학위 석사 학위논문

Solvable or Not, That is the Question

– The effects of information
about the presence of unsolvable problems
on problem solving performance–

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2014 년 2 월

서울대학교 대학원
심리학과
박수진

Abstract

Solvable or Not, That is the Question:

The effect of information about the presence of unsolvable problems on problem solving performance

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Research on problem solving has mostly examined solvable tasks. However, in real life, we encounter more often problems that have no apparent solutions. Given the lack of research on problem solving when faced with unsolvable problems, we investigated the effect of giving information about the presence of unsolvable anagrams among solvable ones. In Experiment 1, for the same set of anagrams, half of the college students were informed about the presence of unsolvable anagrams and the other half were not. Some of the anagrams were either very difficult or unsolvable. The results showed that the uninformed group outperformed the informed one and the former group spent more time on the task. We replicated the results in Experiment 2 in a within-subject design. However, when there were no difficult or unsolvable items, in Experiment 3, there was no difference between the two groups. These findings suggest that the information about solvability of a problem strongly influences the effort spent and thus the accuracy on the task only when there were difficult or unsolvable items.

Key Words: problem solving, unsolvable problems, persistence, giving-up,

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Student Number: 2011-23138

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Albert Einstein said "It's not that I'm so smart, it's just that I stay with problems longer.' This remark reminds us of the importance of persistence in problem solving. In order to be successful in solving a difficult problem, one should keep on trying until it is solved. In fact, many of the greatest scientific discoveries were not made on a single trial, but rather as a result of hundreds or thousands of failures. Edison invented the light bulb after thousands of failures (Josephson, 1992). If Edison gave up inventing the light bulb after a few failures, our life today would not be quite the same (Jones, 2002). Granted that persistence is necessary, it is not easy for us to devote ourselves to challenging problems. We worry that we will ultimately fail in spite of our persistence. This worry is justifiable considering that many people have dedicated their whole lives to solving a problem in vain. Alchemists who wanted to find out the recipe to make gold are a group of people who wasted their and perhaps their families' lives. A lot of mathematicians have agonized in vain for 300 years to solve the infamous Fermat's Theorem until it was finally solved by Andrew Wiles in 1993. Even in our daily lives, there are many problems that do not seem to have clear answers, such as the meaning of life or the existence of suffering, etc. The point is that not all the problems we think of are solvable. Instead some problems are solvable but others are not. Persistence by itself is, therefore, not the golden key to the extraordinary achievement. Rather, it is a double-edged sword depending on the type of problems. For solvable problems, it can lead us to success. For unsolvable problems, unless we transform the original problem into a solvable one, persistence can be a folly rather than a merit.

Despite the ubiquity of unsolvable problems, past research has mainly examined

problem solving using solvable problems with set answers (e.g., Newell & Simon, 1972; Paas, 1992; Reed & Bolstad, 1991). Until now researchers have focused on what people do to solve solvable problems, overlooking the fact that people typically make judgments about whether a problem is solvable or not while they are trying to solve it. Focusing on solvable problems would be enough if all we want to do is to help students learn the problems taught in educational settings. However, a more realistic study of problem solving should have the condition in which both solvable and unsolvable problems exist. Including the unsolvable problems along with solvable ones is not just for increasing the ecological validity. It also has practical implications for assessment. As Payne and Duggan (2012) pointed out, rational decisions to quit is an important component of effective behavior – there is little to be gained from continued persistence on a problem that you will never solve. Those who persist on solvable problems and are quick to quit attempting the unsolvable one would be preferred to those who can do either one of them. As a first step, the present study aims at resolving the limitations of previous studies with math word problem, and replicating their main findings.

The problems used in past experiments that included both solvable and unsolvable problems were mostly math word problems. Low and Over (1989) created two sets of algebra word problem. One set of problems contained all the information needed to solve the problems, and another set contained problems with missing information, thereby leading the problems unsolvable. They found that the ability to tell whether a problem is solvable or not accounted for 90 % of the variance in the solution rate of the similar type of problems. Detecting missing information was also attributed to the expertise in the domain. Low and Over (1989, 1990 & 1993) showed that subjects with expertise used a deep structure to classify the problems and thus were better than novices both in detecting missing as well as irrelevant information and in the solution rates.

Rehder (1999) further examined people's ability to detect unsolvable algebra word

problems with problems that are missing information. To investigate the specific conditions under which people are likely to notice missing information and detect unsolvable problems among solvable ones, Rehder (1999) addressed the following three questions: First, is it automatic to detect the missing information as part of normal problem solving, or is it necessary to pay extra attention on the part of the problem solver to detect it? Second, if extra attention is required, does it activate a specific procedures to detect missing information, or suppress the automatized problem solving procedures? Third, if specific procedures are required, what are those procedures and the mental problem representations they require to operate? If the detection of unsolvable problems among solvable ones does not occur automatically as part of normal problem solving, the special effort and the ability required would be worth investigating as unsolvable problem solving is the essential component of human problem solving.

To answer the questions above, Rehder (1999) used algebraic structure of four problems, and associated familiar and unfamiliar cover stories. Each participant received each of the four problems. Two of the problems were solvable and two were unsolvable because of the missing information. Half the participants received problems with familiar cover stories, and the other half received the problems with unfamiliar cover stories. Crossed with this factor was information condition: Half of the participants were informed that some of the problems might be unsolvable (informed condition) and the other half was not (uninformed condition). If detecting unsolvable problems requires the conscious effort and attention of the problem solver, the hint will lead to more frequent detection of such problems because it will induce in problem solvers the explicit goal of detecting missing information. If the detection of missing information occurs automatically, then the hint should provide no assistance compared to when no hint is provided. He found that detection of missing information is likely to be greater when a hint is given, when a problem has an unfamiliar

cover story, and when the problem solver has more expertise. He also found that participants were more likely to give up when given the hint that there might be unsolvable problems.

Considering its importance in the study with unsolvable problems, it is surprising that his findings were not replicated or followed up in subsequent studies. The article was cited less than 10 times according to Social Sciences Citation Index (SSCI) as of 2013. One of the reasons to that would be because his research finding was obtained from a group data. Using group data was justified by statistical logic in his paper, but it is desirable to replicate his findings based on individual performances. Another related reason for the lack of follow-up studies might be the statistical analysis used in his study. He used signal detection theory (SDT) which provided independent measures of problem solvers' detection sensitivity (ability to discriminate between solvable and unsolvable problems) and their response bias (tendency to report that problems are unsolvable). To get these two measures, however, much more observations and more complex analysis are required in SDT than typical data analysis.

The current study is trying to replicate some findings in Rehder (1999) without the above two limitations. In other words, we used individual data instead of group data and t-test was used for data analysis. We used anagrams as stimuli. Some are easy to solve, some difficult, and some unsolvable. Participants were asked to solve a set of anagrams with (Informed condition) without (Uninformed condition) the information that there are unsolvable ones.

Overview of the Experiment

Unsolvable problem solving is a widespread everyday phenomenon: people face numerous problems without explicit answers or solutions. When solving unsolvable problems, some people persist until completing the task, whereas some give up after only a few trials. How people react to unsolvable problems is a critical issue that needs to be further addressed, because the mechanisms to understand why people persist or quit is an important component

of human problem solving (Payne & Duggan, 2011) and our everyday activities invariably present us with unsolvable problems as well as solvable ones (Rehder, 1999).

The current research is going to investigate the effects of (a) information about the presence of unsolvable task and (b) presence of difficult/ unsolvable problems influence persistence and accuracy of solvable problems. The study predicts that the information about the presence of unsolvable task will influence both persistence and problem solving accuracy. We further predict that the effect of information about the presence of unsolvable problems would be absent without difficult or unsolvable problems. The hypotheses for the current experiment are as below (Figure 1);

Hypothesis 1: Participants *not* informed of the existence of unsolvable problems would, perform better and spend longer time on solvable problems than those informed of the existence of unsolvable problems.

Hypothesis 2: The above pattern will be observed even when unsolvable problems are substituted with difficult problems.

