss aversion and feel worse when they choose to give up the thing they have now and decide not to change their option. Thus, if the participants who utilized system 1 thinking process performed significantly worse than those who used the system 2 thinking process, then the team would conclude that the system 1 thinking process did worsen people's objective judgement.

Ethics

Following the APA psychology guide's ethical criteria (Young, 2017), the research team made it clear that participants could leave the experiment at any moment without any negative consequence. Also, any person who withdraws could ask for their data to be removed. Before starting, I told each participant, "This experiment is about the psychology of decision-making" to avoid deception. The debriefing also followed after the experiment ended by clearly stating what this experiment was trying to find and what knowledge the participants could gain.

Results

By conducting the experiment in two classes, we gathered two sets of data for the same questionnaires. We conducted a *t*-test and a Cohen's *d* effect size to analyze the means of the scores of two samples of the questions answered. We also selected the subjects who used more than 180 seconds to finish all three questions as those who used system 2 thinking. We designated the subjects who used less than 180 seconds to finish all three questions, were those using system 1 thinking. We denoted those who answered the questions correctly with a 1 and those who answered incorrectly with a 0.

Our results highlight the statistically significant performance differential between system 1 thinkers (fast, intuitive) and system 2 thinkers (slower, analytical). The results demonstrated that students who worked rapidly through the questions (less than 180 seconds) scored means of 0.217, 0.174, and 0.169, while those who took more time (system 2) scored 0.588, 0.706, and 0.588 (i.e., a perfect score was 1.000). All three sets of scores were statistically significant. Thus, for teaching and learning, speed is often the enemy over accuracy, when students act on recognition heuristics (e.g., when they go with their intuition or their first word that comes to mind), they often are more likely to be wrong than when they take more time to process their responses intentionally. Teachers need to realize this difference because today's educational institutions often tend to inadvertently reward quickness, e.g., timed tests and first to raise hand participation (Ritchhart et al., 2011).

Question 1

The first question was: "Which has the smaller population, San Diego or San Antonio?" As displayed in Table 1, 42 students responded to the first question, with 24 participants using system 1 thinking and 18 participants using system 2 thinking. We denoted those who answered the questions correctly with a 1 and those who answered incorrectly with a 0 (a perfect score would have been mean score of 1). People who used system 1 for the first question earned a mean score of 0.217, with a standard deviation of 0.492. For the people who used system 2 in the first question, their mean score was 0.588 and the standard deviation is 0.370. In order to evaluate whether the difference is significant, we used a two-sample *t*-test and the Cohen's *d* effect size score. The *p*-value is less than 0.001, which indicates a highly significant statistical difference. For this question the Cohen's *d* effect size score was 0.84, which is considered to be a large effect size. These scores in our study disagree with some previous studies that asserted that the utilization of recognition heuristics can enhance individuals' speed and accuracy in responding to questions (Basehore & Anderson, 2016). The results from the present study suggest that participants using system 1 (heuristics) performed substantially worse than those using system 2 in terms of efficiency.

Table 1

Question 1

System type	Mean	Standard Deviation	Number of Correct Answers	Number Choosing Each System
1	0.217	0.492	5	24
2	0.588	0.370	10	18
t-Statistic	Degrees of Freedom	*p*-value	Cohen's *d*	
3.95	38	<0.001	0.84	

Note. *p* value < 0.001 is highly statistically significant; the Cohen's *d* = 0.84 is a large effect size

Question 2

The second question for students was: "With a dice that has four green sides and two red sides, which of the following sequences has the highest chance of being rolled:

1. RGRRRG; 2. GRGRRR; 3. GRRRRR? The statistical performance of the two systems differs considerably. People who used system 1 for the second question earned a mean score of 0.174 with a standard deviation of 0.379. For those who used system 2 for the second question, their mean score was 0.706, and the standard deviation was 0.456. In order to evaluate whether the difference is significant, we used a two-sample *t*-test and the Cohen's *d* effect size. For this question, the *p* value is < 0.001, which is considered to be statistically very significant. The Cohen's *d* effect size score is 1.29, which is considered to be a very large effect size. The difference between system 2 and system 1 has more than a 99% chance of being caused by the differences in the two systems (see Table 2).

