

Effect of Bilingualism on Intelligence

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1. Introduction

This study reports the effect of learning through second language as medium of instruction on intelligence of ten year old children in a monocultural environment of Chennai, India. 30 boys and 30 girls of monolingual and bilingual group in each category with low, average and above average proficiency in Tamil were randomly selected. Monolingual children spoke Tamil at home and studied in school through Tamil and bilingual children spoke with average proficiency in Telugu or Kannada at home only and studied through Tamil medium at school from first grade. Both the linguistic groups were tested in Tamil version of Wechsler's intelligence scale for children. Results indicated that levels of second language proficiency do not mediate global intelligence and nonverbal intelligence. The effect on the components of nonverbal intelligence indicated that levels of second language proficiency and ability of perceptual analysis in scanning essentials from nonessentials and perceptual organization are interdependent. Levels of second language proficiency do not affect logical reasoning, perception of part to whole relationship and flexible manipulation of codes. When children have a higher level of second language proficiency, they perform better on verbal intelligence. Levels of second language proficiency and range of information possessed by bilingual children, the ability to solve arithmetic problems, vocabulary are interdependent. The degree of proficiency in second language does not affect comprehension of social judgment and verbal concept formation.

Bilingualism is a universal phenomenon in a monocultural country like India where this study was conducted. Multiple factors interact in learning a second language. The problem of research is not what effects bilingualism per se has on cognitive process, rather than in identification of those conditions under which bilingual experiences are likely to retard or accelerate growth. The level of bilingual competency is emphasized as an intervening variable in mediating the effects of their bilingual experiences on cognition. But the attainment of threshold level itself is determined by various environmental factors, (Cummins, 1976). Cummins assumes that a high level of threshold in the second language is essential for positive influences while a failure to attain a minimum threshold level competency in that language will have a negative effect.

The social environment plays an important role in the development of language. Lambert (1975) attributes the positive influence of bilingualism to additive context in which second language is socially relevant and is learned by supplementing the first language, that is, without replacing the first language. The negative consequences are due to subtractive bilingualism where the first language is replaced by the second language. According to Lambert, it culminates in lack of competence in either of these languages resulting in a retarding effect on cognition.

In India, individuals with proficiency in more than one language are considered as superior persons with capacity to draw wisdom and culture from various resources (Sharma, 1977). In the west, immigrants of different cultures strive to assimilate into the local culture by learning the language of the environment. Thus the effect of bilingualism and biculture are intertwined in the process of becoming a bilingual individual. As for the linguistic policy in education in Chennai, government schools follow two language formula. Children in government schools can learn academics either through Tamil or English medium and also learn English and Tamil as languages. The majority of the courses at undergraduate and postgraduate levels are taught in English medium. The foregoing analysis of linguistic medium of education reveals that the majority of Indian students in their educational career may undergo a psycholinguistic conflict of code switching and code maintenance (Sharma, 1977).

Even though voluminous studies have been done on varied dimensions of bilingualism in the west, there is lack of studies to be conducted in a monocultural context like India. In this study, theoretical framework of Lambert's additive bilingualism and Cummins's threshold hypothesis of second

language in the bilingual environment was investigated and compared with monolingual children on intelligence.

30 monolingual and 30 bilingual boys and girls of 10 years of age, from middle socioeconomic status with low, average and high levels of Tamil proficiency were randomly selected.

2. Measures

Reading and speaking skills in first language, as rated by parents as average was taken as the criteria for maintenance of first language. Since the focus is to ascertain the effect of second language proficiency as medium of instruction in school on bilingual children, writing was chosen as the linguistic skill in Tamil and was assessed through cloze technique. A Tamil Language test to assess proficiency in writing skill was developed for this study.

Standardized test like Metropolitan Achievement test are time consuming to administer and score. Swain, Lapkin and Barik (1976) utilized cloze technique on an experimental basis. The test is easy to construct and economical to administer and score (Oler and Conrad, 1971; Stubbs and Tucker, 1974) and is highly reliable (Oller and Inal, 1971; Swain, Lapkin and Barik, 1976) to ascertain language proficiency. Based on these results, a Tamil language proficiency test was constructed to measure proficiency in Tamil.