Hypothesis 3: There will be no difference between the informed and uninformed groups when there are no unsolvable or difficult problems.

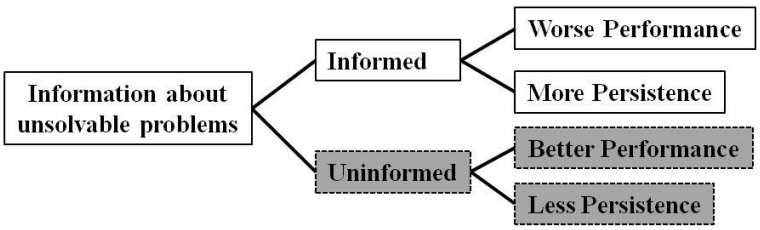

Figure 1. Synthesized Hypothesized Model

Experiment 1: The effect of Instruction when there are Unsolvable/ Difficult Problems (Between-subject Design)

The effect of information about the presence of unsolvable task was examined. In

experiment 1, each set of anagram contained either difficult (e.g. Difficult Set) or unsolvable anagrams (e.g. Unsolvable Set). The current study assumes that the effect of instruction in the presence of difficult/ unsolvable problems on problem solving accuracy and attempted time for solution to be shown in two opposite ways.

Method

Participants

One hundred twelve subjects at Seoul National University (61 males and 53 females) aged from 18 to 31 participated in this study as one of their course requirements for Psychology.

Stimuli

The stimuli used in the current experiment are anagrams with varying difficulty and unsolvable anagrams – Solvable Easy, Solvable Difficult and Unsolvable. Anagram is a task that is presented with a string of letters (e.g. TNOMH). One has to find a meaningful word that can be spelled using all and only the letters given (e.g. MONTH) (Gilhooly & Johnson, 1978). Anagram has been studied in many aspects of problem solving tasks and it has been identified that anagram is a good measure to identify the underlying problem solving strategies used by people (Bourne, Ekstrand & Dominowski, 1971; Newell & Simon, 1972). Anagram can vary widely in terms of its difficulty depending on the word frequency and the familiarity with the letter, even with the length and the number of solutions held constant (Mayzner & Tresselt, 1958). The difficulty of the anagrams were controlled in regard to Gilhooly & Johnson (1978), Tresselt and Mayzner(1966). In the practice session, 3 relatively easy anagrams were used to familiarize subjects with the experimental program.

There were two set types – 1) Difficult Set: 14 Solvable Easy anagrams + 6 Solvable Difficult anagrams and 2) Unsolvable Set: 14 Solvable Easy anagrams + 6 Unsolvable

anagrams. Subjects solved 20 anagrams in 25- minute. The Solvable Difficult/ Unsolvable anagrams were anagram no. 3, 6, 7, 11, 13 and 18 in both Difficult Set and Unsolvable Set (i.e. 6 difficult or unsolvable anagrams in each set). All the remaining 14 anagrams were identical Solvable Easy anagrams in both Difficult Set and Unsolvable Set types.

Design

The design of the experiment is 2 x 2 between-subjects factorial design (Table 1). There are two independent variables in the experiment: 1) Informed vs. Uninformed Group about the presence of unsolvable anagrams, and 2) Difficult Set vs. Unsolvable Set. The dependent variables were problem solving accuracy and attempted time for solution for 14 Solvable Easy anagrams. Solvable Difficult/ Unsolvable anagrams were anagram no. 3, 6, 7, 11, 13 and 18 in both Difficult Set and Unsolvable Set (i.e. 6 difficult or unsolvable anagrams in each set). Solvable Difficult and Unsolvable anagrams were not included in data analysis, as they were not directly related to the purpose of the current study.

Table 1. Experiment 1 design

	Informed Group	Uninformed Group
Solvable Difficult Set	A: Informed Group + Solvable Difficult	B: Uninformed Group + Solvable Difficult
Unsolvable Set	C: Informed Group + Unsolvable	D: Uninformed Group + Unsolvable

Procedure

Subjects were blinded about the purpose of the experiment. They were told that the experiment is to test verbal intelligence. Subjects first filled out a demographic questionnaire consisting of questions about their gender, age, major, standardized English test score, CGPA, Korean college entrance examination score, and indicated if they have ever lived in an

English-speaking country before for more than 2 years.

Problems were presented on a computer display (Programmed in Adobe Flash). After completing the task, subjects did a practice session of solving 3 anagrams in 3- minute. They were instructed by an experimenter on how they should type in the questions on the experimental program (Figure 2) and how they should save and/or submit their answers. Subjects were allowed to save and return to the problem later if they were unsure of the problem (i.e. return-permitted) by clicking 'SAVE' button. If subjects finished solving the anagram, they submitted their answers by clicking 'SUBMIT' button next to the 'SAVE' button. Subjects were able to see the remaining minutes they had until completing the experiment on the top right corner of the screen.

After completing the practice session, subjects were randomly divided into two groups according to the information about the unsolvable anagram: Informed Group vs. Uninformed Group. In informed group, subjects were told about the presence of unsolvable anagrams and were asked to leave them blank if they thought the anagram was unsolvable. In uninformed group, subjects were instructed to solve all anagrams. Subjects were asked to solve 20 anagrams in 25 - minute. They were free to go if they finished solving 20 anagrams before the given time limit.

After the experiment, they filled out after-experiment questionnaire. They were asked to indicate: a) difficulty of the anagrams in the experiment, b) if they thought the experiment contained any unsolvable anagrams: yes/no – if answered yes, how many were unsolvable, and lastly c) anything unusual or strange about the experiment. The experiment took about 25 to 40 minutes in total and subjects were debriefed about the real purpose of the experiment when they completed the experiment with a debriefing form.

Figure 2. Experimental Program Format

Results

Attempted time for solution and problem solving accuracy of 16 Solvable Easy anagrams were examined depending on whether subjects were informed or uninformed about the presence of unsolvable anagrams. Due to the problem with the former experimental program, we were not able to measure the attempted time for solution for each anagram for some participants. So in this results section, we only report the attempted time for solution of subjects who used the revised experimental program that measured the attempted time for solution subject took for each anagram question. Analyses were conducted using SPSS and Excel.

Attempted time for solution

The first question examined in Experiment 1 was the attempted time for solution of the 16 Solvable Easy anagrams between Informed vs. Uninformed groups about the presence of unsolvable anagrams, and between Difficult Set vs. Unsolvable Set types. The attempted time for solution between informed and uninformed groups evinced longer attempted time for solution for uninformed group as compared to informed group in Unsolvable Set (M = 13.56 vs. 10.16, MSE = 1.58, $t(9) = 2.45$, $p < .05$, $r = .5$). The same was also shown in Difficult Set

(M = 16.02 vs. 12.02, MSE = 1.79, $t(9) = 1.87$, $p < .05$, $r = .42$). The finding shows that uninformed group about the presence of unsolvable problems tends to spend longer time in both Unsolvable and Difficult Sets (Figure 3), thereby confirming our hypothesis.

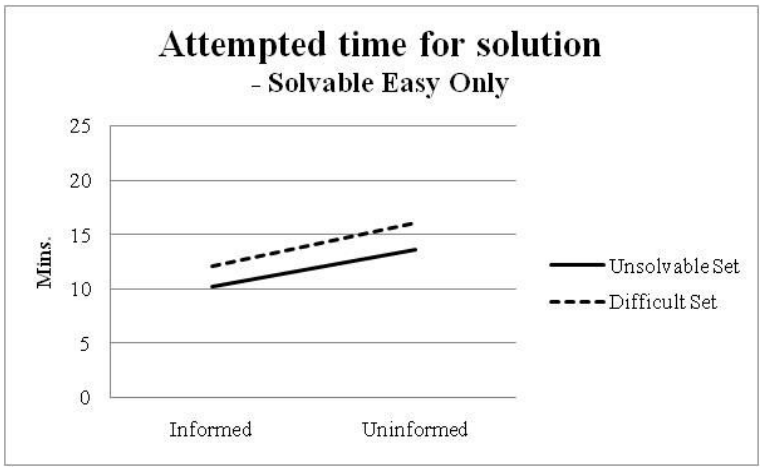

Figure 3. Attempted time for solution of informed vs. uninformed groups on Solvable Easy anagrams

Accuracy

Accuracy for Solvable Easy anagrams between Informed vs. Uninformed groups about the presence of unsolvable anagrams and between Difficult Set and Unsolvable Set types were also examined. The problem solving accuracy between informed and uninformed groups showed better accuracy for uninformed group than informed group in Unsolvable Set (M = 9.14 vs. 7.42, MSE = .94, $t(25)=1.87$, $p < .05$, $r = 0.24$). The same was also replicated in Difficult Set (M = 10.14 vs. 8.32, MSE = .79, $t(25)=2.33$, $p < .05$, $r = 0.26$). It suggests that uninformed group about the presence of unsolvable problems tend to perform better in both Unsolvable and Difficult Set types (Figure 4).

