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10 The Relationship Between Degree of Bilingualism and Cognitive Ability: A Critical Discussion and Some New Longitudinal Data

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In 1962, Elizabeth Peal and Wallace Lambert of McGill University published a monograph entitled "The Relation of Bilingualism to Intelligence." The research, conducted in Montreal with 10-year-old children, compared the performance of monolinguals to that of bilingual, French/English-speaking subjects on a variety of standard tests of intelligence. In contrast to previous research on bilingualism and intelligence, Peal and Lambert (1962) discovered that their bilingual sample showed superior performance on measures of verbal intelligence and on nonverbal tests "involving concept-formation or symbolic flexibility [p. 14]." What differentiated the study from its ancestral relatives was the care with which Peal and Lambert exercised control over sample selection. They drew a distinction between true, "balanced bilinguals" who are proficient in both their first (L1) and second language (L2) and "pseudo-bilinguals" who, for various reasons, have not yet attained age-appropriate abilities in their second language. According to Peal and Lambert (1962): "The pseudo-bilingual knows one language much better than the other, and does not use his second language in communication. The true (or balanced) bilingual masters both at an early age and has facility with both as means of communication [p. 6]." Into their sample of bilinguals, only those considered "balanced" were admitted.

Peal and Lambert's study had substantial impact on two fronts. First, it raised the consciousness of researchers on the problem of selecting appropri-

ate bilingual samples to an extent such that the prototype of subsequent studies on bilingualism became group comparisons of balanced bilinguals to monolingual counterparts matched on appropriate variables. Second, the results served to allay commonly held fears concerning the products of bilingual education, namely, that it would produce retarded, poorly educated, anomic individuals without affiliation to either ethnolinguistic group and incapable of functioning in either language (Tucker & d'Anglejan, 1971). Bilingual education would not create, the study assured, a social or cognitive Frankenstein.

In this chapter, we provide a brief review of research prior to Peal and Lambert's study and more recent studies on bilingualism and intelligence (for an earlier review with a linguistic focus, see Lindholm, 1980; for an expanded and detailed review of the first 6 decades of research, see Diaz, 1983). In the course of the review, we point out both theoretical and methodological weaknesses inherent in the typical bilingual-monolingual comparison. In addition, we stress the paucity of longitudinal investigations that allow for the assessment of statements concerning the cause-effect relations between bilingualism and cognitive abilities. Then, we report preliminary results from our own study, which attempts to correct for these weaknesses. We conclude with some theoretical speculations regarding the nature of the relationship between bilingualism and thought.

THE FIRST 4 DECADES OF RESEARCH

Psychological studies of the relation between bilingualism and cognitive abilities began in the early 1920s out of concern raised by the flourishing of psychometric tests of intelligence. The concern was that bilingual children would suffer from some linguistic disadvantages, which could, in turn, prevent fair assessment of their intellectual abilities and potential. The fact that the measurement of intelligence is heavily dependent on verbal abilities made psychologists and educators deeply concerned (and rightfully so!) about the validity of such tests for bilingual children. As expected, the majority of studies prior to Peal and Lambert's (1962) study found that bilinguals were linguistically deficient in comparison to their monolingual counterparts. Among other things, bilinguals were shown to have deficient articulation (Carrow, 1957), lower standards in written composition, more grammatical errors (Harris, 1948; Saer, 1924), and a considerably reduced vocabulary (Barke & Williams, 1938; Grabo, 1931; Saer, 1924). The consistent finding was that bilinguals suffered from a so-called "language handicap" (see reviews by Arsenian, 1937; Darcy, 1953, 1963; Macnamara, 1966).

Unfortunately, consistent findings about bilinguals' "language handicap" led too quickly to statements regarding the negative effects of bilingualism rather than to a serious questioning of the validity of psychometric tests of intelligence for this population. Negative, and rather harsh, statements condemning bilingualism as a social plague (Epstein, 1905) or as "a hardship devoid of apparent advantage" (Yoshioka, 1929) were common in the early literature. In short, the measured language handicap of bilinguals was interpreted as a linguistic confusion that deeply affected children's intellectual development and academic performance up to the college years (Saer, 1940).

The majority of early studies in the area, however, suffered from a wide range of methodological problems, and as a result, most current investigators in the field regard the findings of early studies as totally unreliable (see Cummins, 1976). A good number of early studies, for example, failed to control for group differences in socioeconomic status between bilingual and monolingual samples. As early as 1930, McCarthy pointed out that bilingualism in the US was seriously confounded with low socioeconomic status. She found that more than half of the bilingual school children could be classified as belonging to families from the unskilled labor occupational group. Along the same lines, Fukuda (1925) alerted researchers to the fact that high-scoring English-speaking subjects were mostly in the occupational and executive classes; he reported a correlation of .53 between the Whittier (socioeconomic) Scale and the Binet IQ in his sample. Nevertheless, prior to the early 1960s, most studies investigating the effects of bilingualism on children's intelligence did not take into account group differences in socioeconomic status.

A second major methodological flaw of early studies is that it was often questionable whether the "bilingual" subjects were in fact fluent in both languages. Brunner (1929), for example, assumed that children's bilingualism would be estimated by the foreignness of their parents. Brunner divided his bilingual sample into three categories: (1) both parents born in this country; (2) one parent born here and the other abroad; and (3) both parents born abroad. The classification was simply assumed to represent various degrees of children's bilingualism. In other studies, the sample's bilingualism was assessed through family names or even place of residence (see Darcy, 1953, for a review). As present investigators have repeatedly stated, it is impossible to ascertain whether the bilingual subjects of many studies were indeed bilingual or just monolingual of a minority language.

Toward the end of the 1950s, research on the effects of bilingualism showed the following consistent findings. Monolinguals performed significantly higher than bilinguals on measures of verbal intelligence. On measures of nonverbal ability, some studies showed that monolinguals were also at an advantage, but group differences on this variable were not consistent across studies. However, because of the serious methodological flaws just mentioned, none of the results, even if they were statistically significant in either direction, can be easily interpreted. Peal and Lambert's (1962) study, described briefly in the introduction, took steps to assure the selection of true, balanced bilinguals. In addition, it recruited wisdom from previous studies in controlling for socioeconomic level.

