Psychological Gaps between

constructors and interpreters of causal maps

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Abstract: *This paper investigates psychological differences between constructors and interpreters of causal maps. This paper argues that dissipation effects and dilution effects applies to those who are to interpret causal maps not to those who construct them. Dissipation effects are psychological tendency that people perceive causal effect as weak as the number of causal links increases. Dilution effects occur when people undervalue the strength of causal relation as the number of causal variables increases. Experimental results show that concentration effects opposite to the dissipation effects and dilution effects explain more correctly the perception of constructors of causal maps. This paper points out that this asymmetric psychological tendencies between constructors and interpreters of causal maps is the psychological source of the communication problems between systems thinkers and their clients.*

Keywords: cognitive psychology, systems thinking, dissipation effects, dilution effects, concentration effects

I. Communication problems between systems thinkers and their clients

Systems thinking is to develop meaningful causal maps illustrating main forces dominating the system in question. Systems thinkers communicate with their clients about the causal maps. They try to share ideas on the sources of problems and leverage points to attack the problems (Dennis 2002, Kim 2004). However, there are usually communication problems between them.

Last year I participated in the government projects and the government officials asked us to draw simple and important causal maps showing dynamics of human

resource management in the Korean government. My team members did draw causal maps that they think simple and important. But at first glance, government officials had shaken their heads and said, “we want simple causal map that we can understand. These maps are too complex and only deal with unimportant things.”

We hold several project meetings to meet our clients’ request on the simple causal maps. But all most everyone in our project team said, “these causal maps are simple enough and they deal with important things!” I could not persuade my team members any more and I did draw by myself a simple causal map that government clients wanted. After this experience, I felt that there are fundamental psychological gaps between systems thinkers and their clients, more deeply rooted in their mind than the communication problems

II. Psychological tendencies in interpreting and constructing causal maps

Consulting with causal maps and experiencing lots of psychological barriers, I found that there are at least three kinds of psychological tendencies that can greatly affect perception of the causal maps, that is, dissipation effects, dilution effects, and concentration effects. While the dissipation effects and dilution effects can be applied to the context of interpretation of causal maps, the concentration effects can be applied to the context of construction.

Dissipation Effects

Whte (1997, 1998, 1999, 2000) investigated how people reasoned about the dynamics of a simple food web. The food web was a set of eating relationships between various animals and plants. Subjects judged effects of different kinds of disturbance within the food web. Their judgments showed a consistent tendency that White named a dissipation effect: a tendency to judge that effects of a perturbation at a particular locus in an ecosystem on food web dissipate as they spread out from that locus. In other words, the strongest effects are judged to occur at locations adjacent to the perturbation, and the weakest effects at locations most distant from it.

System dynamicists observed this psychological tendency long ago, when they said that policy makers tend to search solutions only near the problem. As Jay Forrester pointed out, solutions are not effective as people expect (Forrester 1971).

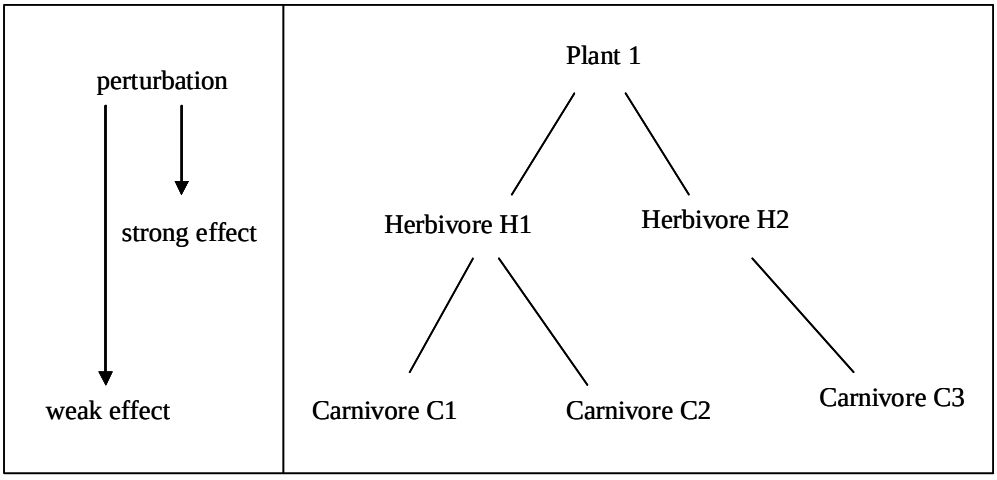


Figure 1. Dissipation Effects and the food web used in the experiment by White (1997)

Dilution Effects

Another psychological tendency that may affect people's judgment on the degree of causal effect is the dilution effects. If there are multiple causality parallel to the target variable, the effect of causal relation will be perceived weak. On the contrary if there is only one causal factor, its effect will be perceived strong. In psychological studies, the dilution effect was found when people facing with nondiagnostic information showed psychological tendency to underestimate the causal relationships of diagnostic information (Tetlock & Boettger 1989, Meyvis & Janiszewski 2002). Figure 2 compares the single causality and multiple causality. A's causal effect on B will be perceived stronger in single causality compared to that of the multiple causality.

