Awareness of Limit to Ability by Age and HRD
—An International Comparison by Research Field—

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Introduction

In the face of intensified technical innovations and competition among companies, new measures for nurturing and managing R&D personnel are being sought. This paper contains (1) a summary analysis of leading manufacturers' R&D researchers' awareness of age-related limitations regarding their research ability; and (2) conclusions, based on the aforementioned analysis, regarding measures for effectively developing the R&D abilities of such researchers. The analysis is based on data obtained by the "International Comparative Questionnaire Surveys concerning the Development of the Careers and Abilities of R&D Researchers (1989—90)" conducted by the Japan Productivity Center (now the Japan Productivity Center for Socio-Economic Development) and two surveys conducted by the Keio University Institute for Economic and Industrial Studies: "A Research Project concerning the Nurturing and Development of Personnel for Creative Research and Development in Japanese Companies: International Comparative Surveys concerning the Opinions of Development Researchers" (1997—8) and "Domestic Surveys concerning the Opinions of Researchers in Basic-Research Fields" (1994).

1. Awareness of Age-Related Limitations on Research Ability

There has been a tendency to ridicule Japanese R&D researchers, saying that their awareness of the limitations of their research ability increases as they become older. According to surveys conducted by the Japan Productivity Center, Japanese R&D researchers feel limitations of their research ability at some time from their late 30s to their early 40s. In contrast, however, in the United Kingdom, Germany and the United States, 70% of the researchers stated that research ability "varies among individuals" and that the differences are not related to age. In Japan, however, only slightly more than 14% of the respondents attributed research-ability limitations to "differences among individuals."

According to the surveys conducted by the Keio University Institute for Economic and Industrial Studies (1997—8), although there is weak awareness of age-related limitations in the United Kingdom, Korea, and India, strong awareness of age-related limitations exists in both Japan and Taiwan. Concerning aware-

Table 1 Age Limit (%)

	Any age limit For researcher?			How comes the age limit?		
	Yes	No	Total	Specific age	Depens on individual	Total
UK	23.1	76.9	100.0 (765)	35.1	64.9	100.0 (174)
Japan	53.5	46.5	100.0 (1124)	78.8	21.2	100.0 (600)
Korea	32.4	67.6	100.0 (1068)	94.8	5.2	100.0 (344)
India	35.0	61.8	100.0 (411)	41.0	54.9	100.0 (144)
Taiwan	51.4	47.1	100.0 (512)	72.2	27.8	100.0 (263)
Total	39.1	60	100.0 (3880)	64.4	34.8	100.0 (1525)

ness of limitations on research ability, a number of respondents in the United Kingdom and India answered that such limitations depend on differences among individuals but not on their ages. In contrast, Korean, Taiwanese, and Japanese researchers share a strong awareness of limitations of their research ability in terms of age. Japanese researchers in particular strongly feel a limitation of their ability in their early 40s.

The 1994 survey by the Keio University Institute for Economic and Industrial Studies revealed that basic-studies researchers feel a limitation of ability in terms of age: "early 40s" was pointed out by 30% of the respondents, and "late 40s" was mentioned by 27%, making two large groups of researchers who mentioned the 40s. The survey also indicated that slightly less than 30% of the respondents attribute ability limitations to "differences among individuals."

Why do Japanese R&D researchers feel ability limitations more strongly in terms of age? Inasmuch as there is no rational ground for believing that Japanese people have any hereditary characteristics that would result in a limitation of ability at earlier ages than would be the case with other peoples, what is the explanation for the feelings of the Japanese researchers?

The first explanatory factor concerns what can be called the result of being in a technological-development catch-up situation. Usually, developing countries introduce technology from developed countries and aim to catch up with the latter. Related to this, when a country tries to introduce advanced basic technology and to apply it for manufacturing products or for other development activity, it is a managerial policy to utilize younger personnel, who have much stamina, for conducting research and development work.

A second factor relates to the existence of a seniority-based promotion / pay-raise system, by which R&D researchers are made to leave the front line of research and development activities at specified ages.

