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REACTION TIMES AND INTELLIGENCE: A COMPARISON OF CHINESE-AMERICAN AND ANGLO-AMERICAN CHILDREN

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Summary. Chinese-American and Anglo-American school children were compared on a nonverbal test of intelligence (Raven's Progressive Matrices) and on twelve chronometric variables which measure the speed with which basic information processes (e.g. stimulus apprehension, decision, and discrimination) can be carried out. All of these tasks are correlated with psychometric intelligence. The two groups differed significantly on most of the variables, but the differences appear to be multidimensional and are not simply due to a group difference in psychometric intelligence, equivalent to about 5 IQ points in favour of the Chinese-Americans. The results are compared with those of Lynn and his colleagues on British, Japanese, and Hong Kong children, and both consistencies and inconsistencies are found.

Introduction

Lynn & Shigehisa (1991) have studied intelligence test scores and reaction time (RT) variables on British and Japanese 9-year-old children. They concluded that the Japanese children were more efficient information processors at the neurological level, because they averaged 0·65 SD (equivalent to about 10 IQ points) higher than the British on the Raven Standard Progressive Matrices (SPM), a nonverbal test of reasoning, and also averaged 0·50 SD faster in RT on very simple tasks that have virtually no intellectual content. In fact, these elementary cognitive tasks involve only the speed of elementary information processes such as stimulus apprehension, decision, and discrimination and they proved exceedingly easy for 9-year-old children, even the most difficult task eliciting average RTs of less than 500 milliseconds (ms).

Lynn & Shigehisa also reported that (1) fast RT and low intraindividual variability in RT consistently correlated with psychometric intelligence; (2) the Japanese had faster RTs than the British on the simple, choice, and discrimination RT tasks by 0·40, 0·69, and 0·41 SD units, respectively; and (3) paradoxically, the Japanese had larger intraindividual variability in RT (as measured by the SD of the individual's RTs over a given number of trials) than the British, even though the SD of RT (RT-SD) is negatively correlated with psychometric intelligence within each group. A number of studies (Jensen, 1993a) have also shown negative correlations between RT-SD and psychometric *g*, the common factor in all complex mental tests, of which Raven's SPM is an especially good index. Hence the negative correlation between RT-SD and SPM within the Japanese and British group is not surprising. What is puzzling, however, is the positive correlation between groups, which may merely be a sampling fluke in Lynn & Shigehisa's (1991) study.

If the particular pattern of Japanese–British differences in the various RT variables found by Lynn & Shigehisa reflects a racial, rather than a national or cultural, difference, a similar pattern of differences should be found when other samples of Asians and Caucasians are compared. Group means can only be compared and interpreted if the groups are truly random samples from each population or are strictly comparable with respect to socioeconomic and demographic variables. This requirement is exceedingly difficult to achieve. However, patterns (or profiles) based on mean differences between groups (expressed in standardised units), that reflect racial differences, can legitimately be compared across different studies, even when the contrasted groups are not claimed to be perfectly random samples but are otherwise demonstrably comparable samples.

The purpose of the present study is to determine whether the distinctive pattern of Japanese–British differences reported by Lynn & Shigehisa (1991) is found in other Asian–Caucasian comparisons, by comparing Chinese-American and Anglo-American schoolchildren on the same tests used by Lynn & Shigehisa. The present results are also compared with the pattern of differences (based on the same variables) obtained from Hong Kong Chinese and British children by Lynn, Chan & Eysenck (1991).

Method

Subjects

All subjects were pupils in regular education classes in approximately equal numbers from Grades 4 to 6. All schools were predominantly middle-class suburban schools. One school, however, was located in the comparatively poor Chinatown section of a large city, from which nearly all of the Chinese-American sample was drawn. Lynn & Shigehisa's subjects were 9 years of age but in the present study children were tested in three grades (ages 9–11 years) in order to obtain sufficiently large samples from the schools available for testing. Age, however, was controlled statistically in the total combined groups by a multiple regression technique, which removed the linear, quadratic, and cubic components of age variance from all psychometric and chronometric variables prior to the data analyses. There were 585 Anglo-American (AA) children (i.e. white children of European ancestry) with a mean age of 10·93 (SD = 1·09) years, and 167 Chinese-American (CA) children with a mean age of 10·40 (SD = 1·00) years.

