TWO COURSES OF EXPERTISE

Giyoo Hatano
Dokkyo University
Kayoko Inagaki
Chiba University

At least some aspects of cognitive development can be conceptualized as processes of spontaneous expertise[1]: Starting with little or no documented declarative knowledge or rules, children acquire domain-specific content knowledge enabling them to solve various problems in the target domain through accumulated experience. In this paper, after briefly discussing the significance of the above conceptualization, we will propose three issues related to the processes of spontaneous expertise, which are, we believe, not only theoretically interesting in developmental research, but also can profitably be studied cross-culturally.

What significance does it have to conceptualize the processes of cognitive development as those of spontaneous expertise? It has been asserted that developmental or adult-child differences in cognition are similar to expert-novice differences (e.g., Brown & DeLoach, 1978). This assertion implies that adults and children differ primarily in the amount and structuredness of knowledge in the target domain; in other words, in explaining the adult-child differences, maturational and/or domain-general cognitive variables are at most secondary. Thus this assertion gives an answer to the question, "What develops?" — It is domain-specific knowledge that develops.

To conceptualize the *processes* of cognitive development as those of spontaneous expertise goes a little further: It suggests an answer to the question, "How does it develop?". The processes of expertise are undoubtedly based upon the accumulation of experience, which mostly consists of solving problems in a given domain. In the course of expertise, people, under the supervision of more capable members, come to solve more and more complex problems in the domain, utilizing relevant prior knowledge which is in turn gradually enriched and integrated. Using Piagetian terminology (Piaget, 1950), a new problem situation is assimilated into pre-existing knowledge, and this results in accommodation of the knowledge. The key concern for developmental re-

---

An earlier version of this paper was presented at the Conference on Child Development in Japan and the United States, April 1983, Stanford, CA. The authors are grateful to the participants of the conference for their stimulating comments and reactions, and to David Crandall for his editing and proofreading the manuscript.
Request for reprints should be addressed to Giyoo Hatano, Dokkyo University, 600 Sakae-cho, Soka-shi, Saitama, Japan, 340.

1) We recognize that there are other courses of expertise. For example, one may proceed from a well-defined set of declarative knowledge or rules to proceduralization and automatization (See Anderson, 1981).

search is thus, according to the above conceptualization, analysing relationships between problem solving and acquisition/integration of knowledge in a domain.

1. FROM PROCEDURAL TO CONCEPTUAL KNOWLEDGE

Our first issue concerns the processes through which novices become adaptive experts, i.e., those who not only perform procedural skills efficiently but also understand the meaning of the skills and nature of their object. For the comprehension of the nature of the object, what role is played by repeated practice in daily life of the procedural skills involved? This issue is apparently very similar to what Piaget (1976, 1978) attempted to examine, but as we will see later, there are some important differences.

In any society, less mature members acquire a body of procedural knowledge, i.e., decision rules as well as executive strategies, along with the skills necessary for applying that knowledge. Both the knowledge and its attendant skills comprise an important part of the culture, and are useful to their possessors in solving problems often encountered, thus enlarging the latter's competence as members of the society. Such skills are therefore repeatedly performed. In a familiar environment, people behave quite effectively with just procedural knowledge, without understanding. Usually they acquire the knowledge and skills without undue difficulty, through direct observation, verbal instructions, corrective feedback, and/or supervision. In this sense knowledge is transmitted from culture to individual, though individual selectivity operates in the process.

However, since, we assume, human beings have intrinsic motivation for understanding, they are not satisfied with the procedural competence achieved: they also want to understand, i.e., to find the meaning of the procedural skill. What is the distinction between the performance of the procedural skill with and without understanding? When do we consider that a skill is performed with understanding? It is when the performer can explain why it works, i.e., verbalize the principle involved; or at the least, when he/she can judge, in addition to the conventional version of the skill, its variations as appropriate or inappropriate, and/or can modify the skill according to changes in constraints (cf. Greeno, 1980). These explicit and implicit forms of understanding seem to be possible only when the performer has knowledge representing more or less comprehensively the nature of the object of the procedure and its surrounding "world". This knowledge gives meaning to each step of the skill and provides criteria for selection of possible alternatives for each step within the procedure. It may even enable him/her to invent new procedures and/or make new predictions. We will call this conceptual knowledge. So-called mental models (Gentner & Stevens, 1983), with which people can run mental simulation, and thus make predictions/explanations about an unfamiliar object/situation beyond their past experience, can be regarded as a form of conceptual knowledge. By constructing conceptual knowledge, one can go beyond the culturally given. Without it, what is possible, when the original version has appeared to reach its limits of effectiveness, is just trial-and-error, or empirical minor adjustment.