PEAL AND LAMBERT (1962): THE PUNCTUATION POINT IN RESEARCH

Both bilingual and monolingual samples for the Peal and Lambert study were selected from the same school system in Montreal. All 10-year-old children in the system were included in the initial screening by four measures, the composite of which was used to determine whether the child should be considered monolingual or balanced bilingual. The measures were: (1) the relative frequency of words provided in a word association task in L1 and L2; (2) the relative frequency of words in L1 and L2 detected in a series of letters; (3) the frequency of words recognized in L2 (English) from a subset chosen from the Peabody Picture Vocabulary Test; and (4) subjective self-ratings on ability in speaking, understanding, reading, and writing in L2. Children who fell in the extremes of these scales were determined to be monolingual or balanced bilingual. The final sample consisted of 75 monolinguals and 89 bilinguals; all children were administered a modified version of the Lavoie-Larendeau Group Test of General Intelligence (Lavoie & Laurendeau, 1960), the Raven's Coloured Progressive Matrices (Raven, 1956; Raven, Court, & Raven, 1976), and a French version of selected subtests of the Thurstone Primary Mental Abilities Test (Thurstone & Thurstone, 1954).

Contrary to the findings of earlier studies, the results of the Peal and Lambert study showed that bilinguals performed *significantly* better than monolinguals on most of the cognitive tests and subtests, even when group differences in sex, age, and socioeconomic status were appropriately controlled. Bilingual children performed significantly higher than monolinguals on tests of both verbal and nonverbal abilities; the bilinguals' superiority in nonverbal tests was more clearly evident in those subtests that required mental manipulation and reorganization of visual stimuli, rather than mere perceptual abilities. A factor analysis of test scores indicated that bilinguals were superior to monolinguals in concept formation and in tasks that required a certain mental or symbolic flexibility. Overall, bilinguals were found to have a more diversified pattern of abilities than their monolingual peers.

Peal and Lambert's (1962) findings must be considered with a certain degree of caution, however. First, as Macnamara (1966) has pointed out, the process of subject selection might have introduced a bias in favor of the bilingual sample. Peal and Lambert's bilingual sample included only children who scored above a certain determined level in the English Peabody Picture Vocabulary Test, a test commonly used to measure intelligence in monolinguals.

It is possible that the intelligence of French-Canadian children might be reflected in a measure of English (the second language) vocabulary. Second, the bilingual sample, on the average, belonged to a higher grade than the monolingual sample; perhaps the superiority observed in bilinguals was the result of their having longer exposure to formal education. And third, the frequency distribution of the Raven's test scores was very different for the two groups of children; it was negatively skewed for bilinguals, whereas the opposite was true for monolinguals. In short, the cognitive advantages observed in Peal and Lambert's balanced bilingual sample could have been inflated by several artifacts in their subject selection procedures. As Peal and Lambert (1962) admitted:

> A partial explanation of this [the results] may lie in our method of choosing the bilingual sample. Those suffering from a language handicap may unintentionally have been eliminated. We attempted to select bilinguals who were balanced, that is, equally fluent in both languages. However, when the balance measures did not give a clear indication of whether or not a given child was bilingual, more weight was attached to his score on the English vocabulary tests. Thus some bilinguals who might be balanced, but whose vocabulary in English and French might be small, would be omitted from our sample. The less intelligent bilinguals, those who have not acquired as large an English vocabulary, would not be considered bilingual enough for our study [p. 15].

Nevertheless, Peal and Lambert's (1962) empirical distinction between bilinguals and pseudobilinguals made a significant (and much needed) methodological contribution to the field. Their distinction has forced recent investigators to select their bilingual sample with greater care and measure the sample's actual knowledge of the two languages.

RECENT STUDIES

Since Peal and Lambert (1962), a variety of studies have been reported in which monolingual children are compared to balanced bilingual children. In most of these studies, balanced bilinguals have shown advantages in several cognitive abilities, such as concept formation (Liedtke & Nelson, 1968) and metalinguistic awareness (Cummins, 1978). In addition, many studies suggest that balanced bilinguals demonstrate a greater flexibility than monolinguals in their performance on different cognitive tasks (Balkan, 1970). Above all, recent research not only has replicated Peal and Lambert's positive findings regarding balanced bilingualism, but also has given empirical support for linguists' statements regarding the cognitive and linguistic advantages of raising a child bilingually.

In contrast to early psychological studies of childhood bilingualism, individual case studies by linguists (Leopold, 1939, 1947, 1949a, 1949b; Ronjat, 1913) had concluded that early bilingualism was advantageous to children's cognitive and linguistic development. In particular, Leopold (1961), based on observations of his bilingually raised daughter, suggested that bilingualism promoted an early separation of the word sound from the word meaning: "a noticeable looseness of the link between the phonetic word and its meaning [p. 358]." Furthermore, Leopold postulated a fascinating connection between the semantic and cognitive development of bilingual children, namely that the separation of sound and meaning leads to an early awareness of the conventionality of words and the arbitrariness of language. This awareness could promote, in turn, more abstract levels of thinking. Vygotsky (1935/1975) saw the cognitive advantages of bilingualism along the same lines; in his own words (as cited in Cummins, 1976), bilingualism frees the mind "from the prison of concrete language and phenomena [p. 34]."

Leopold's observations have been tested empiricaly by Ianco-Worrall (1972) in a remarkable well-designed and controlled study of English-Afrikaans bilingual children in South Africa. The bilingual sample consisted of nursery school children who had been raised in a one person-one language environment, similar to the situation of Leopold's daughter Hildegard. The sample's degree of bilingualism was determined by several measures, including detailed interviews with parents and teachers as well as a direct test of the children's vocabulary in both languages. Two comparable monolingual samples, one English and one Afrikaans, were included in the study.

In a first experiment, children were administered a semantic-phonetic preferences test. The test consisted of eight sets of three words each. A typical set contained the words *cap, can,* and *hat.* Children were asked questions such as: "Which word is more like *cap, can* or *hat*?" Choosing the word *can* or *hat* indicated the child's phonetic preference or semantic preference, respectively, in analyzing word similarities. The capacity to compare words on the basis of a semantic dimension is regarded as more advanced developmentally than comparing words along a phonetic dimension.

The results of this experiment showed not only that semantic preferences increased with age, but also that bilinguals outranked monolinguals in choosing words along a semantic rather than a phonetic dimension. As Ianco-Worrall (1972) reported: "of the young 4-6 year old bilinguals, 54% consistently chose to interpret similarity between words in terms of the semantic dimension. Of the unilingual groups of the same age, not one Afrikaans speaker and only one English speaker showed similar choice behavior [p. 1398]." Ianco-Worrall concluded that bilingual children raised in a one person-one language environment reach a stage of semantic development 2-3 years earlier than monolingual children.

In a second experiment, using Vygotsky's (1962) interviewing techniques, Ianco-Worrall (1972) asked her subjects to explain the names of different things (e.g., why is a dog called "dog"?). She also asked children whether or not the names of things could be arbitrarily interchanged. Children's responses to the first question were assigned to different categories such as perceptible attributes, functional attributes, social convention, and so forth. The results of this second experiment showed no reliable differences between bilingual and monolingual children in the types of explanations offered. For the second question, however, the differences favored the bilingual children; bilinguals replied that names of objects could in principle be changed, whereas the opposite was true for monolingual children.

