Partial Analogical Transfer in Problem Solving: Roles of Centrality and Order

Tsunhin J. Wong (thjwong@hkusua.hku.hk)

Albert W. L. Chau (awlchau@hkucc.hku.hk)
Department of Psychology, University of Hong Kong
Pokfulam Road, Hong Kong

Antonietti (1991) first presented the idea of partial analogies in solving an ill-defined problem. Prior to that, studies looking into the role of analogies in problem solving used complete analogies. Antonietti concluded that partial analogies helped problem solving only when all the cues were present and presented in the correct order.

The conditions for partial analogy to work as identified by Antonietti seem to be overly stringent. Partial analogy should be effective in most situations as most analogical cues available in daily life are partial in nature. This study therefore looks into the role of analogical transfer of partial analogies.

Our study differs from Antonietti (1991) in a few ways. First, as it is logical to assume that some analogical cues are more crucial than the others, the notion of centrality of an analogy was examined. Second, we also revisited if analogical cues have to be presented in the exact order in order to be effective. Finally, we presented the partial analogies as problems for participants to solve rather than disguised them as arithmetic problems.

Method

Forty undergraduates at the University of Hong Kong participated in the experiment as part of a course requirement. None of them had been exposed to the problems used in the study.

Every participant completed the experiment on a computer. The problems were written in Flash with both texts and diagrams.

Procedure

Two types of problems were used in the experiment. The analogy problems were concerned about how to direct water to a target location. They were used to prime participants to use the two strategies which are necessary for solving the target problems: divergence which is dividing the flow to avoid overload and convergence which is pulling together the divided flows to achieve the intensity needed. The target problems were the Fortress problem and Duncker's radiation problem. The first problem deals with how to organize soldiers to conquer and castle while the other deals with how to use X-ray to destroy a tumor.

Each participant was first told some basic concepts subjects in fluid dynamics. S/he then proceeded to solve one of the four versions of the analogy problem depending on the experimental condition to which s/he was assigned: i) *partial analogies* presented in the *correct* order (divergence then convergence), ii) *partial analogies* presented in the *reverse* order (convergence then divergence), iii) *complete* analogy; and iv) *unrelated* analogy. Finally the participant was asked to solve the two target problems. If s/he could not solve a problem within 5 minutes, s/he was then told that the problems they had tackled earlier might help them. A total of 10 minutes were allowed to solve each problem.

Results and Discussion

43.9% of the subjects solved the Duncker's problem without being prompted to use the previous problems, with the highest in the *partial-correct* condition (81.8%) and the lowest in the *unrelated* condition (20%).

Solving the Fortress problem in the *unrelated* condition required more time than in all the other conditions. Time required to solve the Duncker's problem was in the decreasing order of: *partial-correct, partial-reverse, complete, and unrelated.* Besides, the *partial-correct* condition required the least prompting for using the partial analogy condition.

Contrary to Antonietti's study, participants in the *partial-reverse* condition were able to solve the target problems spontaneously. In other words, exposure to partial analogies is sufficient for priming to occur though the exact temporal order can provide additional facilitation. Second, it was also found that partial analogies were more effective than *complete* analogy in priming the participant to solve the target problem. This is possibly due to the complexity involved in solving the complete analogy problem. Third, the present findings suggested that convergence plays a more central role in analogical transfer. This is in line with Pedone, et al (2001) who found that convergence alone was sufficient to trigger spontaneous analogical transfer. The second and third findings together suggested that convergence is the more central partial analogy. Only it should be presented to achieve the greatest priming or facilitatory effect in problem solving. Presenting a less useful partial analogy (divergence) lowers instead of enhances the transfer in problem solving performance. This may be explained by introducing a weight system in the branches of the structural mapping theory (Gentner, 1983) or constraints in the multiconstraint theory (Holyoak & Thagard, 1980).

References

Antonietti, A. (1991). Effects of partial analogies on solving an ill-defined problem. *Psychological Reports, 68*, 947-60.

Pedone, R., Hummel, J. E., & Holyoak, K. J. (2001). The use of diagrams in analogical problem solving. *Memory & Cognition, 29(2)*, 214-221.

Gentner, D. (1983). Structural-mapping: A theoretical framework for analogy. *Cognitive Science, 7*, 155-170.

Holyoak, K. J., & Thagard, P. (1980). Analogical mapping by constraint satisfaction. *Cognitive Science, 13*, 295-355.