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Intuition Versus Analysis- Which Process is Most Appropriate for Solving Everyday Problems with Differing Levels of Social Content and Complexity?

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Intuition Versus Analysis—Which Process is Most Appropriate for Solving Everyday Problems with Differing Levels of Social Content and Complexity?

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Abstract

The investigators wanted to test the theories laid out by Hammond (1987) and McMackin and Slovic (2001) that problem attributes affect the appropriateness of intuition for solving problems. The study investigated the appropriateness of strategy (intuition, analysis, or no strategy) for everyday problems that varied in social nature and complexity. It was hypothesized that problems high in social nature and complexity would be solved more accurately using intuition. Results were partially supported but only among novice participants. Results indicate that highly intuitive novice individuals score more accurately than those who are highly analytical when solving everyday problems. One of the implications of the study is that expertise should be included in future studies on intuition.

Intuition Versus Analysis—Which Process is Most Appropriate for Solving Everyday Problems with Differing Levels of Social Content and Complexity?

In her senior year at college, Andrea faces a dilemma. A prestigious company offers her a job that is two hours from where her fiancé has accepted a job. She knows that if she accepts this job offer she will only be able to see him twice a month. It is getting close to the time where she has to decide whether to accept or decline this offer, and she has received no other job offers. What should she do? This problem is very complicated but not unrealistic. On a weekly basis we are faced with complicated social problems, perhaps not *quite* as complicated as Andrea's, but nonetheless problems that are neither quickly nor easily solved. When faced with making a difficult decision such as Andrea's it is not uncommon for friends to offer advisory statements such as "trust your instincts" or "trust your intuitions" to arrive at the best decision possible. While most people have heard this advice at one time or another, just how accurate are our intuitions about social sitiations?

Social problems are not the only type of problems in which one may have to use intuitions. Some every-day problems that people face are too complicated to adequately break down and analyze. Take the case of Dave, for example. Dave is currently applying to counseling masters programs across the country and will soon have to choose between the five graduate programs that have accepted him. Dave may try analytically deciphering which school is the right one for him. He may try comparing the schools on objective variables such as student to professor ratio or job placement rates. While this might sound like an accurate way to make his decision, he may arrive at a more accurate answer by viewing the problem holistically. Often graduating high school students are told that their optimal college choice will just "feel

right" or they will "know" after they visit a campus that the school is right for them. When Dave makes this complicated decision he may be better off viewing the problem as a whole rather than looking at individual variables in the problem because he will never be able to analyze every single variable in such a multi-faceted problem.

Dual-Processing Theory

Before investigating whether analysis or intuition will work better for solving problems, it will be beneficial to review the processes that underlie intuition and analysis. There are two basic ways of processing information, intuitive and analytical (Kruglanski et al., 2003).

Intuitive processing. Lieberman (2003) represents the intuitive processing mode as a quick, low-effort, relatively superficial, and heuristic-based process that is without conscious awareness and reflection. Lieberman's view is that intuitive processing is either prewired by our biology or a product of early experience and emotional conditioning. He also believes that the system operates largely by default, in a reflexive and mechanistic manner, much like the earlier example of Dan's cognitions. Epstein (1991) views the intuitive mode as holistic, automatic, effortless, affective, slower and more resistant to change, context-specific, and passive and preconscious. Hogarth (2005) theorizes that the system may involve feelings and emotions.

An example of intuitive processing is the means through which people acquire stereotypes. Everyday Eric sees a man smoking outside of his workplace. In seeing this, all the associations that Eric has ever had about smoking are elicited by this situation. Eric might make certain automatic associations with the smoker, such as he generally leads a very unhealthy

lifestyle. One day, Eric sees the smoker at the gym and realizes that his assumption was unfounded.

Analytical processing. In contrast to intuitive processing, the analytical processing mode involves activation of the prefrontal cortex and reflects explicit learning of symbolic rules, principles, procedures, and cultural norms (Lieberman, 2003). An example of this is formal schooling. We use this processing system to learn explicit knowledge such as reading, writing, and arithmetic. Processing based on this system is reflective, deliberative, and constructive rather than mechanistic. It is rule-based, abstract, and domain general. The rules learned in the analytical processing mode can be applied in many domains. For example, when Susie first learns to read the book Hop on Pop she can apply the rules of reading to other books, she is not restricted to reading only Hop on Pop. Analytical processing is intentional and capable of overriding intuitive processes (Lieberman, 2003). Deliberate judgments always involve the analytical system, but automatic processes do not rely on the analytical system.

Cognitive Miser View

Although differences exist between the variations on dual-process models, the consensus between researchers is that each system is distinguished by the presence or the absence of cognitive effort (Forgas, Williams & von Hippel, 2003). The models distinguish between superficial, fast, heuristic processing styles, and slower, more effortful, systematic processing styles (Lieberman, 2003). Offering more evidence for dual-process theory is the idea that these two processing styles correspond to neural activity in different parts of the brain (Forgas et al., 2003). Now that I have explained the two processes, I will address how these two processes relate to problem solving and decision-making.

Intuition, Analysis and Decision-making

Many decision-making researchers argue that careful analysis leads to more accurate decisions than intuition (McMackin & Slovic, 2000). From the prevailing "cognitive miser" perspective on judgment, intuition is viewed as a shortcut or a product of mental laziness. From this perspective, heuristics such as intuition function as time and effort-saving mechanisms, not as a goal-serving device (Brewer, 2003). These researchers believe that relying on intuition leads to faulty decision-making and that analytical reasoning is the best method to achieve goals (Tversky & Kahneman, 1983).

Tversky and Kahneman (1983) found evidence that intuition is biased and inaccurate in their research on intuitive probability judgment. For example, in one study subjects were shown brief personality descriptions of several individuals and asked to assess whether the person was an engineer or a lawyer. In one experimental condition, participants were told that the pool from which the descriptions were drawn consisted of 70 engineers and 30 lawyers. In the other condition, they were told the opposite, 30 engineers and 70 lawyers. People responded to the following sketch under both of these conditions:

> Dick is a 30 year-old man. He is married with no children. A man of high ability and high motivation, he promises to be quite successful in his field. He is well liked by his colleagues.