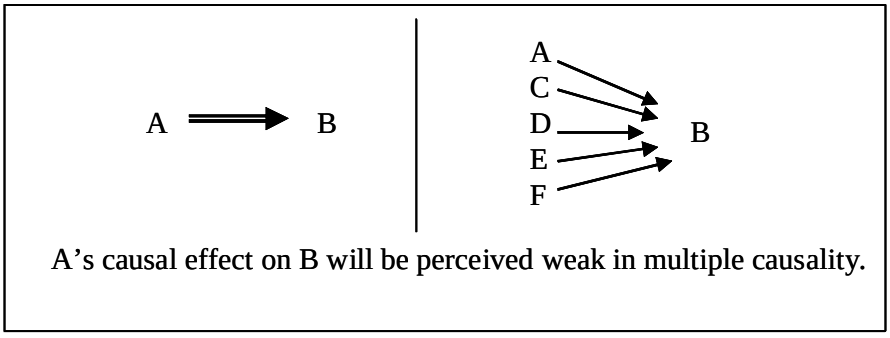


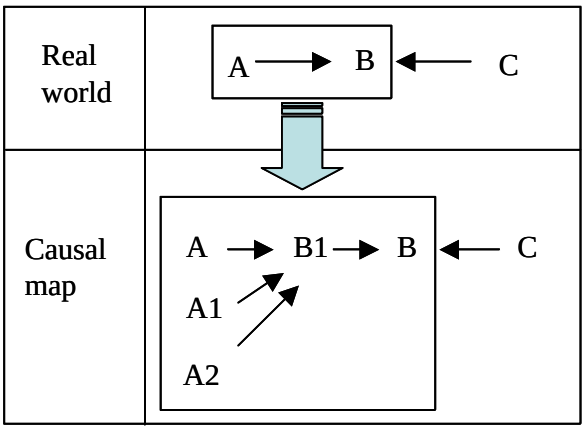
Figure 2. Dilution effects

The dilution effect seems to have a reasonable logical base. One can think that the dilution effect is the psychological tendency based on common senses. People can think that there are competition among causes in producing effects. Multiple causes means high competition and thus the strength of causal effects produced by individual variables will be reduced. On the other hand some psychologists assume an averaging model to account for the dilution effect. People tend to average effects of causal variables to judge the total effects. To average, people must give weights to causal variables. And thus if there are many causal variables, each causal variables receive low weights.

Above psychological tendencies are for those who read or interpret causal maps rather than those who make or construct causal maps. We must inquire whether or not these psychological tendencies like dissipation effects and dilution effect can be applied to constructors of causal maps.

Concentration effects

The first time I realized the concentration effects was when I discuss on the psychological distance in the cognitive map of policy makers (Kim 2000). At first I assummed a dissipation effects in the psychological analysis of cognitive maps. That is, policy makers are assumed to regard variables close to the policy goal as important in achieving the goal. In the same reason, I assumed they will regard policy variables located distant from the policy goal as unimportant to achieving it.



Concentration Effect

Figure 3. Concentration effects in the context of constrcuting causal maps

At this idea, professor Moon pointed out other possibility that the distant variables can be regarded more important. His idea is like this. Policy makers will concentrate on sectors that he believe important in achieving policy goals. As he thinks a lot of time on the specific sectors, he will say a lot of variables on the subject in the detailed level. At last, the cognitive map constructed from their spoken statements will reflect their interest and contain more variables on the sectors that they think important. So, variables distant from the policy goal can reflect their concern and concentration.

From this discussion, I agreed on his idea and named this psychological tendency as concentration effects. The concentration effects can occur not only in the cognitive maps but also in causal maps by systems thinkers. In several meetings with systems thinkers, I am convinced that the concentration effects can be applied to most of the systems thinkers I met. They concentrate on the sectors they think important and they put lots of variables on the sectors. At last, their causal maps come in the shape that looks simple where they think unimportant or uninteresting, but complex where they think important or interesting.

The concentration effects are opposite to the dissipation effect, in the sense that constructors perceive the effect of long causal chains as strong. Constructors draw long causal chain because they think their effect is strong. With this opposing tendencies, we can explain why systems thinkers and their clients have communication problems so often. The clients perceive the short and simple causal chain as strong and import, while systems thinkers think that the long and complex causal chains have strong effects and so are important in the system.

