Gaps in the Explanation of the Relational Shift in Analogy Development

Clayton T. Morrison and Changsin Lee ({clayton,chang}@turing.paccs.binghamton.edu)
Department of Philosophy; Binghamton University (SUNY)
Binghamton, NY 13902-6000 USA

Children go through a *realtional shift* that marks a shift from making similarity comparisons on the basis of object features alone (a round red ball is like a round red apple) to similarity comparisons made on the basis of shared relations (a dollhouse is like a flowerpot if both are the largest items in two sets). Gentner, Rattermann, Markman & Kotovsky (1995) utilize Structure-Mapping Theory (SMT), and the Structure-Mapping Engine (SME) computational model, to explain the relational shift as a result of changes in the child's knowledge of the world. We present five critical observations of their computational account:

(1) *Gaps in the SME simulation*: SME is a model of representation structural alignment and mapping only — SME does not explain how structured repesentation originates or changes, and therefore what mechanisms produced the representation change (knowledge change) to result in behavior indicating that the shift has taken place.

(2) *The SME-based approach to representation and its entailments*: One of Gentner *et al.*'s reported experiments demonstrated that children who received simple (same-dimensional) relational comparisons *before* any difficult (cross-dimensional) relational comparisons (the *blocked* condition) performed significantly better than those who received random order of comparison difficulty. Gentner *et al.* propose that the mechanism for representation change here is re-representation: over the course of simple same-dimension comparison trials, the child comes to re-represent the compared relations in dimension-general terms, giving the child the capacity to make dimension-general relational comparisons. Two possible accounts of re-representation: (a) *Pre-existing re-representation capacity*: child *can* antecedently build dimension-general relations, but doesn't recognize the need to do so until (and only until) repeated presentation of the easier same-dimension relational comparisons; or (b) *Emergent re-representation capacity*: child *cannot* antecedently build dimension-general relations, and over the course of repeated same-dimension comparisons, the ability to build a dimensions-general representation of the relations *emerges*. However, other models which provide representations for SME or can re-represent SME-based representations require the existence of predefined rules for representation construction and re-representation. Thus, the SME-based models suggest a partial explanation of "pre-existing re-representation capacity." Still lacking is an account of why the children did not represent dimension-generally until *after* the repreated and consistent presentation of the easier trials. Accounting for "emergent re-representation capacity," however, is clearly beyond the scope of current SME-based models. We need an account of how the predicate categories for the relations, and the rules for replacement o instantiation of already existing relations, get there in th first place. While it is entirely possible that re-representatio in the blocked-experiment case could involve either (a) pre existing or (b) emergent re-representaiton accounts, we fin it highly unlikely that *only* the pre-existing conditio occurs: (i) It is implausible that *all* of our cases of re representation *always* antecedently require the requisit knowledge of how to re-represent; (ii) The ability to re represent has to be acquired at *some* point — it seem strange to require that it not occur when it is needed most *while trying to solve the very problems that require such re representation*; (iii) It is intuitively appealing that emergen re-representation can occur during comparison because i directly implicates analogy-making in the deepest form o learning and creativity: where fundamentally new ways o representing the world are acquired.

(3) *SME's modularity*: SME's modular decompositio approach to the study of analogy is not the source of th current incompleteness of SMT's account of the origins o structured representation. SME may closely interact wit representation-building (category building) modules allowing alignment and mapping processes to influenc representation construction. However, the blocke experiment case highlights that accounting for representatio development directly implicates mapping in categor creation, and therefore the account will need to include *both* mapping and constructing modules, with a focuss on th *interaction* between the two.

(4) *The role of language*: Genter *et al.* emphasize th importance of language learning in analogy-making However, they only consider the referential function o language: linguistic labels invoke and refer to relevan knowledge structures that already exist in children. Not ye integrated into the computational account is how children learn relational terms or acquire higher-order relationa concepts through language acquisition and use.

(5) *The distinction between knowledge structures an cognitive process*: A clean distinction is made betwee knowledge representation as structures, and the cognitiv process of alignment and mapping for comparing structures While this distinction has proved useful for demonstratin the role of knowledge change in the development of analogy making, it is implausible that it can be maintained acros *all* kinds of cognition and over developmental time Developmental theorists like Vygotsky have made a stron case that children not only use language to catalogue th ontology of their world, but also for representing what ca be done with it — including how to think about it — th way they *process* new information and make inferences.