The participants judged the probability of Dick being an engineer as .5 whether the stated proportion of engineers in the group was a .7 or .3, an irrational judgment. When participants relied on their intuitions, they generated a biased, illogical answer. People thought that since there were only two options, there was a 50% chance that Dick was an engineer. However, if

they had analyzed the problem they may have realized the fault of their logic. This research illustrates that people do make errors when they use intuition to perform certain tasks, in this case a mathematical problem, probability. The researchers have found this phenomenon in other experiments based on tests of logic (Kahneman & Tversky, 1972; Tversky & Kahneman, 1971; Tversky & Kahneman, 1974). While analysis may lead to a more accurate answer for highly logical types of problems, researchers have found evidence that for certain types of problems, intuition prevails over analysis.

Positive Effects of Intuitive Reasoning

In opposition to the cognitive miser view is the view that intuitive reasoning prevails over analytical reasoning under certain conditions. Specifically, intuition benefits problems that are highly complex and highly social in nature.

Complexity of problems. There is evidence that intuitive reasoning may prevail when a problem is too complex for all of the variables to be adequately analyzed. Wilson and Schooler (1991) found that judgments of the different brands of jam were impaired when participants were asked to analyze reasons for choosing the jam.

Participants ranked five different brands of jam. Participants in the intuitive condition rater their overall preference, while participants in the analytical condition rated the jam based on specific dimensions (e.g., color and consistency). When the outcomes were compared with expert jam connoisseur opinions, intuitive judgments corresponded more closely with the experts' ratings than analytical judgments did. The researchers theorized that intuition may have prevailed over analysis in this task because the problem had too many variables to analyze. When forced to give reasons for a highly complex problem, participants may pick out a variable

that is not as important, such as color, and inflate the importance of it. If this is the case, people should do better on complex problems when they view the problem intuitively.

Other researchers have also found evidence that tasks that were relatively complex were better solved using intuition (e.g., Hammond et al., 1987). Hogarth (2005) has hypothesized that the greater the complexity of a problem, the harder it is to apply the appropriate analytical formula to solve the task. A good example of this is the shopping cart problem. Standing in the grocery line one might want to figure out the total cost of the purchase. If one has only 8 or 9 items, a good way to figure out the cost would be to use a calculator. However if one has fifty or sixty items in the cart, one risks the chance of putting the decimal point in the wrong place when using the calculator; therefore, this option would probably be less effective. A more efficient strategy in this case might be to estimate how much the bill will cost based on the fullness of the cart. In the vein of the shopping cart example, intuition should benefit problems that are highly complex. I plan to test Hogarth's model on the characteristic of complexity.

Social characteristics of problems. There is evidence for the benefit of intuition in social scenarios as well. Although people may not remember the specific stimuli that triggered attitudes towards people, their spontaneous social judgments are quite accurate in reflecting their experiences (Betsch, Plesser, Schwieren, & Gutig, 2001). A number of studies have indicated that ratings of brief observations or thin slices of expressive behavior can be used to predict social and clinical outcomes at levels significantly above those expected by chance (Ambady & Rosenthal, 1992).

Thin slices of behavior research have been used in the area of interpersonal expectations and biases. In this type of research participants are shown a brief clip or sound byte of an

interpersonal nature and asked to rate people on certain characteristics. They are intuitive judgments because the participants are only given part of the information needed to make the prediction.

For example Bugenthal, Caporael, & Shennum (1980) found that participants could accurately predict parent's expectations of their child's behavior based on an audio clip of the parent's voice. The ratings of the tone of voice of mothers with normal children and the tone of voice of mothers whose children had behavior problems differed significantly. The mothers of children with behavior problems voices revealed a lack of confidence in their ability to control their children.

In addition, research has shown that from watching brief exchanges of judges interacting with jurors in actual criminal trials, raters could predict the judges' expectations for the trial outcome and the criminal history of the defendant (Blanck & Rosenthal, 1992).

Even stronger evidence for the benefit of intuition in social situations are findings that people are fairly accurate at identifying emotions from exposures to nonverbal behavior lasting only 6 seconds long. Ambady and Rosenthal (1992) found that participants could accurately rate characteristics of teachers from watching a video clip that was only 6 seconds long. The ratings of the teachers corresponded to ratings the students gave after having the teacher for an entire year. The ratings also corresponded to how the teachers had rated themselves on the characteristics at a level greater than chance. This example illustrates the power of intuition. From a clip that was only 6 seconds long, participants were able to accurately rate characteristics of teachers.

These examples demonstrate how intuitive reasoning has been effective in the realm of social judgments. The strategy of intuition may help more than the strategy of analysis on social problems because social knowledge is acquired through the tacit system rather than the deliberate system (Ambady & Rosenthal, 1992; Harris & Rosenthal, 1985). We communicate our interpersonal experiences and biases through subtle, almost imperceptible, non-verbal cues that are so subtle that they are not encoded nor decoded at a conscious level of awareness. Ambady and Rosenthal (1992) also argue for the accuracy of intuition in social judgment,

> "We believe something is communicated through expressive behavior. Much of this expressive behavior is unintended, unconscious, and yet extremely effective. For example we communicate our interpersonal expectancies and biases through very subtle, almost imperceptible, nonverbal cues. These cues are so subtle that they are neither encoded nor decoded at an intentional, conscious level of awareness" (p.256).