The cloze technique consists of a passage, in which first few sentences were left intact in the beginning to aid comprehension. Every *n*th word usually randomly chosen is deleted. Usually two types of score are obtained. They are exact response and acceptable response. In exact response, only the word in the original passage is considered as correct while in acceptable response, words conveying equivalent meaning of the exact response are scored. Acceptable response method yields valuable information for formative research (Swain, Lapin and Barik, 1976) and is an effective and efficient measure to ascertain language proficiency of young children. The acceptable response method was used in the present study.

3. Construction of Tamil language proficiency test

To develop a valid measure of Tamil proficiency test for 10 year old children, 3 Tamil passages were chosen, bearing in mind that the passage should be unfamiliar to the children to prevent reproduction from memory. Three passages were chosen. The first three sentences in the beginning of the passage were without any blanks to facilitate comprehension of the passage. Every fifth word in the passage was left as blank for the children to complete.

The same three passages without blanks were given to five Tamil teachers of fifth grade in different schools. The teachers rated on a five point scale with 5 for most appropriate. They rated the criteria on applicability of the passage to the fifth grade children, understandability of the passage, clarity of the content, difficulty of the passage, familiarity of the words in the passage, sequential arrangement of sentences to follow the idea in the passage. One way analysis of variance revealed applicability of one of the passages ($F=0.29$, NS; $F=6.89$, $p<0.01$; $F = 5.21$, $p<0.01$). The insignificant difference between the ratings of the teachers on one of the passages revealed the consistent approval of the passage.

Reliability: The test was administered through test- retest method. The test was administered with an interval of three weeks in between the two sessions of administration of the test. The coefficient of correlation of 0.85 at 0.01 level of significance indicated the internal consistency of the measure.

Validity of the test was measured by the ratings of five teachers. A five point scale was used to measure the rating. An insignificant ratio computed through one way analysis of variance indicated no difference between the raters ($F=0.89$; NS). So that passage was chosen for the present study.

To test the normality of distribution of the scores, the Tamil proficiency test was administered to 200 randomly chosen fifth grade children from different schools of Madras city. The obtained scores were tested by chi-square goodness of fit. The observed value of 12.26 was less than the expected value of 23.68 at 0.05 level indicating that the fit was good. Proficiency in Tamil language as low, average and above average was classified based on interquartile range. The scores below the first quartile, i.e., below 14 was considered Low proficiency, the score between the first and third quartile, i.e., between 14 and 23 was considered as Average proficiency and those above the third quartile, i.e., above 23 was considered as Above average.

Wechsler's Intelligence scale for children was used to test, verbal and nonverbal Intelligence. Wechsler (1949) operationally defines intelligence as the aggregate or global capacity of the individual to act purposefully, to think rationally and to deal effectively with his environment. He refers to intelligence as an aggregate capacity emphasizing the components as qualitatively undifferentiable but not entirely independent elements or abilities. The resultant intelligent behavior is the product of the configuration of the number of elements or abilities and non-intellectual factors. Wechsler's Intelligence scale for children consists of 12 tests. The Verbal subscale consists of information, comprehension, arithmetic, similarities, vocabulary, digit span and the Nonverbal consists of picture completion, picture arrangement, and block design, object assembly, coding or maze.

Since the investigation involved Tamil medium school children, WISC was administered in Tamil language to the randomly selected subjects. 15 boys and 15 girls were selected randomly from both monolingual and bilingual groups. The mean age of the group was 10.2 years. The English version of Gujarati adaptation of Wechsler's Intelligence Scale for children (Bhatt, 1970) was translated in Tamil by a Tamil scholar. The English and Tamil version were administered with an interval of one month between the administrations. The coefficient of correlation between English and Tamil versions of WISC was found to be 0.93 which is significant at 0.01 level. This ensured the reliability of the Tamil version of WISC (Table 1). The test was administered to monolingual and bilingual children in Tamil to the randomly selected samples.

Table 1
Reliability of Coefficient for WISC.

Test	r corrected by Spearman Brown Prophecy formula
Verbal Scale	0.96
Nonverbal Scale	0.89
Full scale	0.93

Sample:

The bilingual population was those who had average linguistic skills in their first language, Telugu or Kannada, as rated by parents, in dimension of reading and speech. It was the only language spoken at home. They learned through their second language, Tamil, from first grade. First language (Telugu or Kannada) of the bilingual children was not taught or spoken at school. Monolingual children learned through their first language, namely Tamil, from first grade. The two linguistic groups had exposure to Tamil as medium of instruction for four years and at the final year of the elementary school, the children were tested on Wechsler Intelligence scale for Intelligence. A random sample of children from schools of different educational districts - north, south and east of Chennai city was selected. The schools were chosen in proportion to the numbers in their population (Table 2).