The mean Raven SPM score of the AA was 38·8 (SD = 10·2), and of the CA it was 41·9 (SD = 8·37). The standardized CA–AA difference is +0·32 SD units (equivalent to about 5 IQ points), which is statistically significant ($t = 3{\cdot}59$, $p < 0{\cdot}001$). Although this difference is approximately half the Japanese–British difference reported by Lynn & Shigehisa, the average socioeconomic level of the CA was below that of the AA. Despite their lower socioeconomic status the CA scored higher than AA on the SPM, a

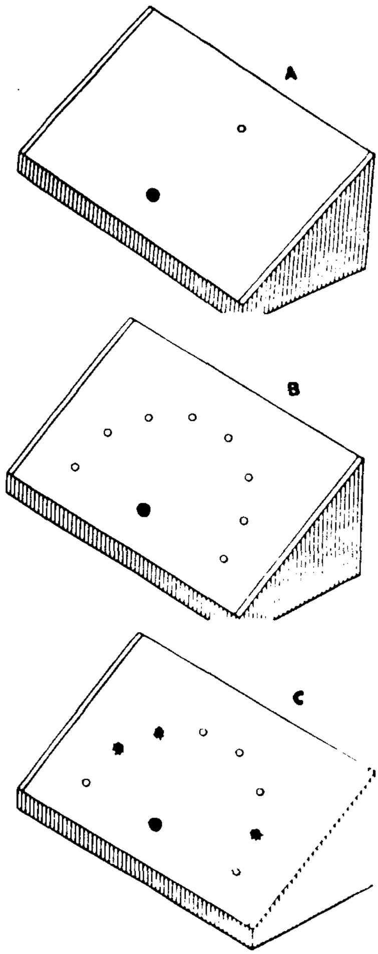

Fig. 1. Response console for simple RT (A), choice RT (B), and odd-man-out RT (C). The black dot in the lower centre of each panel is the 'home' button. The open circles, 15 cm from the home button, are green under-lighted push buttons. In A and B, only one green button lights up on each trial; on C, three buttons light up simultaneously, with unequal distances between them, the remotest from the other two being the odd-man-out which the subject must touch.

60-item multiple choice nonverbal paper-and-pencil test of reasoning based on figural patterns. The test was administered to intact classes, with a 45-minute time limit.

RT apparatus and procedures

Both the apparatus and procedures were virtually identical in every way to those used by Lynn & Shigehisa. The tests for simple RT, choice RT and odd-man-out discrimination RT were administered individually in that order for all subjects, with the testing procedure described by Lynn & Shigehisa; the response consoles are shown in Fig. 1.

Four variables were obtained from each chronometric task: RT is the interval (in ms) between onset of the stimulus and the subject's lifting his/her finger from the home button (measured as median RT over all trials); movement time (MT) is the interval between lifting the finger from the home button and pressing the lighted stimulus button, a movement of 6 inches (measured as median MT over all trials); RT-SD is a measure of the variability of the subject's RT from trial to trial, calculated as the SD of the subject's RTs over all trials; standard deviation of movement time (MT-SD) is analogous to RT-SD, as a measure of intraindividual variability in MT.

Total errors (not reported by Lynn & Shigehisa (1991) and Lynn *et al.*, 1991) is the number of wrong button presses plus the number of trials on which RT < 170 ms or > 999 ms. These off-limit trials, which are flukes for normal children in Grades 4 to 6, were recycled, so that every subject's median RT was based on the same number of trials with RT between 170 ms and 1000 ms.

Results

To facilitate direct comparison, the data analyses presented in Tables 1 to 4 correspond to Tables 1 to 4 on Lynn & Shigehisa's study of British (B) and Japanese (J) children; they are also analogous to the four tables (with Tables 1 and 2 interchanged) in Lynn *et al.*'s (1991) study comparing British and Hong Kong Chinese (HK) children. Hence, three studies of Caucasian–Asian differences can be compared on the same set of chronometric variables.