III. Experiment and analysis on the concentration effects

While dissipation effects was confirmed several times by White (1997, 1998, 1999, 2000), the opposing concentration effects has no supporting evidence yet. To experiment on the concentration effects, I devised several questions that are intended to put subjects to construct causal maps. Subjects in the experiments performed by White were given the food web, and they were asked to interpret the map. But I used open questions and requested subjects to draws causal chains by themselves. With this method, I tried to test the concentration effects in the context of map construction, while dissipation effects of White were tested in the context of map interpretation.

In the experiment, 122 students were participated. They were freshmen and did not have any experience on the causal maps. The first question to the subject was to draw causal chains between presidential leadership and national economic performance as in figure 4. This question is to check how many causal linkages the subjects have in their

minds.

Next question is to check how many parallel causalities the subjects have in mind. That is, I asked “what other factors do you think will affects national economics?” To emphasize parallel causality, answer sheet was formed as laundry lists as in figure 5.

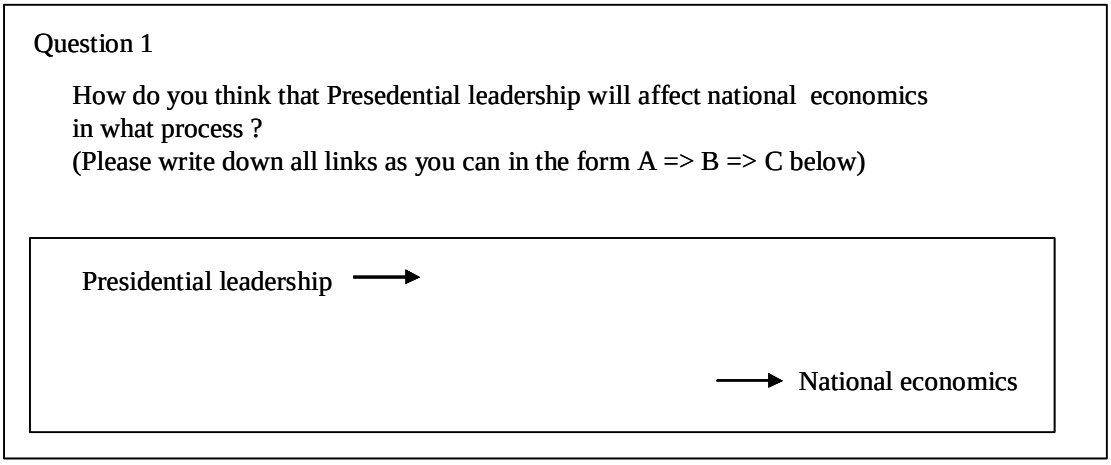


Figure 4. Question for checking number of causal linking and dissipation effects

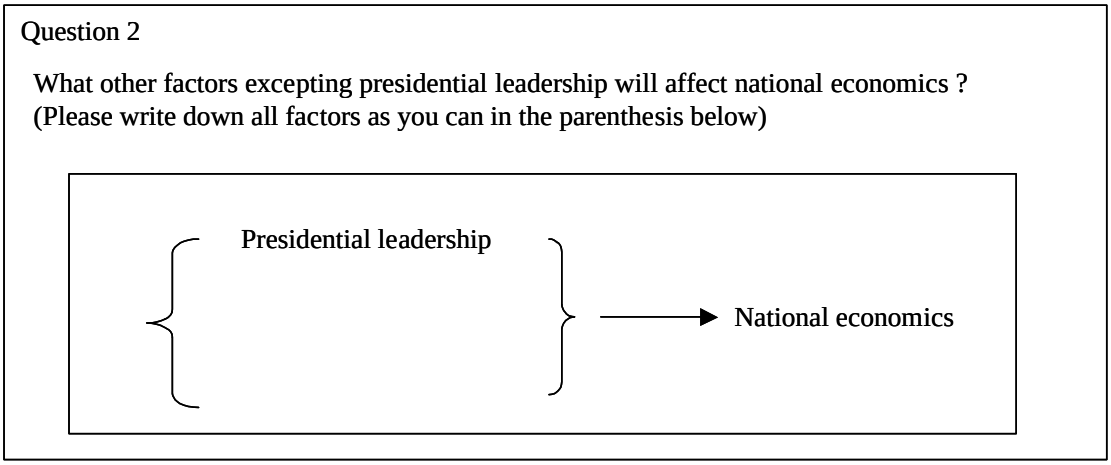


Figure 5. Question for checking multiple causal factors and dilution effects

And then I asked two questions to the subjects. The first question is on the case of increase in the presidential leadership, and the second one is on the case of decrease in the leadership. Subjects are to judge how much degree of change will be occurred in the national economics.