Table 2

Question 2

System type	Mean	Standard Deviation	Number of Correct Answers	Number Choosing Each System
1	0.174	0.379	4	24
2	0.706	0.456	12	18

t-Statistic	Degrees of Freedom	*p*-value	Cohen's *d*
5.018	38.428	< 0.001	1.29

Note. *p <0.001* = highly statistically significant; Cohen's *d* 1.29 = very large effect size

Question 3

The final question was: "Suppose you are on a game show and you are given the choice of three doors. Behind one door is a car, behind the others, goats. You pick a door, say, Number 1, and the host, who knows what is behind the doors, opens another door, say Number 3, which has a goat. He then says to you, "Do you want to switch to door Number 2?" "Is it to your advantage to switch your choice?" In this practice, people who employ system 1 thinking and do the intuitive decision-making might be affected by loss aversion and feel worse when they choose to give up the thing they have now and decide not to change their option. Thus, if the participants who utilize system 1 thinking process perform significantly worse than those who use the system 2 thinking process, then the research team shall conclude that the system 1 thinking process does worsen people's objective judgement.

The difference between scores that generated from system 1 compared to system 2 had a significant difference. Participants who used system 1 thinking earned a mean score of 0.169 and a standard deviation of 0.378. People who chose system 2 thinking earned a mean score of 0.588 and a standard deviation score of 0.489. From the calculation, the *p*-value is less than 0.001, a highly significant difference, and the Cohen's *d* was 0.98, a large effect size. The findings revealed a highly significant difference between the two systems, with system 2 outperforming system 1 (see Table 3).

Table 3

Question 3

System type	Mean	Standard Deviation	Number of Correct Answers	Number Choosing Each System
1	0.169	0.378	4	24
2	0.588	0.489	10	18
t-Statistic	Degrees of Freedom	*p*-value	Cohen's *d*	
-5.018	38.428	< 0.001	0.98	

Note. $p < 0.001$ is highly statistically significant

Does the Type of Question Used Affect the Performance?

The third question included in the original study was aimed at indicating the value of system 1, as it can improve thinking, and the second question was aimed at showing that system 1 ultimately generates biases. To see whether the type of question asked led to a different performance of system 1, we used an ANOVA test to assess if there was a significant difference in the score of the type of question that the people using system 1 received under different types of questions.

From the ANOVA statistics in Table 4, the *p*-values between question 1 and question 2 and between question 1 and question 3 are both less than 0.01, indicating that there is a statistically significant difference between the groups. This raised another question did the three different questions have different results? To test this question, we conducted post-hoc tests. The post-hoc tests were conducted using the Tukey's HSD method (The Tukey's honestly significant difference test is used to test differences among sample means for significance. The Tukey's HSD tests all pairwise differences while controlling the probability of making one or more type I errors). As shown Table 4, there is a significant difference in means between questions 1 and 2, and between questions 1 and 3, but not between questions 2 and 3. Since there is a significant difference between question 1 and 2 and between question 1 and 3, it suggests that system 1 thinking process does function differently with different kinds of questions.

Table 4

Comparison of Question Types

Questions Compared	Mean Difference	Standard Error	*t*-value	*p*-value	Cohen's *d*
1 vs. 2	-0.370	0.098	3.78	0.001	0.58
1 vs. 3	-0.347	0.102	3.42	0.003	0.53
2 vs. 3	0.023	0.104	0.22	0.997	0.03

Note. $p < 0.001$ and $p < 0.003$ are highly statistically significant; $p = 0.997$ is not statistically significant. Cohen's *d* 0.58 and 0.53 = medium effect sizes; 0.03 = negligible effect size