Lindholm (1980) reports a study by Sandoval (1976) in which a replication of Ianco-Worrall's results was attempted with a Spanish/Enlish sample of kindergartners and third graders. Although there was a trend favoring the bilinguals, it did not reach statistical significance. However, it is not clear whether the bilingual subjects were truly balanced or simply enrolled in bilingual schools.

More recently, Bain and Yu (1980) investigated the cognitive consequences of raising children according to Ronjat's (1913) one person-one language principle. Bain and Yu studied German-French, English-French, and Chinese-English bilinguals with monolinguals from the respective languages in three different geographical locations. The dependent cognitive variables concerned children's developing awareness of the functions of language as postulated by Luria and examined in tasks such as the ability to follow a set of increasingly complex directions in hide-and-seek situations. In particular, Bain and Yu hypothesized that bilingualism would promote the use of language as a self-directive tool in cognitive tasks. Using a modified version of Luria's (1961) experimental procedures, the results showed that, at about age 4, children raised bilingually in one person-one language environment were better able to use both overt and covert language as a guide and control in their cognitive functioning. The data also favored younger bilingual children, but this trend failed to reach statistical significance. More importantly, the findings were consistent across different language groups and geographical situations.

Several investigators have explored the effects of bilingualism on the development of metalinguistic awareness. Metalinguistic awareness refers to the ability to analyze linguistic output objectively; that is, according to Cummins (1978), "to look *at* language rather than *through* it to the intended meaning [p. 127]." Indeed, as children develop, they become more capable of looking at language as an objective set of rules, as an objective tool for communication. Because bilingualism induces an early separation of word and referent, it is possible that bilingual children also develop an early capacity to focus on and analyze the structural properties of language. Vygotsky (1935/1962) suggested that, because bilinguals could express the same thought in different languages, a bilingual child would tend to "see his language as one particular system among many, to view its phenomena under more general categories, and this leads to an awareness of his linguistic operations [1962, p. 110]." More recently, Ben-Zeev (1977b) hypothesized that bilinguals develop an analytic strategy toward language in order to fight interference between their two languages. Lambert and Tucker (1972) noted that children in the St. Lambert bilingual experiment engaged in some sort of "contrastive linguistics" by comparing similarities and differences between their two languages.

Cummins (1978) investigated the metalinguistic development of third- and sixth-grade Irish-English bilinguals. Children in the sample came from homes where both Irish and English were spoken; all children received formal school instruction in Irish. An appropriate monolingual comparison group was selected that was equivalent to the bilingual group on measures of IQ and socioeconomic status. A first task investigated children's awareness of the arbitrariness of language. Similar to the measure used by Ianco-Worrall (1972), children were asked whether names of objects could be interchanged; they were then asked to explain or justify their responses. The results indicated that, at both third- and sixth-grade levels, bilinguals showed a greater awareness of the arbitrary nature of linguistic reference.

In a second task, children were presented with several contradictory and tautological sentences about some poker chips that were either visible or hidden. The sentences varied in two additional dimensions: true versus false and empirical versus nonempirical. According to Cummins (1978), nonempirical statements refer to sentences that "are true or false by virtue of their linguistic form rather than deriving their truth value from any extralinguistic state of affairs [p. 129]." The task was chosen as a measure of metalinguistic awareness because previous researchers had shown that, in order to evaluate contradictions and tautologies correctly, it is necessary to examine language in an objective manner. Although the performance on this evaluation task was not clear-cut in favor of the bilinguals, sixth-grade bilingual children showed a marked superiority in correctly evaluating hidden nonempirical sentences. But Cummins (1978) notes that the monolinguals "analyzed linguistic input less closely, being more content to give the obvious 'can't tell' response to the hidden nonempirical items [p. 133]."

In a second experiment with balanced Ukranian-English bilinguals, Cummins (1978) investigated children's metalinguistic awareness using a wide variety of measures, including analysis of ambiguous sentences and a class inclusion task. Contrary to previous findings, the bilinguals in this study did not show advantages on the Semantic-Phonetic Preference Test or on an arbitrariness of language task. However, Cummins (1978) reports that "the results of the Class Inclusion and Ambiguities tasks are consistent with previous findings in that they suggest that bilingualism promotes an analytic orientation to linguistic input [p. 135]."

In the studies that have been described, bilinguals exceeded monolinguals in a wide range of linguistic and metalinguistic abilities. Bilinguals showed a greater capacity to analyze the similarity of words along semantic rather than acoustic dimensions, a greater use of language as a self-directing tool in cognitive tasks, and a greater overall awareness of the conventional nature of words and language. Also, in a different study (Feldman & Shen, 1971), bilingual 5-year-olds were better than their monolingual peers at relabeling objects and expressing relations between objects in simple sentences. This awareness or flexibility with respect to the use of language seems to play an important role in the cognitive functioning of bilingual children. In fact, several investigators have claimed that bilinguals are more "cognitively flexible" than monolinguals when performing on both verbal and nonverbal tasks. Although the notion of cognitive flexibility has never been adequately explained (see Cummins, 1976), it is possible that bilinguals' unusual use and awareness of language contributes to a greater flexibility in the manipulation of both verbal and nonverbal symbols.

One of the most frequently cited studies of bilinguals' cognitive flexibility was conducted in Switzerland by Balkan (1970). Balkan administered several tests of nonverbal abilities that purportedly measured cognitive flexibility. The bilingual group, as expected, performed significantly higher than the control monolingual group in two of these measures. One task, Figures Cachees, involved the ability to reorganize a perceptual situation, similar to the familiar Embedded Figures Test. The other task, Histoires, involved sensitivity to the different meanings of a word. Interestingly enough, the positive effects of bilingualsm on these measures were much stronger for children who had become bilingual before the age of 4. The differences between monolinguals and children who had become bilingual at a later age were in favor of the latter but did not reach statistical significance.

Balkan's study implies, as earlier individual case studies by linguists had suggested, that bilingualism might have the most beneficial cognitive effects for those children who learn their two languages simultaneously. Because balanced bilinguals have two different words for most referents, it is not surprising that they show a greater sensitivity than monolinguals to the possible different meanings of a single word, as shown in the Histoires task. On the other hand, Balkan's study offers no clue as to how or why bilingualism should contribute to a greater ability to reorganize and reconstruct perceptual arrays, as shown in the Figures Cachees task. As recent research suggests, the clue might be in bilinguals' greater awareness and flexibility with respect to the use of language, as well as in their greater use of both overt and covert speech in the monitoring of their cognitive functioning (Bain & Yu, 1980).

