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Development and Learning a Second Language: The Acquisition of Analogical Reasoning

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This study examined the cognitive affect of previous experience in an English language environment overseas on language learning strategies of high-ability bilingual Japanese post-secondary students. Information was collected on male and female students who had scored at least 120 on the English Skills Assessment test batteries (ESA), and from structured interviews. Results suggest that students who were brought-up in Japan and initially exposed to native-like English in elementary level schools overseas were significantly more competent in using analogical reasoning in the acquisition and transfer of second language knowledge than those first exposed to English during early childhood overseas, or during adolescence. Findings may help to explain the pattern of differences in high-ability bilingual students in which some consistently outperform others in second language learning.

A central question in the study of the domain of second language learning is whether maturational constraints regulate the direction of cognitive learning, irrespective of the culture that the child grows up in. Acquisition data now indicate that apart from peripheral variation in word knowledge and receptive vocabulary, the declarative and procedural knowledge of language stored about relations in the world by the bilingual child living in different socially acceptable language communities is largely independent of those linguistic environments. It is now well known that children brought-up bilingual from birth or early childhood have more advanced cognitive flexibility, divergent thinking, linguistic creativity and overall second language performance than monolingual children (Peal & Lambert, 1962; Lambert & Anisfeld, 1969; Lambert, 1980; Oller, 1995; Mundy, 1995). However, the premise that bilingualism is less sensitive to the linguistic environment than it is to learning taking place at the right time makes it imperative to abstract away from the applied or functional concerns of bilingualism inherent in these studies to investigate second language learning as a distinct cognitive system.

The traditional view is that learning is not capacity limited, but as language learning does not appear to be dependent on the impoverished nature of natural linguistic enviroments (Stillings, Weisler, Chase, Feinstein, Garfield, & Rissland, 1995, p. 394), it is highly likely that cognitive development has a biological basis. There is strong support for knowledge acquisition intersecting with critical phases in the maturation of the computational architecture of the nervous system (Chomsky, 1980, 1986, 1988; Changeux and Konishi, 1987; Leuba and Garey, 1988; Purves, 1988; Johnson and Newport, 1989; Chugani and Phelps, 1990; Huttenlocher, 1990; Churchland and Sejnowski, 1992), while being sensitive to cultural

constraints (Ochs and Schiefflin, 1984; Holland, Holyoak, Nisbett, and Thagard, 1986; Pinker, 1989; Harris, 1996).

Limitations in processing capacity have been shown to have a differential effect on learning which is more than the simple acquisition of associations, but also the storing of knowledge about relations in the world, and the acquisition of structural representations and mental models (Churchland, 1989, p.119; Halford, 1995, p. 295-301; Pinker, 1995, pp. 124-128). One mechanism on which such learning is based is analogy, a basic ingredient in standardized tests of intelligence (Sternberg, 1977, 1982, 1985), and an important component in the acquisition and transfer of procedural and declarative knowledge in children (Goswami, 1992), and in creativity (Holyoak and Thagard, 1995). Analogy is a structure-preserving map from a base to target corresponding to the relations between two structures independent of attributes (Gentner, 1983; Gick and Holyoak, 1983, Halford, 1995, p.297). For example, in the analogy, "Petrol provides energy for a car just as sugar provides energy for a human being" (ACER, 1982, p.15), petrol: car is the base and sugar: human being is the target. Analogical transfer enables the learner to predict information, reduces the need for learning, and increases creativity (Halford, 1993, cited by Halford, 1995). Although it is easy to see the fundamental importance of analogical transfer in language acquisition, whether there is a critical period for such learning is not yet clear.

Some indication that processing capacity is important in second language learning has been given by Yeni-Komshian (1995), with the most promising support coming from recent studies on late exposure of the deaf to sign language. Mayberry (1995) provides strong support for the notion of a critical language learning period for deaf children. She found that deaf children brought up in monoglot "sign language" households become as fluent in signing as a hearing child would become fluent in speech. Those deaf children with hearing parents not exposed to signing until a later age are less competent. Mayberry has also investigated children who learn a language in infancy, are subsequently deafened in childhood, and then learn to sign. She found they perform much better than those who learn to sign at a later age with no previous language experience, but they fail to gain perfect fluency. They achieve the fluency of a good second language speaker by demonstrating accentuated and oftentimes amusing, but understandable speech. The group with late exposure to signing and with no previous language experience lacks fluency. Similarly, Newport (1990) studied production and comprehension of ASL (American Sign Language) in congenitally deaf adults at least 50 years of age at time of testing, the only difference being age of first exposure to ASL. The first group consisted of deaf children of deaf parents who had been exposed to ASL from birth. The second consisted of "early learners" who had been initially exposed between ages 4 and 6, and the third, were exposed to ASL after age 12. It was found that after 30 years of exposure, only those who had been initially introduced to ESL before the age of six showed native-like fluency, there were