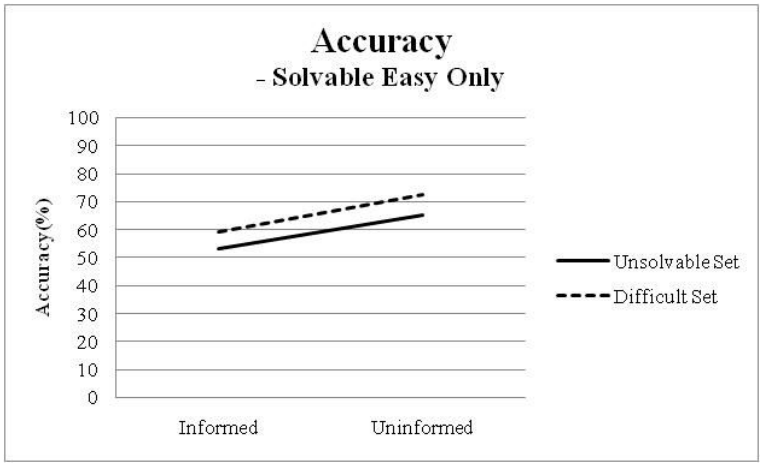

Figure 4. Accuracy of informed vs. uninformed groups on Solvable Easy anagrams

Although not directly related to our hypothesis, the relationship between the attempted time for solution for Solvable Difficult and Unsolvable anagrams and problem solving accuracy was also examined. We were interested in what qualities high performers have that enable them to perform better in problem solving tasks. We predicted that problem solvers with good accuracy would spend less time in unsolvable/ difficult problems when they were informed of the presence of unsolvable anagrams, thereby devoting longer time on Solvable Easy anagrams. However, our results showed that this was not the case. Our finding showed that good problem solvers spent equally long time on unsolvable/ difficult problems in both informed and uninformed conditions. Our results show that good problem solvers are good at problem solving because they are motivated to spend long time on every problem regardless of its solvability (Figure 5 & 6).

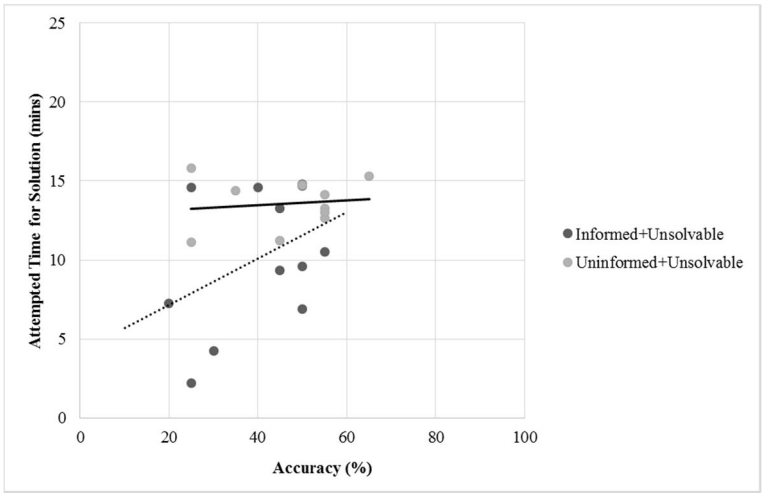

Figure 5. Correlation between accuracy and attempted time for solution for unsolvable anagrams

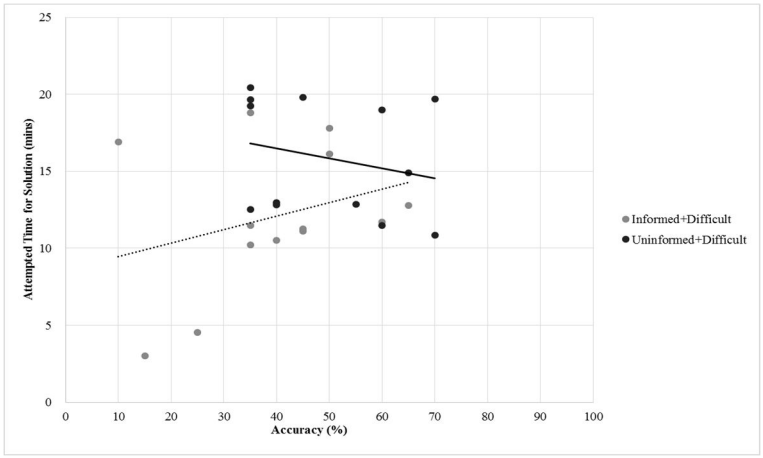

Figure 6. Correlation between accuracy and attempted time for solution for difficult anagrams

Out of 112 subjects, around 83% of subjects (93 subjects) thought the anagram set contained unsolvable anagrams, and on average, people thought there were around 5. 6 problems that were unsolvable out of 20 anagrams. The difficulty of the anagram was rated as 1. 13 on a likert scale from -3 being very easy to 3 being very difficult. When asked why they thought some problems were unsolvable, majority of participants wrote it is because of the number of vowels and consonants. When there were only one vowel and four consonants in 5-worded anagram (ex, anagram: HTMON – answer: MONTH), many subjects thought the anagram was unsolvable. No subjects reported anything unusual/ strange about the

experiment.

Discussion

Our results showed that the information about the presence of unsolvable anagrams (informed vs. uninformed) influence how much time and effort people would exert to solve the problems, and how well they would solve them. The information about the presence of unsolvable problems seems to have a robust influence on accuracy and persistence when solving problems. The finding suggests that information about the presence of unsolvable anagrams is the influential factor on how much time or effort people would exert in solving problems, thereby influencing how well one would perform in the tasks. Payne and Duggan (2011) suggested that solvability of problems influence persistence. They examined the effects of prior probability of solvability and of problem size on measures of effort and confidence with unsolvable problems. Subjects spent longer time on problems with higher solvability and more problem states and vice versa for problems with less solvability and less problem states. Payne and Duggan (2011) used the unsolvable problems as the stimuli, and Rehder (1999) used both solvable and unsolvable problems. The current experiment used solvable easy, solvable difficult and unsolvable anagrams. Our current finding further extends the past work that information about unsolvable problems not only influences how much time/ effort people would spend/exert, but also influences how well people would perform in solving problems (i.e. problem solving accuracy).

Our finding suggests that in problem solving, effort/ time spent and accuracy are positively correlated. Yet, the directionality between effort/ time and accuracy is still not promising. Based on the current finding, we cannot be sure if effort is a leading cause for better accuracy or vice versa. It is promising, however, that the relationship between accuracy and effort could be bidirectional: both accuracy and effort influence each other in certain

ways. Given the ambiguity of the relationship between effort and accuracy, future research could further address the relationship of effort and accuracy in problem solving and the ways in which they are affecting each other.

Confirming the 2nd hypothesis, the effect of information about the presence of unsolvable anagram was evinced in both Difficult Set and Unsolvable Set types: Participants *not* informed of the existence of unsolvable problems performed better and spent longer time on solvable problems. It is important to note that difficult anagrams also operated the same as unsolvable anagrams in Difficult Set in both informed and uninformed conditions. This finding suggests that although subjects might be able to solve difficult problems with more effort/ time spent, when subjects are aware of the presence of unsolvable anagrams, subjects assume difficult anagrams to be unsolvable and thus, give up quickly and perform worse on other solvable problems. This finding is a replication and an extension of the past finding in Rehder (1999) which demonstrated that participants were more likely to conclude that a solvable problem was unsolvable when the information about the presence of unsolvable problem was given.