Question 3 & 4

3. Suppose that presidential leadership is enhanced around 50%,
how much national economics will be enhanced? (%)

4. Suppose that presidential leadership is decayed around 50%,
how much national economics will be decayed? (%)

Figure 6. Question for causal effects

Experiments were performed carefully but rapidly. It takes around fifteen to twenty minutes. Throughout the experiments subjects can ask any questions to the experimenters. Experimental results were checked carefully. The logical consistencies in the causal chains addressed by subjects were checked. I could find that most of the questions are answered properly.

Subjects showed high differences in the number of causal length and parallel causalities. The mean of the number of causal links was 3.508 and the mean of the parallel causal factors was 3.557. The maximum causal length was 8, and the maximum number of parallel causal factors was 11. At last, the means of changes in national economics judged by the subjects are around same amount of the changes in the presidential leardership. Interesting results are that subjects judged the effects of decrease in the performance more strongly than the effects of increase.

	Mean	Max	Min	Std dev
Number of causal links	3.508	8	1	1.63
Number of multiple causal factors	3.557	11	1	1.56
Effect of 50% increase in leadership	41.6%	200%	2%	32.6
Effect of 50% decrease in leadership	-52.2 %	-200%	0%	32.7

Figure 7. Experimental results: basic statistics

With the correlation analysis of the variables, we can find out what psychological tendencies are there in the experiment. Figure 8 shows correlation coefficients and their significant level among the number of causal links, number of multiple causal factors, effects of increase in leadership, and effects of decrease in leadership.

At first, one can find that there was no dissipation effect. According to the

dissipation effect, number of causal links and the effects should show negative correlation coefficient. But in figure 8, one can find there are positive coefficients. This means that there was no dissipation effect. And this can be generalized to the statement that there are no dissipation effect in the context of constructing causal maps.

Correlation Coefficients	Number of multiple causal factors	Effect of 50% decrease in leadership	Effect of 50% increase in leadership
Number of causal links	.4184 P=.000	.1995 p=.028	.0485 P=.595
Effect of 50% increase in leadership	-.0581 P=.525	.4815 P=.000	
Effect of 50% decrease in leadership	.0865 P=.343		

Figure 8. Correlation tables for variables

Secondly, the low significance level of coefficients between number of multiple causal factors and effects of changes in the leadership shows that there were no dilution effects. These findings are different from results of traditional experiments.

Lastly, the positive coefficient between number of causal links and effects of decrease in leadership shows that there were concentration effects. In the concentration effects, those who express longer length of causal chains judged greater causal effects between presidential leadership and the national economics.

Also one can find that number of causal links and number of multiple causal factors shows high correlation coefficient. This result supports concentration effects again. Those who have more concern and knowledge on the relationships answered more causal links and parallel causal factors. In sum, correlation coefficients with high significant level in figure 8 account for the existence of concentration effects rather than dissipation effects or dilution effects.

IV. Conclusion and Insights

One of the most important findings in this experiment is that psychology of constructing causal maps is different from that of interpreting them. This difference creates fundamental psychological gaps between systems thinkers and their clients.

The clients who are to interpret causal maps constructed by systems thinkers are

affected by the dissipation effects and the dilution effects. Experimental results showed that another psychological tendency, the concentration effects, can explain the perception biases of constructors of causal maps. The concentration effects are psychological tendency that systems thinkers draw more variables and causal links when they deal with sectors they think important and interesting.

The psychological gaps between systems thinkers with the concentration effects and their clients who are affected by the dissipation effects and the dilution effects explain why there were so many communication problems between them. Systems thinkers draw complex maps, and want to persuade their clients that those complex maps are really important, while their clients are dominated by the dissipation effects. As long as the model is complex, clients perceive lots of dissipation effects, and they think variables will have weak effects on their policy variables. The clients want to get simple view of their system, but systems thinker fail to give them the simple causal map as long as they are captured in the trap of concentration effects.

The experimental results reported here cannot be generalized, because the experiment reported here has many limitations. First of all, the experiment was too simple. I could not include feedback loops in the experiment. Secondly, the subjects were not systems thinker. They performed only constructors of causal maps. Systems thinker who have good amount of experience and insights can stand out from the trap of the concentration effects. I think that these limitations show future research on the psychological tendencies on the causal maps (Doyle 1997). I believe that further research on the differences between interpreter and constructor of causal maps will shed lights on the harmonious communication and insights sharing between systems thinkers and their clients.

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