SUMMARY FOR REVIEW COMMITTEE

Paper Title:
The resurrection of Inhelder & Piaget's *The Growth of Logical Thinking from Childhood to Adolescence* —Toward a general theory on propositional reasoning—

Summary: (maximum 1000 words, please do not include author names)

Introduction
The purpose of this presentation is to reappraise Inhelder & Piaget's The Growth of Logical Thinking from Childhood to Adolescence (thereafter, referred as GLT), extracting the essential ideas from Piaget's Theory on propositional reasoning. The modern major camps on propositional reasoning are the mental model theory (thereafter, referred as MMT) represented by P.N.Johnson-Laird (Johnson-Laird & Byrne 1991) and the mental logic theory (thereafter, referred as MLT) represented by M. Braine (Braine & O'Brien 1991). The former explains propositional reasoning in terms of drawing up of mental models and their manipulation, whereas the latter explains human reasoning in terms of ready-made mental logics and their application. Although both camps are in keen opposition to each other, they have at least one common characteristic, that is, both are severely criticizing Piaget's theory on propositional reasoning. Johnson-Laird & Byrne (1991, p23) say "The vagueness of his theory masked its inadequacy perhaps even from Piaget himself. The effort to understand it is so great that readers often have no energy left to detect its flaws." Braine & Rumain (1983 p.316) say "Piaget's logic clearly cannot develop at adolescence, or at any time - it is too problematic to stand as a psychological model of anything." As a result, modern reasoning researchers found little to inherit from Piaget's theory and dismissed it almost completely. Nowadays they don't so much as discuss, whether negatively or positively, Piaget's Theory in their research, as if it had nothing worth mentioning, though it has historical interest as a relic from the past.

Analysis
In this presentation, the author tries to show Piaget's Theory on propositional reasoning is the most promising one among those that have ever proposed, emphasizing the importance of the monumental book GLT. Why is Piaget's Theory the most promising one?
First of all, according to Piaget, the entity in charge of propositional reasoning is neither mental model nor mental logic but mental operation, because propositional reasoning is also a kind of mental activity which consists of combining or detaching propositions in a certain way. In this approach, mental models in MMT are mental objects on which mental operations take action or those that they produce after taking action (Evans et al., 2006). What is responsible for reasoning itself is not mental models as figurative aspect of reasoning but mental operations as its operative aspect.
Secondly, propositional operations do not exist individually unlike mental logics or mental models. They are all interconnected with each other and constitute an operational system which Piaget called "une structure d'ensemble". From this perspective, mental logics in MLT are formal formulation which describes some of the relatively stable relations found in the structure of propositional operations. This means that "mental logics" are not immutable instruments taken out of a storage room when necessary, but they are changeable depending on forms the structure of propositional operations take. From this idea it was predicted that even Modus Ponens schema is not an early acquisition and was confirmed experimentally (Nakagaki, 2008), although this schema had been believed to develop at latest at 5 or 6 years old (Braine & O'Brien, 1991). This approach also explains that performance on conditional inference tasks can be predicted from the interpretation

on conditional sentences and that disjunctive inference and interpretation of disjunctive sentences develop almost concurrently (Nakagaki, 1993; Nakagaki, 1991). Thirdly, propositional operations are neither innately given nor learned through education, but are constructed gradually and internally, This means that we need not distinguish the primary inference schemas and the secondary ones like in MLT and the initial models and the fleshed-out ones like in MMT but need to distinguish organizational levels in the structure of propositional operations. This approach explains not only general development of reasoning ability in reasoning tasks. It can also explain naturally what is called U-shape development of Modus Tollens (Nakagaki, A. 1993)

How about reasoning heuristics and biases modern reasoning researchers are most interested in? Piaget's Theory is a competence theory and does not aim to explain reasoning performance. But once an appropriate auxiliary theory is incorporated into Piaget's Theory, it can be transformed into performance theory without changing the original competence theory (Nakagaki, 2005).

Conclusion

Operationalism, structuralism and constructivism are the core ideas of Piaget's Theory on propositional reasoning explicitly expressed in GLT. But unfortunately, modern reasoning researchers fail to understand the significance of these ideas. In reality, the author believes, Piaget's Theory follows the most promising path toward a general theory on propositional reasoning and provides us with indispensable clues in order to solve the current problems researchers are tackling, such as how to explain reasoning biases (for example, matching bias in Wason's selection task).

Reference

Braine, M. D. S. & O'Brien,D.P. (1991). A theory of if：A lexical entry, reasoning program, and pragmatic principles. *Psychological Review, 98*, 182-203.

Braine, M. D. S., & Rumain, B. (1983). Logical reasoning. In J. H. Flavell & E. Markman (Eds.), *Handbook of child psychology. Vol. 3. Cognitive Development* (pp. 263-339). New York: Wiley.

Evans, J. St. B. T., Over, D. E. & Handly, S. J. (2006). Rethinking the Model Theory of Conditionals. In W. Schaeken, A. Vandierendonck, W. Schroyens, and G. d'Ydewalle (eds.), *The Mental Models Theory of Reasoning: Refinements and Extensions*. Lawrence Erlbaum Associates

Inhelder, B.& Piaget, J. (1955). *De la logique de l'enfant à la logique de l'adolescence*. PUF ; English translation (1958). The Growth of Logical Thinking from Childhood to Adolescence. London: Routledge & Kegan Paul.

Johnson-Laird, P. N., & Byrne, R. M. J. (1991). *Deduction*. Hillsdale, NJ: LEA

Nakagaki,A (1991). Developmental study on the acquisition of disjunctive inference schemas. *Reports of National Institute for Educational Research, 22*, 1-19. (written in Japanese)

Nakagaki,A (1993) Developmental study on conditional inference. *Reports of National Institute for Educational Research,27*, 19-35. (written in Japanese)

Nakagaki, A. (2005*). A Theory of Propositional Reasoning*. Doctorial Dissertation, Waseda University (written in Japanese)

Nakagaki, A. (to be posted in ICP 2008). Is an inference rule Modus Ponens really an early acquisition?