A third factor is the effect of social customs. A society that has the custom of requiring the young to honor their elders leads to the importance within organizations of a societal order based on seniority.

Among these three factors, the first cannot be proved to be valid, because Indian and Korean researchers, unlike their counterparts in Japan, do not feel any limitation of ability according to age. The third factor also cannot be proved, as evidenced by the different survey results concerning awareness of age-related limitations that were obtained in Korea, Taiwan and Japan, even though all three countries are in the East-Asian cultural sphere. The second factor might well be imagined as a valid factor, because Japanese companies have been oriented to a seniority-based personnel-management system.

However, in recent years the seniority-based system in Japan has been changing due to the aging of the labor force and the introduction of personnel-management systems based on

Table 2 Main Factors That Make Researchers Ineffective (M. A.) (%)

	Physical factors	Psychological factors	Lack of fresh ideas	Less motivated to challenge new themes	Unable to keepace with technological innovation	Too busy dealing with administrative duties	Too busy undertaking tasks other than research	Others	Total
UK	4.6	14.9	45.1	40.6	36.0	65.1	59.4	12.0	100.0 (174)
Japan	27.0	14.8	34.6	25.0	22.3	69.2	52.7	1.7	100.0 (600)
Korea	15.9	21.4	40.5	32.1	30.1	61.6	66.2	5.2	100.0 (344)
India	33.3	47.9	29.9	40.3	37.5	49.3	51.4	9.0	100.0 (144)
Taiwan	41.4	22.4	32.3	27.4	35.4	49.4	43.7	1.5	100.0 (263)
Total	24.4	24.3	36.5	33.1	32.3	58.9	54.7	5.9	100.0 (1525)

achievement. As a result, the reasons that R&D researchers give to explain ability limitations will shift from being age-related to being related to the traits of individual researchers.

Although awareness of limitations of ability are still stronger in Japan than in other nations, recognition that ability limitations of R&D researchers depends on "differences among individuals" has recently been greater than was in the surveys conducted in the past by the Japan Productivity Center for Socio Economic Development (1989—90).

2. Reasons for Limitations of Ability

In this section I will outline the reasons why R&D researchers feel limitations concerning their research abilities. I will begin with a comparative examination to identify differences among R&D personnel of various countries.

In the surveys of researchers of different countries, "Too busy dealing with administrative duties" and "Too busy undertaking tasks other than research work" were the first- and second-ranked reasons for feeling limitations concerning ability. Reasons such as "Lack of fresh ideas (e.g., creativity)," "Less motivated to deal with new research themes," and "Unable to keep pace with rapid technological innovations" follow, though their ranking varies among countries.

Although in Japan the top two reasons were the same as in other countries, "Too busy dealing with administrative duties" and "Physical factors" were felt by Japanese researchers more strongly on average than was the case in other countries. In contrast, the reasons that were relatively weak among Japanese researchers were "Unable to keep pace with rapid technological innovations" and "Psychological factors (e.g., unable to concentrate)."

The background relating to Japanese R&D personnel feeling that ability limitations are related to age includes the strong effects of "Too busy dealing with administrative duties," "Too busy undertaking tasks other than research work," and "Physical factors."

