Roles of Self Goal Setting in Insight Problem Solving

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Abstract

Previous studies have shown that emphasizing the goal state could facilitate insight problem solving (e.g. Chronicle, MacGregor, & Ormerod, 2004). In these studies, the goal states were given by the experimenters and the participants were instructed to reach them. In the present study, we investigated whether the same facilitative effect could be obtained when the participants were forced to find the goal state by themselves. We used the 6-coin problem and compared the performance between the self goal setting condition and the control condition. The results showed that the participants in the self goal setting condition could solve the problem less often than those in the control condition when they were not allowed to reach the other goal state. It, however, slightly facilitated the insight problem solving if the participants were allowed to change the goal. The results indicated that self goal setting is effective in finding emergent goals.

Keywords: Insight problem solving; Goal setting, Plan

Introduction

Problem solving is defined as an activity in which one tries to fill the gap between the initial and the goal state. It is well known that we adopt some heuristics in order to solve the problems. The hill climbing heuristic is one of the most common ones. It is the way of selecting operators so that the distance between the present state and the goal states can be minimized. To apply the heuristic, we need to know or at least to infer what goal state is. Although no one denies that goal plays a critical role in problem solving, it seems remain a matter of debate what roles the goal plays. In the present study, we investigate what roles the goal plays in insight problem solving.

Importance of Goals in Insight Problem Solving

Although what processes underlies insight problem solving is still open (e.g. special process view vs. business as usual view), there is agreement that the goal plays an important role in insight problem solving. Kaplan and Simon (1990) applied the information processing framework to understand the process of insight problem solving. They argued that one uses some heuristics to narrow the problem space. MacGregor, Ormerod, and Chronicle (2001) have proposed the progress monitoring theory. They argued that hill climbing heuristic underlies the selection of moves to solve the nine-dot problem. Ormerod, MacGregor, and Chronicle (2002) applied the theory to the 8-coin problem.

Hiraki and Suzuki (1998) proposed the dynamic constraint relaxation theory to explain the processes of insight problem solving. They hypothesized three types of constraints working during insight problem solving: object-level, relational, and goal. The object-level constraint is our natural tendency to encode objects at a basic level, although there are numerous other ways of interpretations. The relational constraint is a tendency to choose specific relations among innumerable alternatives. The word "relation" is defined as the manner in which objects are related to each other. The goal constraint is the ideal image, which provides feedback to the other two constraints by evaluating a match between the present and the desired states. They suggested that these constraints create an impasse at the earlier stage during insight problem solving and the incremental relaxation of the constraints driven by failures probabilistically causes qualitative transitions.

Wajima, Abe, and Nakagawa (2008) proposed the chaotic neural network model of the insight problem solving. Their model was implemented the goal orienting mechanism by which the model selects operators to minimize the gap between the present and the goal state. By comparing the models with and without the goal-orienting mechanism, they showed that the goal-orienting mechanism is necessary.

Effects of Goals on Insight Problem Solving

The models mentioned above hypothesized that the goal plays a role as a criterion in evaluating the current states. When the goal state is explicitly shown, one can evaluate the present state easier and more accurately than when not. It can be expected that emphasizing the goal state facilitates the insight problem solving.

Suzuki, Miyazaki, and Hiraki (1999) examined whether emphasizing the goal state could be effective in solving the insight problem using the T-puzzle. The task was to arrange the four pieces such that they formed a T- shape. The goal state is essentially included and is explicitly shown in the original task instruction. In order to emphasize the goal state, they provided the T-shape template with the participants and asked them to match the pieces to it. The results showed that the solution rate in the template condition was higher than that in the control condition. It implied that reinforcing the goal constraint can be effective in insight problem solving.