People may ask themselves why a skill works or why each step is needed after accumulated practice has freed them from monitoring the skill consciously. If they do so, it can be the initial step toward the construction of the relevant conceptual knowledge, but this alone is not sufficient. Two kinds of component knowledge are also needed—First, they need *data* or empirical knowledge : they have to observe covariations of variables, i.e., corresponding changes between actions and consequences or among dimensions of consequences. Variations in key variables may be produced "naturally", by factors beyond intended control, or "socially", in a collective enterprise of performing the skills. Otherwise, people must intentionally vary the procedure to collect the data necessary for construction of conceptual knowledge. In other words, they have to examine versions of the skill other than the conventional one, which are "risky" for the purpose of obtaining successful problem solution. Secondly, they need to have a *model* or preconceptual knowledge,[2] even if a very tentative and implicit one. Without this , it is impossible to determine what variables are to be picked out for consideration, from among an almost infinite number of candidates. A model may be obtained primarily through perception, as a somewhat vague "image" of the object (what it is like). It may be derived indirectly, especially when mechanisms are not visible, on the basis of its functions or reactions to external stimulations. In the latter case, it is often borrowed from another domain through analogy. Prior knowledge about constituent parts, if available, is also utilized in the derivation.[3] These two kinds of component knowledge are reciprocally selective, i. e., the observed data suggest what model should be adopted, and the adopted model constrains what kind of data are to be observed.

It is likely that a farmer, starting with conventional farming skills, will acquire much knowledge about plants in the conceptual form in the course of growing rice, corn or any other given produce, based upon the observation of "naturally produced" covariations. Thanks to this conceptual knowledge, even though it is tentative, an experienced farmer can probably effectively deal with various changes in constraints, e. g., unusual weather or plant disease. He may serve as a consultant for less experienced farmers. He can legitimately be called an adaptive expert (Hatano, 1982a).

Likewise, children may sometimes ask, while performing a procedural skill and receiving feedback, "How does A lead to B ?," "Why is doing X necessary to produce Y ?" (See Karmiloff-Smith & Inhelder, 1975). As Condry & Koslowski (1979) put it , a child, after having found regularity, "seeks to know why and how", i.e., "causal explanations for the way the world is organized" (p. 246). Starting with these questions, they are likely to construct conceptual knowledge. Motoyoshi's observation (1979) suggests that they can incorporate the observed date into a model, even when they cannot see the inside : After accumulated experience in attempting to grow a

2). This is, in other words, the structure which can integrate the observed covariations. We avoid the term "structure", because it may mean a general one like Piaget's structure of co-ordination.

3). Therefore, there can be intermediate stages in the construction of conceptual knowledge where pieces of partial knowledge are not well integrated into a whole, or where different models coexist. For example, a person may know that object A is similar to object B in its construction without being able to specify the difference between the two ; he/she may know that it has parts a and b without grasping how these parts are connected.

flower and in comparing her results with her friends', a five-year-old girl stated — "Flowers are like men. If flowers eat nothing, they will fall down of hunger. If they eat too much, they will become ill."

To summarize, we assume that people, including children, can construct corresponding conceptual knowledge by performing a procedural skill, and with that conceptual knowledge they can be flexible and adaptive, e.g., "invent" other procedural knowledge.

Do we overestimate children's capacity, since Piaget (1976, 1978) demonstrated that there is a delay of several years between the guided successful solution of a problem and understading how and why the solution procedure works ? We don't think so. His findings will certainly be replicated if we give children novel, nonsignificant problems and adopt a rigorous criterion for assessing their understanding, e.g., stating formal-logically coherent justifications. What we would like to emphasize is that even young children can construct some conceptual knowledge through repeated practice in a procedural skill in a "meaningful" context and that this conceptual knowledge can not only invest the procedure with meaning (the how and the why), but also enable them to make predictions in unfamiliar situations and to invent new strategies.