Moreover, it would be worth investigating what would happen if subjects are correctly informed of the presence of highly difficult problems. Would it lead subjects to give up more easily and perform worse as congruent with the current finding or would it lead subjects to persist longer because they know that they can solve the problems eventually? We predict that when informed accurately about the presence of highly difficult problems, subjects would challenge themselves to try harder and spend longer time knowing that they can eventually solve the difficult problem as opposed to the current finding.

We have also examined the correlation between accuracy and the attempted time for solution for difficult/ unsolvable anagrams. We predicted that high performers would spend less time in unsolvable/ difficult problems when they are informed of the existence of

unsolvable problems. We expected high performers to recognize the solvability of problems better when they were aware of the presence of unsolvable anagrams. And this would lead them to spend less time in difficult/ unsolvable tasks and devote longer time to other solvable problems. Yet, we found that higher performers spend equally long time on all tasks rather than spending less time in difficult/ unsolvable tasks. It seems that high performers are motivated to solve all problems and that is the reason why they perform better than other counterparts in problem solving tasks. Yet, this is not promising as the design was return-permitted: subjects could save the answer and return to the question later. If high performers finished all the Solvable Easy anagrams and had some time left, they could go back to the Solvable Difficult/ Unsolvable anagrams, devoting rest of their time to those questions. If the design was return-prohibited, subjects would have to decide whether the problem is solvable or unsolvable, and whether they would persist or give up. In return-prohibited condition, subjects have to make decisions about the solvability of problems and thus, it might have led high performers to spend less time in Solvable Difficult/ Unsolvable anagrams when they were informed of the presence of unsolvable anagrams. We are planning to follow-up on this in the future research.

Experiment 2: The effect of Instruction when there are Unsolvable/ Difficult Problems (Within–Subject Design)

Experiment 2 was designed to test if the same tendency (i.e. uninformed group about the presence of unsolvable anagrams spending longer time and performing better) would also be replicated in within-subject design to find more solid support for the tendency shown in Experiment 1. Since the findings in Experiment 1 were from the group data, some third variables might have played a role, thereby biasing the results. If the same finding is replicated in both between and within-subject design, the effect of instruction when there are

unsolvable/ difficult problems would be deemed as a more pervasive phenomenon. Thus, the current experiment studies the effect of instruction in within-subject design. Experiment 2 predicts the same tendency evinced in Experiment 1 to be replicated and have more conclusive results in problem solving accuracy and attempted time for solution between informed and uninformed conditions about the presence of unsolvable problems.

Method

Participants

Ninety-two subjects at Seoul National University (48 males and 44 females) aged from 18 to 27 participated in this study as one of their course requirements for Psychology.

Stimuli

In Experiment 2, there were two set types – 1. Difficult Set: 8 Solvable Easy anagrams + 4 Solvable Difficult anagrams and 2. Unsolvable Set: 8 Solvable Easy anagrams + 4 Unsolvable anagrams. Subjects solved either two sets of Difficult Set or Unsolvable Set in both informed and uninformed conditions about the presence of unsolvable anagrams. The Solvable Difficult/ Unsolvable anagrams were anagram no. 3, 5, 6 and 10 in both Difficult Set and Unsolvable Set (i.e. 4 difficult or unsolvable anagrams in each set). All the remaining 8 anagrams were identical anagrams in both Difficult Set and Unsolvable Set.

Design

The design of the experiment is 2x2 within-subject design (Table 2). Independent and dependent variables are identical to Experiment 1.

Table 2. Experiment 2 design

	Informed Group	Uninformed Group

Solvable Difficult Set	A1: Informed Group + Solvable Difficult	A2: Uninformed Group + Solvable Difficult
Unsolvable Set	B1: Informed Group + Unsolvable	B2: Uninformed Group + Unsolvable

Procedure

Procedure is identical to Experiment 1, except one subject solved either two sets of Difficult Set or Unsolvable Set in both informed and uninformed conditions about the presence of unsolvable anagrams. Subjects solved anagrams in uninformed condition first and then solved anagrams in informed condition about the presence of unsolvable anagrams. Subjects solved 12 anagrams in 15-minute in both uninformed and informed conditions.

Results

Attempted time for solution and problem solving accuracy in 8 Solvable Easy anagrams were examined depending on whether subjects were informed or uninformed about the presence of unsolvable anagrams. The tendency for uninformed group to persist longer and perform better was replicated in Experiment 2. Due to the problem with the former experimental program, we were not able to measure the attempted time for solution for each anagram for some participants. So in this results section, we only report the attempted time for solution of subjects who used the revised experimental program that could measure attempted time for solution for each anagram. Analyses were conducted using SPSS and Excel.

Attempted time for solution

The attempted time for solution of Solvable Easy anagrams between Informed vs. Uninformed groups about the presence of unsolvable anagrams and between Difficult Set vs.

Unsolvable Set types were examined. The attempted time for solution between informed and uninformed group evinced marginally longer attempted time for solution for informed group as compared to uninformed group in Unsolvable Set (M = 5.53 vs. 3.95, MSE = .67, $t(13)$ = 1.58, p =0.09, r = 0.38). The statistically significant tendency was shown in Difficult Set (M=7.13 vs. 6.13, MSE = .31, $t(13)$ = 2.28, $p < .05$, r = 0.25). The finding shows that uninformed group about the presence of unsolvable anagrams tended to persist longer in both Unsolvable and Difficult Set types (Figure 7).

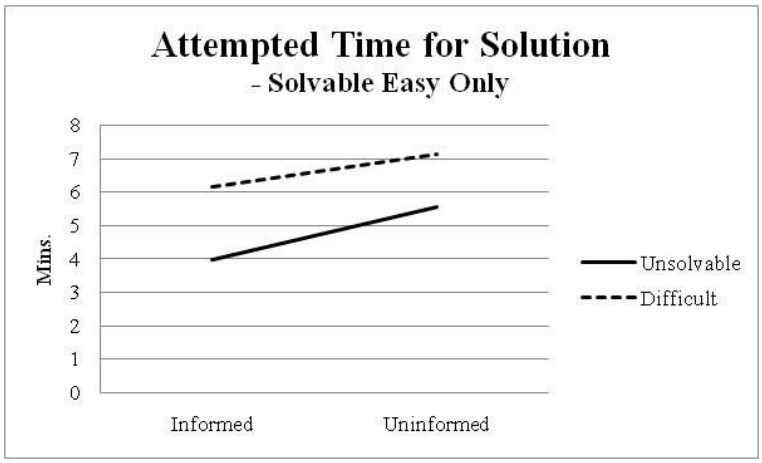

Figure 7. Attempted time for solution of informed vs. uninformed groups on Solvable Easy anagrams

Accuracy

Accuracy for Solvable Easy anagrams between informed and uninformed groups about the presence of unsolvable anagrams and between Difficult Set vs. Unsolvable Set types were examined. The accuracy between informed and uninformed group showed better accuracy for uninformed group than informed group in Unsolvable Set (M = 6.8 vs. 5.4, MSE = .27, $t(48)$ = 3.85, $p < .05$, r = 0.45). The same tendency was also replicated in Difficult Set (M = 6 vs. 4.78, MSE = .31, $t(48)$ = 2.79, $p < .05$, , r = 0.42). It suggests that unformed group tends to perform better in both Unsolvable and Difficult Set Types (Figure 8), thereby replicating the finding in Experiment 1. It is important to note that difficult anagram operated the same as unsolvable anagrams in Difficult Set in both informed and uninformed conditions.

