Modularity and the Facilitation Effect: Psychological Mechanisms of Transfer in Bilingual Students

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This article draws upon recent work in the cognitive neurosciences to suggest that the facilitation effect follows naturally within current psychological theory. A view of the mind as consisting of discrete mental modules, called psychological modularity, is defended with case study evidence of double dissociation. It is argued that transfer of academic subject knowledge occurs in bilingual settings as an epiphenomenon of mental architecture: Because content knowledge is independent of linguistic knowledge, it is accessible to any language or languages a person happens to know. As such, transfer should be seen as a metaphor for a process; it is simply a natural consequence of our mental architecture. Cummins's developmental interdependence hypothesis, threshold hypothesis, and common underlying proficiency model are discussed. It is concluded that the facilitation effect is derived by the modularity thesis within a framework in which language is viewed as a cognitive domain separate from literacy and school subject matter knowledge.

Keywords: *bilingualism; psychological modularity; cognitive science; selective impairment; transfer; minority students; bilingual education; academic achievement; interdependence hypothesis; common underlying proficiency (CUP) model*

Approximately 4.5 million English language learners (ELLs) were enrolled in U.S. public schools in the 2000/2001 school year—an approximate increase of 32% over the reported 1997/1998 enrollments—with the largest concentrations of students represented in California (1,511,646), Texas (570,022), Florida (254,517), New York (239,097), Illinois (140,528), and Arizona (135,248). The Marshall Islands, Micronesia, Palau, and Puerto Rico reported 100% of their public school students to be ELLs (see Kindler, 2002). These numbers are expected to continue to grow for at least another

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quarter century according to Campbell (1994), with highest concentrations among Spanish-language students.

ELL students have been the focus of considerable attention among local and state policy makers in the United States. A question of central importance has been whether children who are still learning a second language (L2) should receive instruction in school subjects bilingually or monolingually.

Rossell and Baker (1996) argued that the available evidence on this question tends to mitigate against the bilingual approach but is inconclusive. As part of an attempt to make sense of these results, these authors challenged what they termed the *facilitation theory*, which posits a relationship between languages used in a bilingual education setting such that learning in a first language (L1) facilitates learning outcomes in an L2. According to Rossell and Baker, the facilitation theory lacks empirical support and constitutes "a poorly cast theory." They further asserted,

> There is no underlying psychological mechanism that accounts for the facilitation effect. Rather than being deduced from well established mental processes, the facilitation effect has to be accepted as a fundamental characteristic of the brain itself. (Rossell & Baker, 1996, p. 31)

Rossell and Baker did not specify what the "well established mental processes" actually are but, rather, simply suggested that they are well understood and that their nature is such that a facilitation effect would be unexpected.

In this article, we present a standard view of well established mental processes among cognitive neuroscientists known as *psychological modularity* and argue that the facilitation effect posited by proponents of bilingual education follows naturally from it. We thus make the "underlying psychological mechanism that accounts for the facilitation effect" sufficiently explicit to conclude that the facilitation theory is consistent with current research in the cognitive neurosciences, entirely expected, and indeed constitutes "a fundamental characteristic of the brain itself," contrary to Rossell and Baker's (1996, p. 31) assertions. Indeed, we argue that what we commonly call transfer is best viewed as a metaphor for a consequence of our mental architecture and not itself a process per se. Here, we limit our focus to the issue of transfer of subject matter knowledge from one language to the next and do not address linguistic transfer (e.g., influence of L1 phonology on L2 phonology and so on).

