Relationship Between Environmental Factors and Cognitive Functioning Among Chinese Adults

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INTRODUCTION

Over the past thirty years, a substantial number of cross-cultural studies have investigated ethnic-related differences in intelligence. Cross-cultural differences in cognitive performance have received various interpretations. From a hereditarian's perspective, the differences may be explained in terms of inherited intellectual abilities, without the implication that one is superior or inferior (Dasen, 1977). In contrast, environmentalists seek to explain the differences by attributing cultural deficit or inadequate socialization experiences to the lower scoring groups (Sternberg & Subin, 1986). Such alternative interpretations are interesting and certainly have challenged cognitive developmental theorists to examine these issues more intensely. As the number of possible patterns of similarity and difference is growing, cross-cultural psychologists have focused on analyzing contextual effects to account for their results. That is, they have proposed that studies investigating intelligence should be measured within context.

Researchers have long recognized environment or context as an active agent in accounting for individual differences in cognition and development. Labouvie-Vief and Chandler (1978), Gribbin, Schaie, and Parham (1980) and others have called for a "contextualist" theoretical framework. With a focus on cognitive development, these investigators have been especially interested in analyzing the contribution of environment. They have focused on the complex contextual variables that affect the maintenance of adult cognitive performance.

A number of researchers have taken a global approach to examining the relationship of certain aspects of the environment to various outcome measures. For example, macro variables such as social class and socio-historical context are identified as possible predictors of cognitive performance. Some cultural values and sociocultural experiences function to accelerate or constrain intellectual behavior (Seymour & Miller-Jones, 1981). Moreover, the influence of numerous environmental factors on cognitive competencies has also been investigated on a micro-level. It has been demonstrated that higher scores on intelligence tests were associated with higher incomes, larger households and social network (Lehr & Olbrich, 1976). In addition, contextual variables such as parental education, occupational status of parents, subject's education, and home environment were found to predict levels of cognitive performance (O'Hanlon, 1993).

Although many studies have examined cross-cultural aspects of intellectual behavior, there has been little reference to the physical, social, and economic context within which the participants live, work, or study. Therefore, past research has not sufficiently developed an ethnic-cultural ecology that describes experiences of ethnic individuals in context. There is a need for cross-cultural studies in supplementing Western theories of environmental factors and their interaction with cognitive abilities

The design of the present study was based on the model of the Seattle Longitudinal Study (SLS, Schaie, 1996). The objectives of this study were to examine: (1) differences in mean levels of cognitive abilities in Chinese adults over the age span of 20 to 80 years; (2) cohort and gender differences among environmental factors; (3) the relationship of environmental factors to level of cognitive performance. Data on the relationship between the primary mental abilities and contextual variables are reported here.

METHOD

Sample

Subjects for the China PMA Study included 121 Chinese adults (56 women and 65 men) aged 20 to 80 years selected from Tianjin, a large metropolitan area in China. The pool of potential subjects was stratified by education and 10 year age intervals. Approximately 20 subjects were then randomly selected from each stratum. A total of six age-cohorts were analyzed for this study (See Table 1 for a detailed breakdown of cell sizes).

Measures

Intelligence measure. The five tests used to measure mental abilities of the Chinese subjects were Inductive Reasoning, Number, Space, Verbal Meaning and Word Fluency (Thurstone, 1958). The Verbal Meaning test measures the ability to recognize and comprehend words. This test was adapted to the Chinese language by choosing words of varying difficulty level from their middle-school dictionary. In the adaptation of the Word Fluency test the lexical rule was modified. Instead of generating words starting with the same letter, here the subjects were asked to generate multiple Chinese words/characters that start with a

common radical ([illegible]). This test measures a person's active vocabulary and the fluency with which words are retrieved from long term memory using the lexical rule. Inductive Reasoning refers to the ability to identify regularities and to infer principles or rules. This ability was assessed by performance on a Number Series test involving deduction of a rule in a series of numbers in order to pick the next number. The tests for Numerical and Spatial abilities did not require much modification. The Number test required the subject to add and subtract to verify if the solution provided on the test items was correct. Finally, on the Space test the subjects had to compare each abstract figure provided to them with multiple responses and select the figures which would match the stimulus figure on mental rotation. These five Mental abilities were measured under speeded conditions.