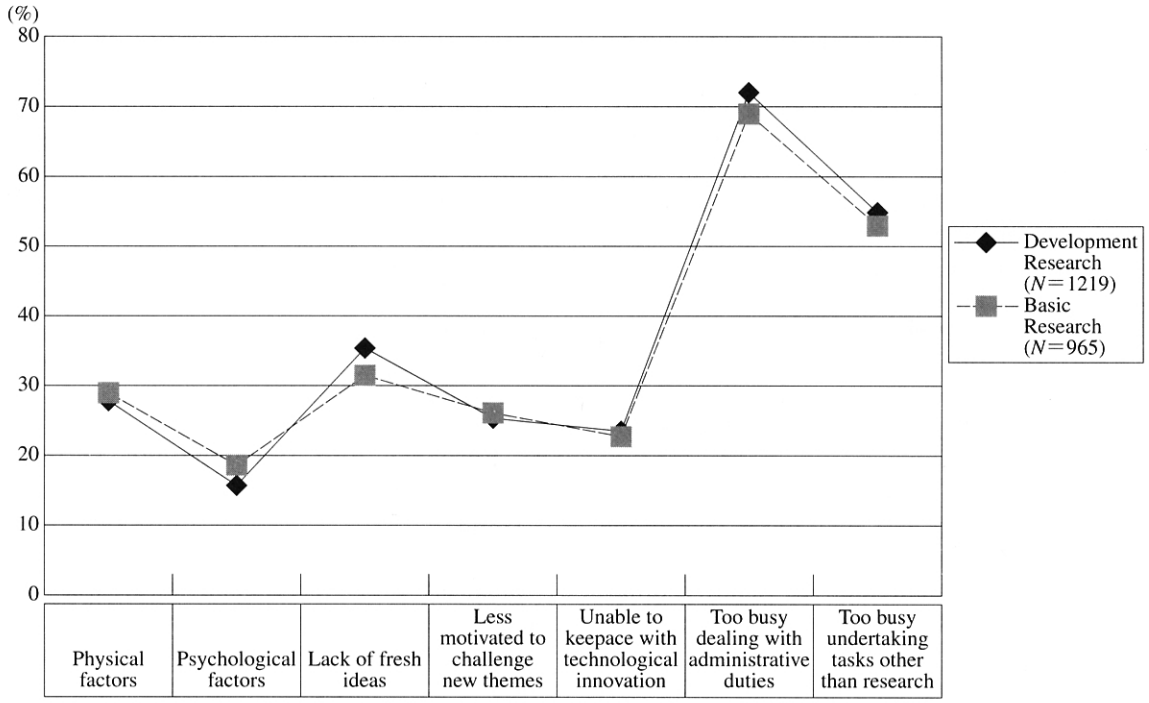
In order to reduce as much as possible researchers' managerial responsibilities and other tasks besides R&D activities, to solve the problem of physical factors, and to eliminate the researchers' feeling of ability limitation, it is necessary to improve the management of research and development activities. In order to enable researchers to concentrate on R&D activities, it is necessary to consider the introduction of various measures, such as reforming the management of research organizations, reorganizing the organizations' personnel systems, and providing researchers with sufficient research assistants.

3. Research and Development Activities and Awareness of Ability Limitations

Japanese R&D researchers' awareness of ability limitations differ, depending on their fields of work, as indicated by the following analysis. A comparison of the results of a survey concerning development-oriented researchers (1998) and the results of a survey concerning basic-studies-oriented researchers (1994) reveals that the belief that limitations are age-related is slightly stronger among personnel in the developmental research field than in the basic-research field, and that although basic-studies researchers have a stronger feeling that ability limitations are based on "differences among individuals" than do development-oriented researchers, the latter group of researchers feel ability limitations at earlier ages than do the basic-studies researchers.

In order to analyze the difference in awareness of ability limitation between personnel in the fields of research and development, I will compare the reasons that the two groups give for ability limitation. More than one-half of the respondents in both basic-research areas and in developmental research areas point out "Too busy dealing with administrative duties" and "Too busy undertaking tasks other than research work" as the reasons.

Compared with basic researchers, the reasons why development researchers feel more strongly are "Unable to keep pace with rapid technological innovations" and "Lack of fresh



Graph 1 Main Factors That Make Researchers Ineffective by Research Field

ideas (e. g., creativity)." In contrast, basic-studies researchers see "Psychological factors (e.g., unable to concentrate) as a crucial cause of ability limitation.

When considering how the abilities of R&D personnel should be developed, an analysis of researchers' awareness of age-related ability limitations leads to the following conclusions. First, although Japanese researchers have a stronger sense that ability limitation is age-related than do their overseas counterparts, the feeling that ability limitations depend on differences among individuals is increasing among the Japanese. Second, no significant difference has been found between research-oriented personnel vis-á-vis development-oriented personnel with regard to awareness of ability limitations. Third, many basic-studies researchers consider ability limitations to be related to differences among individuals. Fourth, for development researchers the reasons for ability limitations are an inability to keep up with rapid technical innovations or a breakdown of the ability to think creatively.