Further evidence of bilinguals' so-called cognitive flexibility has been offered by Ben-Zeev's (1977) study with Hebrew-English bilingual children. When compared to monolinguals, the bilingual children in the study showed a marked superiority in symbol substitution and verbal transformation tasks. The symbol substitution task involved children's ability to substitute words in a sentence according to the experimenter's instructions. In a typical instance, children were asked to replace the word *I* with the word *spaghetti*. Children were given correct scores when they were able to say sentences like "Spaghetti *am* cold," rather than "Spaghetti *is* cold" or a similar sentence that, although grammatically correct, violated the rules of the game. The bilinguals' higher performance on the verbal transformation task involved better detection of changes in a spoken stimulus that is repeated continuously by means of a tape loop. Warren and Warren (1966) have reported that when a spoken stimulus is presented in such a way, subjects older than 6 years report hearing frequent changes in what the taped voice says. The authors attributed this illusion to the development of a reorganization mechanism that aids in the perception of ongoing speech.

The bilingual children in Ben-Zeev's study also outperformed the monolingual group on certain aspects of a matrix transposition task. Bilinguals were better at isolating and specifying the underlying dimensions of the matrix, but no group differences were found on the rearrangement of figures in the matrix. The two comparison groups also performed similarly on Raven's progressive matrices. It should be noted that the bilinguals in Ben-Zeev's study showed cognitive advantages only on measures that were directly related to linguistic ability and on the verbal aspects of the matrix transformation task.

Ben-Zeev (1977) noted that throughout the study bilingual children seemed to approach the cognitive tasks in a truly analytic way. They also seemed more attentive to both the structure and details of the tasks administered, as well as more sensitive to feedback from the tasks and the experimenter. Ben-Zeev explained these improved abilities in terms of bilinguals' confrontation with their two languages. She argued that, in order to avoid linguistic interference, bilinguals must develop a keen awareness of the structural similarities and differences between their two languages as well as a special sensitivity to linguistic feedback from the environment. Supposedly, this more developed analytic strategy toward linguistic structures is transferred to other structures and patterns associated with different cognitive tasks. Ben-Zeev (1977) summarized her results as follows:

> Two strategies characterized the thinking patterns of the bilinguals in relation to verbal material: readiness to impute structure and readiness to reorganize. The patterns they seek are primarily linguistic, but this process also operates with visual patterns, as in their aptness at isolating the dimensions of a matrix.

With visual material the spatial reorganizational skill did not appear, however [p. 1017].

In conclusion, the nature or meaning of cognitive flexibility is far from being fully understood; however, the studies just reviewed suggest that the flexibility noted in bilinguals could stem from language-related abilities, such as the use of language in monitoring cognitive functioning or an early awareness of the conventionality and structural properties of language.

OBSERVATIONS ON THE STATE OF THE ART

The recent studies suggest that if one compares bilinguals who are approximately equivalent in their abilities in L1 and L2 with a monolingual group matched for age, socioeconomic level, and other relevant variables and administers a measure of cognitive flexibility to both groups, the bilinguals will do better. Now, consider an ideal (from the viewpoint of good experimental science) research design. You would begin by taking a random sample of individuals and assigning them randomly to either an experimental group or control group, thereby controlling for any background error in sampling. The experimental group is placed in an environment that fosters bilingualism, whereas the control group remains in a monolingual environment. Once the treatment has had time to take effect (i.e., once the subjects in the condition have become balanced bilinguals), you administer your dependent measure, making sure that the person who administers the dependent measure is blind to whether the subject being tested is in the treatment or control condition. And, lo and behold, you find a difference in favor of bilinguals. Under this ideal situation, one can reasonably conclude that bilingualism causes cognitive flexibility, or whatever cognitive advantage this flexibility stands for. You could also go on to speculate about why this result came about and construe various other experimental conditions to test your hypotheses.

In what ways is the ideal research design unlike the circumstances under which current studies of bilingualism are conducted? We would point out at least two. First, in the real world, there is no such thing as random assignment to a bilingual or monolingual group. Most often, bilingualism or monolingualism is determined by sociolinguistic facts that are, as would be true of most sociolinguistic facts, related to a wide range of social variables. What this really means is that there will be a large number of variables that differentiate the bilingual from the monolingual other than simply that the bilingual speaks two languages and the monolingual one. It is possible, of course, to match the two groups with respect to some variables (e.g., ethnicity) or to control them statistically (e.g., by partialing out the effects of socioeconomic level). But at what point can we be satisfied that *all* the relevant variables have been controlled for, such that the difference between the two groups can be attributed to the number of languages that the person knows? So, the skeptic could argue, "While you have controlled for *a,b,c,d,e,* and *f,* you haven't controlled for *g.*"

The second way in which the ideal situation is unlike the reality of the studies is more methodological and has to do with the adoption of a blind procedure (a double-blind is impossible, because presumably the subjects would know whether they are bilingual or monolingual). In none of the studies reviewed have we seen evidence of attempts by the researchers to keep the identity of the subject blind to the experimenter. If the experimenter is keen on the hypothesis of the study and in addition knows whether the subject is a bilingual or a monolingual child, one cannot rule out unintended experimenter bias effects (Rosenthal, 1976). In practice, it may be quite difficult to attempt to maintain a blind procedure. Bilingual and monolingual children are most often found in different schools, different neighborhoods, and would probably show some behavioral manifestations of their linguality. It is, however, an effect that one must bear in mind when interpreting the results of studies using the prototype design.

The methodological problems stemming from the reality of actual bilingual situations lend difficulty to supporting empirically the claim that bilingualism is associated with greater cognitive flexibility. One partial solution to both of these problems can be achieved in a rarely used design of looking at effects *within* a bilingual sample (Duncan & DeAvila, 1979). If *degree* of bilingualism can be reliably measured within a sample of children becoming bilingual and if this measure of degree can be shown to be related to cognitive flexibility, then one would have come one step closer to finding a pure relationship between bilingualism and cognitive flexibility. Using a within-bilingual sample, it is also possible to control for experimenter bias. Inasmuch as the subjects could come from the same schools, if the L1 and L2 abilities were kept blind to the experimenter, it would minimize bias effects.

In addition to the foregoing problems, there is the implied but untested statement about direction of causality. As Peal and Lambert (1962) put it: "one may ask whether the more intelligent children, as measured by nonverbal intelligence tests, are the ones who become bilingual, or whether bilingualism itself has a favorable effect on nonverbal intelligence [p. 13]." One handle on this problem would be through a longitudinal study in which both variables are measured repeatedly over time. We are aware of just one study (Barik & Swain, 1976) in which longitudinal data were available. Barik and Swain compared 32 low L2 achievers with 32 high achievers in a French immersion program in Ottawa over a 3-year period (Grades K–3). They report that the high achievers performed better on subtests of analogies and following verbal directions even when initial IQ scores at Time 1 were controlled.