Table 1 shows the mean and SD of each of the chronometric variables for the AA and CA groups, and the standardised difference (AA–CA) on each variable, which is the mean difference divided by the average within-group SD. Most of the differences are statistically significant. The overall difference between the AA and CA groups on all fourteen chronometric variables and errors tested by multivariate analysis of variance yields a first canonical variable that is highly significant [$F(15,736) = 15.77$, $p < 0.0001$], showing that this battery of chronometric tests as a whole discriminates reliably between the two groups. But the average AA–CA difference for just the RT measures (i.e. the mean of simple, choice, and odd-man-out RT) is not significant (−0·07). This is discrepant from the analogous differences from B–J and B–HK. There are also discrepancies between the averages of the other chronometric variables when averaged over the three tasks:

	AA–CA	B–J	B–HK
RT	−0·07	+0·50	+0·55
MT	−0·31	+0·35	−0·28
RT-SD	−0·42	−0·45	−0·07
MT-SD	+0·26	−0·38	−0·48

The degree of similarity between studies in the pattern of these differences can be indexed by the Pearson correlation (r) and the Spearman rank-order correlation (r_s). Both coefficients are independently informative as descriptive statistics. For (AA–CA) × (B–J), $r = -0.12$, $r_s = 0.40$; for (AA–CA) × (B–HK), $r = -0.22$, $r_s = 0.14$; for (B–J) × (B–HK), $r = 0.60$, $r_s = 0.40$. Thus the pattern of Caucasian–Asian differences on this set of chronometric variables is not consistent across the various samples

Table 1. Means and SDs of Chinese-American (CA) and Anglo-American (AA) children on reaction time parameters, and AA–CA differences in SD units

Reaction times	CA Mean	CA SD	AA Mean	AA SD	AA–CA difference
Simple reaction	373·5	80·1	347·4	60·7	−0·40***
Simple movement	321·7	102·1	295·0	90·0	−0·29**
Simple reaction—SD	103·6	76·0	84·4	55·5	−0·32***
Simple movement—SD	90·7	49·8	93·1	61·8	0·04
Choice reaction	438·1	70·2	439·2	73·4	0·01
Choice movement	324·9	94·8	309·5	81·7	−0·18
Choice reaction—SD	135·2	78·0	95·6	48·8	−0·70***
Choice movement—SD	80·7	35·5	97·3	52·5	0·34***
OMO† reaction	691·1	181·0	717·2	151·9	0·16
OMO movement	410·7	126·7	360·3	108·1	−0·45***
OMO reaction—SD	198·1	86·8	179·1	76·5	−0·24**
OMO movement—SD	146·7	46·4	177·8	83·9	0·40***
Choice-simple RT	64·6	53·9	91·9	54·5	0·50***
OMO-simple RT	317·7	159·8	369·9	138·7	0·36***

*, **, ***: Significant at the 5%, 1% and 0·1% levels.
†Odd-man-out (in all Tables).

of Asians and Caucasians. The correlations between groups for the whole column vector of fourteen variables are: for (AA–CA) × (B–J), $r = -0{\cdot}19$, $r_s = 0{\cdot}27$; for (AA–CA) × (B–HK), $r = 0{\cdot}32$, $r_s = 0{\cdot}16$; for (B–J) × (B–HK), $r = 0{\cdot}49$, $r_s = 0{\cdot}69$. The much higher correlations between the two studies by Lynn and his co-workers may be attributable in part to the fact that the British sample is identical in both studies. The overall resemblance between the patterns of Caucasian–Asian differences in the three studies is tenuous.

The slower RTs of the CA than of the AA in the present study could be partly attributable to the CA sacrificing speed for accuracy of response. The CA had slightly but significantly ($p < 0{\cdot}05$) lower errors rates than the AA in the Simple RT task, on which they also had significantly ($p < 0{\cdot}001$) slower RT than the AA group. The percentage of each group showing no errors on each of the three tasks is as follows; the AA–CA difference in error rates was tested by chi-squared.

