A CROSS-CULTURAL STUDY ON CHILDREN'S CONCEPTION OF SPEED AND DURATION: A COMPARISON BETWEEN JAPANESE AND THAI CHILDREN

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Japanese and Thai preschool children were shown the same visual displays of moving objects and asked to compare the speed of those movers. The results significantly indicate that Thai children show less of a tendency to judge the speed by the temporal precedence, as compared with Japanese children. The present study has also shown that there were more observable tendencies to judge the length of time, or duration by the length of distance in Japanese kindergarten children than in Thai kindergarten children. The above results can be explained well by the effect of their mother language they use; the linguistic differentiation in Thai gave rise to differentiations in Thai preschool children's conception of speed and duration.

Piaget (1946) asked some preschool children which one of two small mechanical snails took the most time to cross a table. From their responses, he suggested that children under eight years of age judged speed by the temporal precedence of the moving bodies, and that their judgement of duration remained undifferentiated from that of distance. Based on a replication experiment, Cohen (1967) concluded that in children under nine years of age the concept of time was undifferentiated from that of space. Their conclusions, however, leave much to be discussed, for a clear explanation of the effect of language especially on the conception

of preschool children has scarcely been given to us. As pointed out in the author's previous articles (Mori, 1973; Mori, Kitagawa, & Tadang, 1974), Piaget's epistemology lacks some perfection because it explains the immaturity of children's conception from the incompleteness of their logical thinking. He has failed to notice that children develop their recognition by acquiring language which is the vehicle of intersubjectivity in the society of the period.

If linguistic relativity hypothesis holds more or less true for the conception in early childhood, the linguistic differentiation in the mother language used daily by children will give rise to differentiations in their conception.

For instance, children are likely to judge speed from temporal precedence and say, "The mover went faster because it arrived earlier" as Piaget mentioned, but these two words *fast* and *early* meaning speed and temporal precedence respectively, have the same pronunciation in the Japanese language, i.e. *hayai*. On the other hand, in Thai language, these two words are differentiated in their pronun-

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TABLE 1
Expressions for temporal precedence and speed

	English	Japanese	Thai	English	Japanese	Thai
Time	<i>early</i>	<i>hayai</i>	<i>khon</i>	<i>late</i>	<i>osoi</i>	<i>lhang</i>
Speed	<i>fast</i>	<i>hayai</i>	<i>reo</i>	<i>slow</i>	<i>osoi</i>	<i>shaa</i>

TABLE 2
Words showing temporal length and spatial length

	English	Japanese	Thai	English	Japanese	Thai
Time	<i>long</i>	<i>nagai</i>	<i>nan</i>	<i>short</i>	<i>mijikai</i>	<i>noi</i>
Distance	<i>long</i>	<i>nagai</i>	<i>eyao</i>	<i>short</i>	<i>mijikai</i>	<i>san</i>

ciation as well as in meaning; high speed is signified by *reo* and temporal precedence by *khon* (Table 1).

Furthermore, there are no phonic distinctions between words showing temporal length and those showing spatial length in Japanese, English, and French, in which temporal length and spatial length are both expressed by the same words, e.g., *long* and *short*; in Thai, on the other hand, each is expressed by a different word (Table 2).

The purpose of the present study is to examine two hypotheses proposed as follows.

Hypothesis

(1) Since the Japanese language generally uses the same spoken word to express speed and temporal precedence while the Thai language has two distinctive words as mentioned above, Thai kindergarten children will be able to discriminate between those words, and thus be capable of judging speed more correctly than Japanese kindergarten.

(2) Thai kindergarten children, aided by their language, will show less of a tendency to judge the duration of a moving body by the distance covered, as compared with Japanese kindergarten children. On the other hand, the effect of language on the conception of elementary school children will be reduced by the development

of their mental faculty through various experiences.

EXPERIMENT 1

This experiment was designed to examine hypothesis (1) mentioned above.

Method

Subjects. The *Ss* were 63 Japanese kindergarten children (4.7–5.7 years old, average 5.3 years old) and 29 Thai kindergarten children (3.9–6.1 years old, average 4.8 years old)². As results of an intelligence test (the Tanaka Intelligence Test: Form B), there was no statistically significant difference ($t_0 = 1.98$, $df = 90$) between the mean intelligence score (IS) of Japanese children (mean IS = 66.1, $SD = 28.3$) and that of Thai children (mean IS = 44.9, $SD = 33.9$), nor was there a significant difference ($t_0 = .625$, $df = 90$) between the mean IQ of Japanese children (mean IQ = 102.7, $SD = 13.5$) and that of Thai children (mean IQ =

² This experiment was carried out at Hirano National Kindergarten (a branch of Osaka University of Education in Osaka City) in Japan, and at Rajumnusil Kindergarten (a private school in Chum Phae City) in Thailand, which are both located in the urban district. As infant education has recently been popularized in Thailand, too, Rajumnusil Kindergarten is open to the children of all classes with respect to the socioeconomic background. The same may be said of the Thai schools in Experiment 2.