In a sense, what we have formulated here is an attempt to revive the Piagetian spirit. Though with greater emphasis on the constraints of eco-social settings and on the domain-specificity of cognitive competence, we have kept two of his basic ideas intact : Human beings are assumed to have intrinsic motivation for understanding and an important part of knowledge acquisition is endogenous, i.e., through reflexive abstraction. We would like to point out that the acquisition of conceptual knowledge is endogenous in the sense that it is not directly dependent upon external feedback : External feedback serves only as a cue for interpretation ; internal feedback is brought about by reorganizing pieces of prior knowledge. Therefore, studying this first issue may shed light on an often-neglected aspect of the Piagetian theory.

Since some procedural knowledge and skills are specific to a culture or subculture, it should be rewarding to examine by cross-cultural comparison what conceptual knowledge is brought about by practice in such a culture-specific skill. Furthermore, it would be interesting to examine whether children's spontaneous construction process of conceptual knowledge is universal across cultures. On one hand, often-observed similarities in thinking among children who have grown up in a variety of cultures and between children and primitive people suggest this universality. On the other hand, historical differences between Western science and Japanese science suggest there can be different routes for elaboration of the conceptual knowledge called science : While physics, especially with its atomistic and mechanistic ideas, has played a central role in Western science, Japanese endogenous science evolved until the Meiji Restoration with medicine, which was wholistic and vitalistic, as its core (Yasunaga, 1976). Even children may construct different conceptual knowledge according to the cultural availability and conspicuousness of already existing models.

An example will clarify the last point. We found that, although they had knowledge differentiating between human beings and non-humans, a majority of Japanese young children made explicit and/or implicit personistic predictions/explanations when asked about situations unfamiliar to them. For example, a five-year-old replied to the question, "A tulip blooms in the day time. How about at night ?," with "It *sleeps* from evening, closing its flower." (Hatano & Inagaki, 1984). It will be worth examining whether this frequent reliance on personification, i.e., using knowledge about human beings as the "base domain" for analogy in their attempt to construct conceptual knowledge about non-human objects, is found only among Japanese children or universally across cultures.

2. GENERALIZED CONSEQUENCES OF ROUTINE EXPERTISE

Adaptive expertise is not the sole course of spontaneous development, however. Sometimes, people, in solving a large number of problems, merely learn to perform a skill faster and more accurately, without constructing/enriching their conceptual knowledge, even after some room in their attentional resources has been produced through automatization of the procedure. For example, we suppose many an amateur gardener has repeatedly grown Saint Paulia flowers as prescribed in a greenhouse where both temperature and humidity can be automatically controlled, without understanding the nature of the flowers, the conditions under which they grow best, or the contents of the fertilizer mix. Our lives are full of procedures which we carry out simply to get things done, and if we repeat them hundreds of times we can become quite skillful at them. However, our skill is useful only as long as the object and its constraints are constant, i.e., the same set of materials and devices is available. Thus we may become routine experts, but not adaptive ones ; routine experts are outstanding in terms of speed, accuracy, and automaticity of performance, but lack flexibility and adaptability to new problems. Nevertheless, people do not hesitate to call them experts, since their procedural skills are highly effective for solving everyday problems in a stable environment.

It is clear that even young children can become routine experts. The processes of routine expertise have been fairly well conceptualized (e.g., Anderson, 1981). Therefore, let's propose as the second challenging issue to study, not the processes of routine expertise themselves, but their "generalized consequences". Hereafter, we will demonstrate what we mean by this expression by referring to the studies on abacus operation and on the processing of Kanji, conducted by the first author and his associates.

It is generally agreed that a procedural skill is often efficient but only for a limited type of problem, mainly because the information embedded in the skill cannot be easily recombined to form other procedural skills (e.g., Rumelhart, 1979). However, practice in a procedural skill will facilitate the development of other procedural skills in the same domain, and thus have some generalized consequences, by transfer of training in the classical sense, i.e., through shared components. We found (Hatano & Suga, 1981) that after-school abacus learning made third graders' paper-and-pencil addition/subtraction of multi-digit numbers faster and more accurate primarily through the shared component skills of basic computation (e.g., use of the number facts of single digit addition/subtraction and of complementary-numbers-to-10). Though this practice did not improve pupils' understanding of carrying/borrowing principles per se, it reduced "bugs", i.e., the consistent application of wrong algorithms, as well as slips in paper-and-pencil computation, probably because these learners had little difficulty in executing the right procedure.