Kojima, Ito, and Matsui (2008) investigated whether emphasizing the goal state could facilitate insight problem solving using the F puzzle. The F puzzle is to arrange the four pieces so as to make the F-shape. Along with the T-puzzle, the goal state is essentially included and is explicitly shown in the original task instruction. In order to emphasize the goal state, they provided the F-shape template with the participants and asked them to match the pieces to it. In addition to the template condition, they introduced the instruction condition, in which the participants were not provided any external aid and were required only to imagine the F-shape. The results showed that the solution rate in the template condition was higher than those in the instruction condition and in the control condition. Kojima et al. (2008) concluded that giving the template was effective in emphasizing the goal state and facilitating the top-down processing and that the top-down processing can be effective in insight problem solving.

Because these studies used the insight problem having a fixed goal, the participants had to reach it. However some insight problems, for example, the 6-coin problem, have more than one goal states. What roles does goal information play in solving the multi goal states problem? Chronicle, MacGregor, and Ormerod (2004) addressed the question using the 6-coin problem. They showed that the participants could reach the solution more often when they were given the visualized goal state than when were given only the original instruction.

Purpose of the Present Study

Previous studies have shown that emphasizing the goal state could facilitate insight problem solving. In the previous studies, the information of the goal states were given by the experimenters and the participants were instructed to reach the goal state. In the present study, we investigate whether or not the same facilitative effect can be obtained when the participants are asked to find the goal state by themselves before performing the tasks. If emphasizing the goal state facilitated insight problem solving, we expected that self goal setting could be effective in insight problem solving as long as they set the goal state appropriately.

Experiment 1

Method

Participants Fifty-two undergraduates from Chubu University participated in the experiment and received a course credit following the completion of the experimental session. None have seen the 6-coin problem. They were randomly assigned to one of the two conditions: self goal setting and control. Twenty-eight participants were assigned to the self goal condition and 24 to the control condition.

Task The 6-coin problem (Chronicle et al., 2004) was used. The task was to rearrange the coins from the initial state shown in Figure 1 such that each coin touched exactly two others following these four rules: (a) one can have three moves, no more and no fewer. (b) In each move, they have

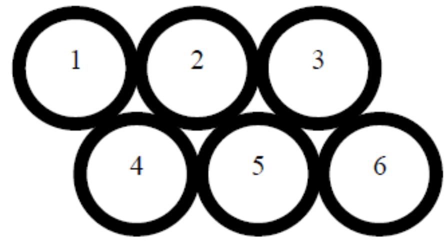

Figure 1: The initial state of the 6-coin problem cited from Chronicle et al. (2004). The numbers in the circles were not shown the participants.

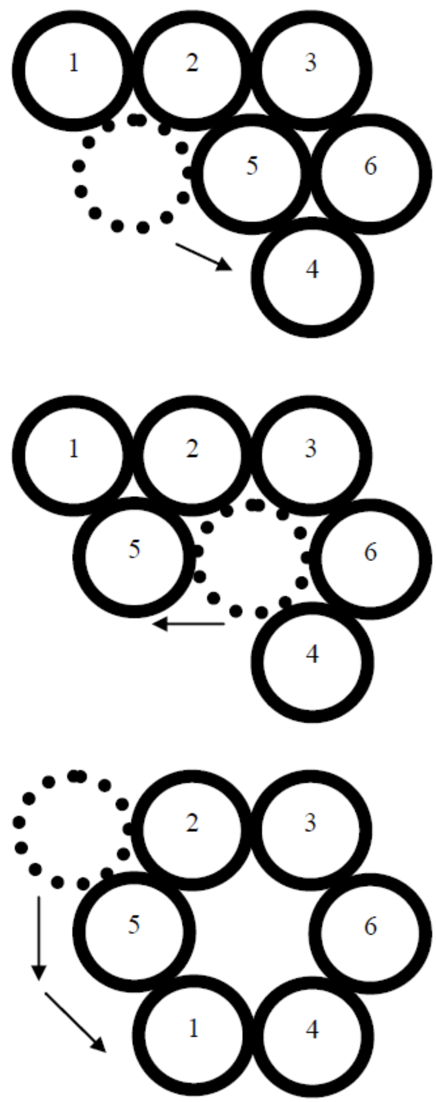

Figure 2: An example route to the ring goal state cited from Chronicle et al. (2004).