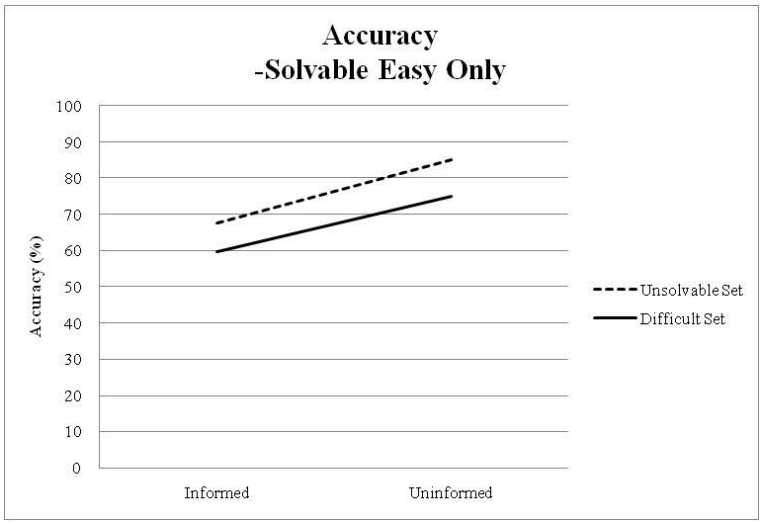

Figure 8. Accuracy of informed vs. uninformed groups on Solvable Easy anagrams

We found the same results shown in Experiment 1 when we analyzed the relationship between the attempted time for solution for unsolvable/ difficult anagrams and problem solving accuracy. Our results once again show that good problem solvers are good at problem solving because they are motivated to spend equally long time on every problem regardless of its solvability (Figure 9 & 10).

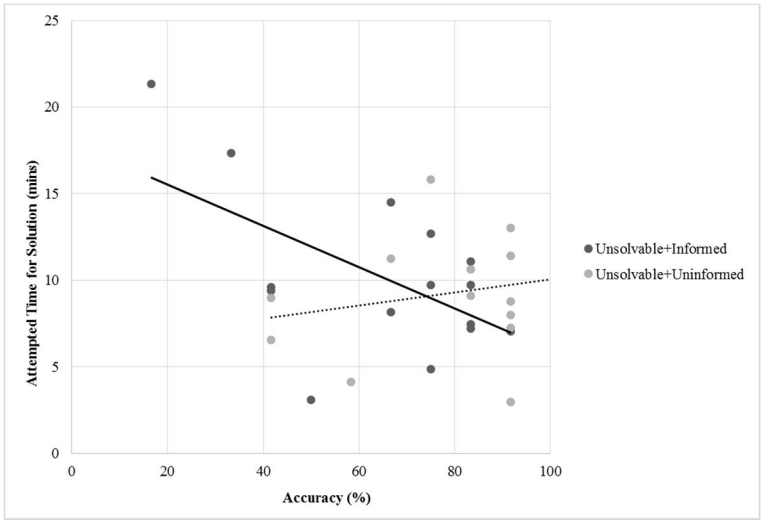

Figure 9. Correlation between accuracy and attempted time for solution for unsolvable anagrams

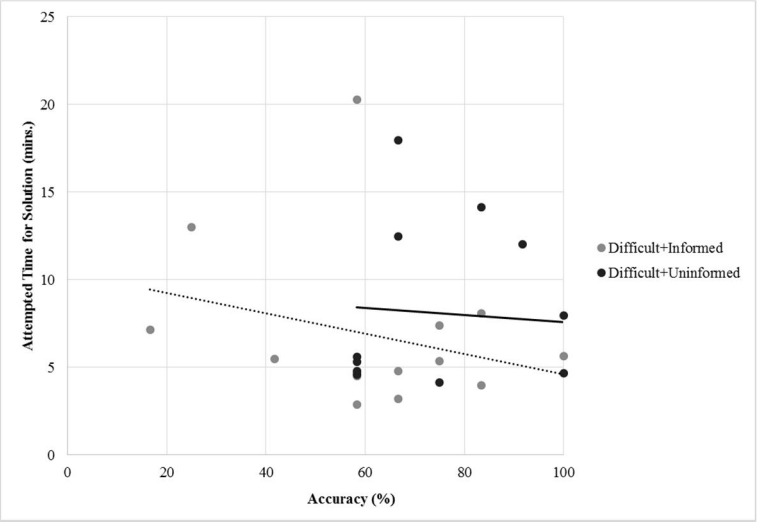

Figure 10. Correlation between accuracy and attempted time for solution for difficult anagrams

Out of 92 subjects, around 59.7% of subjects (55 subjects) thought the anagram set contained unsolvable anagrams, and on average, people thought there were around 4.1 problems that were unsolvable out of 12 anagrams. The difficulty of the anagram was rated as 1. 59 on a likert scale from -3 being very easy to 3 being very difficult. When asked why they thought some problems were unsolvable, many wrote it is because of the number of vowels and consonants. When there were only one vowel and 4 consonants in 5-worded anagram (ex, anagram: HTMON – answer: MONTH), many subjects thought the anagram was unsolvable. No subjects reported anything strange/ weird about the experiment.

Discussion

The findings in Experiment 2 show the same tendency, replicating the findings in Experiment 1 in within-subject design. Our results showed whether a subject is informed or uninformed about the presence of unsolvable anagrams influences how much time one would spend to solve the problems and how well one would solve them. The information about the solvability of problems seems to have a strong influence on accuracy and persistence on Solvable Easy anagrams, and it is a pervasive phenomenon not biased by any uncontrolled

third variables.

The fact that same tendency was demonstrated in both between-subjects and within-subject designs gives stronger support that the effect of information about the presence of unsolvable problems is indeed a robust phenomenon regardless of the experimental designs. Further discussion is the same as discussed in Experiment 1, as Experiment 2 replicated the same finding.

Experiment 3: Instruction Effect –

The influence of information on accuracy and persistence

Experiment 1 and 2 replicated the same pattern – subjects uninformed about the presence of unsolvable anagrams spending longer time and performing better in both between-subjects and within-subject designs, in both Difficult Set and Unsolvable Set. Past work demonstrated that the effects of prior probability of solvability on measures of effort showed that if a problem was more likely to be solvable, problem solver spends longer trying to solve problem (Payne & Duggan, 2011). Rehder (1999) also showed that people tends to conclude that a solvable problem was unsolvable when they were aware of the presence of unsolvable problems, when the problems were unfamiliar to subjects and with the passage of time. And thus problem solving of solvable problems was sometime abandoned prematurely. However, no past research showed if it was only the effect of information about *un*solvability that causes people to persist or give up in solving unsolvable problems, or factors like the actual presence of unsolvable/ difficult problems that are causing people to give up or persist.

In Experiment 3, we tested the effect of instruction only on attempted time for solution and accuracy using Solvable Easy anagrams without Solvable Difficult/ Unsolvable anagrams. We predicted that the effect of information about solvability of a problem on attempted time for solution and accuracy would be absent, if there are no Solvable Difficult/

Unsolvable anagrams. We predicted that there will be insignificant difference on time/ effort and accuracy between informed vs. uninformed group about the presence of unsolvable anagrams.

Method

Participants

Fifty-one subjects (30 males and 21 females) at Seoul National University aged from 20 to 28 participated in this study for their course credits in Introduction to Psychology class. The major, CGPA, English proficiency of subjects were controlled.

Stimuli

In Experiment 3, 16 only Solvable Easy anagrams were used. And they were asked to solve 16 anagrams in 20-minute.

Procedure

Procedure is identical to previous experiments 1 and 2.

Design of the Study

The design of the experiment is between-subjects design (Table 3). The independent variable for Experiment 3 was: Misinformed Group vs. Control Group about the presence of unsolvable anagrams. The dependent variables were problem solving accuracy and attempted time for solution for 16 Solvable Easy anagrams.

Table 3. Experiment 3 design

	Misinformed Group	Control Group
Solvable Easy Set	Misinformed Group + Solvable Easy	Control Group + Solvable Easy

Results

Persistence and accuracy in 16 Solvable Easy anagrams were examined depending

on whether subjects were informed or uninformed about the presence of unsolvable anagrams. As the previous experiments, analyses were conducted sing SPSS and Excel.