Rationale and Predictions

Knowing which strategy to use in approaching social and highly complex problems will help us all to solve problems more easily and accurately. Recent research has pointed out the value that intuition might have for highly complex and social situations. In the present study, I investigated the effects of the independent variables of problem complexity, social nature of problem, and problem solving strategy on the dependent variable, problem solving accuracy using the Practical Problem Solving Questionnaire, an inventory of everyday college problems. I predicted an interaction between problem complexity and problem solving strategy. Specifically, the analytical strategy should produce more correct answers when applied to the less complex problems, and the intuitive strategy should produce more correct answers when

applied to highly complex problems. I also predicted an interaction between problem solving strategy and the social nature of the problem. That is, more social problems should be solved better using intuitive strategy and less social problems should be solved more accurately using analysis. I also predicted a three-way interaction in that the intuitive strategy will produce the most correct answers in the subset of problems that is high complex and social in nature.

RATINGS STUDY

In order to manipulate these task characteristics (social nature, complexity), the experimental materials were rated on these dimensions. These ratings were used to create sets of problems that varied systematically in their social nature and degree of complexity.

Methods

Participants

Twenty-five undergraduate students from Illinois Wesleyan University (15 women, 10 men) were recruited to participate in the pilot study. Participants ranged in age from 19 to 21 (M=20.36 SD=.70). Students were recruited through advertisements and received compensation through a pizza party given after the experimental session was over.

Materials

Practical problem solving questionnaire rating survey. The rating survey was designed in order to test the validity of the problem scenarios that would be posed to college students in the *Practical Problem Solving Questionnaire* (*PPSQ*). Because the study is designed to test the tacit knowledge of college students, the scenarios involve problems that a college student would

be likely to encounter in his or her everyday life. For examples of the problems, see Appendix A.

Each of the thirty problem scenarios were rated on each of these characteristics on a 7-point Likert scale: ambiguity, complexity, concreteness, decomposability (Is the problem easy to decompose into parts or steps?), easy to solve quickly, how much the problem involves the consideration of interpersonal relationships to solve, how much the problem involves the consideration of emotions to solve, and how much the person rating the problem thought he/she was competent to solve it. Higher ratings indicated that the characteristics described the problem scenario. For rated characteristics and scale, see Appendix B.

Procedure

Participants were tested in groups of one to twelve in the common area of a college dorm. Students were told that the rating would take around an hour, and that they would receive a pizza party after the rating session was over. Packets were handed out and each section was explained. Students were told to rate each problem on the 7 characteristics and told not to try to answer the problem. The experimenter told the students to read through and complete an example carefully before they began rating the questions. Participants were given a chance to ask any questions that they might have.

Results

From the pilot study we were able to divide the questions into four subsets of problems: problems that were social/high complexity in nature, social/low complexity in nature, non-social/high complexity in nature, and non-social/ low complexity in nature.

Social vs. non-social problems. Problems were considered social in nature if the mean of the student ratings was above a 4 on how much the problem involved the consideration of interpersonal relationships to solve and/or if the mean was above a 4 on how much problem involved the consideration of emotions to solve. If the question was rated above a 4 on either of these scales, it was considered social. Any question that the experimenters had previously thought was social or non-social and that was not rated as such by the students was thrown out due to inconsistency.

High complexity vs. low complexity problems. Problems were considered highly complex if the mean of the student ratings were below a 4 on decomposability. Also, problems were considered highly complex if the mean of the student ratings was below a 4 on concreteness. Any question that the experimenters had previously thought was highly complex or low complex and was not rated as such by the participants was thrown out due to inconsistency. All problems were rated above a 4 on complexity.

Competence. All of the problems used were rated above a 4 on the characteristic "this problem is one that you are competent to solve."

EXPERIMENTAL STUDY

The experimental study was designed to test the primary hypothesis regarding the interaction of strategy use and task characteristics.

Method

Participants

Participants were 189 (53 male, 136 female, mean age= 18.92 *SD*= 1.01; 65 analytical condition, 65 control condition, 59 intuitive condition) undergraduate students from Illinois Wesleyan University. Of the participants, 81 were first-year students, 82 were sophomores, 11

were juniors, and 15 seniors. Students were recruited through advertisements, word of mouth, and announcements in introduction to psychology classes. The students received compensation through either a $10 gift certificate to the campus bookstore or class credit for an introductory psychology course. The treatment of the participants was in accordance with the ethical standards of the APA.

Materials

Practical problem solving questionnaire. The *Practical Problem Solving Questionnaire* was adapted from two established tests of tacit knowledge, the *College Student Tacit Knowledge Inventory (CSTKI; PACE, 2002)* and the *Everyday Situational Judgment Tacit Knowledge Inventory (ESJI; PACE, 2002).* The *CSTKI* is a measure used to judge a person's demonstrated tacit knowledge in the social and academic realms of college life. This measure contains a sequence of dilemmas common to the college setting, for example, settling a problem with a roommate or identifying the steps a student should take in order to ensure an A on a research paper. Each problem has a brief description of the dilemma, followed by a sequence of possible solutions, which the participant rates in terms of its relative effectiveness. The *ESJI* is a measure used to measure tacit knowledge in the workplace. See Appendix A for samples of problems.

The *PPSQ* expands on the range of problems offered in the *CSTKI* and the *ESJI to* include more problems that are non-social.

The problem solving accuracy score was calculated as a distance score from the consensus of all participants. The mean for every response option was computed, and the deviation of each individual's response from this consensus was calculated. The deviations for each response option were averaged to create and overall deviation score on each problem. The

average distance score was calculated for each of the subsets of problems (high complexity/social, high complexity/non-social, low complexity/social, and low complexity/non-social).

Strategy Use Questionnaire. (Pretz, 2004) The Strategy Use Questionnaire asks participants to specify the nature of their problem-solving process. This measure serves as a manipulation check of the experimental intervention and indicates whether participants complied with the strategy instructions. After each of the four subsets of problems, participants filled out the Strategy Use Questionnaire and reported what strategies that they actually used when they were solving the problems. For an example, see Appendix C.

Analytical and intuitive cognitive styles. Analytical and intuitive cognitive styles were measured as an individual-difference variable using the Rational-Experiential Inventory (REI; Epstein, Pacini & Norris; 1998). The REI is a 40-item questionnaire with two subscales for rational and experiential abilities. It is scored on a 5-point Likert scale. The rational subscale attempts to quantify an individual's reliance and preference for logic when solving problems. The experiential inventory estimates the degree to which a person prefers to rely on intuition. The two scales are independent, in other words, a person may be high or low on one or both of the scales. For an example, see Appendix D.