Table 2
Distribution of schools in Madras city.

Districts	Population	Sample
North	83	6
South	164	12
East	97	7

Information regarding socioeconomic status was collected from parent through Socioeconomic status scale (Rao, 1975). Children belonging to middle socioeconomic status were identified and classified according to the linguistic group with different levels of Tamil proficiency. 30 boys and 30

girls in monolingual and bilingual group with low, average and above average proficiency in Tamil language from middle socioeconomic status and from fifth grade were selected from randomly selected schools. Bilingual and monolingual children who learned through Tamil from first grade were considered and were tested at the fifth grade. The insignificant t values (Table 3) revealed the insignificant difference between the groups.

Table 3

Mean, Standard deviation and t values comparing the age of monolingual and bilingual children with different levels of Tamil proficiency.

Levels of Tamil Proficiency	Monolinguals		Bilinguals		t value	Significance
	Mean	S.D	Mean	S.D		
Low	10.61	1.23	10.21	1.06	1.46	N.S
Average	10.06	2.96	9.68	2.01	0.63	N.S
Above average	9.79	3.21	10.01	3.08	0.29	N.S

WISC was administered to the samples. The data collected were analyzed statistically. Multivariate three way analysis of variance was computed to study the effect of independent variables namely linguality (monolingual vs. bilingual group), levels of Tamil proficiency (low vs. average vs. above average), sex (boys vs. girls) and interaction effect on the dependent measure, intelligence. Stepwise multiple regression was computed to study the extent to which the component of intelligence contributed to the total intelligence in the linguistic groups.

4. Results

Global intelligence: The interaction between the linguistic groups and levels of Tamil proficiency on intelligence revealed insignificant effect on global intelligence ($F = 2.91$; NS).

Nonverbal intelligence: The insignificant interaction effect revealed no difference on global nonverbal intelligence ($F = 0.89$, NS) (Table 4).

Table 4

Summary of Analysis of Variance of Linguistic groups, Levels of Tamil proficiency, Sex and Interaction effects on Nonverbal Intelligence.

Source	d.f	Sum of Square	Mean Square	F	Significance
Between the Linguistic groups	1	54267.78	54267.78	0.80	NS
Between levels of Tamil Proficiency	2	83542.56	41771.28	0.62	NS
Between Sex	1	88862.00	88862.00	1.31	NS
Interactions:					
Linguistic groups x Levels of Tamil Proficiency	2	120344.19	60172.09	0.89	NS
Linguistic groups x Sex	1	63946.66	63946.66	0.95	NS
Levels of Tamil Proficiency x Sex	2	622280.19	311140.09	4.60	$P < 0.05$
Linguistic groups x Levels of Tamil proficiency x Sex	2	139732.06	69866.00	1.03	NS
Error	348	23552943.00	67680.87		
Total	359	24725918.44			

Monolingual and bilingual groups with different levels of Tamil proficiency have similar levels of nonverbal intelligence. It is inferred that nonverbal intelligence is independent of second language proficiency. The result supported the findings of Jones (1952, 1966). Jones found that no difference exists between monolingual and bilingual children in nonverbal intelligence.

4.1 Effect on Verbal intelligence

The significant interaction effect of linguistic groups and levels of Tamil proficiency (Table 5) indicated that monolingual and bilingual group differed in verbal intelligence and t- test revealed the trend (Table 6).

Table 5

Summary of Analysis of Variance of Linguistic groups, Levels of Tamil proficiency, Sex and Interaction effects on Verbal Intelligence.