100.6, $SD=17.3$). Both in Experiment 1 and in Experiment 2, Thai children were tested by Thai experimenters: Japanese children by Japanese experimenters.

Apparatus and procedure. The instruments included in the first inquiry were a box and two toy cars which were placed on the upper side of the box with two parallel slits as shown in Fig. 1. Each toy car had a small stick fixed under it and this stick protruded down through the slits. The bottom of the box was open so that the experimenter could hold the sticks and move the toy cars along the slits without the Ss seeing the experimenter's hands. The Ss watched one of the cars start off slowly and, when it had gone half way, the other car started and moved faster than the first one. The first car reached the end point shortly before the second car arrived. Immediately after this visual display was over, the Ss were asked one by one whether the two cars had run with equal speed or not, and, if not, which one had run faster (Quiz 1).

In the second inquiry two iron balls were used, which were rolled down from the tops of two slants that led to parallel grooves on a board. The slants were adjusted in order that one ball might move faster than the other along the longer groove, when they were simultaneously released. The slants were hidden by two wooden boards so that the Ss could see only the grooves Sa-A and Sb-B. The slower ball rolled from Sa to A, and stopped at A, a little before the faster one which rolled from Sb to B (Fig. 2) stopped at B. The Ss were individually shown this visual display and orally asked the same questions (Quiz 2) as Quiz 1.

Results and Discussions

The answers from both Japanese and Thai children are shown in Table 3.

FIG. 1. The device used in Quiz 1.

FIG. 2. The device used in Quiz 2.

TABLE 3
The numbers and percents of right and wrong answers

	Quiz 1		Quiz 2	
	Japanese children	Thai children	Japanese children	Thai children
Correct answer	9 (14)	16 (55)	8 (13)	20 (69)†
Wrong answer	54 (86)	13 (45)	55 (87)	9 (31)

† Numbers in parenthesis indicate percentages

Compared with ratios between Japanese and Thai children's responses, there were statistically significant differences at $p < .001$ in Quiz 1 ($\chi^2=16.78$, $df=1$) and also at $p < .001$ in Quiz 2 ($\chi^2=29.70$, $df=1$). There was also a significant difference between Japanese and Thai children's responses both to Quiz 1 and Quiz 2 at $p < .001$ ($t_0=7.09$, $df=90$). These results showed that Thai children were able to discriminate between the words of temporal precedence and the words of speed, which conceivably led them to obtain more advanced concepts of speed than Japanese children of nearly the same age. The results offered enough reliability to indicate that hypothesis (1) was acceptable.

EXPERIMENT 2

This experiment was designed to examine hypothesis (2).

Method

Subjects. Children under eight years of age and children above nine years of age were

chosen as the *Ss* of this experiment in order to re-examine the results of Piaget's and Cohen's experiments. The *Ss* were 62 kindergarten children (5.4–6.3 years old, average 5.9 years old) and 111 elementary school children (10.4–11.3 years old, average 10.8 years old) in Japan, and 105 kindergarten children (3.9–6.4 years old, average 5.5 years old) and 106 elementary school children (8.7–12.5 years old, average 10.9 years old) in Thailand.³ In the Tanaka Intelligence Test (Form B), there was no significant difference ($t_0=1.95$, $df=165$) between the mean IS of Japanese kindergarten children (mean IS=86.8, $SD=32.5$) and that of Thai kindergarten children (mean IS=73.1, $SD=48.9$), nor was there a significant difference ($t_0=.14$, $df=165$) between the mean IQ of Japanese children (mean IQ=101.8, $SD=12.1$) and that of Thai children (mean IQ=101.4, $SD=19.8$). As to elementary school children, there was, also no significant difference ($t_0=1.95$, $df=215$) between the mean IS of Japanese children (mean IS=62.3, $SD=9.8$) and that of Thai children (mean IS=59.4, $SD=11.9$), nor was there a significant difference ($t_0=1.80$, $df=215$) between the mean IQ of Japanese children (mean IQ=106.3, $SD=14.6$) and that of Thai children (mean IQ=102.4, $SD=17.2$).