Moreover, routine expertise in a procedural skill often produces as by-products strategies or consolidated sequences of behaviors by which the skill can be even more efficiently performed. These by products are essentially cultural learning sets. Thus routine experts often show a capacity remarkably different from that of ordinary people in tasks which, though apparently very different, induce these sequences of behaviors. Scribner and Cole (1981) demonstrated that literacies developed and used in different contexts tend to produce a correspondingly differentiated pattern of cognitive competence. We have also shown that experienced readers of Japanese can quickly infer the meaning of unfamiliar Kanji compound words appearing in a discourse by combining prototypal meanings of the component Kanji, because they are so accustomed to retrieve the meaning directly from Kanji and to rely on compounding schemata (Hatano et al., 1981). A study in progress suggests that this skill for inferring the meaning can be generalized to "artificial" words, components of which are new, experimentally introduced symbols with verbally given prototypal meanings.

Finally, routine expertise may produce new mental devices convenient for performing a given task. Abacus experts come to interiorize the operation, and thus can calculate without an abacus as accurately as, and often faster than, with the instrument (Hatano et al., 1977). Grand experts of this abacus-derived mental arithmetic have a mental abacus of an extended size, on which they can represent a number of many figures. We found that such grand experts could rapidly reproduce a series of 15 digits either forward or backward. It might be added that their span for English alphabet letters or for fruit names was not different from 7 ± 2. Their memory for digits was quite stable, and partially compatible with verbal input and output, but vulnerable to visuo-spatial interference (Hatano & Osawa, 1983). They still held digits in working memory, not in the rehearsal buffer but in visuo-spatial storage, and did not transmit them to long-term memory. By this powerful mental device of representation, they could mentally calculate a series of large numbers in an algorithmic fashion. A recent developmental study (Hatano et al., 1984) demonstrated that even lower intermediate abacus operators, who could mentally add/subtract numbers of 2–3 figures only, relied on a mental abacus for memorizing digits to some extent. As abacus operators became experts in abacus and mental calculation, the mental abacus came to play a more and more dominant role.

In sum, routine expertise may in fact produce more or less "generalized consequences," not through understanding but through well-established patterns and/or modes of processing. It should be rewarding to examine by cross-cultural comparison what generalized consequences are brought about by practice in a culture-specific skill, which is necessitated by the eco-social environment or has been fostered by cultural tradition. Since it takes thousands of hours of practice to become a grand expert, it is impossible to assign randomly subjects to either the experimental or control condition. Therefore, cross-cultural comparison is often the only realistically possible research strategy. The more closely we observe the target skill and context for its use, the more likely we will be able to assess the the subtle characteristics of its experts, i.e., generalized consequences of the skill.

3. FACTORS DIFFERENTIATING ADAPTIVE AND ROUTINE EXPERTISE

Let's move on to the third issue. If there are two courses of expertise, i.e., adaptive and routine, as described above, then what factors differentiate them? No one can give us a comprehensive answer with the present scanty empirical evidence, but we would like to discuss our speculations in a little more detail, deriving basic ideas from Piaget (1950). Piaget believed that human beings are intrinsically motivated to understand the world, as we mentioned before, and at the same time he pointed out that, in order to understand, it is necessary to systematically examine the effects of variations in action upon outcome. This can be done either by actively manipulating certain variables or by observing naturally occurring variations. However, we all know that people are not always engaged in such active experimentation. This being so, what factors encourage one to engage in such experimentation? We would like to tentatively propose three factors.