The Facilitation Theory

Rossell and Baker (1996) described Jim Cummins as the primary proponent of the facilitation theory and cited the interdependence hypothesis and

the threshold hypothesis. In Cummins's (1979, 1994) work, the relationship between a child's learning experience in two languages and content area knowledge may be captured by the following statement:

> *The Interdependence Hypothesis*
>
> To the extent that instruction in L*x* is effective in promoting proficiency in L*x*, transfer of this proficiency to L*y* will occur provided there is adequate exposure to L*y* (either in school or in the environment) and adequate motivation to learn L*y*. (Cummins, 1994, p. 19)

The threshold hypothesis is a companion to the interdependence hypothesis. The threshold hypothesis (Cummins, 1976, 1979) posits that the level of linguistic competence attained by a bilingual child in their L1 and L2 may affect cognitive growth in other domains. Cummins (1976, 1979) believed that there were two thresholds and that attainment beyond the lower threshold would be sufficient to keep children from falling behind academically, "but the attainment of a second, higher level of bilingual competence might be necessary to lead to accelerated cognitive growth" (1976, p. 24). He claimed that children with low levels of proficiency in both their L1 and L2 may suffer negative cognitive effects, but once mastery in one language has been obtained, the child has moved beyond the first threshold and will suffer neither positive nor negative effects. When a child develops high levels of proficiency in both languages, positive cognitive effects result, in Cummins's view.

Another important aspect of Cummins's (1981) framework related to the facilitation effect, although one that was not discussed by Rossell and Baker (1996), is the common underlying proficiency (CUP) model. Cummins contrasted the perspective of a common proficiency underlying both languages with the assumption that separate proficiencies underlie each (called the separate underlying proficiency [SUP] model). Cummins noted that the SUP model suggests that instructional effort devoted to a child's L1 detracts from the L2, whereas the CUP perspective conceptualizes these developmental domains as having a shared underlying proficiency. Cummins rejected SUP in favor of CUP on the basis of evidence he reviewed.

A common feature of the three theories presented in Cummins's (1976, 1979, 1981) work, and an assumption underlying the discussion in Rossell and Baker (1996) as well, is the view that language and language-related academic subject matter are not distinct. The surface features of the L1 and L2 for Cummins are those that "have become relatively automatized or less cognitively demanding whereas the underlying proficiency is that involved in cognitively demanding communicative tasks" (1981, p. 25).

Elsewhere, we have suggested that the threshold hypothesis (as well as the basic interpersonal communication skills/cognitive-academic language proficiency [BICS/CALP] distinction) leads to a number of undesirable consequences in the way we think about the learning situation of ELL students, because it conceptualizes language development in terms specific to the culture of schooling, essentially defining *lower proficiency* precisely as the language of the unschooled (for a discussion, see MacSwan, 2000b; MacSwan & Rolstad, 2003). The SUP/CUP distinction appears to rely on a similar conception of language proficiency. However, the model begins to make clear how specific views about mental architecture might be useful in explaining the descriptive facts observed in studies about the effectiveness of bilingual education programs. Bialystok and Cummins (1991), in fact, noted in passing that research on psychological modularity may be relevant to our theories about how various facets of research on language minority students fit together. Our purpose is to add some specificity to this suggestion. In the course of doing so, we distinguish between learning language and learning in other domains and take transfer to be a simple consequence of cognitive architecture.

In Cummins's (1976, 1979) system, the interdependence hypothesis asserts that transfer of proficiency across languages will occur (assuming sufficient exposure and motivation). The threshold hypothesis, on the other hand, posits a developmental relationship between the L1 and L2. However, no psychological apparatus is specified, and it remains unclear why a linguistic threshold in the L1 should have the described effects in the cognitive and academic domains. That is, why would we expect that a learner would need to pass a threshold, viewed as discrete or continuous, in one language before she could excel cognitively or academically in another?

The CUP model suggests that instruction in either language has positive effects on the proficiency that the two languages share. Here, Cummins (1981) presented a picture of the cognitive architecture responsible for transfer in terms suggestive of contemporaneous research in linguistics in the areas of syntax and semantics. If we understand language proficiency to include aspects of school knowledge, as Cummins does, then it follows within the model that growth in academic subjects will result from instruction in the L1 and hence will be facilitated by primary language instruction. In this way, Cummins captures the facilitation effect in his CUP model, but the model is plagued by a problem: We are not given an explicit theory of how "cognitively demanding communicative tasks" could be considered aspects of the human language faculty and are left with a conception of language proficiency that appears to regard higher language proficiency in terms specific

to the culture of the educated classes. We believe our presentation here remedies these problems in ways we will discuss below.