Procedure

Participants were tested in groups of one to thirty in classrooms. Groups were assigned to one of three conditions in which they were instructed to use either an analytical strategy, a holistic intuitive strategy, or no specific instructed strategy (control group). Condition assignment was designed to balance differences in gender and class year across groups.

Students filled out two consent forms, one for them to keep and one for the researchers' records, which was collected separately from any data. They then completed the REI and another personality questionnaire relevant to another project. Subsequently, the students were instructed on the concept of practical problem solving and the types of problems that they would be encountering on the *PPSQ*. After completing two practice problems, they were given strategy instructions specific to their experimental condition: analytical, holistic intuitive, or no strategy.

Analytical instruction. Those in the analytical instruction group were given a definition of analysis and told to use the following steps to analyze the problems and the solutions to the problems:

1. First, define the problem.
2. Identify the relevant pieces of information in the problem.
3. Decide how you will use your resources to solve the problem.
4. Finally, identify and evaluate the possible consequences of potential solutions.

The instruction lasted about 5 minutes.

Holistic intuition instruction. Those in the holistic intuition group were instructed to rely on their intuition as a strategy to rate the questions posed in the survey. They were told to try to see the problem as a whole, to view the problem from various perspectives and not to focus on any one part. They were told to imagine the situation vividly, then to view the problem holistically by taking various perspectives on the problem, and to trust feelings and hunches about a problem. Lastly, they were told that if they became stuck on a particular problem that they should incubate, that is, skip the problem and come back to it later. The instruction lasted around 5 minutes.

Control group. The control group was told to use whatever strategy came naturally to them. Instruction took around one minute.

After instruction, students in all three conditions completed all of the problems on the PPSQ. The entire session took around an hour. After students turned in their surveys, they were given either course credit or a $10 gift certificate to the IWU bookstore and a debriefing sheet.

Predictions and Hypotheses

Hypothesis 1. There will be an interaction between the social nature of the problem and strategy. Social problems approached with the strategy of intuition will be more accurately solved than those approached with the strategy of analysis. Likewise, non-social problems approached with the strategy of analysis will be more accurately solved than those approached with the strategy of intuition.

Hypothesis 2. There will be an interaction between the complexity of the problem and the strategy used. In other words, the more complex the problem, the more accurate the strategy of intuition will be. Conversely, the less complex the problem the more accurate the strategy of analysis will be to solve it.

Hypothesis 3. There will be a three-way interaction between strategy, complexity, and the social nature of the problem. In other words, the strategy of intuition will produce the most accurate results with those questions that are highly complex and social in nature. Conversely, the strategy of analysis will produce the most accurate results for those questions that are the least complex and least social in nature. All predictions are represented in Figure 1 in Appendix.

Data-analytic strategy. Given the current experimental design, the hypotheses can be tested in two ways, by examining the impact of the instructional manipulation, and by examining individual differences in cognitive style among uninstructed participants.

Results

Reliability

All measures used in this study were reliable (Cronbach's $\alpha > .70$). Refer to Table 1 for reliability values.

Manipulation Check

Our intention in manipulating problem solving strategy was to expose participants to three problem solving strategies (intuitive, analytical, and control). To determine whether the manipulation worked participants filled out the strategy use questionnaire. Participants rated their use of (3) analytical and (5) intuitive strategies after each problem set on a 5-point Likert scale. An analysis of variance was performed to assess the effect of the strategy manipulation on reported strategy use. Refer to Table 2 for means.

The interaction effect of reported strategy use and condition was highly significant, $F(1, 36) = 8.76, p<.0009$. Participants in the analytical condition reported using analytical strategies to solve the problem subsets, and participants in the intuitive condition reported using intuitive strategies to solve the problem subsets. Participants in the control group used a combination of both.

For the analyses using condition as an independent variable, participants who did not use the instructed strategy were eliminated from the analysis. I eliminated participants who were

below the means for analytical and intuitive use in the appropriate condition. This resulted in a sample of 49 participants in the intuitive condition, and 52 in the analytical condition.

Testing the Hypotheses

Effect of instruction. The purpose of this analysis was to determine whether the independent variable of instruction condition (analytical, intuitive, or none) had an effect on problem solving score for social and highly complex problems. I predicted that participants in the intuitive condition would solve social problems more accurately than participants in the analytical condition. Refer to Figure 2 in Appendix.

Problem solving practice scores and individual differences in cognitive style (REI scores) were used as covariates in the analysis. There was no interaction effect of instruction and social nature of the problem, $F(1, 96)=.054.$, $p=.817$. Counter to predictions, participants in the intuitive condition did not solve social problems more accurately than participants in the analytical condition. There was no interaction effect of instruction and problem complexity, $F(1, 96)=.500$, $p=.481$. Counter to predictions, participants in the intuitive condition did not solve complex problems more accurately than participants in the analytical condition. I also predicted a 3-way interaction of (social) X (complex) X (condition). This interaction was not significant, $F(1, 96)=.251$, $p=.618$.

Effect of cognitive style. Because there were no effects of instruction, the same hypotheses were tested among participants in the control group ($N=39$) using individual differences of cognitive style on the REI as the independent variable. The analytical group was comprised of 20 participants who had scored above the median on the rational scale of the REI and below the median on the intuitive scale. The intuitive group was comprised of 19

individuals who had scored above the median on the intuitive scale of the REI and below the median on the rational scales.

I tested the predictions using a 2 (social) X 2 (complex) 2 X (cognitive style) mixed ANOVA. Problem solving practice scores were used as a covariate in the analysis. Social and complexity factors were within-subjects variables and individual differences in cognitive style were the between-subjects factor. The results are displayed in Figure 3 in the Appendix.