Summary

To compare system 1 (fast, heuristic-based thinking) against system 2 (slow, more analytical thinking) thought, the study generated data from two groups. The participants were divided by whether they took over or under 180 seconds to answer three questions. For all three questions, 24 students used system 1 thinking and 14 students used system 2 thinking to respond to each of the three questions. In all three cases students who used system 2 thinking had statistically significant higher scores than students who used system 1 thinking. These results were clear evidence of a vast performance disparity: those in system 2 had statistically significant higher mean scores (0.588; 0.706; 0.588) than the system 1 group (0.217; 0.174; 0.169). The results of a two-sample *t*-test (p-value <0.001 for each question) and Cohen's d (0.84; 1.29; 0.98) confirmed the differences were highly significant. These scores indicated that while some earlier studies focused on recognition heuristics, the participants in this study who used quick, heuristic-based thinking performed substantially worse than those who took extra time in deliberation.

Conclusions

Based on these results, we can conclude that although the type of question asked has a different performance within the group, system 1 impaired the thinking process significantly more (in bias generation) than system 2. Contrary to previous studies (Gigerenzer & Brighton, 2009), that showed the accuracy of heuristic thinking when determining the decision making, the participants in our study only recognized one. Our experimental results show that system 1 thinking did not help improve the thinking process for good decision making in our participating high-school students for the questions we posed to participants. Thus, we conclude that, at least for our high-school students, to make good decisions and avoid biases, they should rely more on the use of the system 2 process rather than system 1. This was evident from the results of the three different questions.

We are very much aware that our investigation is limited to a small sample of subjects, and that based on our statistical analysis, the type of question used will affect system 1 processing. Thus, there is a possibility that the performance difference among participants may be attributed to the question types or wording. Therefore, future studies are needed to investigate whether the wording of the question will affect participants' performance. Moreover, even though, dual process theory has been heavily debated in the literature, neurological evidence is also needed to make the dual process theory a solid theory for human reasoning, judgement, and unbiased decision-making.

How and Why the Findings Matter for Teachers and Students

Our study indicated that students' intuition, which is linked to fast thinking, often leads to quicker completion of academic tasks through the use of heuristics. However, while this approach may improve time-efficiency, it is not always effective, as reliance on mental shortcuts can sometimes result in errors or superficial understanding rather than deep, accurate learning.

Recommendations for Students

Based on our study, we can suggest that that fast, intuitive decision-making, using system 1 thinking, can increase speed but also elevate the risk of errors due to cognitive biases or oversimplification. Therefore, when time allows, we would advise students to deliberately re-check answers/work, this would not be a sign of uncertainty or inefficiency, but rather a strategic practice aimed at improving accuracy, depth, and coherence. Rechecking validates the ideas that needs to go into any answer, thinking critically and not just responding to what is asked and shifts cognition toward system 2 (slower, more analytical thinking) enabling critical evaluation, detection of inconsistencies, and refinement of ideas, ultimately leading to stronger, more validated outcomes.

A very relevant study by Metcalfe and Finn (2008), on metacognition and error correction, showed that students who engaged in deliberate re-checking and self-explanation significantly improved their performance on problem-solving tasks, particularly by catching heuristic-based mistakes that arose from rapid initial responses. This aligns with the idea that revisiting answers facilitates deeper processing and reduces overreliance on intuition.

Thus, our study contributes to the growing body of work on metacognitive strategies in education by empirically linking system 1 and system 2 frameworks to practical classroom interventions. Specifically, it offers evidence that structured re-checking protocols can mitigate the pitfalls of fast thinking, providing a teachable method to foster critical thinking and accuracy (areas often emphasized in theory but less frequently tested in applied, in-situ educational research). Future studies could explore longitudinal impacts or variations across disciplines to further validate and refine this approach.