The study we report in the remainder of the chapter addresses the foregoing concerns with previous studies of the relationship between bilingualism and cognitive flexibility. We are interested in assessing the relative abilities in both L1 and L2 of children in the process of becoming bilingual and in following them on a longitudinal basis to determine whether degree of bilingualism is related to cognitive flexibility and to assess the direction of causality between linguistic and cognitive variables.

THE PRESENT LONGITUDINAL STUDY

The two-dimensional space created by relative abilities in L1 and L2 is pictured in Fig. 10.1 (a), marked by a line with a slope of 1 along which ideally balanced bilinguals will cluster. This two-space is, of course, an ideal situation that is unmeasured, and we presently have no way of locating any given sample of bilingual individuals in absolute terms. Thus, depending on sample characteristics, the two-space defined by a set of L1 and L2 measures can vary. Figure 10.1 (b) shows two hypothetical samples, A and B, where B represents a group of individuals that is more "balanced" than A. The point is that although we cannot determine the two-space location of a group of bilinguals in any particular study using a particular measure, the effects of degree of bilingualism can be studied by looking at the variation in the L2 measure while controlling for variation in the L1 measure. As can be seen in Fig. 10.1 (c), individual A2 is more bilingual than individual A1, and B2 is more bilingual than B1. We hypothesize that the variation in L2 controlling for variation in L1 is attributable to the degree of bilingualism, and this variation should be related in a positive way to cognitive ability.

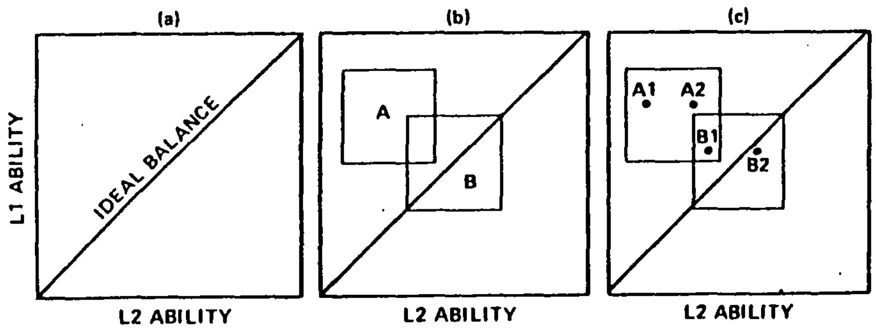

FIG. 10.1 Conceptualization of balanced bilingualism, how different bilingual samples are embedded within it, and how individuals are embedded within samples. Panel a shows ideal balance line between L1 and L2 abilities. Panel b shows placement of two different samples (A and B) within idealized space. Panel c shows individuals within the sample spaces.

Description of the Project

The subjects in our study are currently enrolled in classes from the Bilingual Education Program in the New Haven, Connecticut, public schools. Children who are enrolled in the program are dominant in Spanish. Placement in the bilingual program for the subjects is determined primarily on the basis of information provided by the parents and by the teachers of the classrooms to which they are initially assigned. Children who are reported as being exclusively Spanish-speaking or mainly Spanish-speaking are channeled into the bilingual classes, while those reported as predominantly or exclusively English-speaking are placed in monolingual, mainstream classrooms. Those children who reportedly use both languages are further assessed for dominance through the Language Assessment Battery, and Spanish-dominant children are placed in the bilingual classrooms.

The director of the bilingual program estimates that of the 165,000 residents in New Haven, there are 18,000 Hispanics, primarily Puerto Ricans. There are at present roughly 2700 Hispanic students in the school system between Grades K–12, of which roughly 45% are in bilingual classes.

All bilingual classes are conducted on a 50:50 ratio of Spanish and English as languages of instruction. Based on teacher recommendation, when the children approach equivalence between their English and Spanish ability, they are placed into the mainstream, English monolingual classes. Thus, like most bilingual education programs in the United States, the New Haven program is transitional in nature, as opposed to the maintenance or immersion programs found in Canada (see Swain, 1974).

Subjects

At Time 1 (the beginning of the Fall Semester), we began by screening all children in the kindergarten and first-grade classes in three schools in the New Haven public school system. We wanted to exclude from the study children who showed evidence of general language impairment. All 180 children were administered a Spanish adaptation of the Peabody Picture Vocabulary Test (SPVT), which is described in more detail later. On the basis of the distribution of the SPVT scores, subjects whose score was more than 1 standard deviation below the mean were eliminated. Our test-based evaluations were consistent with the reports of classroom teachers. In sum, out of the initial 180, we were left with 154 subjects, who were further tested with the remainder of the Time 1 measures.

By Time 2, approximately 6 months later, 30 of the 154 subjects had moved away from the school system, leaving us with 124 subjects. In addition (or, more accurately, in subtraction), a remaining subject at Time 2 was so exceedingly dominant in English at both times that she was eliminated from the study as being quite different from the rest of our sample. Thus, our final sample for the first year of the study consisted of 123 subjects, and we leave out of further discussion the remainder of the subjects.

The sample of 123 subjects contained 56 (45%) kindergartners and 67 (55%) first graders, with 55 (45%) girls and 68 (55%) boys. All of these children were of Puerto Rican descent. The mean age was 6 years 0 months, with a range from 4.1 to 8.3.

Aside from this general information, which was available for all subjects, we obtained more specific demographic information through a questionnaire sent to the parents. The questionnaires were distributed at Time 1, and of our sample, 88 (72%) responded, some after a second request. We have done some analyses to see whether the estimates obtained from the questionnaire responses would be reasonable estimates for the total sample. We compared all available variables in the study between responders and nonresponders and did not find any significant differences in the means. Thus, we assume the 88 responses to be a reasonably unbiased representation of the population sampled.

The questionnaire data indicate that 42% of the subjects were born in the United States, the remainder in Puerto Rico. The parents have lived in the continental United States for a mean of 2 years (SD = 6 years), ranging from 5 months to 26 years. They have lived at their reported address for an average of 2 years (SD = 1 year, 10 months), with the range extending from 1 month to 8 years. There is a mean of .91 rooms per occupant in the household (SD = .60). Of the heads of household, 37% are employed and 63% are unemployed.