Source	d.f	Sum of Square	Mean Square	F	Significance
Between the Linguistic groups	1	10868.01	10868.01	52.58	p<0.01
Between the levels of Tamil Proficiency	2	24589.86	12294.93	59.48	p<0.01
Between Sex	1	67.60	67.60	0.33	NS
Interactions:					
Linguistic groups x Levels of Tamil Proficiency	2	2054.94	1027.47	4.97	p<0.01
Linguistic groups x Sex	1	182.04	182.04	0.88	NS
Levels of Tamil Proficiency x Sex	2	1445.15	722.58	3.49	p<0.05
Linguistic groups x Levels of Tamil Proficiency x Sex	2	230.11	115.05	0.56	NS
Error	348	71931.93	206.70		
Total	359	111369.64			

Table 6

Comparison of monolingual and bilingual children with different levels of Tamil proficiency on Verbal intelligence.

Levels of Tamil Proficiency	Monolinguals		Bilinguals		t value	Significance
	Mean	S.D	Mean	S.D		
Low	93.40	2.19	85.63	4.01	2.86	p<0.01
Average	97.72	3.06	105.03	3.29	2.79	p<0.01
Above average	102.18	3.96	111.90	3.02	4.77	p<0.01

A low level of second language proficiency has a retarding effect on verbal intelligence of bilingual children. The increased levels of second language proficiency influences verbal intelligence of bilingual children in comparison to the monolinguals with similar level of Tamil proficiency.

4.2 Effect on the components of nonverbal intelligence

Even though global nonverbal intelligence does not differentiate the linguistic groups, the effects on the individual components of nonverbal intelligence was ascertained by analysis of variance. Results indicated that monolinguals and bilinguals differ significantly on perceptual analysis (F =11.69, p <

0.01), perceptual organization ($F = 4.20, p < 0.05$) and they do not differ in the ability to reason logically ($F = 1.14, NS$), in perception of part to whole relationship ($F = 1.23, NS$), and in the ability to manipulate code flexibly ($F = 0.16, NS$). The trend was revealed by t analysis. Bilingual children with a lower level of second language proficiency have a poor analysis of differentiating essentials from nonessentials as compared to the monolingual group with a similar level of Tamil proficiency. However, bilinguals with average and above average proficiency in second language excelled their counterpart in the monolingual group (Table 7).

Table 7

Comparison of monolingual and bilingual children with different levels of Tamil proficiency on perceptual analysis.

Levels of Tamil Proficiency	Monolinguals		Bilinguals		t value	Significance
	Mean	S.D	Mean	S.D		
Low	12.73	3.21	8.89	2.16	2.85	$p < 0.01$
Average	13.01	3.13	14.81	3.26	0.98	NS
Above average	13.82	1.96	15.39	2.09	2.12	$p < 0.05$

Bilingual children with a lower level of second language, has less ability in perceptual organization than their counterpart in the monolingual group. The trend is reversed for bilingual children with average and above average proficiency in second language (Table 8). They are able to perceive and synthesize the abstract design which is influenced by flexible approach. The results support the assumption of Cummins' threshold hypothesis.

Table 8

Comparison of monolingual and bilingual children with different levels of Tamil proficiency on perceptual organization.

Levels of Tamil Proficiency	Monolinguals		Bilinguals		t value	Significance
	Mean	S.D	Mean	S.D		
Low	20.59	3.06	15.26	4.02	2.32	$p < 0.05$
Average	22.06	3.26	28.76	3.11	3.67	$p < 0.01$
Above average	25.09	4.11	32.56	3.99	2.53	$p < 0.05$

4.3 Effect on the components of verbal intelligence

Analyzing the effect on the components of verbal intelligence, monolingual and bilingual groups with different levels of Tamil proficiency differ in the amount of information they possess ($F = 4.91, p < 0.01$), ability to solve arithmetic problems ($F = 8.16, p < 0.01$), vocabulary ($F = 4.17, p < 0.01$), and they do not differ in comprehension ($F = 0.45, NS$) and concept formation ($F = 0.43, NS$).

Analysis on the range of information possessed by the children revealed that monolinguals with a lower level of Tamil proficiency have a wider range of information than their counterpart in the bilingual group. But the bilingual children with average and above average proficiency excelled their counterpart which confirms Cummins assumption of threshold hypothesis. Levels of second language proficiency and range of information are interdependent (Table 9).

Table 9

Comparison of monolingual and bilingual children with different levels of Tamil proficiency on Information.