Recommendations for Teachers

The researchers in this study recognize the importance of the fact that classroom pace needs to be adjusted, sometimes it needs to be slowed down, so that students can move from superficial to deep analytical thinking. The argument that classroom pace should be strategically adjusted (often slowed) rests on a fundamental cognitive principle: deep analytical thinking requires time and cognitive resources that are unavailable during rapid, high-pressure instruction (Sweller et al., 2019). When the pace is relentlessly fast, students are often forced into a reactive mode, relying on surface-level recognition, memorization, or guesswork (system 1 thinking) to keep up (Brown et al., 2014; Hattie & Yates, 2014). This can create an illusion of fluency or engagement while bypassing the crucial stages of elaboration, connection-making, and critical evaluation (Sweller et al., 2019). Slowing the pace intentionally creates the necessary "cognitive space" for students to:

1. **Process Information Deeply:** Instead of simply recording facts, students can interrogate them, connect them to prior knowledge, and explore underlying principles.
2. **Engage in Metacognition:** Students can ask themselves, "Do I truly understand this?" and "How does this relate to what I already know?"
3. **Practice Retrieval and Application:** With more time, activities can shift from quick recall to applying concepts in novel contexts, a key driver of long-term retention.

Educators should realize that on one hand a quick response is often associated with lower accuracy (system 1 thinking), but that on the other hand time constrains often require quick responses, thus presenting a pedagogical dilemma. In order to illustrate to students on these variables, and to apply these variables, teachers should:

1. Introduce Cognitive Systems

Teachers should consider instructing students on the concepts of system 1 (fast, intuitive) and system 2 (slow, analytical) thinking. It is crucial for learners to understand the mechanics of their own decision-making processes, and to learn how to deliberately take time to learn. This deliberate deceleration shifts the cognitive load from keeping up with the flow of information to actively constructing understanding (Sweller et al., 2019). The outcomes are not just "better grades" on a single test, but higher accuracy due to fewer heuristic-based errors, and higher retention due to the creation of stronger, more connected memory traces (Brown et al., 2014; Hattie & Clarke, 2018).

2. Prioritize Thinking Under Pressure

Educators play a vital role in teaching students how to adapt their thinking strategies based on time constraints. Specifically, students need guidance on:

- **Time-Critical Decisions:** Understanding when it is necessary to rely on quick judgment due to a lack of time.
- **Managing Dilemmas:** Learning how to weigh options when facing conflicting demands or limited resources.
- **Strategic Reconsideration:** Knowing when to pause and re-evaluate their initial thoughts as circumstances change.

3. Application for Teachers

Teachers must also recognize that they cannot always adopt a slow, deliberative approach. Therefore, they should actively reflect on their own practice to determine when it is appropriate to utilize system 1 efficiency and when the situation demands the depth of system 2 analysis.

Teach "Wait Time." Teachers can promote students' slow thinking time after asking a question, so that the "quickest" kids do not take over, and everyone will experience system 2 thinking.

Redefine Proficiency. Instead of defining intelligence as being quick, teachers can demonstrate that deep thinking takes time, and that those who put more than one thought in the right context often perform better.

Teach Metacognition. Teachers can guide students in what they should be aware of for these two ways of thinking, so that they can identify when they are in a rapid-evaluating mode to reach the outcome and when they need to slow down to validate their answers.

Conclusion

Our study makes a valuable empirical and practical contribution to this existing body of studies:

- **From Theory to Classroom Practice:** While CLT and the science of learning provide the "why," our study investigates the "how" and "what happens" in a real classroom setting. We suggest moving beyond the laboratory to show what "slowing down" looks like operationally (e.g., through structured re-checking, think-pair-share pauses, extended problem-analysis periods) and measure its direct effects on accuracy and retention metrics.
- **Bridging Cognitive Psychology and Pedagogy:** Our work directly connects the dual-process theory (system 1 vs. system 2) to a specific, actionable teaching strategy (pace adjustment). We provide evidence to suggest that by manipulating an environmental factor (pace) teachers can effectively encourage a shift in the cognitive process students use, thereby validating a key link in the educational application of cognitive science.
- **Addressing the "Coverage" Dilemma:** A major barrier for teachers is the perceived tension between covering required material and teaching for depth. Our study contributes data showing that the trade-off may be worthwhile; the gains in accuracy and retention from a deeper, slower approach on core concepts may offset the "loss" of covering fewer topics superficially. This provides a research-backed argument for curricular prioritization.

In summary, our study strengthens the call for pedagogical patience by providing concrete evidence that when we slow the race to cover content, we win the longer, more important race toward durable and meaningful learning.

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