From a historical point of view, it must be stressed that Cummins's (1976, 1979) original work in this domain antedated the birth of the modularity thesis and therefore could naturally not have been expected to take full advantage of it. Rossell and Baker (1996), on the other hand, made reference to well-established mental processes and, without argument, suggested that we should not expect a facilitation effect based on what is known about the "fundamental characteristic of the brain itself" (p. 31). This assertion cannot be justified in terms of what was learned between the publication of Cummins's work and Rossell and Baker's review.

Evidence of Transfer

Observationally, transfer, in the present context, means simply that what one learns in one language is available in a second. Now more than ever, it seems abundantly clear that children taught bilingually have higher scores on English measures than children taught monolingually, a fact suggesting transfer. For instance, researchers using meta-analysis—widely believed to be the most objective method for research synthesis (Glass, 1976; Glass, McGaw, & Smith, 1981; Hunt, 1997; Lau & Chalmers, 1993)—have consistently reached the conclusion that ELL students taught bilingually do better than children taught in English only on academic measures in English (Greene, 1998; Rolstad, Mahoney, & Glass, 2005; Willig, 1985). Narrative research reviews, which are generally more subjective, have sometimes sided with this perspective (Hakuta & August, 1998; Meyer & Fienberg, 1992; Slavin & Cheung, 2003) and sometimes concluded that existing evidence is inconclusive or inconsistent (Baker & de Kanter, 1981; Rossell & Baker, 1996). Although the Baker (Baker & de Kanter, 1981; Rossell & Baker, 1996) reviews have been widely criticized for failing to evenly apply their own selection criteria and for treating bilingual programs as English-only programs (Dolson, 1985; Greene, 1998; Hernandez-Chavez, 1984; Krashen, 1996; Malherbe, 1978; Secada, 1987; Slavin & Cheung, 2003; Tucker, 1980), Slavin and Cheung's (2003) recent report, focused on the effects of bilingual instruction on English reading, noted,

> Looking past the small number of randomized experiments, outcomes of multi-year studies with pretests available before treatments began show mixed results, but most such studies favor bilingual education over immersion approaches. Among studies that met the criteria for inclusion, none significantly favored immersion programs, but some found no difference. (pp. 20-21)

It has also been widely claimed that core aspects of L1 reading ability transfer to an L2 and widely suggested that readers rely upon their knowledge of the phonological, morphological, syntactic, and semantic properties of their language in the process of decoding text (Perfetti, 1985, 1994; Postal, 1972). If correct, this observation has important consequences for curriculum and bilingual education, as Wong Fillmore and Valadez (1986) have pointed out,

> There is no other area of the curriculum in which the arguments for beginning with native language instruction are clearer. Reading is unquestionably a language-dependent skill. . . . What the reader must apply in this constructive process, as we have learned from studies of reading comprehension, is knowledge that is *not* encoded in the written word: knowledge of the language, of conventions of its use, of the real world, and of the topics treated in the text. (p. 661)

Studies that attempt to show correlations between L1 reading ability and L2 reading ability do not report consistent results, often due to a lack of control of a crucial variable: the level of proficiency in the L2. However, Carrell (1991) studied two groups of university-level students, native Spanish speakers learning English ($n = 45$) and native English speakers learning Spanish ($n = 75$), to discover whether L1 reading ability or L2 proficiency was a stronger predictor of L2 reading ability. Using multiple regression analysis, Carrell found both independent variables to be significant predicators of L2 reading ability. Taken separately, L1 reading ability contributed, $t = 4.630$, $p < .0001$, and L2 proficiency contributed, $t = 7.594$, $p < .0001$, to the dependent variable. Taken together, the two independent variables accounted for $R^2 = .3970$ of the variance in the dependent variable, shown to be highly significant, $F = 38.516$, $p < .0001$. Droop and Verhoeven (2003) also found oral proficiency in the target language to be of critical importance for the development of both L1 and L2 reading ability.

