

Title	二重構造を持つ問題としての洞察問題の実験的検討
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An experimental examination of the insight problem as a problem with a dual structure

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When we solve the problem, we may come up with a solution unexpectedly after struggling with it. This kind of problem solving is called insight problem solving. And the feeling at this time is sometimes called an “Aha experience”. Insight problem solving is a familiar phenomenon, but its mechanisms remain largely unexplored. The purpose of this study is to elucidate the cognitive process of insight problem solving. Insight problem solving is known to have a variety of empirical features. In the previous study on insight problem solving, it was shown that the perceived proximity to the solution may increase during the answering process, and when the solution is accompanied by an Aha experience, the feeling proximity to the solution is shown to increase rapidly just before the solution. Therefore, we think that the insight problem is structured in such a way that it connects an Aha experience with the perceived proximity to the solution.

In this study, we propose a dual-structure hypothesis on the essential structure of insight problems. We think of problem solving as deriving the solution from the problem statement, which is the set of instructions for the content to be sought. The problem is solved when the solution is uniquely determined by following the instructions. In non-insight problem solving, the solver understands the instructions of the problem from the problem statement and tries to derive a uniquely determined answer. This corresponds to the mapping between the “space of the problem sentences” and one’s internal “space of interpreting problem sentences”, and in non-insight problem solving, the mapping is established in such a way that a solution exists. On the other hand, in insight problem solving, there is a mapping that does not have a solution, and for the respondent, the mapping between the “space of the problem sentences” and the “space of interpreting problem sentences” is unclear. In this case, the solver cannot follow the instructions directly from the problem text and is left searching for a solution. At some point, however, they discover a correspondence between the “space of the problem sentences” and the “space of interpreting problem sentences” that allows them to have a solution, and they are able to derive a solution.

We hypothesize that this phenomenon is due to the fact that insight problems have a special problem structure. Insight problem solving is a special type of problem solving in which the instructions for the solver the meta-problem(the secondary problem), such as “Identify what the problem is”, and the solver follows the instructions of the primary problem, which is revealed by answering the secondary problem. The solver of an insight problem

cannot read the instructions directly from the given problem statement. This is because the primary problem is incomplete and the instructions to be followed are unknown. In this case, the secondary problem is “Identify what the problem is”. By following this instruction, the solver can derive the solution to the secondary problem, which will lead to the completed primary problem. By following the instructions for the primary problem, the respondent can derive the solution to the given problem statement. Therefore, in order to find the solution to an incomplete primary problem, it is necessary to answer the secondary problem and clarify the instructions of the primary problem. The process of solving a secondary problem is a process of searching for an appropriate “space of problems” and “pace of understanding” mapping. The perception of proximity to the solution is a metacognition of the proximity to the solution of the secondary problem, which corresponds to the distance to the appropriate solution in the “space of the problem sentences”. The first-order problem, which is the solution to the second-order problem, is the mapping between the “space of the problem sentences” and the “space of interpreting problem sentences” such that it has a solution. In order to identify the primary problem, we can reason based on the property that the answer to the primary problem is determined to be only one, so we thought that the primary problem and the secondary problem are solved simultaneously, which leads to an Aha experience.

We tested this hypothesis in an experiment using a binary image task. The binary image task is to find an animal in a natural image in which each pixel is black or white by a threshold to the gray scale color binarized to blur the boundary between the animal and the background. This task is known to be associated with an Aha experience when the object is found in the picture. The binary image task was used because the structure is spatial and can be mass produced. If the binary image task has a dual structure, then since the structure of the binary image task is spatial, we would expect the perception of proximity to the solution to accompany the process of finding a portion of the image that is sufficient to recognize the animal. In addition, when finding an animal is accompanied by an Aha experience, we expect the perception the perceived proximity to the solution to increase rapidly immediately before and the gaze to move rapidly toward the animal.

We conducted two experiments using a binary image task. We conducted the preliminary experiment using a computer mouse and the main experiment using eye tracking. In the experiment, the participants were presented with a binary image task and asked to find an animal. After they found an animal or exceeded the time limit, they answered some questions. When the Aha experiences were present, the distance between the gaze and the animal suddenly approached just before the answer was given, which was

consistent with the prediction. Therefore, the duplex hypothesis was experimentally supported. In addition, we hypothesize that we have proposed an experimental framework that can quantitatively handle the relationship between an Aha experience and the perception the perceived proximity to the solution.

In this research, it is possible to treat the cognitive process of insight problem solving as a theoretically explainable phenomenon. We expect that our proposal, which treats insight problem solving as a special kind of problem solving rather than a phenomenon that is completely different in quality from ordinary problem solving, can be applied beyond the framework of insight problem solving research.