subtle deficits in the middle-group, and those exposed after age 12 had significant deficits. As with the other studies reported above, what distinguished native-like fluency in ASL learning were difficulties in the ASL equivalents of morpheme production and with the formation of complex sentences.

Newport's study is of particular importance to the present examination of a group of Japanese national bilinguals who, almost by accident, are comparable to the subjects in the acquisition of ASL. This group of university students have had at least 12 months experience living overseas during childhood and/or adolescence, and have been using both Japanese and English as a primary means of communication. Based on research findings of the positive cognitive consequences of acquiring a second language, that analogy is of importance in cognitive development, and the suggestive, but as yet inconclusive findings that second language learning is age dependent, it is an important research question to determine whether the positive cognitive consequences of 'additive' bilingualism are present in 'subtractive' situations (Turner, 1977), and whether there is a relationship between development and this basic mechanism of learning. It is predicted that this group of high-ability bilingual students brought-up in Japan and initially exposed to native-like English in elementary level schools overseas will be significantly more competent in using analogical reasoning and creative strategies in the acquisition and transfer of second language knowledge than those first exposed to English during early childhood overseas, or during adolescence.

Method

Subjects

The subjects comprised university students (N = 440) aged 228 to 240 months who had lived in an English-speaking environment overseas for a minimum period of 12 months. All subjects were voluntarily recruited from the same university, and 11 were subjected to various exclusion criteria for a variety of methodological, administrative and ethical considerations. The sample drawn comprised 51 females and 26 males, all of whom were freshman and sophomore students. 61% of this sample had attended local English-speaking schools overseas, the majority (66%) attending part-time Japanese language schools.

Instruments

The data set was based on information derived from the English Skills Assessment test batteries (ESA) (ACER, 1982a, 1982b, 1982c), and a structured interview (Mundy, 1995a). The ESA multiple aptitude battery measures developmental levels in 27 language categories clustered in the competency areas of Spelling, Punctuation and Capitalization,

Comprehension, Usage, Vocabulary, Sentence Structure and Logical Relationships. It spans rather narrowly defined language skills (e.g., punctuation, spelling), to more complex cognitive skills such as reading comprehension. At the broadest level, the multiple aptitude battery provides a measure of the effects of learning on cognitive development, in particular logical thinking, problem solving, and creativity (ACER, 1982a, p. 1).

Test items in Part I (ESA) were selected from the Sequential Tests of Educational Progress (STEP) Series II, forms 2A and 2B, for grades 10-12 (Educational Testing Service, 1971). Items for Part II were selected from the Descriptive Tests of Language Skills for College Freshmen (Educational Testing Service, 1978). The items used in the current administration were revised for use with Australian students in Years 11 and 12 of secondary school and the first year of post-secondary education (Year 13). The time restrictions for the tests are comparable with those in STEP and DTLP (ACER, 1982a, p.16). The structured interview was designed to collect information on personal histories of overseas and local (Japanese) experience of schooling, and to constitute a factor called 'overseas experience'. This included details of age of first exposure to an English-language environment, length of time spent in that environment, age and length of re-exposure to a monolingual Japanese environment, and type of formal exposure to a second language environment (i.e. type of school attended).

Procedure

The two ESA test batteries of 110 minutes duration each were administered according to instructions on separate days. The structured interview of 25 minutes duration (approx.) was conducted separately and, on the basis of this information, the sample was categorized into three groups according to age of initial exposure to a monolingual English environment. The three groups are referred to as 'early exposure' ($Exp._{early}$), medial exposure' ($Exp._{med}$) and 'late exposure' ($Exp._{late}$) and are defined as,

1. $Exp._{early}$: those living in the structured language learning environment of a monoglot Japanese household with incidental exposure to a monolingual English environment to age 60 months (n = 25),

2. $Exp._{med}$: those living in the structured language learning environment of a monoglot Japanese household with formal exposure to a monolingual English language environment at school from age 61-120 months (n = 27), and

3. $Exp._{late}$: those living in the structured language learning environment of a monoglot Japanese household with formal exposure to a monolingual English language environment at school after the age of 121 months (n = 27).