I predicted an interaction between the social nature of the problem and cognitive style. This interaction was not significant, $F(1, 36)=.077$, $p=.783$. Participants with intuitive style did not score better on social problems than the participants with analytical style. I predicted an interaction between the complexity of the problem and cognitive style. This interaction was not significant, $F(1, 36)=.975$, $p=.330$. Participants with intuitive style did not score better on complex problems than the participants with intuitive style.

The interaction effect of social X complex X cognitive style was significant, $F(1,36)=4.584$, $p=.039$. Participants with an intuitive cognitive style did not outperform analytical participants on the social complex problems but rather on the nonsocial complex problems. For nonsocial complex problems, highly intuitive people score significantly better than highly analytical people, $F(1,36) = 4.237$ $p=.047$. Among the intuitive participants, scores depended on the complexity of the problem for nonsocial problems, $F(1, 36) =4.504$ $p=.041$. Highly intuitive people did significantly better on the complex nonsocial problems than on the noncomplex nonsocial problems.

Unexpected finding

Previous research has found that strategy success may depend on level of experience (Pretz, 2004). In light of this possibility, I conducted analysis separately for the first year students (N=17) and upper class students (N=22). First year students were tested during their first 2 weeks of college. Upperclassmen were sophomores, juniors, and seniors. The results for the first year students are shown in Figure 4 in Appendix.

The predicted interaction effect of social nature of the problem and cognitive style was not found, $F(1, 14)=.275$, $p=.609$. First year students with intuitive style did not score better overall on social problems than the participants with analytical style. The predicted interaction between the complexity of the problem and cognitive style was also not found, $F(1, 14)=.487$, $p=.497$. First year students with an intuitive style did not score better overall on complex problems than the participants with analytical style.

Among the first year students, the three-way interaction of social X complex X cognitive style was marginally significant, $F(1, 14)=3.569$, $p=.08$. This three-way interaction was due to the performance of intuitive first year students on nonsocial/noncomplex problems. First year students with an intuitive cognitive style did significantly better than first year students with an analytical style on the social/complex problems, $F(1,14)=6.722$, $p=.021$, social/noncomplex problems, $F(1, 14)=8.359$, $p=.012$, and nonsocial complex problems, $F(1,14)=6.877$, $p=.020$. In line with predictions, intuitive cognitive style did not benefit first year students as much on nonsocial/noncomplex problems, $F(1,14)=3.525$, $p=.081$.

Among the sophomores, juniors, and seniors, there were no significant effects for cognitive style, complexity, or social nature of the problem. All p values were greater than .10.

Upperclass students performed equally well on social, complex, and nonsocial/noncomplex problems regardless of the strategy used. See Figure 5 in Appendix.

Discussion

Summary of Results

Overall, my hypotheses were partially supported. In solving problems about collegiate life, the first year students benefited from intuitive cognitive style. Social problems were solved significantly more accurately among first year students with an intuitive cognitive style than those with an analytical cognitive style. This supports my prediction that the more social in nature a problem is, the more appropriate the strategy of intuition is for solving it. This interaction was not found among the upper class students.

Complex problems were solved significantly more accurately among the first year students with intuitive cognitive style than the first year students with analytical cognitive style. This supports my prediction that the more complex the problem, the more appropriate the strategy of intuition is to solve it. This interaction was not found among the upper class students.

Finally, I did find a 3-way interaction of social X complexity X cognitive style among the first year students. When solving nonsocial/noncomplex problems freshman did not benefit as much from intuition. This follows from predictions.

Intuitive versus analytical first year students

Why did intuitive first year students perform better than analytical first years? It is possible that since the first year students would be considered novices at college life they would do worse when they tried to analyze a situation because they did not have enough understanding of what variables were important to solving the problem (Pretz, 2004). Pretz has theorized that

novices are less accurate at analyzing problems because they select the wrong variables to analyze. First year students might do better when using intuition because intuition allows them to look at the problem holistically and not get fixated on irrelevant variables. The finding implies that when in new situations novices should go with their gut instinct because they have a better chance at getting the right answer.

Novice versus expert performance

Why did task characteristics affect novice but not expert problem solving? The upperclass students may have perceived the problems as less social and less complex than the first year students did. The first year students had only been in the domain of college life for two weeks and might have perceived the problems as more complex or social than the upper class students. The finding implies that expertise should be included in future studies on intuition because of its interactive effect with strategy use. Also, future studies should try to create problems that are more social and more complex to address this concern.

Unexpected results for social/complex problems

Why did intuitive participants not solve the social/complex problems most accurately as predicted? During the ratings study, upperclass students rated themselves as being significantly less competent to solve the social/complex problems than the other blocks of problems. It follows that the first year students would find these problems relatively difficult. This may have been why intuition did not show as great a benefit for the social/complex problems as originally predicted.

Manipulation strength

Because there was no effect for strategy manipulation in the original design, this problem clearly needs attention. For future studies, I propose that researchers strengthen the manipulations of intuitive and analytical instruction. Thinking style may be such an automatic process that it is difficult to change someone's course of thought simply by teaching them a strategy. A better way to manipulate problem-solving strategy may be to elicit intuitive and analytical strategies rather than teach the strategies. Hammond and colleagues' (1987) study of highway engineers is a good example of this. Engineers were asked to rate the safety of highways from looking at still photographs, which forced them to rely on their intuition. For the analytical task, engineers were asked to compute a formula to determine the safety of the highways, which forced them to rely on analysis.

Another benefit of eliciting intuition is that we would have more confidence that the participants used the strategy that we wanted them to use. While participants may report that they are using analytical and intuitive strategies, this does not mean that they are actually using it. By eliciting intuitive and analytical strategies researchers can be more confident in the strategy manipulation.

Strategy use may also be affected by the format of the materials. Verbal materials may encourage the use of the analytical system. Perhaps by setting the problems up as word problems we biased people into using analysis. In the future, researchers should consider using pictures or video clips for these same types of problems. In addition, by presenting the problems in a different way, researchers may be able tap into the tacit processes that facilitate intuition more easily.