Environmental measure. The Life Complexity Inventory (LCI; Gribbin et al., 1980) used in the Seattle Longitudinal Study was adapted to obtain comprehensive information on variables that make up the micro-environment of the adults in the Chinese sample. This instrument examines a broad range of adult activities and interests and includes data on interpersonal, work, social, structural, and cultural aspects of the participants' environment. These variables include basic demographic information, home environment questions, characteristics of the work or homemaking environment, neighborhood composition, travel, mobility, reading activities, continued educational pursuits and social network data (see Schaie, 1996, for greater detail). The LCI includes data on frequency of leisure activities based on the work of Lowenthal and associates (Lowenthal et. al., 1975).

The instructions for these measures were translated using bilingual Chinese translators, and the Chinese testers were trained to administer the inventory following the same protocol as used in the Seattle Longitudinal Study (SLS).

SLS data was examined to develop environmental and leisure dimensions that summarize the Life Complexity Inventory (O'Hanlon, 1993). To define dimensions, the total sample was randomly split into two halves (n_1=688, n_2=688) to provide a derivation sample and a verification sample to test replicability of solution found within the sample. Exploratory factor analyses and model development were conducted using the first half of the sample. The resulting factor structure was cross-validated on the second sample using confirmatory factor analyses.

Seven factors emerged that represent micro-environment dimensions. The factors were labeled: a) Work characteristics; b) Social Status; c) Prestige; d) Physical Environment; e) Social Network; f) Mobility; g) Intellectual Environment. (Table 2 lists items defining these dimensions). Together these seven factors provided a broad characterization of the micro-environments of the respondents. In addition, six leisure factors were developed from the list of leisure activities in the LCI. These factors were labeled: a) Household; b) Social; c) Educational/Cultural; d) Fitness; e) Solitary; f) Communication. (Table 3 lists items defining these domains).

RESULTS

Cohort and Gender Differences Regarding Cognitive Abilities

Raw scores of each ability obtained within the sample was standardized into T-Scores (M=50, SD=10) based on the sample means and standard deviations. Since the five Primary Mental abilities are known to be moderately correlated, Multivariate Analysis of Variance (MANOVA) was used for our analyses. The five Mental abilities were the dependent variables, and cohort, gender, and all interactions between them were the independent variables. A significant multivariate main effect was obtained for birth cohort ($p<.001$; Wilk's Lambda criterion). Subjects in cohort 1, 2, and 3 (50, 60, and 70 year old persons) performed significantly lower than the younger three cohorts. Closer examination of univariate analyses for each ability revealed significant cohort differences for all abilities. On four of the five abilities (Verbal ($p<.001$), Reasoning ($p<.001$), Numerical ($p<.001$), and Spatial ($p<.001$) abilities), the cohorts between 50-70 years performed significantly lower than the younger cohorts on an average . On each of these abilities, it was also noted that the oldest cohort (71-80 years) performed unusually well (See Figure 1). Significant main effect of gender was only found on the Spatial ability with men obtaining a higher average performance ($F(1,109)=4.01$), $p<.05$).

Derivation of Chinese Environment and Leisure Factors

Factor solutions obtained from the LCI in the SLS sample were used to compare patterns of age and gender differences in micro-environment dimensions and levels of leisure participation in the Chinese sample. To permit comparison across the various micro-environment dimensions, raw scores of items were standardized into T-Score form (M=50, SD=10) based on the total sample means and standard deviations. Then a linear combination of T-scores was calculated for other factor scores. Multivariate Analyses of Variance (MANOVA) were used. The model represented the eight environmental dimensions and the six leisure dimensions as dependent variables. Cohort, gender and all interactions between them were the independent variables.

