Abduction, Induction, and Analogy
On the Compound Character of Analogical Inferences

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Abstract. Analogical reasoning has been investigated by philosophers and psychologists who have produced different approaches like “schema induction” (Gick and Holyoak) or the “structure-mapping theory” (Gentner). What is commonplace, however, is that analogical reasoning involves processes of matching and mapping. Apart from the differences that exist between these approaches, one important problem appears to be the lack of inferential precision with respect to these processes of matching and mapping. And this is all the more problematic, because analogical reasoning is widely conceived of as “inductive” reasoning. However, inductive reasoning – in a narrow and technical sense – is not creative, whereas analogical reasoning counts as an important source of human creativity. It is C. S. Peirce’s merit to have pointed to this fact and that induction can merely extrapolate and generalize something already at hand, but not the kind of reasoning that leads to new concepts. Indeed, inventive reasoning is usually identified with abduction, and consequently abduction should play at least some role in analogy. Peirce has claimed that analogy is a compound form of reasoning that integrates abduction and induction, but the intriguing question is still, how these two inferences are to be reconstructed precisely. In the proposed paper I hold that analogical reasoning can indeed be analyzed in this way and that this helps us to reach a much more precise and differentiated understanding of the forms and processes of analogical reasoning. In particular I hold that (at least) two forms of analogical reasoning have to be distinguished, because they
represent different inferential paths. The underlying inferential processed will be explicated in detail and illustrated by various examples.

1 Introduction: The Quest for Logic in Analogical Reasoning

Analogical reasoning is a very common form of thinking and problem-solving. Therefore, it is important to understand how it works and how it can be fostered in order to produce new knowledge – especially in the educational domain [1].

Existing psychological theories on analogical reasoning describe it as schema induction [2, 3, 4] or structure-mapping [5, 6, 7, 8]. Both approaches rest on the principle that certain more or less deep insights (schemata, structures) are transferred form a source to a target domain, and that this process comprises two characteristic sub-processes which might be called “matching” and “mapping”. That is, first a target (the domain where a problem has to be solved) and a source (the domain from which the analogy is drawn) have to be matched, then the relevant features of the source have to be mapped onto the target.

A classic example is the radiation problem reported by Gick & Holyoak [2] that originally dates back to Duncker [9]: Subjects are first presented a story about a general who has to conquer a dictator’s fortress. In order to succeed he has to use all his forces, but the access ways to the fortress are so small that his men cannot attack all at once. However, as there are different ways to access the fortress, the solution to the problem lies in splitting up his army and attach from different sides at the same time and with combined forces. After this story the subjects are presented another one, in which a surgeon intends to destroy a tumor in a human brain using radiation. The problem here is that a beam strong enough to destroy the tumor would also destroy all the healthy tissue along its trajectory. How to solve this problem? The idea here is that subjects match the two stories and remember that in the fortress story forces had to be split up and operate from different sides. Now this structure could be mapped to the target problem leading to the suggestion that several weaker beams might be applied from different sides that might converge in the spot where the tumor is located and thus destroy it while leaving the other parts of the brain unaffected.

Apart from the fact that only about 10% of the subjects actually managed to use the analogy and solve the problem without further hints, the task and what is to be considered is very clear. However, what is as yet unclear, is how these processes of matching and mapping are to be understood precisely and in terms of an underlying logic that explains what kinds of inferences take place in individuals undergoing such analogical thought processes. Gentner