Attempted Time for Solution

The attempted time for solution of Solvable Easy anagrams between Misinformed and Control groups about the presence of unsolvable anagrams was examined. The attempted time for solution between misinformed and control groups did not show a statistically significant difference (M = 13.42 vs. 15.96, MSE = 1.78, $t(24) = 1.31$, $p = .18$, *n.s.,* r = - 0.22). The finding evinced that misinformed group showed no significant difference between misinformed and control groups about the presence of unsolvable anagrams, demonstrating that instruction itself does not influence attempted time for solution thereby confirming our hypothesis.

Accuracy

Accuracy for Solvable Easy anagrams between misinformed and a control group about the presence of unsolvable anagrams was examined. The accuracy between informed misinformed and control groups showed no meaningful difference between misinformed and control groups (M = 11.08 vs. 11.85, MSE = 1.01, $t(24) = .58$, $p = .11$, *n.s.,* r = - 0.11). It suggests that instruction itself does not influence accuracy without difficult/ unsolvable anagrams.

Out of 51 subjects, around 70.5% of subjects (36 subjects) thought the anagram set contained unsolvable anagrams, and on average, people thought there were around 3.32 problems that were unsolvable out of 20 anagrams. The difficulty of the anagram was rated as 0.84 on a likert scale from -3 being very easy to 3 being very difficult. When asked why they thought some problems were unsolvable, many wrote it is because of the number of vowels and consonants. When there were only one vowel and 4 consonants in 5-worded anagram (ex, anagram: HTMON – answer: MONTH), many subjects thought the anagram was unsolvable.

No subjects reported anything strange/ weird about the experiment.

Discussion

Experiment 3 showed that the tendency to persist longer and perform better when the presence of unsolvable anagram was not informed is absent when there are no difficult or unsolvable anagrams. It seems that people solve all problems if they can, despite the information about the presence of unsolvable anagrams.

Past work demonstrated that the effects of prior probability of solvability on measures of effort showed that if a problem was more likely to be solvable, problem solver spends longer trying to solve problem (Payne & Duggan, 2011). Rehder(1999) also showed that people tends to conclude that a solvable problem was unsolvable when they were aware of the presence of unsolvable problems, when the problems were unfamiliar to subjects and with the passage of time. And thus problem solving of solvable problems was sometime abandoned prematurely. The present finding extends the past works in that it is not only information about the solvability of problems that causes the difference in persistence and accuracy between informed and uninformed group, but the effect is present only if there are actual difficult/ unsolvable problems. Based on the present finding, it suggests that a problem has to be difficult at least to some degree, in order to successfully manipulate subjects about the information about the presence of unsolvable problems. When subjects judged all problems to be solvable, despite the instruction about the presence of unsolvable problems, subjects ignored the instruction and solved all problems. The instruction alone could not yield subjects to exert more or less effort in solving problems.

It seems that people are not easily fooled by the instruction itself informing whether problems are solvable or unsolvable, yet the decision to quit or persist in solving question is determined by one's own judgment about whether the question is solvable or unsolvable. As

shown in previous experiments 1 and 2, although difficult anagrams could be solved with more time and effort, subjects who were informed about the presence of unsolvable anagrams were more likely to give up, concluding difficult anagrams to be unsolvable. It seems that although a problem is difficult, yet solvable, when subjects are informed of the presence of unsolvable anagrams, subjects are more likely to think difficult problems to be unsolvable and thus quit problem solving.

A number of past works demonstrated that the information about a certain task is a strong influential factor in how people perceive certain objects/situations later (Girgus, J. J., et al. 1997; Yin, 1969; Valentine, 1988; Rhodes et al., 1993; Farah et al., 1998). The current finding extends the past work that information about problems – either solvable or unsolvable – influence how much effort/ time spent and the accuracy later on, congruent with the results in other fields such as object perception. However, in problem solving, it seems that the effect of solvability is at work only if there are actual difficult/ unsolvable tasks. The finding suggests that subjects are not simply manipulated by the instruction of the problems to be either solvable or unsolvable, yet they constantly make their own judgments about whether the problem is solvable or unsolvable and whether to persist or give up.

The current experiment thus implies that despite the information about the presence of unsolvable problems, subjects do not simply believe in the instruction and constantly make their own judgments about the solvability of problems. And thus, when subjects perceive all problems to be solvable, they would solve all problems regardless of the information given to them.

General Discussion

Findings/ Implications of the Present Experiments

The current study evinced that the information about the presence of unsolvable

anagrams – informed vs. uninformed – influence persistence and accuracy on Solvable Easy anagrams throughout between-subjects and within-subject designs, replicating and extending past research which showed that probability of solvability influenced how much effort people would exert to solve a certain problem (Payne & Duggan, 2011). Payne and Duggan (2011) used the unsolvable problems as the stimuli, and Rehder (1999) used both solvable and unsolvable problems, our experiment used solvable easy, solvable difficult and unsolvable anagrams in our experiment.

The findings in the current research gives strong evidence to the phenomenon: When subjects are uninformed about the presence of unsolvable anagrams, they perform better and spend longer time than subjects informed about the presence of unsolvable anagrams. This research extends the past finding by also showing that not only effort/ time spent is influenced by the solvability of problems, but also the accuracy is influenced by the solvability of problems. It implies that accuracy and effort/ time spent are positively correlated. The directionality between effort/ time and accuracy needs to be further addressed. Based on the current finding, it is still unsure what the leading cause is: more effort/ longer time leading to better accuracy or vice versa. It is promising, however, that the relationship between effort/ time and accuracy is bidirectional in that both effort/ time and accuracy are influencing each other. Future research with empirical evidence demonstrating what ways effort/ time and accuracy are influencing each other would be valuable.

It is also interesting to note that difficult anagrams operated the same as unsolvable anagrams in Difficult Set in both informed and uninformed conditions. This finding suggests that although subjects might be able to solve difficult problems with more effort and time, when subjects are aware of the presence of unsolvable anagrams, subjects conclude difficult anagrams to be unsolvable and thus, give up quickly and perform worse on other solvable problems. Rehder (1999) demonstrated that when people were informed of the possible

existence of unsolvable anagrams, with little difficulty, people assumed the solvable problems to be unsolvable. It seems that when people are informed of the possible existence of unsolvable problems, people conclude that difficult, yet solvable problems to be unsolvable. It would be worth investigating what would happen if subjects are correctly informed of the presence of highly difficult problems. Would it lead subjects to give up more easily and perform worse or vice versa? We predict that when informed accurately about the presence of highly difficult problems, subjects would challenge themselves to try harder and spend longer time knowing that they can eventually solve the difficult problem.

The current finding shows that difficult anagrams are often perceived to be unsolvable when they were informed of the presence of unsolvable anagrams, and this influenced the problem solving accuracy and attempted time for solution for solvable problems. The mechanisms to judge the solvability of problems is quite complex, yet needs to be explored in understanding when and why people persist or give up solving problems in more-depth. In real-world, perceived solvability of problems would be the most influential factor in deciding when to quit or persist problem solving, since most real-world problems do not guarantee a concrete answer or solution (Payne & Duggan, 2011). Past findings showed expert-novice paradigm in detecting missing and irrelevant information in problem solving (Low & Over, 1989; Rehder, 1999; Tao, 1992). Researchers showed that subjects who used a deep structure to classify the problems have significantly higher scores in detecting missing and irrelevant information and in the solution rates than those who used surface structure or features for classification. It seems that a subject who is able to identify what information is sufficient, missing or irrelevant for solving a problem understands the problem structure and so is better able to solve it (Tao, 1992). In Rehder (1999), when solving algebra word problems, subjects with better mathematic skill performed well regardless of informed or uninformed condition about the presence of unsolvable anagrams, whereas subjects with

moderate mathematical ability had good success at detecting missing information only when they were informed of the presence of unsolvable problems. Based on the past results, it seems that when estimating the solvability of problems, subjects with more expertise and/or knowledge are better able to predict the solvability of problems more accurately than novices. Judging the problems seems to be a domain where expert-novice paradigm comes into play. Other potential factors that might also be influencing how people judge the solvability of problems should be further addressed, as persistence vs. giving-up decision is an important component of human problem solving.