Cohort and gender differences in environmental dimensions. A 2 (sex) by 6 (cohort) MANOVA was run with the seven environmental dimensions as the dependent variables. The combined dependent variables were statistically significant for cohort ($p<.05$; Wilk's Lambda criterion), but not for sex or for the sex by cohort interaction. Given the significant overall MANOVA, differences among cohorts were investigated. Univariate analyses for each of the seven factors were examined.

Significant cohort differences were found for all factors except for the Prestige, Physical Environment, and Social factors. On the Status factor, the middle-aged cohorts (aged 41-70 years) had significantly higher means than the two youngest cohorts ($F(5,109)=3.45, p<.01$). Younger cohorts (20-50 years) were higher on Mobility ($F(5,109)=2.77, p<.05$), while older cohorts (ages 61-80) were higher on the Work factor ($F(5,109)=9.24, p<.001$). Regarding the Intellectual Environment factor, the youngest cohort (ages 20-30) had significantly higher means than the other five older groups (ages 31-80; $F(5,109)=5.96, p<.001$). In summary, the

older cohorts had higher scores on the Status and Work domains but the younger cohorts had higher scores on Mobility and Intellectual Environment. (See Fig. 2).

Cohort and gender differences in leisure activities. Significant main effects occurred for sex ($p<.01$), cohort ($p<.01$), and the sex by cohort interaction ($p<.05$). Univariate analyses for each of the six factors were examined. Significant sex differences were evident for all of the factors except the Social and Education/Culture factors. The women were found to engage more in activities related to Household ($F(1,109)=20.01, p<.001$), Solitary ($F(1,109)=11.06, p<.001$), and Communication factors ($F(1,109)=16.80, p<.05$; See Fig.3), while men involved more in participant sports and outdoor hobbies which fall under the Fitness factor ($p<.001$).

Cohort differences were significant for Education/Culture and Communication factors. The youngest cohort (20-30 years old) were more involved in educational and cultural activities than cohorts 1-4 ($F(5,109)=3.67, p<.05$; Fig. 4). They also participated more in activities related to the Communication domain (e.g., daydreaming, reminiscing, and writing) than cohorts 2 and 5 ($F(5,109)=2.46, p<.05$).

Environmental dimensions and cognitive performance. The relationship among the environmental factors and the PMA ability scores was examined. These ability measures included the five tests: Verbal, Space, Reasoning, Number, and Word Fluency (see Table 4). Positive correlations suggest that a high score on a given environmental factor is associated with higher ability. Of the seven dimensions, only the Intellectual Environment factor was positively associated with all ability scores with correlations ranging from r = .20 to .32. This finding is expected since this factor appears to measure aspects of the environment (e.g., number of books and art objects in home, number of educational courses taken, number of magazines read) that are related to cognitive performance. The Prestige factor was positively correlated with only the Verbal ability ($p<.05$). Although the Work factor revealed a pattern of negative correlations with all ability scores, this relationship was significant for the Word Fluency ($p<.01$), Inductive Reasoning ($p<.05$), and Number abilities ($p<.01$). A pattern of negative correlations was also detected for the Physical Environment and Social factors, but was significant only for the Number ($p<.05$), and Verbal and Word Fluency abilities ($p<.05$), respectively.

Activity dimensions and cognitive functioning. The activity levels were also correlated with the PMA ability scores. These activity dimensions were: Fitness, Education/Culture, Social, Communication, Solitary, and Household (see Table 5). However, only Fitness was found to have a statistically significant negative correlation with the Word Fluency ability ($p<.05$) and Education/Culture was positively correlated with Verbal ($p<.05$).