The first factor concerns the nature of the object which the procedural skill deals with and the constraints for successfully obtaining the desired outcome, more specifically, to what degree such a system of the object/constraints contains built-in "randomness". When a skill concerns a "natural" object, a variation in critical parameters which often occurs because of the system's built-in randomness, may make the original version of the skill ineffective, thereby motivating one to modify the skill to some extent. In other words, the person applying the skill is given many opportunities for observing the effects of modification of the skill on the outcome. Consequently, repeated application of the procedure with variations is likely to lead to adaptive expertise. On the other hand, when the system that the procedural skill deals with is highly standardized or contains no built-in randomness, there is no necessity for even minor modification of the skill. Here repeated application of the skill without variation is unlikely to lead to adaptive expertise. For example, in traditional agriculture, since there are individual differences in the nature of a plant (e.g., growth rate, vulnerability to disease) and since weather conditions change to some degree from year to year beyond human control, people are obliged to modify their skill depending upon the feedback given in the process of performing it. In home cooking, available materials or devices may not always be the same as the ones described in the recipe. People need to adapt the procedural skill according to the size or kind of materials or devices available to them at the time. Thus, in these cases, it is likely that they will acquire conceptual knowledge, i.e., the how and why of each step. However, in modernized agriculture such as greenhouse plant growing, where people can choose a highly specified variety of plants, and can easily control such weather conditions as temperature and humidity, they need not be flexible in their skills. Likewise, although cooking with an automatic device (e.g., electronic oven) and a detailed recipe involving precise quantification, such as "Put into a bowl one and a half cups of onion processed at dial 2 of a food-processor" rather than "Put into a bowl two medium sized onions cut finely," may ensure a standard dish, it is supposed that people will have less opportunity to acquire the related conceptual knowledge. We may have to consider that our modern technology, which aims at reducing built-in randomness in the system, by no means facilitates the acquisition of conceptual knowledge. If we can empirically confirm the above prediction in cross-cultural studies between technologically more avanced and less advanced societies, it may well have a strong social impact.

The second factor concerns the context in which the procedural skill is used. When the results obtained through performing the skill have no vital importance or usefulness, people tend to produce minor variations in procedural skill and to examine their effects, often playfully. That is, they are willing to engage in active experimentation which creates a greater possibility to acquire conceptual knowledge. On the contrary, when a procedural skill is performed primarily to obtain rewards, people are reluctant to take the risk of varying the skill, since they believe that the safest way is to rely on the "conventional" version. This idea has been supported, though indirectly, by recent studies repeatedly showing that expectation of reward, either tangible or symbolic, deteriorates the quality of performance and/or intrinsic motivation (Lepper & Greene, 1978). Inagaki (1980), reviewing these studies, points out the possibility that the expectation of reward may prevent learners from understanding things deeply: It changes the "goal structure" of the activity and thus leads learners to shift their strategy from "heuristic," such as "examining possibilities of alternative solutions" or "seeking a more universal solution beyond the present successful one," to "algorithmic," such as strategy ensuring steadier and often quicker solutions within a given time. In other words, it is suggested that the announcement of external reinforcement may lead learners to adopt a success- or efficiency-orientation rather than understanding-orientation in order to maximize reward. In fact, Inagaki & Hatano (1984) confirmed that, when college students were required to translate a letter in English into Japanese under the expectation of external evaluation for their performance, they adopted "safety strategy." That is, they spent more time in translation by looking into dictionaries for uncertain words more often than the control students who had been given no such announcement. In spite of this longer time spent, the students who were given the announcement elaborated less expressions in the letter requiring inferences in order to be fully understood. It was suggested that the subjects tended not to go beyond the imposed task of translation into coherent interpretation of the content of the letter. These results imply that overemphasis on giving right answers and making no errors, which we often see in some school settings, may prevent students from constructing conceptual knowledge and thus from becoming adaptive experts.

The third factor is to what degree understanding the object/constraints of procedural skill is valued by reference group members. In a culture where understanding the system is emphasized as a goal, people are encouraged to engage in active experimentation. That is, they are encouraged to try new versions of the procedural skill, even at the cost of efficiency to some extent; they are often requested to explain the appropriateness of the skill as well (mostly to others but sometimes to themselves). Being asked for explanations, people tend to try to select, integrate and elaborate potentially relevant pieces of preconceptual knowledge, probably relying on mental experimentation. On the other hand, in a culture where the prompt performance of a procedural skill and/or its outcome is highly valued, people are discouraged to ask why or examine new variations in the skill. Asking why or forming corresponding conceptual knowledge through experimentation is regarded as extraneous or even detrimental to efficiency of the performance. Hunt & Love (1972) suggested that few great mnemonists like their subject named VP, a sort of routine expert, can be found in American society where asking why as opposed to practicing memorizing is encouraged. We would claim that accumulated practice of procedural skill is likely to lead to adaptive expertise under the former, understanding-oriented culture, while to routine expertise under the latter, promptitude-oriented culture. These contrasting cultures, made up of the shared beliefs of the "developed" people of each society, would be internalized by "developing" members as metacognitive goals of knowing activity through joint enterprise with the developed (See Wertsch, 1979).