Results

ESA performance on a reduced data set considered against the factor of 'overseas experience' demonstrated the significance of age of initial exposure to English, rather than length of exposure, or at what age the student re-entered the Japanese schooling system (see Mundy, 1995a, 1995b). Although age of initial exposure had no influence on Inductive Reasoning and Deductive Reasoning, those students (representing roughly 6% of the original cohort) whose initial exposure to a monolingual English environment was during the elementary school years (61-120 months) had significantly higher scores in Analogical Reasoning than children initially exposed during early childhood (0 - 60 months) or adolescents (>121 months) during the high school years.

A principal components analysis was conducted on the 27 item scores of the ESA test batteries. On the basis of the scree test (Cattell, 1966), and interpretations of that test provided by Tucker, Koopman and Linn (1969) for determining the number of factors to retain and the relationship of the factors to those that emerged in a preliminary analysis (Mundy, 1995a), nine factors were extracted from the 27 measures. These factors were rotated with the varimax normalized method which accounted for 39.63% of the total variance in the outcome scores.

Table 1 indicates that the loadings on these nine factors were relatively clean and interpretable. The highest loadings on Analogical Reasoning (Factor 1/AR) were on the student's ability to draw analogies, use appropriate connectives and recognize principles of organization. The highest loadings on Vocabulary and Usage (Factor 2/VU) were on recognition of errors (pronouns) in standard written English and synonym choice. The highest loadings on Deductive Reasoning (Factor 3/DR) were recognition of errors (modifiers, diction and idiom) and the drawing of inferences. The highest loadings on Inductive Reasoning (Factor 4/IR) were on translation and inference, and analysis of a passage. The remaining factors centering on linguistic rules are less easy to interpret meaningfully.

Table 1

Factor Loadings for ESA Outcome Variables

	Factor loadings								
Variables	1	2	3	4	5	6	7	8	9
Log. Relations 1	0.76	-	-	-	-	-	-	-	-
Log. Relations 2	0.69	-	-	-	-	-	-	-	-
Log. Relations 3	0.54	-	-	-	-	-	-	-	-
Vocabulary	-	0.79	-	-	-	-	-	-	-
Usage 1	-	0.76	-	-	-	-	-	-	-
Usage 2	-	-	0.72	-	-	-	-	-	-
Usage 3	-	-	0.71	-	-	-	-	-	-
Comp. 2.(iii)	-	-	0.57	-	-	-	-	-	-

Comp. 1.(ii)	-	-	-	0.83	-	-	-	-	-
Comp. 1.(iii)	-	-	-	0.64	-	-	-	-	-
Punct. & Cap. 4	-	-	-	-	0.79	-	-	-	-
Punct. & Cap. 3	-	-	-	-	0.71	-	-	-	-
Punct. & Cap. 2	-	-	-	-	0.64	-	-	-	-
Sentence Struct. 1	-	-	-	-	-	0.76	-	-	-
Spelling 1	-	-	-	-	-	0.61	-	-	-0.53
Punct. & Cap. 5	-	-	-	-	-	-	0.84	-	-
Sentence Struct. 3	-	-	-	-	-	-	-	0.79	-
Comp. 2.(i)	-	-	-	-	-	-	-	-	0.78

Note. Dashes indicate factor loadings of less than .50.

Overall Affect of 'Overseas Experience' on Learning English

To examine the influence of the factor 'overseas experience' on the response measure, total ESA scores (Table 2), a univariate analysis of variance with one factor at three levels representing the experience of each subject was conducted. There was no significant difference between the groups, $F(2, 76) = 2.32$, $p>.10$. However, the overall null hypothesis of no differences is not the one to test, but rather two hypotheses represented by the contrasts that define no difference between ($Exp._{early}$) and ($Exp._{late}$), and that ($Exp._{med}$) is different from this average. Differences between exposure groups ($Exp._{early}$) and ($Exp._{med}$), and the groups ($Exp._{early}$) and ($Exp._{late}$) were not significant, but the hypothesis that there is no difference between the groups ($Exp._{med}$) and ($Exp._{late}$) was rejected, $F(1, 52) = 4.37$, $p<.05$.