RT	AA	CA	χ^2	p
Simple	83·1	89·8	4·53	<0·05
Choice	94·7	89·5	5·18	<0·05
Odd-man-out	45·8	45·5	0·01	n.s.

One important feature of the data in Table 1 may be interpreted in the light of other RT studies. Hence it is not merely an *ad hoc* conjecture. The mean MT of the

CAs is consistently slower than that of the AAs on all three tasks. Movement time reflects largely sensory-motor processes rather than a cognitive decision process. And simple RT reflects sensory-motor processes to a much greater extent than does either choice or odd-man-out RT (although the latter probably has a larger sensory component than does choice). Because simple RT contains the same motoric or noncognitive part of choice RT and odd-man-out RT, simple RT can be subtracted from each subject's choice RT and odd-man-out RT, to obtain a measure of decision time (DT), free of the motor component that all RTs have in common. The theoretical rationale for this difference measure has been fully explicated and demonstrated with other RT data (Jensen & Reed, 1990). Difference scores, of course, have lower reliabilities, especially when the elements are highly correlated, as in the present case (see Table 3), and this greatly attenuates the correlation of a difference score with any other variable, such as Raven's SPM. The last two rows of Table 1 show that by subtracting simple RT from both choice RT and odd-man-out RT results in large and significant standardised differences. That is, CA have much faster DT than AA. Multiple analysis of variance of the overall AA–CA difference on both difference scores (i.e. choice–simple RT and odd-man-out–simple RT) yields a highly significant first canonical variate [$F(2,749)=17{\cdot}06$, $p<0{\cdot}0001$]. This result is consistent with the hypothesis that the Chinese are faster in the cognitive processes of information processing (DT), but slower in the motor aspects of response execution (RT–DT and MT). If this interpretation of the data is correct, the highly discrepant result on simple RT between the present study and the two studies by Lynn & Shigehisa and Lynn *et al.* (1991) is especially puzzling.

The surprising negative Caucasian–Asian differences in RT-SD, noted in both the Lynn & Shigehisa and Lynn *et al.* studies, were replicated consistently on all three tasks in the present study. Hence the negative difference (i.e. Asians having greater intraindividual variability in RT) can hardly be regarded as a fluke. This is especially puzzling because lower intraindividual variability has been found to be associated with higher psychometric *g* in numerous studies (Jensen, 1993a), as it is for individual differences within both the Asian and the Caucasian groups in this study and in Lynn's two studies. However, it has been shown (Jensen, 1993a) that RT and RT-SD both comprise unique components that are independently correlated (negatively) with *g* at the level of individual differences. With respect to the Caucasian–Asian difference (but not individual differences within racial groups), the findings seem consistent with the hypothesis that the component unique to RT is negatively correlated with *g* and the component unique to RT-SD is positively correlated with *g*. Because of the large component of variance that is common to both RT and RT-SD, their intercorrelation within groups is positive, and their within group correlations with Raven's SPM are consistently negative.

Table 2 shows the correlations of each of the chronometric variables with Raven's SPM. If SPM is regarded as a good measure of the *g* factor, then these correlations are roughly equivalent to the *g* loadings of the chronometric variables. It can then be asked, does the column vector of loadings (i.e. correlations with SPM) represent the same factor in the CA and AA groups. The coefficient of congruence (r_c) (Harman, 1976) is the most appropriate index of similarity between the two vectors. Values of $r_c>0{\cdot}90$ are generally interpreted as indicating that the factor is the same in both

Table 2. Product-moment correlations of reaction time parameters with Standard Progressive Matrices in Chinese-American and Anglo-American children†

	Correlations with progressive matrices	
Reaction times	CA	AA
Simple reaction	−19*	−07
Simple movement	−16*	−02
Simple reaction-SD	−20**	−19***
Simple movement-SD	−16*	−13**
Choice reaction	−13	−15***
Choice movement	−13	−06
Choice reaction-SD	−23**	−25***
Choice movement-SD	−12	−15
OMO reaction	−21**	−27***
OMO movement	−16*	−09
OMO reaction-SD	−17*	−24***
OMO movement-SD	−21**	−19***
Choice-simple RT	+11	−12**
OMO-simple RT	−14	−27***

Significance: as Table 1.
†Decimal points omitted.

groups; values between 0·80 and 0·90 indicate similarity, but not identity; values below 0·80 cannot be regarded as the same factor. For Table 2, the value of $r_c = 0{\cdot}85$. The analogous value in the Lynn & Shigehisa study of British and Japanese is $r_c = 0{\cdot}78$. For the Lynn *et al.* (1991) study of British and Hong Kong Chinese, $r_c = 0{\cdot}83$.