Findings in experiment 3 showed that the tendency of participants *not* informed of the existence of unsolvable problems performing better and persisting longer is absent when there are no difficult or unsolvable anagrams. Subjects solved all anagrams if they were able to, despite the information about the presence of unsolvable anagrams. This suggests that the instruction effect is present only if there are actual difficult/ unsolvable anagrams. A number of past works demonstrated that the perception of the task is a strong influential factor in many domains including object perception, decision making, attention as well as problem solving (Yin, 1969; Valentine, 1988; Rhodes et al., 1993; Farah et al., 1998). This finding extends the past work that information of the problem – either solvable or unsolvable – influences how much effort/ time spent and the accuracy later on, but the effect of solvability is effective only if there are actual difficult/ unsolvable tasks. The finding suggests that subjects are not simply deceived by the instruction of the problems to be either solvable or unsolvable, but constantly make their own judgments about the problems to be solvable or unsolvable while solving the problems. The current experiment thus shows that although the information about the presence of unsolvable anagram was informed to subjects, they would still solve problems if they judge the problems to be solvable, while continuously making their own judgments about whether the problem is solvable or not. It seems that the

instruction effect would only be effective when difficult or unsolvable anagrams are present. Based on our findings, it is promising that even a small proportion of difficult/ unsolvable problems would have yielded the tendency of uninformed subjects about the presence of unsolvable problems performing better and expending more time/ effort.

We have also examined the correlation between accuracy and the attempted time for solution for difficult/ unsolvable anagrams. We predicted that high performers would spend less time in unsolvable/ difficult problems when they are informed of the existence of unsolvable problems. We thought that high performers would be able to better recognize the solvability of problems when they are aware of the presence of unsolvable anagrams, and this would lead them to spend less time in difficult/ unsolvable tasks and devote longer time on other solvable problems. Yet, we found that higher performers spent equally long time on all tasks rather than spending less time in difficult/ unsolvable tasks. It seems that high performers are motivated to solve all problems with equal amount of time and effort and that is the reason why they perform well in problem solving tasks.

Yet, the above tendency of high performers spending long time on all tasks regardless of solvability is not conclusive, since the design was return-permitted (i.e. subjects can save answer and return back to the question later). If high performers finished all the Solvable Easy anagrams and had some time left, they could go back to the Solvable Difficult/ Unsolvable anagrams, devoting rest of their time to those questions. If the design was return-prohibited, subjects had to decide whether the problem is solvable or unsolvable, and whether they would persist or give up. In return-prohibited condition, subjects have to make decisions about the solvability of problems quickly and thus, it might lead high performers to spend less time in Solvable Difficult/ Unsolvable anagrams when they were informed of the presence of unsolvable anagrams. We are planning to follow-up on this issue in future research.

Future Studies

More future research is needed to explore the mechanisms of unsolvable problem solving. The current research looked at why people persist or give up problem solving. Based on the current findings, there are few interesting inquiries that could be addressed in future studies.

First of all, the results demonstrated in the current study could be followed-up using the real-world unsolvable or ill-defined problems. In the real world, problems are likely to come from novel domains, and with little prior assurance that they can be solved (Rehder, 1999). In the current study, we used anagrams to determine whether one would persist or give up on the face of unsolvable/ ill-defined problems. Conducting a follow-up study with real-world problems would yield stronger support for the finding shown in the current study. And this will have more practical implication as to how people react to unsolvable/ ill-defined problems in their real lives.

Secondly, individual differences causing the persistence vs. giving-up decision would also be worth studying further. In the current experiment, we only looked at the general tendency of the information about the presence of unsolvable anagrams affecting accuracy and time/effort. Yet, there could be individual differences (e.g., motivation, personality traits, happiness, decisiveness, expertise) that might come into play in determining whether one would give up or persist in solving unsolvable/ ill-defined problems. Examining further on these individual differences on ways in which they influence one's own problem solving strategies would inform people better about problem solving for unsolvable problems.

Furthermore, the mechanisms to judge the solvability of problems is quite complex, yet needs to be explored in understanding when and why people persist or give up solving problems in more-depth. In real-world, perceived solvability of problems would be the most influential factor in deciding when to quit or persist problem solving, since most real-world

problems do not guarantee an assurance that they can be solved. The potential factors influencing the decision of solvability would be a meaningful direction future research could further investigate.

Take-home Message

If you believe 'I can do it (i.e. problem is solvable)', you are more likely to persist and succeed than people who thought 'I cannot do it (i.e. problem is unsolvable)', only when the problem contains some moderately difficult/ unsolvable parts.

References

Atkinson, J. W. (1957). Motivational determinants of risk-taking behavior. *Psychological Review, 64,* 359-372.

Atkinson, J. W., & Feather, N.T. (Eds.). (1996). A theory of achievement motivation. New York: Wiley.

Aspinwall, L. G., & Taylor, S. E. (1992). Modeling cognitive adaption: A longitudinal investigation of the impact of individual differences and coping on college adjustment and accuracy. *Journal of Personality and Social Psychology, 63,* 989-1003.

Aspinwall, L. G., & Taylor, S. E. (1997). A stitch in time: Self-regulation and practice coping. *Psychological Bulletin, 121*, 417-436.

Baker, L. (1985). How do we know when we don't undetstand?: Standards for evaluating text comprehension. In C. Forrest-Pressley, G. MacKinnon, & G. Waller(Eds.), *Metacognition, cogntion, and human performance: Volume 1-Theoretical perspectives* (pp.155-206). New York: Academic Press.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behaviora change *Psychological Review, 84,* 191-215.

Baumeister, R. F. (1989). The optimal margin of illusion. *Journal of Social and Clinical Psychology, 8,* 176-189.

Baumeister, R. F., Smart, L., & Boden, J. M. (1996). Relation of threatened egotism to violence and aggression: The dark side of high self-esteem. *Psychological Review, 103,* 5-33.

Bourne, L. E., Jr., Ekstrand, B. R. & Dominowski, R. L. (1971). *The Psychology of Thinking.* Englewood Cliffs, New Jersey: Prentice-Hall. Inc.

Brehm, S. S. & Brehm, J. W. (1981) Psychological *reactance: A theory of freedom and control.* New York: Academic Press.

Colvin, C. R., & Blcok, J. (1994). Do positive illusions foster mental health? An examination of the Taylor and Brown formulation. *Psychological Bulletin, 116,* 3-20.

Farah, M. J. Wilson. K. D., Drain, M., Tanaka, J. N. (1998). What is "special" about face perception? *Psychology Review, 105,* 482-498.

Feather, N. T. (1961). The relationship of persistence at a task to expectation of success and achievement-related motives. *Journal of Abnormal and Social Psychology, 63,* 552-561.

Feather N. T. (1963). The relationship of expectation of success to reported probability task structure, and achievement related motivation. *Journal of Abnormal and Social Psychology, 68,* 231-238.

Feather, N. T. (1967). Valence of outcome and expectation of success in relation to task difficulty and perceived locus of control. *Journal of Personality and Social Psychology, 7,* 552-561.

Frankel, A., & Snyder, M. L. (1978). Poor accuracy following unsolvable problems: Learned helplessness or egotism? *Journal of Personality and Social Psychology, 36,* 1415-1423.

Gardner, H. (2000). *The Disciplined Mind: Beyond Facts and Standardized Tests, the K-12 Education that Every Child Deserves.* New York: Penguin books.

Gilhooly, K.J., & Johnson, C. E. (1978). Effects of solution word attributes on anagram difficulty: A regression analysis. *Quarterly Journal of Experimental psychology*, *30,* 57-70.

Girgus, J. J., Rock, I., & Egatz, R. (1997). The effects of knowledge of reversibility on the reversibility of ambiguous figures. *Perception & Psychophysics, 22,* 550-556.

Green, D. M., & Swets, J. W. (1966). *Signal detection theory and psychophysics.* New York: Wiley.