4. Age-Related Limitations and the Development of Ability

4.1 Awareness of age-related limitations and the effectiveness of ability-development measures

In this section, I will analyze the difference between researchers who have awareness of age-related limitations and those who do not, with regard to how they evaluate the effectiveness of ability-development measures for R&D personnel.

Whether or not development-oriented researchers have awareness of age-related limitations, they regard as effective such ability-development measures as "Guidance by supervisors/seniors in on-the-job training" (hereinafter referred to as "OJT"), "Engaging in work involving heavy responsibility," "Self-development," "Attending academic meetings and conferences in one's field," "Planning and implementing new projects" and "Attending lectures/seminars in one's professional field."

The ability-development measures that are

more strongly considered effective by researchers without awareness of age-related limitations than by those with such awareness are "Self-development," "OJT," "Participation in exchanges and study groups with specialists from other companies," and "In-career study in foreign universities." Particularly with regard to "Self-development," there is a statistically significant difference between researchers having awareness of age-related limitations and those not having such. Namely, more of those who say that limitations are not age-related regard "Self-development" as an effective means of ability development than do those who say that limitations are age-related.

One policy challenge that is suggested by the above analysis concerns how to eliminate from researchers' minds the feeling that limitations are age-related and to provide them with an improved environment in which they can work at the front line of their work field through continued development of their abilities by "OJT" or "Self-development." Specifically, in order to develop the ability of R&D personnel, researchers should be given opportunities to "Engage in work involving heavy responsibility" and to "Participate in joint-research projects with researchers from different fields." In addition, efforts should be made to nurture their ability to think creatively and to improve their technical abilities.

4.2 Correlation between age and ability-development measures

An examination of the correlation between the age of respondents and which ability-development measures they regarded as effective reveals that as the respondents age there is a shift in how they evaluate the effectiveness of various measures. In the younger-age bracket, "OJT," "Attending lectures and seminars," "Participation in study groups within the company" and "Attending academic meetings" are regarded as effective. But as the personnel get older, they indicate that "Engaging in work involving heavy responsibility," "Extensive job rotation beyond the R&D department," "Planning and implementing new projects," "In-career study in domestic universities," and "In-career study in foreign universities" are the effective measures.

In contrast, ability-development measures that have less correlation with age are "Extensive job rotation within the R&D department," "Participation in joint-research projects with researchers from different fields," "Temporary assignment in an affiliated company," "Participation in joint-research projects in other research institutes," "Self-development," and "Participation in exchanges and study groups with specialists from other companies." Because in regard to these items there is no change in the degree of correlation with age, they can be regarded as ability-development measures that are not affected by a researcher's age.

Therefore, the correlation between the age of R&D personnel and their views regarding ability-development measures leads to the following propositions. Young researchers regard OJT and learning from experts as effective measures; middle-aged research personnel regard experience of work involving heavy responsibility and research exchange through studying abroad or outside the company to be effective measures; and senior-age researchers regard job rotation beyond divisional boundaries and planning/promoting new projects as effective measures.

5. Effective Ability-Development Measures

In this chapter, I will analyze the effectiveness of measures to develop the abilities of R&D personnel, especially of development-oriented researchers, in three ways: first, through an international comparison; second, through a consideration of the difference between individual researchers' recognition of effectiveness and the policies of the division in which they work; and third, through consideration, according to R&D field, differences in recognition of the effectiveness of the measures.