These results allow the inference that environmental factors may without doubt impact the individual's cognitive performance. Whereas positive correlations may be interpreted that particular factors (e.g., Intellectual, Prestige, and Education/Culture) enrich cognitive competence, negative correlations (e.g., Work and

Physical Environment) are associated with less flexibility in intellectual functioning.

DISCUSSION

The current study examined an empirical taxonomy of the environment of males, females, and birth cohorts in a Chinese sample. In addition, it attempted to seek an understanding of intellectual behavior that are inextricably embedded in contextually meaningful situations. In sum, the study showed that older subjects on an average performed lower on all the Primary Mental Ability tests. For all abilities the average performance of the 20-30 year olds was significantly higher than for those above 60 years. On all abilities except Word Fluency, performance level was noted to be significantly lower after 50 years. However, the 71-80 year olds performed surprisingly well on all these abilities. This could be because a very select sample of well functioning elderly survived the historical turmoil of the Cultural revolution in China, or that the quality of their education was different even if they did not differ in the number of years of schooling from the younger cohorts.

Seven dimensions of the environment that were labeled Prestige, Status, Leisure, Physical Environment, Mobility, Intellectual Environment, Social Network, and Work Environment were analyzed. For the Mobility, Work, and Leisure factors, significant differences existed primarily between the youngest and oldest cohorts. The six leisure factors developed from the list of leisure activities were Household, Social, Education/Culture, Fitness, Solitary, and Communication. In general, the significant differences reflected higher levels of leisure participation for younger cohorts than older cohorts. Notably, significant cohort differences were present only between the oldest cohorts and the youngest cohorts. This finding suggests that age differences in leisure participation are not evident except at the extremes of the lifespan.

Regarding gender differences, the present study found that women had higher participation on Household, Solitary, and Communication activities than men. Males had significantly higher means than women on the Fitness factor. These results suggest that men and women spend their leisure time pursuing different activities.

Cohort and sex differences varied for each dimension and level of leisure participation. Also noteworthy was the lack of significant gender differences on the micro-environment dimensions. Surprisingly, there was no gender differences on the factors associated with Work, Status, and Prestige. These findings do not reflect the assumption regarding general gender trends in the Chinese society where men are more likely to have higher job status, higher income.

Whereas Intellectual Environment factor was significantly correlated with all PMA scores, the Physical Environment, Social, and Work factors revealed a negative pattern of correlations. Had this been a larger sample, we would expect to find more diversified and interesting correlations as indicated by the marginal p values.

This pilot study offers the possibility to see if and to what

extent hypotheses tested and confirmed on Western samples hold for non-Western cultures. When research is extended in a cross-cultural direction, we are faced with the issue of comparability or equivalent of cross-cultural data (Hui & Triandis, 1985). Therefore, the preliminary results found in this study should be interpreted with caution due to several reasons. The present study was hampered by the lack of a representable taxonomy to describe the environment in a Chinese population. The LCI dimensions analyzed in this study was quantified by factor analytic method using data from the SLS sample. The measurement precision of our measure is limited by the assumption that the dimensions being measured by the Life Complexity Inventory are equivalent in both cultures. This assumption remains to be tested.

The results of these preliminary analyses suggest that cross-cultural researchers need to consider the interplay between intellectual development and environmental factors in order to understand more completely the complexities of cognitive development and performance. It would indeed be very exciting and meaningful to pursue these indicated trends longitudinally and cross-sequentially to provide a clearer understanding of the causal effects of environment on cognitive functioning among ethnic-cultural groups.