We can regard transfer of literacy and content knowledge across languages, then, as a descriptive fact, well attested in numerous studies. The theoretical challenge is to provide a model of the psychological mechanisms that might be seen as underlying this fact.

Psychological Modularity

Although the thesis is relatively new in the modern psychological sciences, Gallistel (2000) characterized modularity as the standard assumption of researchers in cognitive neuroscience with research focused on the specific properties of discrete mental modules, their development, and their interactions with each other (Bradley, Maxwell, Andersen, Banks, & Shenoy,

1996; Curtiss, 1994; Fodor, 1983, 2000; Grinstead, MacSwan, Curtiss, & Gelman, 1998; Musolino, 2004; Rauschecker, Tian, & Hauser, 1995; Weinberger, 1995).[1] Some researchers have argued that mental modules develop as a result of external experiences (Bloom, 1994; O'Grady, 1999); however, most assume that modular architecture is part of the human biological endowment and that each module is a kind of mental organ just like physically differentiated organs in nonmental aspects of human biology (Chomsky, 1995a; Gardner, 1993; Lightfoot, 1982). Gardner (1974, 1991, 1993) popularized the modularity thesis among educational researchers, but Chomsky (1968, 1984) and Fodor (1983) introduced the approach in modern times. Others, notably Jackendoff (1987, 1992, 2002), have proposed refinements of Fodor's approach with somewhat different views about the nature of mental modules and their differentiation. However, for purposes of the present discussion, Fodor's classic formulation of modularity will suffice to make the case that transfer may be expected to occur as a simple consequence of mental architecture.

What Fodor (1983) called vertical faculties of the mind have a long tradition in psychology. In contrast to horizontal faculties like memory, attention, and general intelligence, vertical faculties correspond to domains of intellectual activity, such as language, vision, numbers, music, systems of art, and so on. Each such domain constitutes a *modular cognitive system*:

> Roughly speaking, modular cognitive systems are domain specific, innately specified, hardwired, autonomous, and not assembled. Since modular systems are domain-specific computational mechanisms, it follows that they are species of vertical faculties. (Fodor, 1983, p. 37)

Fodor distinguished between the central processes and input systems, which are domain specific, informationally encapsulated, fast, mandatory, subserved by specific neural architecture, and subject to idiosyncratic pathological breakdown. Each mental module is related to the central processes in Fodor's system.

Cognitive scientists began with the argument from the poverty of the stimulus, demonstrating that the output of the organism is vastly underdetermined by its input, as a way of showing that perception is smart and therefore that perceptual identification cannot be reduced to a chain of reflexive responses. Fodor (1983) pointed out, however, that in so doing, early cognitivists failed to distinguish two distinct ways in which perceptual processes might be smarter (more cognitively informed) than reflexes. Reflexes, Fodor noted, were typically held to be cognitively uninformed (dumb) in two important ways: They were *noninferential* and they were *encapsulated*.

That reflexes are noninferential simply means that they are direct behavioral responses with no mediating cognitive processes. Here the early cognitivists were right to claim, on the argument from the poverty of the stimulus, that a great deal of inference generally intervenes between a proximal stimulus and a perceptual identification. Describing reflexes as encapsulated, on the other hand, means that they are triggered largely without regard to the beliefs and utilities of the behaving organism:

> Suppose that you and I have known each other for many a long year . . . and you have come fully to appreciate the excellence of my character. In particular, you have come to know perfectly well that under no conceivable circumstances would I stick my finger in your eye. Suppose that this belief of yours is both explicit and deeply felt. You would, in fact, go to the wall for it. Still, if I jab my finger near enough to your eyes, and fast enough, you'll blink. . . . [The blink reflex] has no access to what you know about my character or, for that matter, to any other of your beliefs, utilities, [or] expectations. For this reason the blink reflex is often produced when sober reflection would show it to be uncalled for. (Fodor, 1983, p. 71)

By contrast, a chess player's responses are well informed by the state of his utilities (trying to win, trying to lose, or just fooling around) and his beliefs about the task and the current state of the game. Perception, then, is smart like cognition in virtue of its inferential nature, but it is dumb like reflexes in that it is typically encapsulated and insulated from the system of beliefs.