Strengths

Ecological validity. One of the strengths of this study is its ecological validity. I tested real problems that college students face every day and made sure that the problems we created were realistic by getting feedback by way of the ratings study from students that attended the university. In this study I dealt with real problems and probable solutions to the problems.

In the past many cognitive scientists have approached the same problems, but with less real-life applicability. Participants were asked to work on problems that were unrealistic and irrelevant to daily life in the vain of Tversky and Kahneman (1983). This study stands out from previous studies because of the high ecological validity of the study. The findings can be applied outside of the laboratory. The information gained from this research can actually be applied to improve the quality of first year students lives.

Experimental control. Though the study was highly ecologically valid, I was able to maintain control over critical aspects of the experiment. I controlled the complexity and the social nature of the problem and problem solving instruction. The combination of scientific rigor and ecological validity is one of the study's strongest points. The ecological validity of the study required compromise in terms of experimental control. Though the manipulation of social/complexity was relatively weak (based on ratings), we were still able to find effects. Researchers should continue to search for creative ways to scientifically test ecologically valid problems.

Applications

Universities could use the information gained from this study to improve the lives of students. Residential advisors could be trained to teach first year students to rely on their gut instincts during their first months of school. First year students could take the REI to determine

whether have intuitive cognitive style or analytical cognitive style. If they have intuitive style they could be encouraged to continue to rely on their instincts. If they have analytical style they could be encouraged to listen to impulses that they might have been ignoring. These applications could improve the lives of First Year Students at a time where it is especially important to make good judgments.

In sum, future research should include expertise on studies of intuition, create problems that are more social and more complex, make manipulation of strategy stronger, make manipulation checks of strategy use more objective, be aware of the effects that format of materials could have on strategy use, and continue searching for ways to scientifically test ecologically-valid problems.

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Table 1
Reliability of Measures Using Cronbach's Alpha.

Scale	Cronbach's Alpha
1. PPSQ social/complex	.745
2. PPSQ social/noncomplex	.827
3. PPSQ nonsocial/complex	.731
4. PPSQ nonsocial/noncomplex	.779
5. REI analytical	.887
6. REI intuitive	.857
7. SUQ analytical	.807
8. SUQ intuitive	.796

Table 2
Post-intervention Reported Strategy Use by Condition.

Condition	Analytical Strategy Use		Intuitive Strategy Use		
	M	*SD*	*M*	*SD*	*N*
Control group	2.9647	.75279	3.2412	.43679	48
Intuitive group	2.7669	.95191	3.8068	.44287	58
Analysis group	3.7519	.59194	3.3475	.43430	54

Figure Caption

Figure 1. Note: The larger the deviation score, the worse the performance. Controlling for practice average and individual differences in problem solving style.

Fig. 1 **Effect of Condition and Task Characteristics of Problem Solving Score**

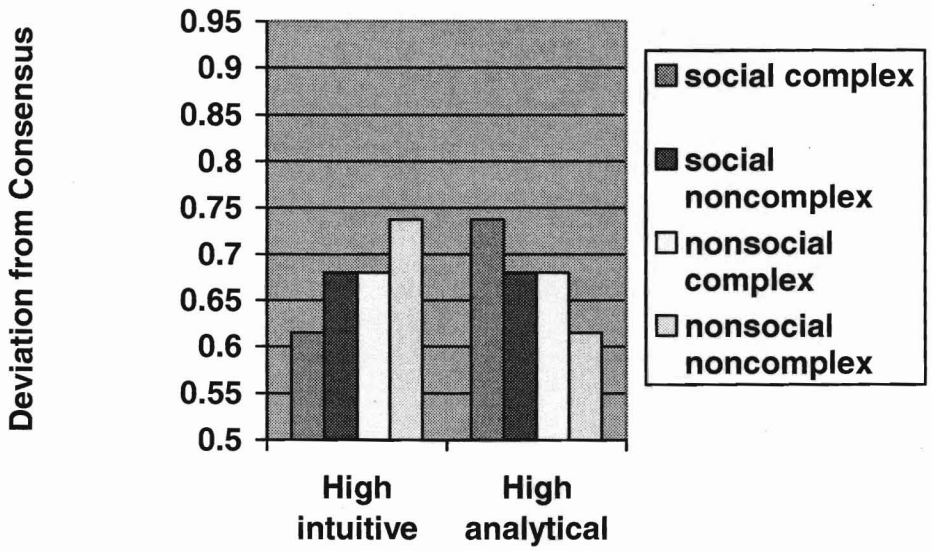


Figure Caption

Figure 2. Note: the larger the deviation score the worse the performance. Controlling for practice average and individual differences in problem solving style.

Fig. 2 **Effect of Condition and Task Characteristics on Problem-Solving Score**

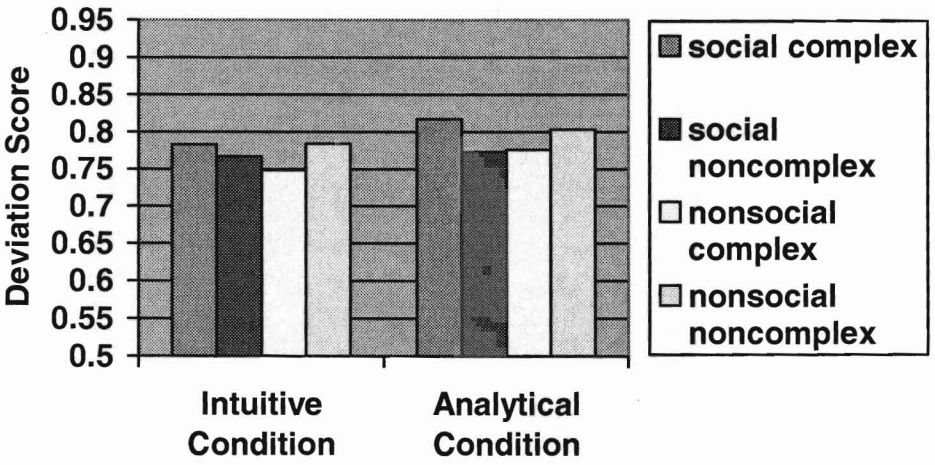


Figure Caption

Figure 3. Note: the larger the deviation score the worse the performance. Controlling for practice average.