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Table 1: Cell Sizes for the Total Sample

Birth Cohorts	Males	Females	Total
1. 1908-1917	6	6	12
2. 1918-1927	13	9	22
3. 1928-1937	14	10	24
4. 1938-1947	12	7	19
5. 1948-1957	9	13	22
6. 1958-1968	11	11	22

Table 2: Variables Defining Micro-Environmental Dimensions

A. *Work*
percentage of work hours spend reading
work status (working vs. not working)
work under time pressure
place where work occurs
people work with

B. *Social Status*
marital status
own home
income
number of rooms in home

C. *Prestige*
level of education
occupational status

D. *Physical Environment*
quality of air in neighborhood
number of trees in neighborhood
noise level in the neighborhood

E. *Social Network*
number of neighbors know well enough to confide in
number of visits to people not in neighborhood

F. *Mobility*
changes in jobs during the last 5 years
changes in households during the last 5 years
changes in professions during the last 5 years

G. *Intellectual Environment*
amount of art objects in home
number of books in home
number of magazines read in last month
number of educational courses taken

Table 3: Variables Defining Leisure Dimensions

A. *Household*

cooking
household chores
shopping

B. *Social*

visiting
social life and parties

C. *Education/Culture*

cultural activities
educational activities

D. *Fitness*

participant sports
outdoor hobbies

E. *Solitary*

solitary games or hobbies
handicrafts

F. *Communication*

daydreaming/reminiscing
writing/corresponding

Table 4: Correlations Between LCI Factors and Cognitive Abilities

LCI Factor	Verbal	Space	Reason	Number	W. Fluency
Prestige	.26**	.02	.05	.05	.16^
Status	.00	-.16	-.04	.03	.06
Intel. Env.	.28**	.20*	.25**	.22*	.19*
Physical Env.	-.16^	-.04	-.08	-.22*	-.10
Social Network	-.21*	-.05	-.05	-.07	-.17*
Work	-.11	-.16^	-.22*	-.23**	-.26**

* p<.05 ** p<.01 ^ trend

Table 5:

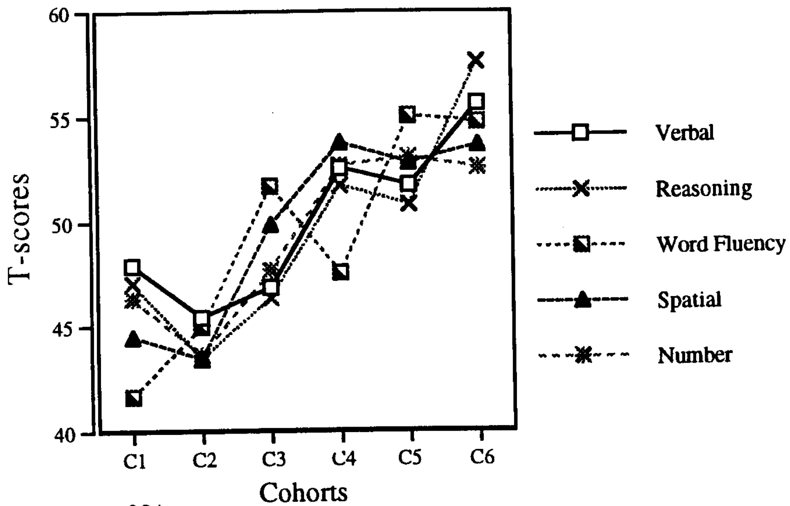
Correlations Between Activity Factors and Cognitive Measures

Activity	Verbal	Space	Reason	Number	W. Fluency
Fitness	.03	.09	.13	-.04	-.18*
Educ/Cult.	.18*	.03	.03	.06	.13
Social	.10	.10	.09	.11	-.03
Communication	-.03	.07	.05	-.06	-.06
Solitary	-.03	-.04	-.08	-.03	.08
Household	-.09	-.01	-.05	-.09	.02