These observations suggest that the perceptual apparatus is both inferential—that is, computational—in nature (given standard arguments from the poverty of the stimulus) and encapsulated (given that perceptual identifications appear to lack access to knowledge or beliefs as input). Hence, perceptual systems are modules of the mind, in some way distinct from other mental faculties. What is unique about perceptual processing (of music, language, noise, taste, smell, vision, touch) is that it appears to be involuntary in the sense that one cannot fail to perceive or process information just by desiring not to do so.

This conception of mental architecture might be represented graphically as in Figure 1. Each module is associated in some way with the perceptual system, and each is common to all members of our species. The language module, central to our discussion here, is slightly elaborated roughly in keeping with recent proposals in linguistics (i.e., the minimalist program of Chomsky, 1995b).[2]

A number of interesting case studies provide evidence from cases of selective impairment that language is discrete and separate from other mental

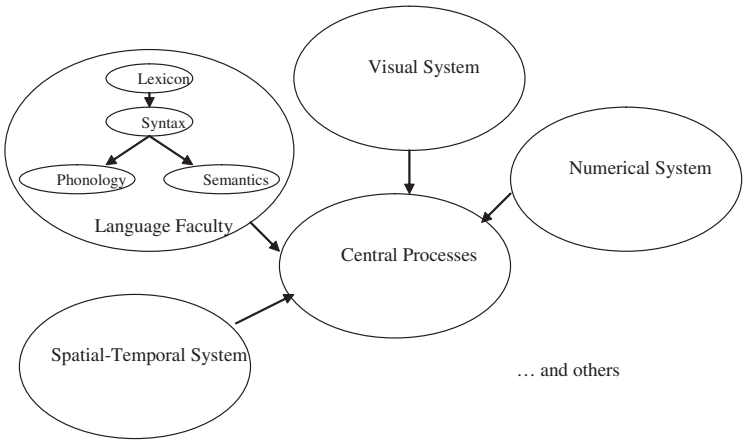

Figure 1. Psychological Modularity

faculties and from the central processes. Consider the cases of Genie, Chelsea, Laura, and Christopher.

Genie

Genie was tragically isolated in a closet from 20 months to past age 13 and received no linguistic input during these years. Curtiss (1977) conducted a study of Genie's speech following her isolation and found that she never passed beyond very basic syntactic and morphological ability, essentially stringing together content words to convey her message. Unlike normally developing children, Genie was never able to use such functional categories as pronouns and prepositions. Examples of her utterances include

1a. Applesauce buy store
"Buy some applesauce at the store."
1b. Genie full stomach
"I have a full stomach."
1c. Want Curtiss play piano
"I want you to play the piano."
1d. Father hit Genie cry long time ago
"When my father hit me, I cried, a long time ago."

Despite her evident inability to acquire grammar in the usual sense, Genie nonetheless acquired a well-developed sense of lexical semantics that included colors and numbers, shape and size terms, and supraordinate, basic, and

subordinate class terms. In addition, she could distinguish between objects in visual and functional terms; speak about nonpresent persons and objects, events to come, and memories; and increased in mental age 2 years for every 1 year following her captivity during the time she was studied. In other words, many aspects of Genie's development proceeded normally and were in certain respects unaffected by her isolation.

Genie's case suggests a dissociation of linguistic and general cognitive abilities. Were language and, say, knowledge of colors, numbers, shapes, and sizes all equally related to general human intelligence, this developmental dissociation would not be expected. Here we see sharp evidence that the dissociation of language from other mental faculties shown in Figure 1 is accurate; were these functions all equally part of a general intelligence of one kind or another, we would not see selective impairment of the sort noted. Another case that exhibits a similar dissociation is Chelsea.