Fig. 3 **Effect of Cognitive Style and Task Characteristics on Problem-Solving Score**

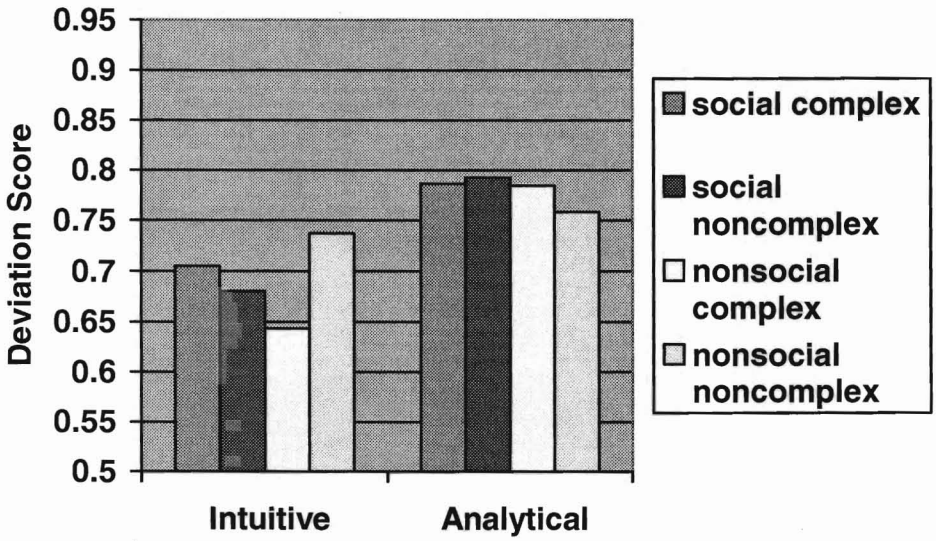


Figure Caption

Figure 4. Note: the larger the deviation score the worse the performance. Controlling for practice average.

Fig. 4 **Effect of Cognitive Style and Task Characteristics on Problem-solving Score-First Year Students Only**

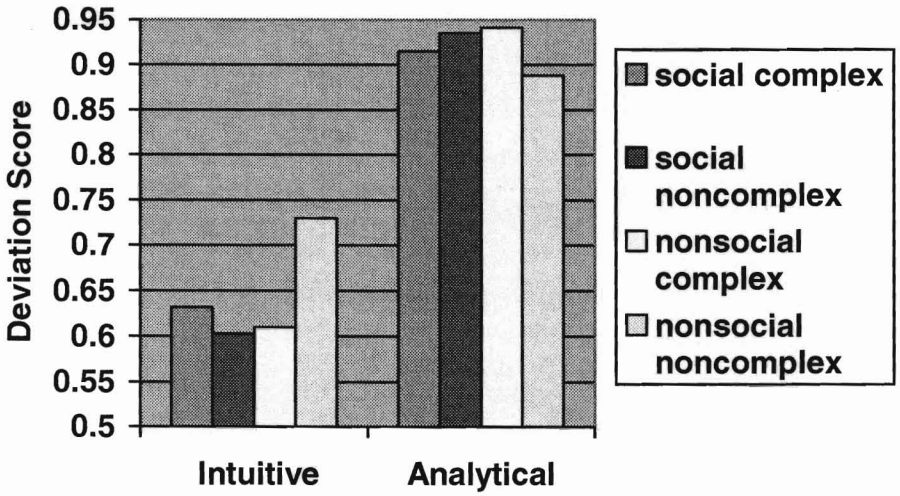
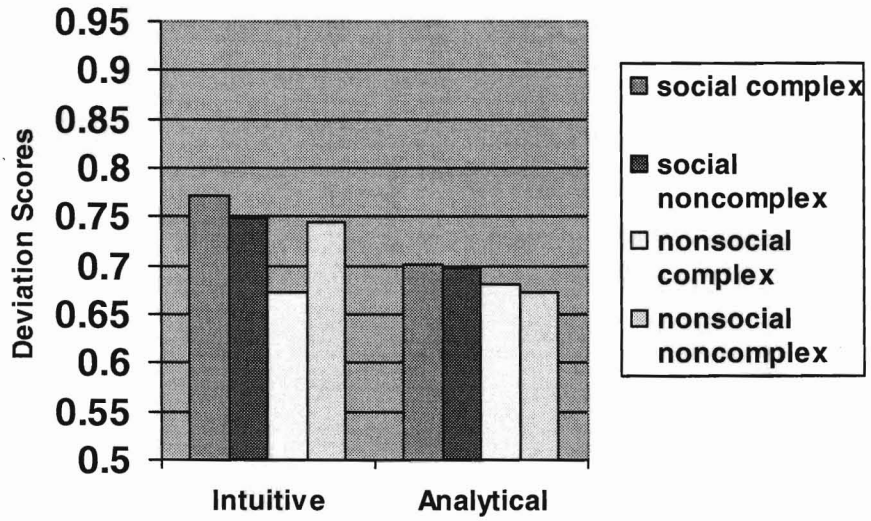


Figure Caption

Figure 5. Note: the larger the deviation score the worse the performance. Controlling for practice average.

Fig. 5 **Effect of Cognitive Style and Task Characteristics on Problem-Solving Score Sophomores, Juniors, and Seniors**



Appendix A

Item 1. Social/noncomplex .