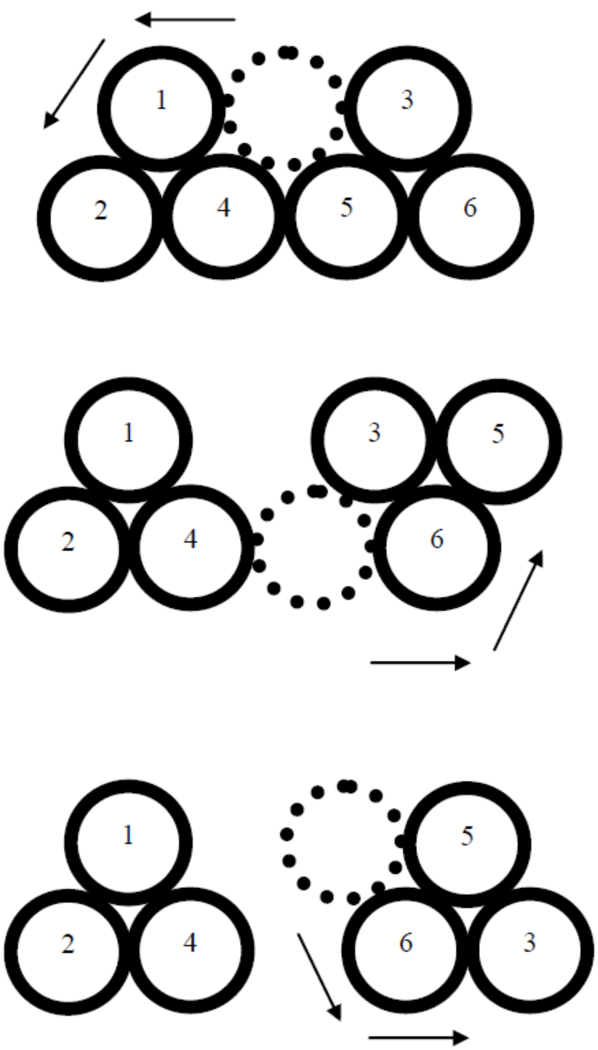

Figure 3: An example route to the 2-group goal state cited from Chronicle et al. (2004).

to slide one coin only. (c) When they slide a coin, it must not disturb any other coins. (d) At the end of each move, the moved coin must be touching two other coins. There could be the following two goal states: ring and 2-group. According to Chronicle et al. (2004), there are only two paths to the ring goal state and 176 to the 2-group one. An example solution path to the former goal state is shown in Figure 2 and the latter in Figure 3.

Procedures Participants were tested individually and their solution attempts were videotaped. For both conditions, participants were shown the initial state of the problem using 6 Japanese 500-yen coins. The participants in the self goal setting condition were asked to draw the goal state on a paper in three minutes and then to reach the goal state in 12 minutes. They were allowed only to reach the goal state they drew. The participants in the control condition were asked only to solve the problem in 15 minutes. The experimental session was terminated when the participants found the solutions or when the designed time elapsed.

Results and Discussions

Because a participant in the self goal setting condition was not able to draw the goal state within three minutes, the data was not included into analyses. As a result, 51 data was used for further analyses.

Firstly, we compared the performance between the self goal condition and the control condition. The performance in each condition is shown in Figure 4. The results showed that the participants in the self goal setting condition could solve the problem less often than those in the control condition (*Chi-square* (df =1, N = 51) = 6.24, $p < .05$).

Next, we examined the relationship between the goal states the participants depicted by themselves and the performance in the self goal setting condition. As shown in Table 1, 44.4% of the participants envisioned the inappropriate goals. Because the participants were restricted to the goal states they set, they could not reach the correct goal in principle. None of the participants who set the ring goal could reach the goal.