Chelsea

Chelsea, a hearing-impaired woman who grew up in a small, rural community and who had no exposure to language until adulthood, lacks general linguistic competence to this day, but she is nonetheless completely competent in numerous other normal human skills and abilities (Curtiss, 1988, 1994, 1996; Dronkers, 1987; Glusker, 1987; Grinstead et al., 1998). With the use of aids, Chelsea's hearing falls within the normal range, and she now possesses a substantial spoken, sign, and written vocabulary, which continues to increase. However, after 13 years of language instruction and exposure, she still does not possess the rudiments of natural language grammar, such as knowledge of clause structure, morphological features, or other properties of syntax. Note, for example, some sample utterances:

2a. Missy girl same both girl
[comparing the gender of 2 animals]

2b. Interviewer: What is the cat chasing?
Chelsea: Cat chasing cat
[Answer: A dog.]

2c. P. broken. Nervous see P.
[P's car had broken down. Chelsea could see that P was nervous.]

Despite the persistence of her linguistic inabilities, Chelsea does not lack competence in other mental faculties. For instance, she can perform mathematical operations in her head and on paper, understands and uses money correctly, and can even keep a balanced checkbook. Notice in the following

examples of Chelsea's speech her ability to talk about numbers, the location of objects, specific times, and money:

3a. [Situation: Chelsea is in a house with three bathrooms but has seen only the two upstairs. She is downstairs, speaking to J, one of the inhabitants.]
C: I go bathroom
[Chelsea turns away and starts to go upstairs. J calls after her.]
J: There's a bathroom down here!
[Chelsea turns around as J points]
C: Three. Three bathroom.

3b. Baby. Have two.
[Chelsea comments correctly on the number of children that one of the investigators has.]

3c. Go work 8:30?

3d. [Regarding the need to buy a new battery for her hearing aid]
C: Change. Throw away. Battery no good. Pay less.
S: How much do they cost?
C: Three dollar. Pay less. Fifty cent.
[She only paid $2.50.]

Like Genie, Chelsea appears to have normal cognitive functioning in a number of cognitive domains. Nonetheless, her language is severely impaired. Again, this dissociation of language and other cognitive abilities suggests that mental modules are developmentally independent. Next, we will consider the case of Laura whose language is essentially normal but who has other severely impaired cognitive abilities.

Laura

Laura was studied at the end of her adolescence and evidenced sophisticated linguistic abilities despite her many other cognitive disabilities (Curtiss, 1988; Yamada, 1990). Laura could rote count into the teens but, despite years of special schooling, did not know basic counting principles. Although she could not count arrays of three or four items or tie her shoe, she displayed a fully mature knowledge of syntax. Examples of her speech are provided:

4a. Did you hear about me not going to this school up in Altadena?

4b. She does paintings, this really good friend of the kids who I went to school with last year and really loved.

4c. He was saying that I lost my battery-powered watch that I loved.

4d. It makes me feel sad because they had to leave.

4e. I'm very good friends of a girl that cuts X's hair, that I'm working with.

The examples illustrate that Laura's speech is perfectly well developed. In 4a, she shows knowledge of nominative and accusative case, subject-auxiliary inversion (evidenced by the placement of "Did . . . "), and gerundive nominalization. All of the utterances show sophisticated instances of overt NP^3 movement, and 4b and 4e reveal sensitivity to subtle and sophisticated principles of subject dislocation.

Yet Laura is severely retarded. Rated on the Wechsler Intelligence Scale for Children, her IQ ranged from 41 to 48 at different testings (Yamada, 1990). Consider the following typical utterances:

5a. I was like 15 or 19 when I started moving out o'home, so now I'm like 15 now, and I can go.

5b. J: How many nights did you stay there [at a hotel with her family]?
L: Oh, about 4 out of 1.

Laura's case, like Genie and Chelsea's, suggest that there is dissociation between language and other cognitive abilities in development. If language and, say, knowledge of numbers both developed as the result of general intelligence, then this dissociation (in either direction) would not be expected. Finally, we turn to the interesting and unusual case of Christopher, the language savant.