The multiple correlation of all twelve chronometric variables with the SPM is 0·39 for AA and 0·45 for CA; both are significant at $p < 0{\cdot}01$.

Also of interest is the Pearson correlation (r_{12}) between (1) the vector of each of the chronometric variable's correlation with SPM and (2) the vector of Caucasian–Asian standardised differences on each chronometric variable. This correlation, r_{12}, reflects the degree to which the AA–CA difference on the chronometric variables is associated with *g*. Lynn & Shigehisa only used the correlations based on their British group; thus only the correlations based on the AA group are used here. The $r_{12} = -0{\cdot}20$, which is non-significant. (The rank-order correlation is −0·24, NS.) (When the correlations of the CA group are used, the corresponding values are 0·52 and 0·44.) The analogous value of Lynn & Shigehisa's r_{12} (based on only the British correlations) is 0·30 (NS). In Lynn *et al.*, the corresponding value of the rank-order correlation corresponding to r_{12}, but based on the averaged correlations in the British and Hong Kong groups, was −0·86 ($p < 0{\cdot}01$). The analogous rank-order correlation in the present study is 0·01. So when the three studies are compared, there is considerable inconsistency in the degree of correlation between the size of group differences on the various chronometric variables and their correlations with the SPM. Whatever processes are responsible for the overall pattern of differences between Caucasians and Asians on the chronometric variables does not appear to be related to their difference in *g*. The AA–CA difference in the noncognitive, motor component of the chronometric variables may be overriding and obscuring the correlation of the corresponding cognitive, information processing component to psychometric *g*.

Table 3 gives the intercorrelations of the chronometric variables within the AA and CA groups, and can be compared with Table 3 of both Lynn & Shigehisa and Lynn *et al.* It is more informative, however, to compare the correlation structure of these twelve variables across the various Asian and Caucasian groups by means of factor analysis, to determine whether the chronometric variables yield essentially the same factors in all groups.

Table 4 shows the results of a factor analysis of the present data. Only the first three principal components had eigenvalues > 1, and these may therefore be regarded as the most significant components. Only three such components emerged for both groups in the study, as well as in all groups in both of the studies by Lynn and his co-workers. The first principal component represents the most general factor of the correlation matrix. The group factors in the matrix are clearly identified by rotating the principal components by the varimax criterion (Harman, 1976), which yields three orthogonal (uncorrelated) factors (Table 4). These factors are quite clear-cut and easily interpretable. The first factor has its salient loadings on the MT variables, the second factor on RT and RT-SD, and the third factor on MT-SD. Congruence coefficients (last row of Table 4) between the corresponding factors for CA and AA show that these variables have virtually identical factor structures in the two groups; only the MT-SD factor, with a congruence coefficient of 0·88, falls short of virtual identity, although it is clearly similar in both groups.

Because the same number of varimax factors was extracted in the Lynn & Shigehisa and Lynn *et al.* studies, the various groups in all of these studies can be compared on the first principal component and on each of the three varimax factors. Table 5 shows the congruence coefficients between every possible pair of groups on each of the factors. There is a high degree of congruence, or near-identity, between the groups for all of the factors except the third (and smallest) factor, which is inconsistent across groups and, moreover, is rather nondescript or poorly defined in some of the groups. (It is therefore referred to hereafter merely as the 3rd factor, without a descriptive label.) The most robust and nearly identical factors across groups are clearly the first principal component and the MT and RT+RT-SD factors.