The participants in the self goal setting condition might not solve the problem because they set the inappropriate goals. Although the participants in the control condition might also search any paths to some inappropriate goals, they were able to change the goals if they wanted. On the other hand, those in the self goal setting condition were not allowed to change the goals even when they found the goal states inappropriate during problem solving. It might put them disadvantage situation.

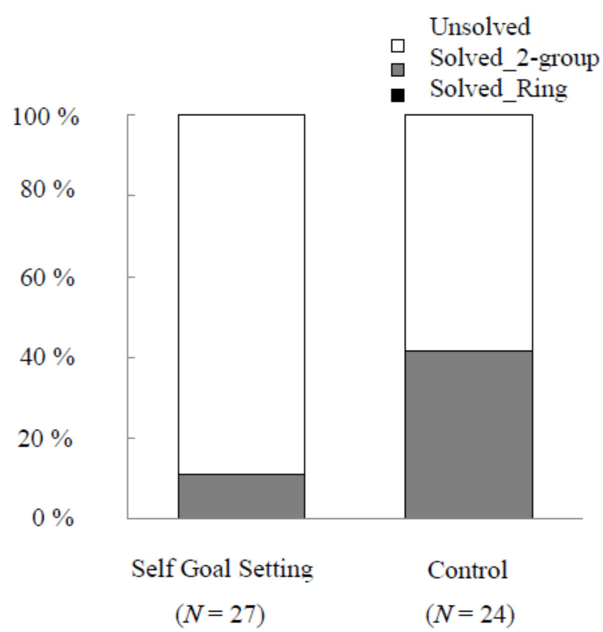

Figure 4: The performance in each condition.

Table 1: The relationship between the self set goals and the performance.

	Solved		Unsolved
	Ring	2-group	
Ring	0	-	10
2-group	-	3	2
Other	-	-	12

Another reason why those in the self goal setting condition could not solve the problem might be because it is more difficult to find any paths to the ring goal than the 2-group goal. Chronicle at al. (2004) have shown that there were only 2 routes to the ring goal whereas 176 to the 2-group goal. Thus, it was more difficult for those who could draw the ring goal state to find the routes to it.

Experiment 2

Contrary to our expectation, in Experiment 1, self goal setting could not facilitate but disrupt the insight problem solving. Because some participants set the inappropriate goals and they were not allowed to change them, the situation might have negative effects on insight problem solving. If the inappropriate goal setting is cause of the disruptive effects, the disruptive effect will be diminished when the participants can change the goal state. In Experiment 2, we examine the effects of self goal setting on insight problem solving when the participants are allowed to change the goal state.

Method

Participants Fifty-five undergraduates from Chubu University participated in the experiment. They received course credit for participation. None have seen the 6-coin problem. Twenty-seven participants were assigned to the self goal condition and 28 to the control condition.

Task and Conditions The task and conditions were the same as in Experiment 1, except that the participants in the self goal setting condition were allowed to reach not only the goals they set but also any other goals.

Results and Discussions

Because a participant in each condition inappropriately finished the experimental session, these two data were excluded from the following analyses. As a result, 53 data was used for the analyses.

We compared the performance between the self goal condition and the control condition. The performance in each condition is shown in Figure 5. The results showed that the participants in the self goal setting condition could solve the problem more often than those in the control condition (*Chi-square* (df =1, N = 53) = 3.18, p = .07).