Christopher

Christopher's linguistic abilities were analyzed in Smith and Tsimpli (1995). Like Laura, Christopher is severely retarded. At 29 years old, tests of his nonverbal IQ range from 60 to 70, and he is unable to button a shirt, trim his fingernails, or vacuum the carpet. Yet, when given passages written in 15 languages, Christopher effortlessly translates the written text into English at about the speed one would normally read out loud in English. Besides English, Christopher has command (at varying levels of proficiency) of Danish, Dutch, Finnish, French, German, Greek, Hindi, Italian, Polish, Portuguese, Russian, Spanish, Swedish, Turkish, and Welsh.

Although Christopher does not engage in elaborative conversation, English constructions produced in his translations reveal a sophisticated knowledge of English. Consider the following examples:

6a. I had to take him out of the car strongly and put—he put himself on the floor and opened his eyes—and shut his eyes, not wishing to see what was waiting for him.

6b. The dog was immovable in the passage, looking the light, of the green light. Fixed—the green, the red light. All of a sudden a green light, motor-cars crossed, and the dog crossed by that side.
6c. Hello Tom. How are you? Can I come in? Of course you can. Come and sit on the bench here.

These examples reveal knowledge of wh-movement,[4] NP-auxiliary inversion, morphology, rules of word formation, overt NP movement, and complex clause structure. A receptive test of English grammar also assessed Christopher to be linguistically sophisticated.

Like Laura's case, Christopher's case reveals that language and other cognitive functions are distinct mental faculties that can be selectively impaired. Many other examples could be given of similar conditions. The facts suggest that discrete mental faculties develop independently of one another and that they do not uniformly reflect some underlying general intelligence.

Modularity: Language, Literacy, and Academic Knowledge

The neuropsychological facts suggest a picture of mental architecture along the lines outlined in Figure 1, suggesting that language is separate and discrete from other faculties. We might reasonably assume that in the case of bilingualism, both languages are represented in the human language faculty (Epstein, Flynn, & Martohardjono, 1996; MacSwan, 2000a). What about literacy? Traditionally, literacy is viewed as an aspect of language proficiency. Cummins (1981), for instance, viewed literacy as one aspect of communicative proficiency and took knowledge of language to *include* knowledge of reading and writing. However, unlike the perceptual systems, writing is a relatively recent invention and does not exist in all human cultures (for a discussion, see Gee, 2001; MacSwan, 2000b; MacSwan & Rolstad, 2003). In addition, it seems that written language does not have the character of a mental module in the sense described.

Literacy appears to rely upon a wide variety of cognitive faculties including knowledge of language, visual processing, shape recognition, motor control, systems of reasoning, and general knowledge of the world (Perfetti, 1985, 1994). A plausible psychological theory of school literacy would take reading and writing to be independent of special-purpose mental faculties of the sort that have been discussed above. On such a view, abilities like reading and writing recruit information as needed from relevant cognitive systems. This view is further supported by evidence from cases of selective impairment in which a blow to the posterior regions of the brain renders a person suddenly unable to read but with all normal language faculties intact; in fact,

some such patients can even still write, but they cannot read their own writing (Gardner, 1974). Thus, school literacy may be seen as one among many of the ways language is used to satisfy human purposes but is itself not a task-specific faculty of the sort described here, nor is it a subcomponent of the language faculty. Although literacy is not a component of linguistic competence in the way syntax or phonology is, it *is* an instance of language use and puts to use numerous other cognitive resources in an effort to encode a linguistic message.

Notice that the observation that literacy is an aspect of academic achievement and not of language per se tells us nothing about how literacy is learned, as Gee (2001) has noted. It may very well be true that literacy is learned precisely the same way an L1 is learned, or an L2 for that matter, or much the same way. This is an independent question that we do not take up here.