Is factor congruence greater within as opposed to across the two racial groups? And how do these intra- and inter-racial congruences compare with the congruence within and across the groups tested in the present study and the groups tested by Lynn and co-workers? To obtain some indication, all the congruence coefficients (from Table 5) in each of these categories were averaged separately for each factor. The average of the congruence coefficients within each of these categories can be compared with the overall average congruence coefficient in the total matrix (Table 6). No suitable significance tests can be applied here, but simple inspection suggests that the factors are just as congruous across the different racial groups as within the same racial groups.

Table 3. Correlation matrix of twelve reaction time parameters† in Chinese-American (bottom left diagonal) and Anglo-American (top right diagonal) children

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1. Simple RT	—	36	47	−02	69	31	34	−06	41	26	17	−03
2. Simple MT	61	—	13	−15	21	83	11	−19	09	67	−10	−18
3. Simple RT-SD	52	30	—	03	41	09	39	−01	36	07	23	04
4. Simple MT-SD	07	02	31	—	03	−16	05	37	02	−13	07	29
5. Choice RT	75	47	48	08	—	24	52	−00	68	15	37	−02
6. Choice MT	57	90	33	−01	50	—	15	−18	14	84	−05	−16
7. Choice RT-SD	54	23	42	22	58	22	—	03	49	18	42	17
8. Choice MT-SD	14	03	27	34	08	−01	25	—	06	−16	08	33
9. OMO RT	47	28	29	04	64	28	35	18	—	05	60	05
10. OMO MT	50	78	30	05	36	85	22	−03	12	—	−01	01
11. OMO RT-SD	43	29	34	13	55	30	41	18	75	18	—	34
12. OMO MT-SD	−14	−20	07	37	−17	−23	02	17	−13	−04	10	—

†Decimal points omitted.

Table 4. Factor analysis of reaction time parameters in Chinese-American (CA) and Anglo-American (AA) samples†

	First *principal* component		Varimax factors					
			MT		RT+RT-SD		MT-SD	
Reaction time	CA	AA	CA	AA	CA	AA	CA	AA
Simple RT	85	74	56	32	63	67	07	−13
Simple MT	77	59	90	88	23	10	−07	−17
Simple RT-SD	61	55	34	04	46	63	45	−05
Simple MT-SD	16	−08	04	−07	06	01	80	69
Choice RT	83	79	37	15	80	85	−01	−06
Choice MT	78	63	92	94	22	11	−10	−13
Choice RT-SD	61	63	17	11	63	70	30	15
Choice MT-SD	20	−11	−07	−11	24	00	60	72
OMO RT	64	68	03	−01	86	83	−08	04
OMO MT	67	55	93	91	05	06	04	01
OMO RT-SD	65	43	08	−14	81	64	05	30
OMO MT-SD	−15	00	−12	−04	20	09	69	76
% Variance	39	30	27	27	26	22	15	15
Congruence coefficient	0·97		0·96		0·96		0·88	

†Decimal points omitted.

The factors appear only slightly more congruous within studies (this versus Lynn & co-workers) than across studies, with the exception of the RT+RT-SD factor, which is slightly more congruent across studies than within studies. But there is very little variation among any of the congruence coefficients for the RT+RT-SD factor, which clearly emerges as the most stable of all the factors, being highly congruous among all five groups.

Discussion and conclusions

Jensen (1988) spelled out the rationale and methodology for applying the techniques of mental chronometry to the study of cross-cultural and population differences in mental abilities. The critical variable measured with chronometric techniques is the speed of information processing in a variety of elementary cognitive tasks (ECTs). Such tasks are so simple and lacking in intellectual content that they required minimal instructions and practice trials to be performed virtually error-free by all persons without sensory-motor impairments. Hence, the only reliable variance is latency of response. It would have been naive to expect that using these ostensibly simple techniques to study racial/cultural differences would yield simple results.

This study allows identification of the consistencies and inconsistencies across the three studies. No overall index of similarity between the studies is feasible; the results are multifaceted and each facet must be considered separately.