Hanusa, S.H., & Schultz, R. (1977). Attributional mediators of learned helpnessness. *Journal of Personality and Social Psychology, 35,* 602-611.

Krutetskii, V. A. (1976). *The psychology of mathematical abilities in schoolchildren* (Joan Teller, Trans.). Chicago: University of Chicago Press.

Low, R., & Over, R. (1989). Detection of missing and irrelevant information within algebraic story problems. *British Journal of Psychology, 59,* 296-305.

Low, R., & Over, R. (1990). Text editing of algebraic word problems. *Australian Journal of Psychology, 42,* 63-73.

Low, R., & Over, R. (1993). Gender differences in solution of algebraic word problems containing irrelevant information. *Journal of Educational Psychology, 85,* 331-339.

Janoff-Bulman, R., & Brickman, P. (1982). Expectations and what people learn from failure. In N.T. Feather (Ed.) Expectations and actions: Expectancy-value models in psychology (pp. 207-237). Hillsdale, NJ:Erlbaum.

John, O. P., & Robins, R. W. (1994). Accuracy and bias in self-perception Individual differences in self-enhancement and the role of narcissism. *Journal of Personality and Social Psychology, 66,* 205-219.

Josephson, M. (1992). *Edison: A Biography.* History Book Club.

Markman, E. M. (1979). Realizing that you don't understand: Elementary school children's awareness of inconsistencies. *Child Development, 50,* 643-655.

Mayzner, M. A. and Tresselt, M. E. (1958). Anagram solution times: a function of letter order and word frequency. *Journal of Experimental Psychology, 56,* 376 – 9.

McGrath, J. E. (1962). The influence of positive interpersonal relations on adjustment and effectiveness in rifle teams. *Journal of Abnormal and Social Psychology, LXV,* 365-375.

McFarlin, D. B. , Baumeister, R. F., & Blascovich, J. (1984). On knowing when to quit: Task failure, self-esteem, advice, and nonproductive persistence. *Journal of Personality, 52,* 138-155.

Mandler, G. and Sarason, S. B. (1952), A Study of anxiety and learning. *Journal of Abnormal and Social Psychology, XLVII,* 166-173.

Mikulincer, M. (1986). Motivational involvement and learned helplessness: The behavioral effects of the importance of uncontrollable events. *Journal of Social and Clinical Psychology.*

Mikulincer, M. (1988). The relationship of probability of success and accuracy following unsolvable problems: reactance and helplessness effects. *Motivation and Emotion.*

Newell, A. and Simon, H. A. (1972). *Human Problem Solving.* Englewood Cliffs, N. J.: Prentice Hall, Inc.

Paas, F. G. W. C. (1992). Training strategies for attaiing transfer of problem-solving skill in statistics:

A cognitive load approach. *Journal of Educational psychology*, *84,* 429-434.

Payne, S. J., & Duggan, G. B. (2011). Giving up problem solving. *Memory and Cognition, 39*, 902-913

Peterson, C., & Seligman, M. E. P. (1984). Causal explanations as a risk factor for depression: Theory and evidence. P*sychological Review, 91,* 347-374.

Pittman, N. L. & Pittman, T. S. (1979). Effects of amount of helplessness training and internal-extenral locus of control on mood and accuracy. *Journal of Personality and Social Psychology, 37,* 39-47.

Reed, S. K., & Bolstad, C. A. (1991). Use of examples and procedures in problem solving. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *17,* 753-766.

Rehder, B. Detecting Unsolvable Algebra Word Problems. *Journal of Educational Psychology, 91,* 669-683.

Rhodes, G., Brake, S., & Atkinson, A. P. (1993). What's lost in inverted faces? *Cognition, 47,* 25-57.

Roth, S., & Kubal, L.(1975). Effects of noncontingent reinforcement on tasks of differing importance: Facilitation and learned helplessness. *Journal of Personality and Social Psychology.*

Schneider, W., & Shiffrin, R. M. (1977). Controlled ad automatic human information processing: I, Detection, search, and attention. *Psychological Review, 84,* 1-66.

Scheier, M. F., Weintraub, J. K., & Carver, C. S. (1986). Coping wth stress: Divergent strategies of optimists and pessimists. *Journal of Personality and Social Psychology, 51,* 1257-1264.

Jones, Steve. (2002). The Internet goes to challenge: How students are living in the future with today's technology.

Tao, P. K. (1992). Detection of missing and irrelevant information within paper and pencil physics problems. *Research in Science Education, 22,* 387-392.

Taylor, S. E. & Brown, J. D. (1988). Illusion and well-being: a social psychological perspective on mental health. *Psychological Bulletin, 103,* 193-210.

Taylor, J. A. and Spence, K. W. (1952). The relationship of anxiety level to accuracy in serial learning. *Journal of Experimental Psychology, 44,* 61-64.

Trope, Y., & Brickman, P. (1975). Difficulty and diagnosticity as determinants of choice among tasks. *Journal of Personality and Social Psychology, 31,* 918-926.

Valentine, T. (1988). Upside-down faces: a review of the effect of inversion upon face recognition. *British Journal of Psychology, 79,* 471-491.

Vitalino, P. P., Russo, J., & Maiuro, R. D. (1987). Locus of control, type of stressor and appraisal within a cognitive-phenomenological model of stress. *Journal of Research in Personality, 21,* 224-237.

Weiner, B., Russell, D., & Lerman, D. (1979). The cognition-emotion process in achievemtn-related contexts. *Journal of Personality and Social Psychology, 37,* 1211-1220.

Wortman, C. B. & Brehm, J. W. (1975). Responses to uncontrollable outcomes: An intergration of reactance theory and the learned helplessness model. In L. Berkowitz(Ed.), *Advances in experimental social psychology*(Vol. 8, pp. 278-226). New York: Academic Press.

Yin, R. K. (1969). Looking at upside-down faces. *Journal of Experimental Psychology, 81,* 141-145.

풀리느냐 풀리지 않느냐, 그 것이 문제로다:
정답이 없는 문제가 있다는 정보가 문제 해결 수행에 미치는 영향

박수진

심리학과

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지금까지의 문제해결 연구는 정답이 있는 문제에 대해서만 연구해왔다. 하지만, 실제 상황에서는 정답이 정확하지 않은 문제를 풀게 되는 경우가 종종 발생한다. 정답이 없는 문제를 풀게 될 때의 문제 해결방식에 대한 연구가 부족한 점을 고려하여, 본 실험에서는 풀릴 수 없는 문제에 대한 정보가 문제 해결 수행과 문제를 푸는데 걸리는 시간에 어떤 영향을 미치는지를 연구하였다. 실험 1에서는, 같은 아나그램(anagram)문제에서, 피험자의 반은 풀 수 없는 문제가 있다는 정보를 받았고, 다른 반은 본 정보를 받지 않은 채로 문제를 풀었다. 총 문제 중 어떠한 문제들은 굉장히 어렵거나 정답이 없는 문제들이 포함되어 있었다. 본 연구는 정답이 없는 문제가 있다는 정보를 받지 않은 피험자 집단이 본 정보를 받았던 집단보다 문제 해결 수행이 높았고, 문제를 푸는데 걸리는 시간이 유의미하게 길었음을 발견했다. 실험 2에서 피험자 내 설계에서도 실험 1의 결과는 반복검증 되었다. 하지만, 실험 3에서 어렵거나 정답이 없는 문제가 제외되었을 때에는 두 집단 간에 수행과 시간에서 유의미한 차이가 나타나지 않았다. 본 실험이 결과는 문제 해결의 가능성이 문제 해결 수행과 문제를 푸는데 걸리는 시간에 영향을 미치고 있으며, 이러한 결과는 오직 어렵거나 정답이 없는 문제가 존재할 때 나타난 다는 것을 보여준다.

주요어: 문제 해결, 풀 수 없는 문제들, 끈기, 포기, 아나그램 문제

학 번 : 2011-23138

ACKNOWLEDGEMENT

I thank Prof. Joo Yong Park for all the help and support from the beginning to the end of the research.