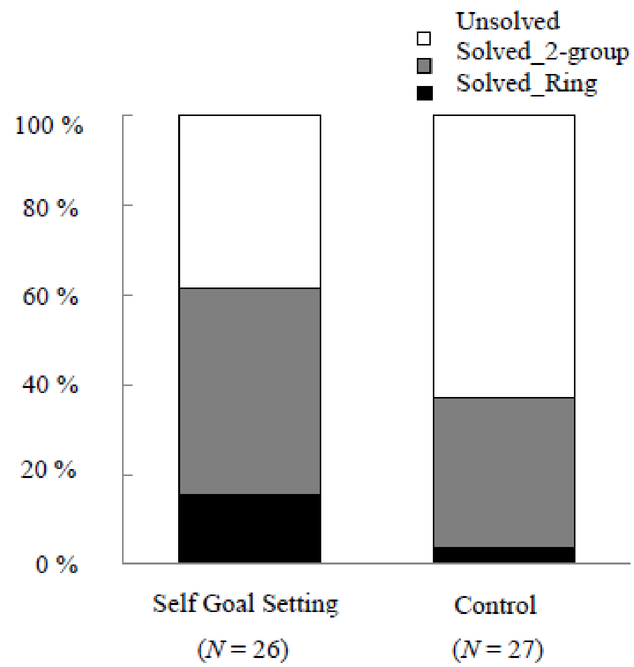

Figure 5: The performance in each condition.

Table 2: The relationship between the self set goals and the performance.

	Solved		Unsolved
	Ring	2-group	
Ring	4	4	4
2-group	0	5	1
Other	0	3	4

Next, we examined the relationship between the goal states the participants set by themselves and the goals they actually reached in the self goal setting condition. As shown in Table 2, 29.2% of the participants drew the inappropriate goal states. Unlike Experiment1, they were allowed to change the goals and 42.9% were able to reach the 2-group goal. Most of the participants who drew the 2-group goal state could find the paths to the 2-group goal. One-third of those who set the ring goal also reach the 2-group goal.

General Discussion

In Experiment 1, self goal setting disrupted the insight problem solving contrary to our expectation. The results were interpreted that because the participants could not set appropriate goal by themselves or because self goal setting itself disrupted the insight problem solving. In Experiment 2, self goal setting slightly facilitated the insight problem solving. However, many participants in the self goal setting condition reached the different goals from those they depicted. Self goal setting can be effective in insight problem solving when the goal works as a working hypothesis, but detrimental as a fixed criterion.

The theory of situated cognition predicted that we can find emergent solutions even when they search for a pre-defined goal. Suchman (1987), for example, argued that when a person takes a canoe in a rapid river, he/she may abandon his/her plan of how to go down in face of rapid currents, but the plan still has a role of orienting actions towards particular courses. It seems very similar to the processes observed in the self goal setting condition of Experiment 2. The participants who depicted the ring goal state at first tried to find the route to the ring goal and after some attempts they might found it too difficult to do. In the midst of the search, they might find another goal state, that is, the 2-group. As shown in Figure 2, the second step seems similar to the 2-group goal state. It might hint the participants that there can be another goal state and they might change the goal state. It can be said that the present study provided evidence supporting the notion the situated cognition theory pointed out.

The question to be addressed further is why the ring goal state set by themselves did not facilitate the insight problem solving whereas did when the experimenter gave the goal state in the Chronicle et al. (2004). The difference in effects of the goal on insight problem solving might be caused by source attribution effects. Several studies have shown that source of information has some effects on the performance. Schunn and Klahr (1993) investigated the effects of other-generated hypotheses on rule discovery. The results showed that giving the other-generated hypothesis led participants to investigate the plausibility of hypotheses more thoroughly and less false terminations with incorrect solutions. Kiyokawa, Ueda, and Okada (2004) experimentally clarified whether assessing other-generated hypotheses could facilitate hypothesis revision using a rule-discovery task. The results revealed that the participants who assessed the other-generated hypotheses before generating and assessing their own hypotheses performed better than those who generated their own hypotheses and assessed them thoroughly. Osman (2008) showed that seeing learning history of another participant facilitated transfer of acquired knowledge during the first task to the second one in implicit learning situation. In addition, she also showed that the facilitative effects was obtained even when the participants were provided with their own learning history in fact, only if they were told that they were derived from another participant. The results suggest that source attribution has the effect on transfer in implicit learning.

Conclusion

The goal plays an important role in insight problem solving by directing the solvers' search. When it is not fixed, that is can be flexibly changed, emphasizing the goal state can facilitate insight problem solving. Even though the content of the goal state is the same, who set the goal can have effects on what effects is emerged: self or the other.

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