Table 3 Effective Methods of Development (%)

		UK	Japan	Korea	India	Taiwan
1	Guidance by supervisor in on-the-job training	32.3	35.5	22.6	18.2	36.3
2	Experience in highly responsible work	16.6	21.5	28.8	20.7	10.2
3	Extensive rotation within the R&D department	3.4	1.6	1.7	3.6	1.0
4	Transfer to operating department	1.6	3.3	0.7	1.0	0.0
5	Participation in joint projects with researchers from other fields	8.7	3.5	3.7	5.4	10.0
6	Planning and implementing new projects	6.0	4.5	9.8	9.2	9.6
7	Temporary assignment in an affiliated company	0.7	0.4	1.4	1.0	0.0
8	Participation in joint projects in other research institutes	1.3	2.8	4.7	1.2	5.9
9	Post-hire study in domestic universities	1.4	3.7	0.9	0.7	0.2
10	Post-hire study in foreign universities	0.4	2.6	1.9	1.7	2.3
11	Self development	17.7	8.0	16.2	24.3	8.6
12	Lectures/seminars in your professional fields	0.9	3.6	3.5	1.9	8.8
13	Participation in exchanges and study groups with specialists from other companies	0.8	2.1	2.7	0.7	2.3
14	Participation in study groups inside the company	0.5	1.2	0.7	0.7	0.6
15	Attending academic meetings and conferences in your field	1.8	5.3	0.4	1.2	0.8
16	Others	2.3	0.3	0.5	8.3	3.5
	Total	100.0 (N=765)	100.0 (N=1129)	100.0 (N=1068)	100.0 (N=411)	100.0 (N=512)

5.1 International comparative analysis

Do effective ability-development measures differ from country to country? Personnel in Japan, as well as in the United Kingdom and Taiwan, point out "OJT" as the top-ranking type of measure. Korean personnel rate "Engaging in work involving heavy responsibility" at the top, while Indian researchers regard "Self-development" as the most effective ability-development measure.

The effectiveness of "Self-development," which is effective particularly for researchers who do not feel that limitations are age-related, is held in low regard in Japan and Taiwan, while it is rated highly in India, the United Kingdom and Korea. Other measures that Japanese regard more highly than do their counterparts in other nations are "Attending academic meetings and conferences in one's field," and "Studying abroad or job rotation to a different division." In contrast, "Planning and implementing new projects," "Self-development," and "Participation in joint-research projects with researchers from different fields" are regarded as less effective by Japanese researchers than by those in other countries.

5.2 Differences between individual researchers and division management personnel regarding their evaluations of ability-development measures

Regarding the effectiveness of ability-development measures, does an individual researcher's view accord with the policy of the division in which the person is working? Even if a development-oriented researcher regards "OJT" as the most effective among the relevant measures, when compared with the evaluation by the division's management personnel who regard it as far more effective, the researcher's appreciation of "OJT" is relatively low. Furthermore, although a development-oriented researcher might think that "Engaging in work involving heavy responsibility" is an effective measure, the division management personnel might not regard that as very effective.

In terms of the measures that individuals consider to be effective, it can be said that effective ability-development measures for

Table 4 Effective Methods of Development by Individual and Campany (%)

		Individual	Campany
1	Guidance by supervisor in on-the-job training	35.5	64.8
2	Experience in highly responsible work	21.5	8.2
3	Extensive rotation within the R&D department	1.6	2.1
4	Transfer to operating department	3.3	1.6
5	Participation in joint projects with researchers from other fields	3.5	0.9
6	Planning and implementing new projects	4.5	4.7
7	Temporary assignment in an affiliated company	0.4	0.2
8	Participation in joint projects in other research institutes	2.8	0.7
9	Post-hire study in domestic universities	3.7	0.5
10	Post-hire study in foreign universities	2.6	1.0
11	Self development	8.0	8.1
12	Lectures/seminars in your professional fields	3.6	2.3
13	Participation in exchanges and study groups with specialists from other companies	2.1	0.8
14	Participation in study groups inside the company	1.2	0.2
15	Attending academic meetings and conferences in your field	5.3	3.0
16	Others	0.3	0.2
	Total	100.0 (N=1219)	100.0 (N=1219)

companies to promote are personnel reassignment beyond a division, joint-research projects, and joint-research studies. In addition, it is important for companies to provide researchers with sufficient opportunities for exchanges with people from different fields, either through studying abroad, joining an institute outside the company, or attending training sessions.