* p<.05

Mean Ability Levels for Cohorts

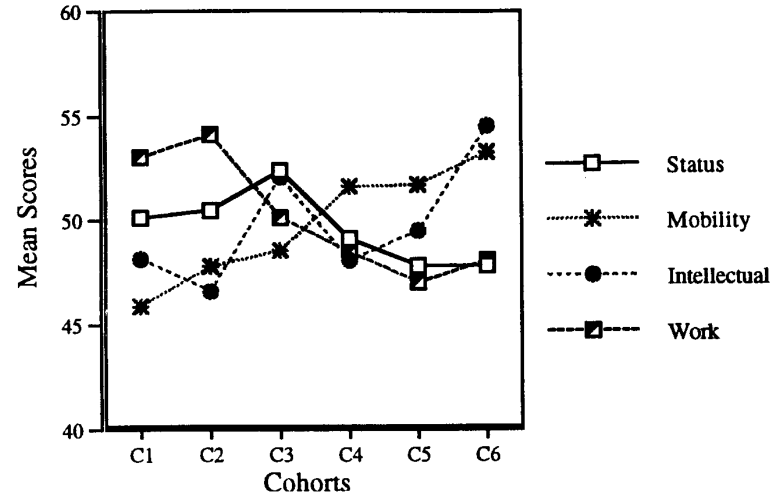
fig.1



p<.001

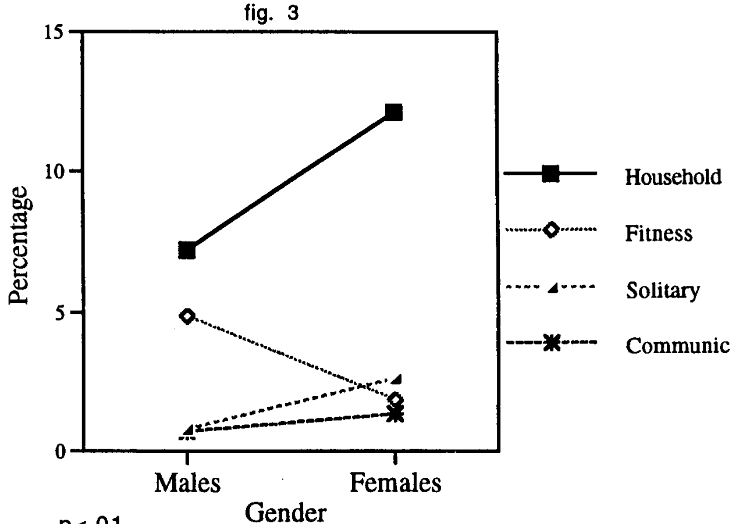
Environmental Dimensions by Cohorts

fig. 2



Leisure Activities by Gender

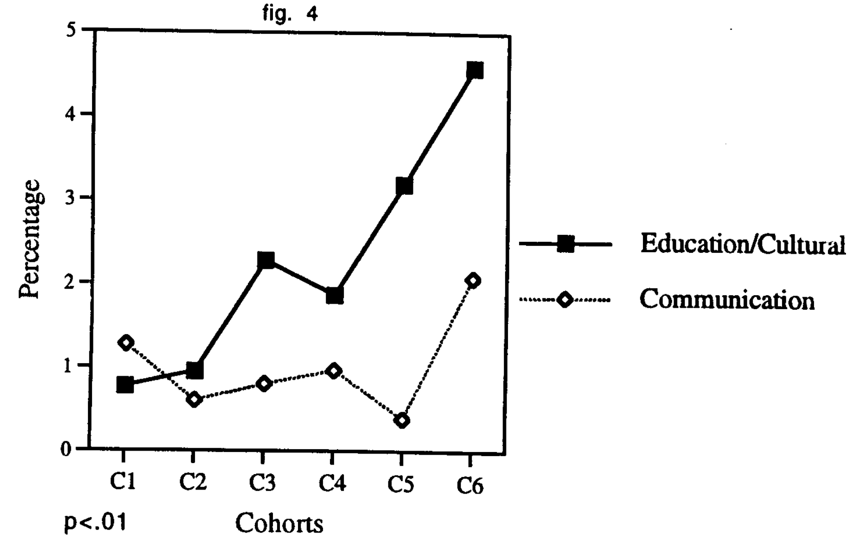
fig. 3



p<.01

Leisure Activities by Cohorts

fig. 4



p<.01