Table 5. Congruence coefficients† between factors extracted from 12 reaction time variables in Anglo-American (AA), British (B), Chinese-American (CA), Hong Kong Chinese (HK) and Japanese (J) groups

Factor		Sample B	CA	HK	J
1st Principal component	AA	862	971	832	859
	B		918	943	970
	CA			913	930
	HK				994
Movement factor	AA	913	957	882	795
	B		882	951	900
	CA			879	797
	HK				958
Reaction time and RT-SD factor	AA	947	963	936	880
	B		962	979	856
	CA			962	928
	HK				906
Third factor (nondescript)	AA	668	878	511	−009
	B		807	902	469
	CA			739	291
	HK				682

†Decimal points omitted.

Table 6. Mean of congruence coefficients (from Table 5) for each factor and mean coefficients within the same racial groups and across different racial groups, and within and across Lynn and Jensen studies

	1st principal component	Varimax factors MT	RT+RT-SD	3rd
Total matrix	0·919	0·892	0·932	0·594
Within race groups	0·925	0·887	0·936	0·595
Across race groups	0·915	0·895	0·929	0·593
Within studies	0·970	0·941	0·926	0·733
Across studies	0·886	0·858	0·932	0·501

Consistencies between the studies

1. Asians scored significantly higher than Caucasians on Raven's SPM.

2. The covariance structure of the chronometric variables is quite similar across all groups and factor analysis yields three highly similar factors in all groups: (i) a large general factor that could be labeled speed and efficiency of performance; (ii) movement time; (iii) reaction time and intraindividual variability in RT.

3. All of the chronometric variables (response latency and its intraindividual variability) are negatively correlated with the SPM. The RT and RT-SD variables usually have larger correlations with SPM than MT and MT-SD.

4. There were highly significant differences, overall, between the Caucasian and Asian groups on the chronometric variables. The overall null hypothesis of no differences between the Asian and Caucasian groups on this set of chronometric variables can be rejected with a very high level of confidence ($p<0{\cdot}001$) in each of the studies. The basis of these differences is not understood. As the ECTs used to obtain the chronometric variables ostensibly involve no cultural or educational content, but tap relatively simple processes, it is difficult to suggest a purely experiential basis for the significant group differences. This seems especially true in the case of intraindividual variability in reaction time (RT-SD), which is not a measure of speed or 'goodness' of performance, and subjects have no awareness that RT-SD is a part of the task or is being measured. Yet RT-SD shows probably the most striking Asian–Caucasian difference. Thus the conjecture by Lynn & Shigehisa that the group differences on these chronometric variables may be explicable in terms of neurological differences does not seem too unlikely.

5. As mentioned above, the most striking consistency between all three studies is the Asian–Caucasian difference in RT-SD. The Asian groups consistently show a larger RT-SD (i.e. greater intraindividual variability in RT) than the Caucasian groups on every task. This is surprising and especially puzzling, because larger RT-SD is probably more strongly associated with lower psychometric intelligence, or *g*, than any other chronometric variable, as shown in many other studies (Jensen, 1993a) as well as within each of the Caucasian and Asian groups in the three studies under discussion. No explanation for this seemingly paradoxical finding can be offered at present, but there can be little doubt that it is an authentic phenomenon.

Inconsistencies between the studies

1. The Chinese-Americans have generally longer RTs and MTs than the Anglo-Americans, although the opposite difference would be expected on the basis of these variables' correlations with the SPM and the fact that the CA score higher on the SPM than the AA. In Lynn & Shigehisa's study however, the Japanese have shorter RTs and MTs than the British; and in Lynn *et al.* the Hong Kong Chinese have shorter RTs but longer MTs than the British.

2. The overall pattern of Caucasian–Asian differences on the whole set of twelve chronometric variables shows much less consistency across the studies than would have been expected.

3. The degree to which the SPM was correlated with each of the chronometric variables afforded only a weak, nonsignificant prediction of the size of the AA–CA

differences on each of the twelve chronometric variables; and this was also the case for Lynn & Shigehisa's British–Japanese differences. But in the Lynn *et al.* study, the size of the British–Hong Kong Chinese differences on the chronometric variables was highly predictable (with a rank order correlation of $-0{\cdot}86$, $p<0{\cdot}01$) from the variables' correlations with the SPM.