Levels of Tamil Proficiency	Monolinguals		Bilinguals		t_value	Significance
	Mean	S.D	Mean	S.D		
Low	11.95	1.86	14.97	3.09	2.58	p < 0.05
Average	14.32	3.06	20.79	3.23	3.63	p < 0.01
Above average	17.01	2.13	25.66	3.53	5.63	p < 0.05

The analysis on the ability to solve arithmetic problems revealed that the ability to solve problems increases with increase in Tamil language proficiency (Table 10). Bilinguals excelled their counterpart when the second language proficiency is average and above average. This confirms the assumption of threshold hypothesis.

Table 10

Comparison of monolingual and bilingual children with different levels of Tamil proficiency on the ability to solve arithmetic problems.

Levels of Tamil Proficiency	Monolinguals		Bilinguals		t_value	Significance
	Mean	S.D	Mean	S.D		
Low	5.35	2.24	3.29	2.13	2.05	p < 0.05
Average	5.42	2.61	8.92	2.26	3.26	p < 0.01
Above average	7.53	2.25	11.25	3.01	2.93	p < 0.01

A low level of second language proficiency has a retarding effect on Vocabulary of bilingual children. The increased levels of second language proficiency influences vocabulary of bilinguals in comparison to monolinguals with similar levels of Tamil proficiency (Table 11).

Table 11

Comparison of monolingual and bilingual Boys with different levels of Tamil proficiency on Vocabulary.

Levels of Tamil Proficiency	Monolinguals		Bilinguals		t_value	Significance
	Mean	S.D	Mean	S.D		
Low	23.07	1.70	19.21	3.61	2.69	p < 0.05
Average	26.07	2.93	30.40	3.38	2.07	p < 0.05
Above average	31.03	3.85	35.17	2.32	2.28	p < 0.05

4.4 Effect on the components of nonverbal and verbal intelligence between the sex of the children between monolingual and bilingual group with different levels of Tamil proficiency

Analysis of variance revealed insignificant difference between boys and girls of monolingual and bilingual group with different levels of Tamil proficiency except for vocabulary (perceptual analysis (F = 0.07, NS), logical reasoning (F = 3.01, NS), perceptual organization (F = 1.10, NS), perception of part to whole relationship (F = 0.95, NS), ability to code flexibly (F = 0.27, NS), information (F = 2.10, NS), comprehension (F = 3.30, NS), ability to solve arithmetic problems (F = 1.91, NS), verbal concept formation (F = 0.13, NS), vocabulary (F = 3.53, p < 0.05).

The results revealed similar trend among boys and girls between the linguistic groups. The monolingual boys and girls with a low level of Tamil proficiency excel their counterpart in the bilingual group in vocabulary. Bilingual boys and girls with average proficiency in second language

excelled in the range of Tamil vocabulary than their counterpart in the monolingual group. But there is no significant difference within boys and girls of monolingual and bilingual group with above average proficiency (Tables 12 and 13).

Table 12

Comparison of monolingual and bilingual Girls with different levels of Tamil proficiency on Vocabulary.

Levels of Tamil Proficiency	Monolinguals		Bilinguals		t _{value}	Significance
	Mean	S.D	Mean	S.D		
Low	24.61	1.80	22.35	2.34	2.07	p < 0.05
Average	27.81	2.14	32.67	3.01	2.86	p < 0.01
Above average	32.91	2.33	34.89	4.02	0.73	N.S

Table 13

Comparison of monolingual and bilingual Boys with different levels of Tamil proficiency on Vocabulary.

Levels of Tamil Proficiency	Monolinguals		Bilinguals		t _{value}	Significance
	Mean	S.D	Mean	S.D		
Low	22.69	2.61	18.59	2.32	2.69	p < 0.05
Average	25.89	2.32	29.09	1.82	2.94	p < 0.01
Above average	28.59	2.96	30.19	3.32	0.65	N.S

4.5 Within Monolingual and Bilingual group

Stepwise multiple regression was carried out to determine the extent of contribution of the components of verbal and nonverbal intelligence in different groups – monolingual group with low (ML1), average (ML2), and above average proficiency in Tamil (ML3) and bilingual group with low (BL1), average (BL2) and above average (BL3) levels of proficiency in Tamil. This would predict the changes in the dependent variables, I.Q, with the known changes in the independent variables of components of nonverbal intelligence namely perceptual analysis (PA), logical reasoning (LR), perceptual organization (PO), synthesis of part to whole relationship (SP), and flexible manipulation of codes (CO) and in the components of verbal intelligence – information (I), comprehension (C), arithmetic (A), similarities (S) and vocabulary (V).