Table 2

Numbers in cells and means on ESA total score[a] for the three levels of 'overseas experience'.

Factor	No. in cell	Mean
Group 1 (early exposure)	25	125.36
Group 2 (medial exposure)	27	132.56
Group 3 (late exposure)	27	124.22
Overall	79	127.44

Note. Maximum score = 158.

[a] This includes 27 items.

Processing Capacity and Acquisition of Structural Representations

Of the nine factors identified by principal components analysis in the general area of linguistic competence, three were selected for further analysis. Analogical Reasoning (AR)/ using connectives [$AR._1$], drawing analogies [$AR._2$], recognizing principles of cognitive organization [$AR._3$]), Deductive Reasoning (DR) / drawing inferences [$DR._1$], recognizing

errors in modifiers [DR.$_2$], diction and idiom [DR.$_3$]), and Inductive Reasoning (IR)/ translation [IR.$_1$], inference [IR.$_2$], analysis [IR.$_3$]) were used to characterize the students in the three exposure groups Exp.$_{(early/med/late)}$ (see Table 3). The questions asked of the data were similar to the preliminary analysis above; namely, the contrasts that define no difference between (Exp.$_{early}$) and Exp.$_{(late)}$, and that (Exp.$_{med}$) was different from this average, but interest in this analysis was whether the groups were equal or different across the profile of scores representing the three areas of linguistic competence -- that is, whether the group mean vectors (not just univariate group means) differ. No particular relationships were postulated between these three variables so the questions asked of the data set were general ones; viz. whether the variables as a set could be used to identify the between-groups relationships described above.

Table 3

Numbers in cells and mean vectors on the three linguistic competence factors for the three levels of the factor 'overseas experience'.

Factor level	No. in cell	Observed mean vector		
		(AR)	(DR)	(IR)
Group 1 (early exposure)	25	13.24	9.72	3.96
Group 2 (medial exposure)	27	14.89	10.22	3.81
Group 3 (late exposure)	27	12.85	8.81	3.37
Overall	79	13.67	9.58	3.71

The hypothesis that there are no differences overall between the groups was rejected (Pillai's statistic was insignificant). 11% of the variability in discriminant scores was attributable to between-group differences ($.3250^2 = .1056$). Univariate tests for Deductive Reasoning, $F(2, 76) = 2.51$, $p>.05$, and Inductive Reasoning, $F(2,76) = 0.894$, $p>.05$ were not significant; however, the univariate test for group differences in Analogical Reasoning was significant, $F(2,76) = 3.584$, $p<.05$. Within-group differences in Analogical Reasoning [AR.$_{1,2,3}$] were significant between exposure groups (Exp.$_{med}$) and (Exp.$_{early}$), $t(50) = -2.20$, $P<.05$, and (Exp.$_{med}$) and (Exp.$_{late}$), $t(52) = 2.63$, $p<.05$, but were not significant between (Exp.$_{early}$) and (Exp.$_{late}$), $t(50) = 0.42$, $p>.05$.

Post hoc tests were conducted on adjusted means for the variables comprising Analogical Reasoning [AR.$_{1,2,3}$]. The variable [AR.$_2$] was significant between exposure groups Exp.$_{(med)}$ and Exp.$_{(early)}$, $t(44) = -2.24$, $P<.05$, and Exp.$_{(med)}$ and Exp.$_{(late)}$, $t(46) = 2.22$, $p<.05$, but was not significant between Exp.$_{(early)}$ and Exp.$_{(late)}$, $t(50) = 0.02$,

$p>.05$. Analogical Reasoning 3/[$AR._3$] was significant between exposure groups Exp.($_{med}$) and Exp.($_{late}$), $t\ (52) = 2.27$, $p<.05$, but was insignificant between Exp.($_{early}$) and Exp.($_{late}$), $t\ (50) = 0.60$, $p>.05$, and Exp.($_{med}$) and Exp.($_{early}$), $t(50) = -1.56$, $p>.05$.