These salient inconsistencies between the studies can hardly be dismissed as statistical flukes, but as yet there is no theoretically coherent explanation for them. It must be acknowledged that these significant inconsistencies of the chronometric data across the Chinese and Japanese groups make a racial–biological interpretation of the findings much more problematic than would otherwise be the case. One confounding factor seems evident—the motor aspect of responding, which is generally slower in both of the Chinese groups than in the Caucasian groups. But this is not the case for the Japanese. This motor factor that apparently suppresses Chinese performance is manifested mostly in MT but to some degree also in RT, particularly simple RT, which has a relatively small cognitive component compared to choice RT and odd-man-out RT. In both Chinese groups, when simple RT is subtracted out of choice and odd-man-out RT, thereby removing the motor component and leaving only the cognitive processing component, the Chinese–Caucasian differences on these residual components were consistently much larger and in the direction predicted by the SPM difference between the groups.

But probably the most striking and puzzling finding is the greater intraindividual variability of RT in the CA than in the AA despite the negative r between RT-SD and SPM within both groups. It is undoubtedly a real phenomenon. It is consistent with the theory that psychometric *g* does not reflect some unitary neurological variable, but rather reflects the net effect of some limited number of different information processes that are brought to bear on a cognitive task. Although *g* appears unitary in factor analyses at the level of complex psychometric tests, it does not seem to be unitary at the level of elementary cognitive processes (Kranzler & Jensen, 1991). The composition of *g* in different racial/cultural groups (and in males and females) may consist of different mixes of variance contributed by these various elemental processes. Racial/cultural differences in psychometric *g* can be analysed with the techniques of mental chronometry in much the same way that many researchers in recent years have been analysing individual differences in *g* (reviews in Eysenck, 1982; Jensen, 1986; Vernon, 1987). Only two studies (other than those referenced here) have used comparable chronometric methods in the study of racial/cultural differences in *g* (Jensen, 1993b; Lynn & Holmshaw, 1990).

The present study, which replicates and expands on the work of Lynn and his co-workers, highlights some of the complications, surprises, and puzzles. Unexpected inconsistencies remain to be clarified about the nature of Caucasian–Asian differences in this domain.

References

Eysenck, H. J. (Ed.) (1982) *A Model for Intelligence*. Springer-Verlag, Heidelberg.

Harman, H. H. (1976) *Modern Factor Analysis*, 3rd edn. University of Chicago Press. Chicago, Illinois.

JENSEN, A. R. (1986) Methodological and statistical techniques for the chronometric study of mental abilities. In: *Methodological and Statistical Advances in the Study of Individual Differences*. Edited by C. R. Reynolds & V. L. Willson. Plenum, New York.

JENSEN, A. R. (1988) Speed of information processing and population differences. In: *Human Abilities in Cultural Context*. Edited by S. H. Irvine & J. W. Berry. Cambridge University Press, Cambridge.

JENSEN, A. R. (1993a) The importance of intraindividual variation in reaction time. *Person. indiv. Diff.* **13,** 869.

JENSEN, A. R. (1993b) Spearman's hypothesis tested with chronometric information-processing tasks. *Intelligence*, **17,** 47.

JENSEN, A. R. & REED, T. E. (1990) Simple reaction time as a suppressor variable in the chronometric study of intelligence. *Intelligence*, **14,** 375.

KRANZLER, J. H. & JENSEN, A. R. (1991) The nature of psychometric *g*: unitary process or a number of independent processes? *Intelligence*, **15,** 397.

LYNN, R., CHAN, J. W. C. & EYSENCK, H. J. (1991) Reaction times and intelligence in Chinese and British children. *Perc. motor Skills*, **72,** 443.

LYNN, R. & HOLMSHAW, M. (1990) Black–white differences in reaction times and intelligence. *Soc. Behav. Pers.* **18,** 299.

LYNN, R. & SHIGEHISA, T. (1991) Reaction times and intelligence: a comparison of Japanese and British children. *J. biosoc. Sci.* **23,** 409.

VERNON, P. A. (Ed.) (1987) *Speed of Information Processing and Intelligence*. Ablex, Norwood, NJ.

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