The multiple correlation coefficients give the total influence of all the independent variables on the dependent variable – nonverbal IQ, which varies from 0.68 to 0.78 that are significant at 0.05 level (Table 14). The significant regression coefficient indicates that with increase in Tamil language proficiency, a significant changes occur in both monolingual and bilingual groups in perceptual analysis and in perceptual organization.

Table 14
Nonverbal IQ

Groups	PA	LR	PO	SP	CO	C.D	R
ML1	1.42	0.95	2.65	2.33	0.49	65%	0.68
ML2	2.22*	2.02	2.71*	2.09	1.21	69%	0.71
ML3	3.09*	1.98	3.01*	2.11	1.48	73%	0.76
BL1	2.62*	1.26	3.01*	1.42	0.89	61%	0.65
BL2	2.86*	1.21	2.89*	1.57	1.42	70%	0.72
BL3	3.70*	1.44	3.68*	1.60	1.89	72%	0.78

*p < 0.05

In all the groups, the multiple correlation coefficients range from 0.61 to 0.86 which are significant (Table15).

Analyzing the regression coefficients, information, problem solving ability in arithmetic and vocabulary contribute significantly in all the groups. The increase in trend is seen in all the groups implying that an increase in the linguistic proficiency contributes to improvement in these variables to the total intelligence. The amount of variations in the dependent variable is explained by coefficient of

determination (C.D) that shows an increasing trend implying that an increase in the significant variable reduces the variation in the dependent variable.

Table 15 Verbal IQ

Groups	I	C	A	S	V	C.D	<u>R</u>
ML1	1.64*	1.01	2.22*	1.26	1.82*	62%	0.65
ML2	1.91*	1.21	2.82*	1.82	1.87*	65%	0.73
ML3	3.01*	1.89	3.06*	1.86	2.52*	73%	0.76
BL1	1.69*	0.89	1.96*	0.99	1.72*	65%	0.69
BL2	2.32*	1.26	2.96	1.89	2.02	71%	0.79
BL3	3.26*	2.68*	3.11*	1.91	3.26	72%	0.86

*p < 0.05

5. Summary

In summary levels of second language proficiency do not mediate global intelligence and global nonverbal intelligence. The effect of second language proficiency on the components of nonverbal intelligence indicated that levels of second language proficiency and ability of perceptual analysis in scanning essentials from nonessentials and perceptual organization are interdependent. Levels of second language proficiency do not affect logical reasoning, perception of part to whole relationship and flexible manipulation of codes. Between the linguistic groups, there is no sex based differences on the components of nonverbal intelligence namely perceptual analysis, logical reasoning, perceptual organization, perception of part to whole relationship and flexible manipulation of codes.

Levels of second language proficiency and verbal intelligence are interdependent. When children have a higher level of second language proficiency, they perform better on verbal intelligence. Levels of second language proficiency and range of information possessed by bilingual children, the ability to solve arithmetic problems, vocabulary are interdependent. The degree of proficiency in second language does not affect comprehension of social judgment and verbal concept formation. With reference to components of verbal intelligence, there is no sex based differences between the linguistic groups on information, comprehension of social judgment, problem solving ability in arithmetic and verbal concept formation but there is a difference on vocabulary.

Within the linguistic groups, levels of Tamil proficiency and global intelligence, nonverbal intelligence are independent. Among the monolingual and bilingual group, threshold levels of proficiency in second language and verbal intelligence are interdependent. Analysis on the components of nonverbal intelligence indicated no difference, within the monolingual group, on the five components of nonverbal intelligence. Among the bilingual group, levels of second language proficiency and perceptual analysis, perceptual organization are interdependent. Levels of second language proficiency and logical reasoning, perception of part to whole relationship, flexible manipulation of codes are interdependent. In a monocultural environment, learning through second language has beneficial effect on certain dimension of nonverbal intelligence and on verbal intelligence.

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ISB4: Proceedings of the 4th International Symposium on Bilingualism

edited by James Cohen, Kara T. McAlister,
Kellie Rolstad, and Jeff MacSwan

Cascadilla Press Somerville, MA 2005

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ISBN 978-1-57473-210-8 CD-ROM
ISBN 978-1-57473-107-1 library binding (5-volume set)

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