Apparatus and procedure. Moving bodies used in this experiment were two model electric locomotives. Three inquiries similar to those employed by Piaget and Cohen were provided for the present study.

Inquiry A: Two locomotives started at the same time from point P and P' on the same starting line. They move in the same direction on two parallel straight tracks as shown

FIG. 3. Distance which the locomotives moved and duration in Inquiry A.

FIG. 4. Distance which the locomotives moved and duration in Inquiry B.

FIG. 5. Distance which the locomotive moved and duration in Inquiry C.

in Fig. 3. The locomotives moved with different speeds. The faster locomotive stopped at point Q, 3.85 m from starting point P, and 7 sec after it had started, and the slower one stopped at point Q', 1.70 m from starting point P' and 9 sec after it had started.

Immediately after being shown this demonstration, the children were asked which one moved longer in time (Quiz A).

Inquiry B: Two locomotives with different speed started at the same time from the same starting line and stopped simultaneously on the parallel tracks as in Inquiry A. The faster locomotive moved a distance of 3.42 m and the slower one moved a distance of 1.95 m for 8 sec till stopping (Fig. 4).

Immediately after being given this demonstration, the *Ss* were asked if the locomotives stopped simultaneously (Quiz B-1), and which one moved longer in time (Quiz B-2).

Inquiry C: One locomotive moved on a straight track, speeding up on the way (at point Q). A bell was rung when the locomotive increased speed. The duration of its movement before the bell sounded was equal to the duration after the ringing of the bell. First the locomotive ran 1.92 m from point P for 3.5 sec at a uniform speed, and then it moved 2.65 m from point Q at a faster speed for another 3.5 sec as shown in Fig. 5.

Just as the demonstration was over, the children were asked if the locomotive required more time before or after the ringing of the bell (Quiz C).

The children had to explain the reason why they answered each question, except Quiz B-1. Kindergarten children were questioned one by one by experimenters and elementary

³ This experiment was carried out at Katsuyama Aiwa Second Kindergarten (a private school in Osaka City) and Tennoji National Elementary School (a branch of Osaka University of Educa-

tion in Osaka City) in Japan, and at the following national schools in Thailand: Khon Kaen kindergarten and Khon Kaen Elementary School in Khon Kaen City.

TABLE 4
The number of children who responded to Quiz A

	Kindergarten children		Elementary school children	
	Japan	Thailand	Japan	Thailand
The one moving the longer distance took more time.	51 (82)	68 (65)	15 (14)	20 (19)†
The one moving the shorter distance took more time. (correct response)	11 (18)	37 (35)	45 (40)	66 (62)
Both took the same amount of time.	0	0	51 (46)	20 (19)
Total	62	105	111	106

† Numbers in parenthesis indicate percentages.

TABLE 5
The number of children who responded to Quiz B-1

	Kindergarten children		Elementary school children	
	Japan	Thailand	Japan	Thailand
Both stopped simultaneously. (correct response)	11 (18)	34 (32)	94 (80)	84 (79)†
Both did not stop simultaneously.	50 (82)	71 (68)	17 (20)	22 (21)
Total	61	105	111	106

† Numbers in parenthesis indicate percentages.

TABLE 6
The number of children who responded to Quiz B-2

	Kindergarten children		Elementary school children	
	Japan	Thailand	Japan	Thailand
The one moving the longer distance took more time.	41 (66)	47 (45)	8 (7)	12 (11)†
The one moving the shorter distance took more time.	17 (27)	40 (38)	8 (7)	9 (8)
Both took the same amount of time. (correct response)	4 (7)	18 (17)	95 (86)	85 (81)
Total	62	105	111	106

† Numbers in parenthesis indicate percentages.

school children were given questionnaires.

Results and Discussion

The results of the children's responses obtained in this experiment are shown in Tables 4 to 7.