Discussion

This study examined the cognitive effect of previous experience in an English language environment on the language learning strategies of high-ability bilingual Japanese post-secondary students. Performance on a reduced data set of nine factors considered against the factor of 'overseas experience' found that overseas experienced students who were brought-up in Japan and initially exposed to native-like English during mid-childhood in elementary level schools overseas evidenced more advanced use of analogical reasoning in the acquisition and transfer of second language knowledge than overseas experienced students first exposed to English from birth and during early childhood, and those students initially exposed during adolescence. The findings provide support for the positive cognitive consequences of bilingualism in 'subtractive' (Turner, 1977), but, more importantly, demonstrate a relationship between processing capacity and language learning.

Before these findings are discussed further, several qualifications are in order. First, results may not be generalizable because of the group classification based on age of initial exposure. Initially it was thought possible to look for a linear relationship between age of initial exposure and language performance by means of a regression or correlation analysis, but it was found that the diversity of 'overseas experience' did not make for a simple linear relationship throughout the range. Furthermore, this particular item of information was not easy to define accurately and, consequently, arbitrary elements were introduced into its measurement. Second, data may not be generalizable to other groups because given the number of variables for each student ($n = 27$), a method of data reduction was used to decrease the number of statistical tests conducted and to enhance the comprehensibility of the outcomes (Alt, 1990). Third, although the mid-childhood years were found to be significant in the acquisition of analogical reasoning, the group contrasts were decided on from *a priori* considerations and interests. Fourth, each hypothesis was tested at the 5% level. This relatively low level was chosen simply because of the size of the data available (79 observations in all), thereby allowing only relatively weaker conclusions to be drawn. Discussion of the observed age of exposure differences should be understood in the context of these limitations.

The findings are consistent with the previously formulated hypotheses of Mayberry (1995) and Newport (1990) that pertain to a critical period for the deaf to learn sign language (ASL). Both the positive effects on learning 'signing' in childhood based on previous language learning and the long-term effects of early exposure provide reasonable explanations for the

group affects demonstrated here. The findings also agree with one explanation of the difficulties of late exposure to signing in the formation of complex sentences in Newport's study, and to attempts to reconceptualize the intersection between development and learning (Halford, 1995).

Finally, the significantly greater use of analogy in the acquisition of second language knowledge demonstrated by children during their elementary school years overseas may be attributed to exposure to English in the structured learning environment of the local elementary school. Any further conclusions are speculative at this time, but there are two possible explanations. First, even if the Japanese child is born and/or brought-up in an English-speaking community overseas, she tends be insulated from native-like English within 'a cultural cocoon' that promotes strong identification with the Japanese language. Second, in communication with others in the intricate, dynamic and often chaotic web of social relationships the bilingual student weaves and disassembles in the elementary school, she may be unconsciously encouraged to take stop-gap measures to fill in the gaps in language knowledge by making analogies.

References

Alt, M. (1990), *Exploring Hyperspace*. London: McGraw-Hill.

Australian Council for Educational Research, (1982a), *English Skills Assessment, Manual*. Hawthorn, Vic.: Allenby Press.

Australian Council for Educational Research, (1982b), *English Skills Assessment, Test Booklet 1*. Hawthorn, Vic.: Allenby Press.

Australian Council for Educational Research, (1982c), *English Skills Assessment, Test Booklet 2*. Hawthorn, Vic.: Allenby Press.

Cattell, R. F. (1966), The scree test for the number of factors. *Multivariate Behavioral Research, 1*, 245-276.

Changeux, J., and Konishi, M. (1987), *The neural and molecular bases of learning*. New York: Wiley.

Chomsky, N. (1986), *Knowledge of Language. Its nature, origin, and use*. New York: Praeger.

Chomsky, N. (1988), *Language and problems of knowledge*. The Managua lectures. Cambridge, Mass.: MIT Press.

Chugani, H. T., and Phelps, M. E. (1990), Imaging human brain development with positron emission tomography. *Journal of Nuclear Medicine, 32*, 23-26.

Churchland, P. S., and Sejnowski, (1992), *The computational brain*. Cambridge, Mass.: MIT Press.

Educational Testing Service. (1971), *Sequential Tests of Educational Progress, Grades 10-12: Teachers Manual for Administering, Scoring and Interpreting*. Princeton. NJ: ETS.

Educational Testing Service. (1978), *Guide to the Use of the Descriptive Tests of Language Skills*. Princeton, NJ: ETS.