Since Japanese schools and homes are said to be efficiency-oriented rather than understanding-oriented (Hatano, 1982b), it will be interesting to examine whether Japanese children are in fact inferior to those who are growing up in understanding-oriented culture in terms of flexibility and adaptability of procedural knowledge.

REFERENCES

Anderson, J. R. (Ed.) *Cognitive skills and their acquisition.* Hillsdale, N.J. : Erlbaum, 1981.

Brown, A. L. & DeLoache, J. S. Skills, plans, and self-regulation. In R. Siegler (Ed.), *Children's thinking : What develops ?* Hillsdale, N. J. : Erlbaum, 1978.

Condry, J. & Koslowski, B. Can education be made "intrinsically interesting" to children ? In L. G. Katz (Ed.), *Current topics in early childhood education,* Vol. Ⅱ, Ablex, 1979.

Gentner, D. & Stevens, A. L. *Mental models.* Hillsdale, N. J. : Erlbaum, 1983.

Greeno, J. G. *Forms of understanding in mathematical problem solving.* Paper presented at the 22nd International Congress of Psychology, Leipzig, 1980.

Hatano, G. Cognitive consequences of practice in culture specific procedural skills. *Quarterly Newsletter of Laboratory of Comparative Human Cognition,* 1982a, 4, 15–18.

Hatano, G. Should parents be teachers too ? : A Japanses view. *Dokkyo University Bulletin of Liberal Arts,* 1982b, 17, 54–72.

Hatano, G. & Inagaki, K. *Personification as analogy.* Paper to be presented at the American Educational Research Association Annual Meeting, New Orleans, 1984.

Hatano, G., Kuhara, K. & Akiyama, M. Kanji help readers of Japanese infer the meaning of unfamiliar words. *Quarterly Newsletter of Laboratory of Comparative Human Cognition,* 1981, 3, 30–33.

Hatano, G., Miyake, Y. & Binks, M. G. Performance of expert abacus operators. *Cognition,* 1977, 5, 57–71.

Hatano, G. & Osawa, K. Digit memory of grand experts in abacus-derived mental calculation. *Cognition,* 1983, 15, 95–110.

Hatano, G., Amaiwa, S. & Shimizu, K. *Formation of "mental abacus"for computation and for memorizing digits : A developmental study.* Paper to be presented at the American Educational Research Association Annual Meeting, New Orleans, 1984.

Hatano, G. & Suga, Y. *Abacus learning, digit span and multi-digit addition/subtraction skills among 3rd-graders.* Paper presented at the American Educational Research Association Annual Meeting, Los Angeles, 1981.

Hunt, E. & Love, T. How good can memory be ? In A. W. Melton & E. Martin (Eds.) *Coding processes in human memory.* Washington, D. C. : Winston, 1972.

Inagaki, K. Effects of external reinforcement on intrinsic motivation. *Japanese Psychological Review,* 1980, 23, 121–132. (in Japanese).

Inagaki, K. & Hatano, G. *Effects of external evaluation on reading comprehension and intrinsic interest.* Paper to be presented at the American Educational Research Association Annual Meeting, New Orleans, 1984.

Karmiloff-Smith, A. & Inhelder, B. If you want to get ahead, get a theory. *Cognition,* 1975, 3, 195–212.

Lepper, M. R. & Greene, D. (Eds.) *The hidden cost of reward.* Hillsdale, N. J. : Erlbaum, 1978.

Motoyoshi, M. *Essays on education for day care children ; emphasizing daily life activities.* Tokyo : Froebel-Kan, 1979. (in Japanese).

Piaget, J. *The grasp of consciousness.* London : Routledge & Kagan Paul, 1976.

Piaget, J. *Success and understanding.* London : Routledge & Kagan Paul, 1978.

Piaget, J. *The psychology of intelligence.* New York : Harcourt Brace, 1950.

Rumelhart, D. E. *Analogical processes and procedural representations.* CHIP Report No. 81. Center for Human Information Processing, University of California, San Diego, 1979.

Scribner, S. & Cole, M. *The psychology of literacy.* Cambridge, Mass : Harvard University Press, 1981.

Wertsch, J. V. From social interaction to higher psychological processes : A clarification and application of Vygotsky's theory. *Human Development,* 1979, 22, 1–22.

Yasunaga, T. *Ando Shoyeki.* Tokyo : Heibon-Sha, 1976. (in Japanese).