Employment is directly related to the number of adults in the household. Of all questionnaire respondents, 55% were single-parent heads of household, and 32% had two adults in the household. Of the two-adult households, 64% (18/28) had the head employed, whereas only 14% (6/42) of single-adult household heads reportedly were employed. The significant association between number of adults and employment, $\chi^2(1) = 18.64$, $p = .001$, is consonant with the understanding that single parents in general have low rates of employment, presumably due in part to the fact that a caretaker would be required at home. Only a small minority of the subjects are without siblings (7%). The median number of siblings is 2.

In the questionnaire, we also asked the parents to rate the extent to which Spanish and English are used between various individuals at home. We provided a 5-point scale, with 1 corresponding to "only Spanish," 3 to "both Spanish and English," and 5 to "only English." In all three possible discourse combinations (adult-child, child-sibling, adult-adult), the responses were heavily skewed toward Spanish (for adult-child, 1 = 42%, 2 = 23%, 3 = 33%, 4 = 2%, 5 = 0%; for child-sibling, 1 = 32%, 2 = 21%, 3 = 43%, 4 = 2%, 5 = 2%; for adult-adult, 1 = 50%, 2 = 32%, 3 = 17%,

4 = 2%, 5 = 1%. These three ratings of the extent of use of Spanish and English at home are highly correlated, $r = +.52$ to $r = +.61$, and when combined, related negatively with the years of residence the United States mainland mentioned earlier, $r = +.34$. It appears that the longer the stay (and the earlier the year of arrival) in the United States, the more the dominant language permeates the home.

Measures

The ability in Spanish (L1) was assessed by administering an adaption of the Peabody Picture Vocabulary Test reported and distributed by Wiener, Simond, and Weiss (1978). Like the English version of the Peabody Picture Vocabulary Test (Dunn, 1965), the test is individually administered and consists of the child choosing a series of vocabulary items (ordered by increasing age-normed difficulty) out of four pictured alternatives. Wiener et al. standardized their Spanish version on Puerto Rican children in New York City. English (L2) ability was assessed through Form A of the vocabulary test. We refer to the Spanish test as SPVT and the English test as EPVT; when they are followed by a number (EPVT1, EPVT2, SPVT1, SPVT2), the number refers to the Time (1 = fall or 2 = spring) variable.

We should make it clear at this point that we did not intend to use these vocabulary tests as a measure of intelligence, as is commonly used (and misused) in monolingual populations. Rather, they were meant to be a measure of the relative abilities within each of the two languages for our bilingual sample. It should be noted here that the numerical raw scores for the two tests are not comparable. That is to say, a child who receives a score of 20 on both the EPVT and SPVT cannot be considered equivalent in his or her relative abilities in English and Spanish. On the other hand, the SPVT and EPVT have demonstrated the ability to rank children reliably along the respective Spanish and English language proficiency dimensions.

In order to validate the SPVT and EPVT as measures of language, a group of 40 children within our sample was given a story-retelling task in the two languages. Both the Spanish and English stories consisted of 14 sentences, paired with cartoon pictures. The experimenter first told the story while flipping through a picture book and, immediately upon completion, asked the child to tell the story cued by the pictures. The child's utterances were tape recorded and subsequently transcribed. The protocols were rated in a 5-point scale, with 1 being minimal use of the language and 5 being full fluency, by two independent raters. Only fluency was judged; accuracy of the retelling was ignored for this study. Interrater reliablities were .96 (Spearman-Brown) for English and .89 (Spearman-Brown) for Spanish. The mean ratings for both English and Spanish were significantly correlated with the EPVT1 and SPVT1 scores, $r = +.82$ for English rating with EPVT1, $r = +.36$ for

Spanish. The lower Spanish correlation most likely reflects the fact that the range of SPVT1 scores was more restricted than the EPVT1 scores for this particular subsample and also the possibility that the children are more Spanish-dominant and a simple story-retelling task may not reflect differences at higher levels of linguistic ability. We are currently pursuing further validation of the vocabularly measures, but for the moment believe that the tests do mirror quite accurately our subjects' variation in ability in both languages.

As a measure of nonverbal cognitive ability, we chose the Raven's Coloured Progressive Matrices Test (Raven, 1956; Raven et al., 1976), a measure on which the most robust differences were found between bilinguals and monolinguals in the Peal and Lambert study. Raw scores rather than percentiles were used because the test has not been standardized on populations comparable to ours. The Raven scores at Time 1 and Time 2 are hereafter referred to as Raven1 and Raven2.

In addition to these measures, we administered a test of metalinguistic ability (to judge the grammaticality of Spanish sentences and to detect English words embedded in Spanish sentences) and a measure of social perpective-taking (Chandler's "bystander cartoons"), but these data are still in the process of being analyzed and are not reported in this chapter.

Procedures

All measures were administered individually at the schools in empty rooms or quiet hallway corners by Spanish-English (balanced) bilingual experimenters. Except for presentation of the EPVT items, all testing was conducted in Spanish. Each measure was administered twice, once during the fall semester (Time 1) and again in the spring (Time 2). The average time lag between the two times was 6 months. Except for the constraint that SPVT1 was administered first at the very beginning of the study for initial screening, as mentioned earlier with reference to sample selection, order of tests was counterbalanced. At each time, each child was tested in three sessions, one with the SPVT, second with the EPVT, and third with the cognitive tests. In order that the experimenter remain blind to the child's ability in both languages, the same experimenter never tested any particular child in both EPVT and SPVT; hence, the subject's degree of bilingualism was not known to the experimenters until after completion of the data collection.

Results

There are two separate questions we ask of the data. First, is degree of bilingualism related to cognitive ability at any one time? This can be answered by looking within Time 1 and within Time 2 separately. Second, does degree of bilingualism at Time 1 predict cognitive ability at Time 2, or alternatively, does cognitive ability at Time 1 predict degree of bilingualism at Time 2?

Within-Time Analysis: Time 1. The means and standard deviations for Time 1 and Time 2 measures can be found in Table 10.1. The first analysis divided subjects into groups on the bases of their abilities in each language. We grouped subjects into three levels of EPVT scores and three levels of SPVT scores, the crossing of which produces nine groups. EPVT1 raw scores ranged from 3 to 55, $M = 26.24$, $SD = 14.86$, and SPVT1 raw scores ranged from 21 to 81, $M = 44.32$, $SD = 13.26$. Upon inspection of the data, we felt that 20-point intervals for both EPVT and SPVT raw scores would represent reasonable layering of subjects with respect to their abilities, recognizing of course that the division is arbitrary and conducted solely for purposes of inspecting differences described in means. The following were divisions, imposed both on the Time 1 and Time 2 data: Spanish Layer 1: SPVT 1-40; Spanish Layer 2: SPVT 41-60; Spanish Layer 3: SPVT greater than 60; English Layer 1: EPVT 1-20; English Layer 2: EPVT 21-40; English Layer 3: EPVT greater than 40. Means and standard deviations for Raven1 scores for each of the nine groups composed of the crossing of the Spanish and English layers can be found in Table 10.2 (a). Inspection of the means suggests strongly that Raven1 means increase with increasing levels of English layering. However, this is confounded with the ages of the subjects in the groups, as can be observed in Table 10.2 (b).