5.3 Relation between perceived effectiveness of ability-development measures and fields of R&D work

Does the perceived effectiveness of ability-development measures differ between personnel in research-oriented fields and those in development-oriented fields? With regard to the ability-development measures that are common to both basic-studies researchers and development-oriented researchers, "OJT" is ranked first, "Engaging in work involving high responsibility " ranked second, and "Self-development" is third.

The ability-development measures that seem to be more highly regarded as effective by personnel in developmental research fields than by personnel in basic-research fields are "Job rotation to a different division," "Participation in joint-research projects with researchers from other fields" and "Attending lectures/seminars in one's professional field." The measures that are regarded as more effective by personnel in basic-research fields than in developmental research fields are "Extensive job rotation within the R&D department" and "Studying abroad."

The results of the above comparisons suggest the following conclusion. For basic-studies researchers, extensively specialized types of personnel-nurturing measures such as polishing one's expertise in a specific field and learning from top-level experts from around the world are effective. In contrast, for development-oriented researchers, measures that involve exchanges with outside resources, such as being transferred to other divisions, joint-research projects with other divisions, and attending training sessions or seminars are effective.

6. Conclusion

With awareness of age-related limitations declining among Japanese R&D researchers, who increasingly believe that limitations differ among individuals, the development of

Table 5 Effective Methods of Development by Research Field (%)

		Development Research	Basic Research
1	Guidance by supervisor in on-the-job training	35.5	36.9
2	Experience in highly responsible work	21.5	23.6
3	Extensive rotation within the R&D department	1.6	3.5
4	Transfer to operating department	3.3	0.3
5	Participation in joint projects with researchers from other fields	3.5	1.8
6	Planning and implementing new projects	4.5	5.2
7	Temporary assignment in an affiliated company	0.4	0.2
8	Participation in joint projects in other research institutes	2.8	2.7
9	Post-hire study in domestic universities	3.7	3.9
10	Post-hire study in foreign universities	2.6	3.9
11	Self development	8.0	7.5
12	Lectures/seminars in your professional fields	3.6	1.7
13	Participation in exchanges and study groups with specialists from other companies	2.1	2.0
14	Participation in study groups inside the company	1.2	0.7
15	Attending academic meetings and conferences in your field	5.3	4.2
16	Others	0.3	1.9
	Total	100.0 (N=1219)	100.0 (N=965)

effective measures for nurturing personnel has become a crucial issue of personnel-policy development. In particular, reform of personnel systems and reorganization of the management of research centers are required so that R&D personnel can overcome feelings of age-related ability limitations and can work at the front line of research and development throughout their careers by nurturing the ability to think creatively or to master new technology.

Related to the above are several challenges. The first challenge is an interrelated set: to minimize researchers' work on other than R&D activities and to build a system that enables researchers to concentrate on their own activities and to eliminate the sense of age-related limitations.

The second challenge is to adopt effective ability-development measures for R&D personnel. These are, in addition to OJT and self-development, job rotation and allowing workers to be engage in work that involves heavy responsibility and to participate in joint-research projects with researchers from different fields. Among these measures, self-development is effective especially for researchers without an awareness of age-related limitations.

The third challenge is to select ability-development measures that are suitable according to the age of the researchers, because the perceived effectiveness of the measures differs according to the age of the researchers.

The fourth challenge involves reducing the difference between the perceptions of management personnel of R&D divisions and those of individual researchers therein with regard to the effectiveness of various measures. In particular, management personnel of such divisions regard OJT as more effective than the researchers do, while the researchers regard engaging in work that involves heavy responsibility as more effective than management personnel do.

The fifth challenge involves first, to recognize that the perceived effectiveness of ability-development measures differs between the researchers in the two major fields of research: basic-studies and development-oriented; and second, to implement measures that reflect that recognition. For basic-studies researchers, extensively specialized personnel-nurturing measures are perceived as effective, while

those in development-oriented fields regard measures that involve exchanges with outside resources as most effective.

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