Someone is talking loudly on her cell phone at the next table in the library while you are trying to write a paper. A courtesy policy exists that states that students may use cell phones in the library if they use them in the stairwell. Rate the quality of the following options:

1	2	3	4	5	6	7
----+----	----+----	----+----	----+----	----+----	----+----	----+----
Extremely Bad	Very Bad	Somewhat Bad	Neither Bad Nor Good	Somewhat Good	Very Good	Extremely Good

_____a) Politely ask the girl to go to the stairwell if she wants to use her cell phone.

_____b) Do nothing.

_____c) Make a mental note to buy earplugs for your next study session in the library.

_____d) Talk loudly to yourself. The person talking on the phone will realize how annoying she is being.

_____e) Go to the librarian and tell her about the problem.

_____f) Sat to your friend who is sitting next to you, "Don't you hate it when people talk on cell phones in the library," loud enough for the perpetrator to hear.

_____g) Move to a table that is out of earshot.

Item 2 Nonsocial/complex.

You are looking for a new job right after graduation. You have received two offers. How do you decide which to accept? Rate the quality of the following criteria:

1	2	3	4	5	6	7
----+----	----+----	----+----	----+----	----+----	----+----	----+----
Extremely Bad	Very Bad	Somewhat Bad	Neither Bad Nor Good	Somewhat Good	Very Good	Extremely Good

_____a) With a highly prestigious company.
_____b) Has very regular hours.
_____c) Provides four weeks vacation per year.
_____d) Pays very well.
_____e) Gives you the most desirable skills.
_____f) Is recommended by a friend.
_____g) Is located near your residence.
_____h) Gives the opportunity for advancement in the organization.
_____i) Is in a field that is growing rapidly.
_____j) Feels right to you.

Item 3 nonsocial/noncomplex.
You need to write a term paper. How do you start? Rate the quality of each of the following options:

1	2	3	4	5	6	7
Extremely Bad	Very Bad	Somewhat Bad	Neither Bad Nor Good	Somewhat Good	Very Good	Extremely Good

_____a) Look at a sample paper written by a friend.
_____b) Do an outline and develop a thesis before you write even one word.
_____c) Just start writing and see how your ideas develop.
_____d) Use word association to spark ideas.

Item 4 Social/Complex.
It is the second semester of your senior year. You have just become engaged and are trying at the same time to decide where to attend graduate school. You have been accepted at a graduate school that it highly esteemed in your field. The only problem is that it is a 4 hour drive from where your fiancée has just accepted a job. Rate the quality of the following options:

1	2	3	4	5	6	7
Extremely Bad	Very Bad	Somewhat Bad	Neither Bad Nor Good	Somewhat Good	Very Good	Extremely Good

_____a) You decide to go to the graduate school regardless of the effect it has on your relationship. You will never get another opportunity like this.
_____b) You decide to go to the graduate school, but not before discussing it with your fiancée. You decide to compromise and live at the midpoint between your school and your fiancées work.
_____c) You decide to have a long-distance relationship and plan to marry after you have completed the graduate program.
_____d) You try to convince your fiancée to look for a job closer to your school.
_____e) You decide not to accept admission at the school and begin to consider graduate programs closer in proximity to your fiancées work.
_____f) You decide to go to the graduate school, trusting that the relationship will work itself out if it's meant to be.
_____g) You decide to postpone your plans for graduate school for now, and get a job near your fiancée.
_____h) Elope and then take a vacation to think about your priorities in life.

Appendix B

Please give your ratings based on a scale of 1 to 7 to reflect how well each characteristic describes that situation.

1	2	3	4	5	6	7
Not at all	Barely	Somewhat	Moderately	Fairly	Very	Extremely

When you read the description of this situation and its possible solutions, do you consider the situation

_____Ambiguous?
_____Complex?
_____Concrete?
_____Easy to decompose into parts or steps?
_____Easy to solve quickly?
_____One that involves the consideration of interpersonal relationships to solve?
_____One that involves the consideration of emotions to solve?
_____One that you are competent to solve?

Appendix C

Strategy Use Questionnaire

We are interested in the strategies you used to solve these everyday problems. Below is a list of strategies you may have used in rating the response options for the problem scenarios you just solved. Using the scale below, please indicate **the extent to which you used each strategy in solving this set of problems**. We are interested in what strategies **you actually used** in solving these problems. (Circle the number that corresponds to your response.)

	Not at all		**Sometimes**		**Frequently**
Imagine the situation very vividly.	1	2	3	4	5
Break the problem down into steps.	1	2	3	4	5
View the problem from a variety of perspectives.	1	2	3	4	5
Carefully define the problem.	1	2	3	4	5
Rely on guesses, hunches, or feelings.	1	2	3	4	5
Monitor your problem-solving process.	1	2	3	4	5
Skip the problem when you are stuck.	1	2	3	4	5
Consider information that is implied about the situation that is not mentioned in the problem description.	1	2	3	4	5

Appendix D

Rational Ability
r22. Reasoning things out carefully is not one of my strong points.
26. I have a logical mind.
r30. I am not very good in solving problems that require careful logical analysis.
r34. I don't reason well under pressure.
38. I am much better at figuring things out logically than most people.

Rational Favorability
3. I prefer complex to simple problems.
r7. Thinking is not my idea of an enjoyable activity.
11. I enjoy solving problems that require hard thinking.
r15. Knowing the answer without having to understand the reasoning behind it is good enough for me.
18. I enjoy intellectual challenges.

Total Rationality = Sum of Rational Ability & Rational Engagement

Experiential Ability
r2. If I were to rely on my gut feelings, I would often make mistakes.
6. When it comes to trusting people, I can usually rely on my gut feelings.
10. I believe in trusting my hunches.
r13. I suspect my hunches are inaccurate as often as they are accurate.
19. I can usually feel when a person is right or wrong, even if I can't explain how I know.
Experiential Favorability
r4. I generally don't depend on my feelings to help me make decisions.
8. I like to rely on my intuitive impressions.
r12. I think it is foolish to make important decisions based on feelings.
r16. I would not want to depend on anyone who described himself or herself as intuitive.
20. I often go by my instincts when deciding on a course of action.

Total Experientiality = Sum Experiential Ability & Experiential Engagement

Note: r denotes item was reverse scored. Items were rated on a Likert scale of 1-5.