The next step was to assess the strength of the relationship between degree of bilingualism and cognitive ability through partial correlation, where EPVT1 is correlated with Raven1, controlling for age and SPVT1. The partial correlation coefficient is .267 $p = .002$, indicating a significant relationship between degree of bilingualism and nonverbal cognitive ability.

TABLE 10.1
Means and Standard Deviations of Basic Measures for the Bilingual Sample ($N = 123$)

Variable	*Mean*	*SD*
Time 1 Measures		
Age in months	71.89	10.15
EPVT1	26.24	14.86
SPVT1	44.33	13.26
Raven1	15.34	3.17
Time 2 Measures		
Age in months	77.89	10.15
EPVT2	33.99	16.94
SPVT2	52.69	13.56
Raven2	16.16	3.72

TABLE 10.2(a)
Raven1 Means for Bilingual Groups

Spanish	English: Layer 1 EPVT (1-20)	Layer 2 EPVT (21-40)	Layer 3 EPVT (>40)
Layer 3 SPVT (> 60)	M = 11.0 SD = 0 n = 1	M = 13.5 SD = 2.1 n = 2	M = 18.3 SD = 5.7 n = 7
Layer 2 SPVT (41-60)	M = 14.4 SD = 3.0 n = 15	M = 15.5 SD = 2.6 n = 38	M = 16.5 SD = 3.5 n = 14
Layer 1 SPVT (1-40)	M = 14.3 SD = 2.5 n = 30	M = 16.4 SD = 3.2 n = 14	M = 13.5 SD = .8 n = 2

TABLE 10.2(b)
Mean Age for Bilingual Groups at Time 1

Spanish	English: Layer 1 EPVT (1-20)	Layer 2 EPVT (21-40)	Layer 3 EPVT (>40)
Layer 3 SPVT (>60)	M = 74.0 SD = 0 n = 1	M = 82.0 SD = 8.485 n = 2	M = 79.0 SD = 5.8 n = 7
Layer 2 SPVT (41-60)	M = 71.4 SD = 11.5 n = 15	M = 77.8 SD = 8.1 n = 38	M = 79.4 SD = 7.1 n = 14
Layer 1 SPVT (1-40)	M = 61.9 SD = 3.4 n = 30	M = 66.4 SD = 7.3 n = 14	M = 63 SD = 7.071 n = 2

From the parent questionnaires, we included two measures of the socioeconomic levels of the subjects. One was simply whether the head of household was employed (coded 1) or unemployed (coded 0). The other was the number of rooms in their residence, divided by the number of occupants. Although the two measures were not related, $r = .09$, *ns*, both were correlated with EPVT1, for employment, $r = .20$, $p < .05$; for home space, $r = .18$, $p < .05$. When EPVT1 is correlated with Raven1 controlling for these socioeconomic variables in addition to age and SPVT1, the relationship is still significantly different from 0, partial correlation = .201, $p < .05$. Thus, even controlling for socioeconomic level, degree of bilingualism is related to nonverbal cognitive ability.

Within-Time Analysis: Time 2. The overall means for the measures at Time 2 can be found in Table 10.1. The detailed means shown in Table 10.3 specify Raven's levels and age levels when the subjects were divided into groups by Spanish and English layerings using the same criteria as in Time 1.

The partial correlation of EPVT2 and Raven2, controlling for age and SPV2 is .357, $p < .001$. Controlling for the socioeconomic variables, the relationship does not change substantially, partial correlation = .281, $p = .008$. Thus, both Time 1 and Time 2 data indicate that degree of bilingualism is related to performance on the Raven's matrices.

Between-Time Analysis. We established earlier that degree of bilingualism is positively related to Ravens at both times. However, which of these is

TABLE 10.3(a)
Raven2 Means for Bilingual Groups

Spanish	English: Layer 1 EPVT (1-20)	Layer 2 EPVT (21-40)	Layer 3 EPVT (>40)
Layer 3 SPVT (>60)	M = 14.8 SD = 2.8 n = 6	M = 17.0 SD = 3.4 n = 11	M = 18.8 SD = 4.1 n = 17
Layer 2 SPVT (41-60)	M = 14.2 SD = 1.6 n = 15	M = 15.1 SD = 3.0 n = 20	M = 17.7 SD = 4.1 n = 31
Layer 1 SPVT (> 1-40)	M = 13.9 SD = 1.7 n = 10	M = 13.4 SD = 2.5 n = 10	M = 18.7 SD = 4.2 n = 3

TABLE 10.3(b)
Mean Age for Bilingual Groups at Time 2

Spanish	English: Layer 1 EPVT (1-20)	Layer 2 EPVT (21-40)	Layer 3 EPVT (>40)
Layer 3 SPVT (>60)	M = 74.0 SD = 11.1 n = 6	M = 85.5 SD = 8.1 n = 11	M = 88.2 SD = 6.3 n = 17
Layer 2 SPVT (41-60	M = 71.7 SD = 10.1 n = 15	M = 77.8 SD = 9.4 n = 20	M = 79.9 SD = 8.1 n = 31
Layer 1 SPVT (> 1-40)	M = 67.3 SD = 2.9 n = 10	M = 71.6 SD = 7.7 n = 10	M = 72.3 SD = 8.5 n = 3

TABLE 10.4
Zero-Order Correlation Matrix for Language and Ravens at Both Times (n = 123)

N	Age	EPVT1	SPVT1	Raven1	EPVT2	SPVT2	Raven 2
Age	--	.476	.658	.166	.446	.522	.351
EPVT1	.476	--	.445	.318	.828	.333	.484
SPVT1	.658	.445	-	.165	.399	.687	.436
Raven1	.166	.318	.165	–	.315	.128	.486
EPVT2	.446	.828	.399	.315	–	.316	.466
SPVT2	.522	.333	.687	.128	.316	–	.331
Raven2	.351	.484	.436	.486	.466	.331	–

the causal factor? Specifically, we need to know whether Raven2 can be predicted by degree of bilingualism at Time 1 while controlling for the appropriate variables (including Raven1), or whether we can explain more variance by predicting degree of bilingualism at Time 2 by Raven1 while controlling for appropriate variables (including degree of bilingualism at Time 1). These alternatives are not mutually exclusive, of course, but statistical rejection of one model makes the alternative model more plausible. The zero-order correlation matrix of age, EPVT1, SPVT1, Raven1, EPTV2, SPVT2, and Raven2 can be found in Table 10.4. From the basic information described, we tested two alternative models using multiple regression.