Modularity: Explaining the Facilitation Effect

We suggest, then, that bilinguals experience transfer of academic knowledge across languages because both languages have access to the central processes. In this regard, the usual meaning of *transfer*, which implies that a process moves knowledge from one language to another, is incorrect. Rather, both languages have access to the same store of knowledge, which is available to learners regardless of how the knowledge was acquired in the first place. Transfer simply occurs as a natural consequence of mental architecture. The picture in Figure 1 is reminiscent of Cummins's (1981) representation of the CUP model, except that in our view, knowledge of language is discretely represented and distinct from other knowledge systems (what Cummins called underlying proficiency). This is an important enhancement: If we view literacy and other aspects of academic knowledge as somehow part of the underlying proficiency of learners, we foster a conception of language proficiency in which higher levels are defined in terms of the language and language use of the educated classes. Because language is the natural possession of all members of the human species, regardless of cultural or socioeconomic background, defining levels of language ability in terms of how much one knows about the nonlinguistic worlds of the educated classes tends to legitimate classism. Furthermore, apart from being disfavored by the neuropsychological evidence, such a theory caries with it an unfulfilled obligation to make explicit the contents or structure of the CUP.

We defined the facilitation effect as a relationship between languages used in a bilingual setting such that learning in an L1 facilitates learning outcomes in an L2. If we refer here to learning academic subjects and literacy, then facilitation consists in transfer. But it might be argued, as Krashen (1996) has

suggested, that learning school subjects in an L1 facilitates growth in L2 linguistic knowledge as well by providing students with a richer understanding of the context and setting in which linguistic inferences are made regarding word meaning and the grammatical structure of the L2. This suggests a conception of semantic bootstrapping consistent with research in L1 acquisition (Grimshaw, 1981; Pinker, 1984).

Conclusions

We have outlined the modularity thesis and reviewed four cases of selective impairment to support it. Two cases (Genie and Chelsea) show that severely impaired language may be accompanied by essentially normal cognitive abilities in other domains of mental life. The other two cases (Laura and Christopher) reveal that perfectly normal language ability may be found in individuals who are severely retarded. Together, the cases considered suggest that human cognitive systems are modular, as presented graphically in Figure 1; each subsystem, in Fodor's (1983) terms, is domain specific, informationally encapsulated, fast, mandatory, subserved by specific neural architecture, and subject to idiosyncratic pathological breakdown.

Viewed in these terms, transfer is effortless; it refers to the accessibility of information across linguistic domains, in the central processes, and made available to the language system. In this sense, transfer in bilinguals is not different from knowledge access in monolinguals. Facilitation obtained among languages used in a bilingual setting when learning in an L1 facilitates learning outcomes in an L2.

Because children typically take some time to learn an L2, the home language is the best medium for instruction in the early years of a child's academic career. This approach allows students to keep up academically while taking the time needed to master an L2. It also affirms children's sense of identity and belonging in the classroom and integrates them as well as their world into the local community of learners (Rolstad, 1999, 2000). Krashen (1996) further suggested that instruction in a child's home language serves as a resource for acquiring linguistic knowledge in the L2 by providing a context for making inferences about word meaning and language structure.

Rossell and Baker (1996) were incorrect to claim that our current understanding of the nature of the mind/brain and mental processes suggests that we should not find a facilitation effect. Quite the contrary, the facilitation effect is a natural consequence of mental architecture, as understood in the modern cognitive neurosciences, and a fundamental characteristic of the brain itself.

Notes

1. Connectionism is another active area of research in cognitive science. See Marcus (1998) for remarks on this approach.

2. See Adger (2003) for an accessible discussion of the minimalist program. MacSwan (2000b) adapted this framework to bilinguals' language on evidence from code switching.

3. NP (noun phrase), also commonly called a DP (determiner phrase), is a phrasal category in syntactic theory that appears as a node in a phrase structure representation. Under certain conditions, it undergoes movement (or inversion with an adjacent element) within the phrase structure representation.

4. Wh-movement entails the fronting of syntactic elements that host question words (such as *what*, *who*, *how*, *when*, *where*) within a hierarchical phrase structure representation in the class of languages known as wh-movement languages (English among them).

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