Gentner, D. (1983), Structure-mapping: A theoretical framework for analogy. *Cognitive Science, 7*, 155-170.

Gick, M. L., & Holyoak, K. J. (1983), Schema induction and analogical transfer. *Cognitive Science, 15*, 1-38.

Goswami, U. (1992), *Analogical Reasoning in Children*. Hove: Erlbaum.

Halford, G. S. (1993), *Children's understanding: The development of mental models*. Hillsdale, NJ.: Erlbaum.

Harris, P. L. (1996), Children and scientists: False analogies and neglected similarities. In L. Hirschfield and S. Gelman (Eds.), *Domain Specificity in Cognition and Culture*. Cambridge: Cambridge University Press.

Halford, G. S. (1995), Learning Processes in Cognitive Development: A Reassessment with Some Unexpected Implications, *Human Development, 38*, 295-301.

Holland, J. H., Holyoak, K. J., Nisbett, R. E., & Thagard, P. R. (1986), *Induction: Processes of Inference, Learning, and Discovery*. Cambridge, MA: MIT Press.

Huttenlocher, P. R. (1990), Morphometric study of human cerebral cortex development. *Neuropsychologica, 28*, 517-27.

Johnson, J., & Newport, E. (1989), Critical period efforts in second-language learning: The influence of maturational state on the acquisition of English as a second language. *Cognitive Psychology, 21*, 60-90.

Lambert, W. E., & Anisfeld, E. (1969), A note on the relationship of bilingualism and intelligence. *Canadian Journal of Behavioral Science, 1*, 123-128.

Leuba, G., and Garey, L. J. (1987), Evolution of neuronal numerical density in the developing and aging visual cortex. *Human Neurobiology, 70*, 11-18.

Mayberry, J. (1995, Feb.), Unpublished paper presented at the American Association for the Advancement of Science (AAAS) Conference, Atlanta.

Mundy, K. G. (1995a), *Cognitive and social outcomes of retroactive bilingualism in heritage language environments*. (Working Paper Series). Tokyo: Sophia University.

Mundy, K. G. (1995b, Jan.), *Cognitive outcomes of retroactive bilingualism in heritage language environments*. Paper presented at the meeting of the 7th CSLR Conference, Tokyo.

Oller, K. (1995, Feb.), Unpublished paper presented at the American Association for the Advancement of Science (AAAS) Conference, Atlanta.

Peal, E., & Lambert, W. E. (1962), The relation of bilingualism to intelligence. *Psychological Monographs, 76*, 1-23.

Pinker, S. (1989), Language acquisition. In M. Posner (ed.). *Foundations of cognitive science*. Cambridge, Mass.: MIT Press.

Purves, D. (1988), *A trophic theory of neuronal organization*. Cambridge, Mass.: Harvard University Press.

Reynolds, V. (1980), *The biology of human action*. Oxford: Freeman.

Snow, C., & Hoefnagel-Hohle, M. (1978), The critical period for language acquisition: Evidence from second language learning. *Child Development, 49*, 1114-28.

Sternberg, R. J. (1977), *Intelligence, information processing, and analogical reasoning: The componential analysis of human abilities*. Hillsdale, NJ.: Erlbaum.

Sternberg, R. J. (1982), Reasoning, problem solving and intelligence. In R. J. Sternberg (Ed.). *Handbook of human intelligence*, pp. 225-307. New York: Cambridge University Press.

Sternberg, R. J. (1985), General intellectual ability. In R. J. Sternberg (Ed.). *Human abilities: An information processing approach.*. New York: Freeman.

Sternberg, R. J., & Gardner, M. K. (1983), Unities in inductive reasoning. *Journal of Experimental Psychology: General , 112*, 80-116.

Stillings, N. A., Weisler, S. E., Chase, C. H., Feinstein, M. H., Garfield, J. L., & Rissland, E. L. (1995), *Cognitive Science*. Cambridge, Mass.: MIT Press.

Tucker, R. F., Koopman, R. F., & Linn, R. L. (1969), Evaluation of factor analytic research procedures by means of simulated correlation matrices. *Psychometrika, 34,* 421-459.

Yeni-Komshain, G. (1995, Feb.), Unpublished paper presented to the American Association for the Advancement of Science (AAAS) Conference, Atlanta.