The first analysis tested the null hypothesis that degree of bilingualism is not predicted by Ravens. In a stepwise multiple regression, EPVT2 was regressed on age, EPVT1, SPVT1, and SPVT2 in Step 1; then Raven1 was entered in Step 2. The important statistic here is the Beta for Raven1 for its F ratio. The results of the analysis show that Raven1 does not add significantly to the variance accounted for when controlling for age, EPVT1, SPVT1, and SPVT2, Beta = .056, $F(1, 117) = 1.077$, *ns*. The multiple R for the final equation was .832. Raven1 contributed only .3% additional variance toward predicting EPVT2. We conclude, then, that the null hypothesis cannot be rejected.

In the second analysis, we tested the null hypothesis that degree of bilingualism does not predict Raven scores. In this stepwise multiple regression, Raven2 was regressed on age, Raven1, SPVT1, and SPVT2 entered in Step 1; then EPVT1 entered in Step 2. The results show a significant Beta for EPVT1, Beta = .252, $F(1, 117) = 8.761, p < .01$. The multiple R for the final equation was .643. EPVT1 contributed 4.1% additional variance toward predicting Raven2, even when the other variables were entered first. Thus, we reject the null hypothesis in favor of the interpretation that degree of bilingualism affects nonverbal cognitive ability.

To control for socioeconomic level, we decided to test the results controlling for employment and home space for the 77 subjects for whom we had

data available. Raven2 was regressed on age, Raven1, SPVT1, SPVT2, employment, and residence in Step 1; then EPVT1 in Step 2. EPVT1 still maintained a significant Beta, .251, $F(1, 69) = 3.89, p = .05$. Multiple R was .54, with EPVT adding 4% toward predicting variance in Raven2.

DISCUSSION

We began our study with a concern that studies reported in the literature did not unambiguously show that bilingualism fosters cognitive development. A first difficulty was that most studies involved group comparisons of bilinguals and monolinguals, and therefore, the results could be attributed to group differences other than language ability. Second, most studies involved cross-sectional comparisons where cause–effect relationships could not be appropriately evaluated. The study just reported makes more plausible the claim about the positive effects of bilingualism. First, we were able to show an effect *within* a sample of bilinguals. And second, when two alternative models for the direction of causality were tested on the longitudinal data, the model claiming degree of bilingualism to be the causal link was more consistent with our obtained data than the model claiming cognitive ability to be the causal variable. By the end of the full term of this longitudinal study, in which we will follow up the subjects for an additional 2 years, with the addition of other cognitive measures, we hope to make an even stronger claim regarding the positive effects of bilingualism on cognitive abilities.

The fact that our data support the claim that bilingualism fosters cognitive development is just a first step in understanding the issues at hand. The question remains as to *how* bilingualism affects cognitive ability, especially when cognitive ability is measured by performance in nonverbal tasks. A long time ago, Leopold (1949b) postulated that bilingual children were forced to higher levels of abstract thought by the early need to separate the word from its referent. In a similar vein, Cummins (1976) and Ben-Zeev (1977) have suggested that the cognitive advantages of bilingualism could be explained by bilinguals' need to objectify and manipulate linguistic structures. Ben-Zeev, for example, argues that in order to avoid linguistic interference bilingual children must develop a greater awareness and sensitivity to linguistic cues. Bilinguals' greater sensitivity to linguistic structure and detail is then transferred and generalized to different verbal and nonverbal tasks.

The process by which bilinguals' metalinguistic awareness affects performance in nonverbal tests such as the Ravens has never been adequately explained or understood. Bain and Yu's (1980) study suggests that bilinguals are better able to use language as a tool to monitor cognitive functioning, increasing their capacity to memorize information and control more effectively the different steps in solving a problem. Cognitive-developmental research shows an increasing use of verbal mediation in the performance of nonverbal tasks with increasing age (Conrad, 1971). Furthermore, Hunt's (1974) research suggests that performance on the Raven test would be improved by the use of linguistic, rather than spatial, strategies in the solution of the matrices. It is possible, as Diaz (1983) suggested, that childhood bilingualism fosters a rather precocious use of verbal mediation in the processing of information and this, in turn, explains bilinguals' improved performance on nonverbal tasks.

One of the main difficulties in answering such important questions lies in the fact that most studies in the area have relied on data from psychometric tests. To the best of our knowledge, there are no information-processing studies of young bilingual children, and it is not clear what cognitive processes or cognitive strategies, if any, truly differentiate bilingual from monolingual children. It is almost impossible, with our present knowledge, to develop a process model of how bilingualism affects children's cognitive abilities or accelerates cognitive development. The development (and empirical support) of a detailed model relating bilingualism and cognitive development is still a few years ahead.

Finally, theory developed at the individual level of the child must ultimately be related to the larger picture of bilingualism as it occurs in various forms around the world. An important distinction that must be included in any study of the effects of bilingualism is between additive versus subtractive bilingualism (Lambert, 1978; Lambert & Taylor, 1981), which is related to the distinction between elite versus folk bilingualism (Fishman, 1977; Paulston, 1975, 1980). In an additive situation, children learn their second language in addition to their first, thus creating balanced bilingualism. As Lambert and Taylor (1981) recently put it: "an additive form of bilingualism [implies] that these children, with no fear of ethnic/linguistic erosion, can add one or more foreign languages to their accumulating skills, and profit immensely from the experience, cognitively, socially, and even economically [p. 14]." In a subtractive situation, the second language gradually replaces the first. To quote Lambert and Taylor (1981) once again: "the hyphenated American child, like the French-Canadian child, embarks on a 'subtractive' bilingual route as soon as he/she enters a school where a high prestige, socially powerful, dominant language like English is introduced as the exclusive language of instruction [p. 14]."

As Cummins (1976) pointed out, studies that have shown positive effects of bilingualism invariably are conducted in situations of additive bilingualism. This observation led Cummins to hypothesize that there is a critical threshold level of L1 and L2 ability that must be attained before the positive effects of bilingualism can be observed. In our own study, the children in the sample at the time of observation were definitely in an additive bilingual situation; that is, they were progressing in both L1 and L2, rather than L2 gradually replacing L1. Unfortunately, the policy of limiting bilingual education in the United States to transitional programs translates into the fact that as children are mainstreamed into monolingual classes, the bilingual situation takes a turn toward a subtractive form. We believe that the study of bilinguals' cognitive development is not only a fascinating academic problem with serious theoretical implications, but also an important data base that should influence society's choices regarding the policy of educating children bilingually.

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