Kindergarten children. In Quiz A, there

was a significant difference in the chi-square test for comparison of ratios ($\chi^2 = 5.83$, $df = 1$, $p < .05$) between Japanese children and Thai children who said, "The locomotive moving the longer distance took longer." In Quiz B-1, the chi-square test for comparison of ratios between Japa-

TABLE 7
The number of children who responded to Quiz C

	Kindergarten children		Elementary school children	
	Japan	Thailand	Japan	Thailand
It took more time before the bell rang.	17 (30)	37 (35)	24 (22)	48 (45)†
It took more time after the bell rang.	38 (67)	52 (50)	29 (26)	49 (46)
It took the same amount of time before and after the bell rang. (correct response)	2 (3)	16 (15)	58 (52)	9 (9)
Total	57	105	111	106

† Numbers in parenthesis indicate percentages.

nese children's responses and Thai children's responses indicated significant differences ($\chi^2=4.02$, $df=1$, $p<.05$). More Japanese children said, "Both locomotives did not stop simultaneously." In Quiz B-2, a significant difference between children's responses in both countries was shown ($\chi^2=8.06$, $df=2$, $p<.05$). Japanese children said, "The one moving the longer distance took longer" more frequently than Thai children ($\chi^2=7.13$, $df=1$, $p<.01$). Whereas, Thai children said, "Both took the same amount of time" more frequently than Japanese children ($\chi^2=3.90$, $df=1$, $p<.01$). It can be considered that fewer Japanese children had the concept of simultaneity (in Quiz B-1) because "taking longer" means

"moving a longer distance" (in Quiz B-2). The same was true of Quiz C. That is, there were more observable tendencies to respond "the one moving the longer distance took more time" in Japanese children than in Thai children ($\chi^2=4.39$, $df=1$, $p<.05$).

The above results showed that Japanese children had more tendency to respond "the one moving the longer distance took more time" as compared with Thai children.

In the following, their reasons are discussed.

The reasons why the one moving the longer distance took more time are shown in Figs. 6 and 7. The figures are expressed in percentages for the sake of com-

FIG. 6. The percentage of the reasons given among kindergarten children for thinking that the one moving the longer distance took longer.

parison. To any of the above three inquiries, the Japanese children responded "it took longer because it moved a longer distance" more frequently than the Thai children.

Elementary school children. In Quiz A, there was a significant difference in the chi-square test for comparison of ratios between the children's responses in the two countries ($\chi^2=18.11$, $df=2$, $p<.01$), but no significant difference between the two ratios of children who said, "The one moving the longer distance took longer" ($\chi^2=1.15$, $df=1$, N.S.). In Quiz B, there was no significant difference between the ratios of children's responses in the two countries (Quiz B-1; $\chi^2=1.09$, $df=1$, N.S., Quiz B-2; $\chi^2=1.30$, $df=2$, N.S.). In Quiz C, Japanese children responded more correctly than Thai children did. Thai children showed a tendency to make either of the wrong responses as shown in Table 7. The following facts may explain the reason for this. In Japan, the tendency for elementary school children to respond "the one moving the longer distance took longer", decreased in comparison with kindergarten children ($\chi^2=25.82$, $df=1$, $p<.01$). On the other hand, in Thailand it hardly decreased at all ($\chi^2=.23$, $df=1$, N.S.). Forty-five percent (50 children) of the elementary school children in Japan could judge on the basis of Piaget's type (the period of time required

for moving the long distance with high speed=the period of time required for moving the short distance with low speed). In Thailand, there was no significant difference in the chi-square test for comparison of ratios between kindergarten children and elementary school children which judged the duration by the distance covered (Quiz A; $\chi^2=.41$, $df=1$, N.S., Quiz B-2; $\chi^2=1.10$, $df=1$, N.S., Quiz C; $\chi^2=.41$, $df=1$, N.S.). Spatio-temporal concepts changed more remarkably from kindergarten children to elementary school children in Japan than in Thailand. In general the above mentioned results show that their mother language had very little effect on elementary school children's conception.

Consequently, it may be concluded that the spatio-temporal conception of kindergarten children considerably depends on the differences of their mother language.

CONCLUSION AND SUMMARY

Japanese and Thai kindergarten children were shown the same visual displays of moving objects and asked to compare the speed of those movers. The results significantly indicate that Thai children show less of a tendency to judge the speed by the temporal precedence, as compared with Japanese children.

Piaget et al. suggested that the children

FIG. 7. The percentage of the reasons given among elementary school children for "the one moving the longer distance took longer".

at the intuitive thinking stage cannot yet differentiate between temporal and spatial concepts. But this investigation has also shown that there were more observable tendencies to judge the length of time, or duration by the length of distance in Japanese kindergarten children than in Thai kindergarten children, and that spatio-temporal conception changed more remarkably from kindergarten children to elementary school children in Japan than in Thailand. The results of these experiments provide strong evidence in favor of an explanation that the linguistic differentiation in Thai led Thai kindergarten children to discriminate between the conception of duration and that of distance.

Consequently, it may be concluded that preschool children's conception of speed and duration considerably depends on

the differences of their mother language.

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