BILINGUAL COGNITION: THE WALLACE LAMBERT CONNECTION

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Following 22 months of wartime service in the Canadian Navy, Allan earned three degrees—B.Sc., M.Sc., and Ph. D. (1959)—from McGill University. During and after his Ph. D. program in psychology, he held the following University positions: Sessional Psychology Lecturer, Summer School, 1957, Sir George Williams College; Research Psychologist, Cornell University, May 1958-September 1959; Assistant Professor, Psychology, University of New Brunswick, 1959-1962; Psychology Department Faculty member at the University of Western Ontario since 1962 (Full Professor, 1967; Professor Emeritus from1992 to the present).

During his teaching career he has taught various psychology undergraduate and graduate courses, and supervised many graduate students, including 30 Ph. D. students who went on to productive academic and other professional careers.

His own research and scholarly work was supported for more than thirty years by grants from several granting agencies, most continuously from the Natural Sciences and Engineering Research Council of Canada. The support is reflected in publications of five books (most recently "Mind and its evolution: A dual coding theoretical approach," Erlbaum, 2007) and approximately 200 journal articles and book chapters.

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ABSTRACT

A course I took from Wallace Lambert in 1954 at McGill required a novel experiment. Lambert encouraged me to investigate language learning implications of a French-English difference in grammatical habits whereby, in English, descriptive adjectives typically precede the nouns they modify whereas the reverse order is typical in French. A language habits hypothesis thus suggests that unfamiliar phrases would be easiest to remember in their language-typical grammatical order. A mnemonic technique with which I was familiar uses concrete nouns as memory pegs (reminders) for associated information, suggesting that, by analogy, the noun-adjective order would be favored in language memory regardless of language habits. An experiment I devised clearly supported the prediction from the memory–peg hypothesis. Later, tests of that hypothesis and other variants led to the development of a general dual coding theory (DCT) of cognition that entails the cooperative interplay of verbal and nonverbal mental processes in memory, language, and thought. In the extended program, Lambert and I collaborated on experiments involving bilingual memory and cognition that supported DCT and its extension to bilingualism.

BACKGROUND

My research connection to Wallace Lambert began early in my attempts to develop a general scientific theory of mind aimed at explaining such intellectual abilities as memory, problem solving, language, and thinking. The connection began in 1954 when Lambert joined the Psychology faculty at McGill University. I then had a McGill undergraduate degree and wanted to get into their psychology graduate program. To qualify I had to take make-up undergraduate courses, one of which was an honour's level course on human experimental psychology taught by Lambert. Part of the course required each student to devise and conduct an independent experiment under his supervision.

Among other possibilities, Lambert and I considered untested implications of a grammatical word-order difference between English and French. In English, descriptive adjectives generally precede nouns (e.g., the red, white, and blue flag) whereas in French such adjectives typically follow nouns (e.g., le drapeau bleu, blanc, rouge). The research question was whether English and French speakers would differ in how easily they could learn and remember novel phrases presented in an adjective-noun (A-N) or a noun-adjective (N-A) grammatical order. Lambert reasoned from a language habits perspective that Anglophones should do better with phrases presented in the typical English A-N order whereas Francophones should do better with the N-A order. I argued instead that the N-A order would be easier for both linguistic groups, and that the counter-intuitive part of the prediction could be initially tested using only English language phrases and speakers.

My expectation was based on an analogical extension of a mnemonic technique I had learned in one session of a commercial public speaking course I took in 1950. The instructor asked us to name 20 objects in the meeting room, with a brief pause between each. A student recorded the words and their numerical order. We then called out the numbers from one to twenty in random order and the instructor promptly recalled the associated words. We were mightily impressed. The instructor assured us that the memory feat was easy and taught us how to do likewise.

We first memorized a list of rhyming number-word pairs: one-bun, two-shoe, three-tree, four-door, five-hive, six-sticks, and so on, up to 20-horn of plenty We then used the rhyme to remember a list of items by combining mental images of a bun, shoe, tree, etc. with images suggested by the memory targets. For example, take pencil, chair, and lamp as the first three words in a list of words to be remembered and visualize a pencil as, say, a filler inside a hamburger bun, a chair with a leg stuck in a shoe, and a lamp as a decoration on a Christmas tree. Now, start with the numbers one, two, three in any order and you will find that they quickly prompt you to remember the rhyming peg-words bun, shoe, tree, which in turn will remind you of the images of the associated object pairs from which you can retrieve the target word.

In the extension of the rhyme mnemonic to the phrase learning experiment, I viewed the first words of a series of phrases as memory pegs (reminders) for the remaining words, with nouns in the N-A order being more effective pegs than adjectives in the A-N order because the nouns could more readily evoke images that include the adjectival properties than vice versa. In support of the hypothesis, native English speakers learned lists of N-A phrases in fewer trials than lists of A-N phrases.

In the published report (Lambert & Paivio, 1956), we referred to the nouns as *conceptual pegs* for storing and subsequently retrieving the adjectival modifiers. This would turn out to be a felicitous and productive rephrasing of the memory-peg metaphor in subsequent experiments in which the conceptual-peg hypothesis became part of the increasingly complex structure of dual coding theory (DCT) of cognition—a structure that was to include the verbal associative mechanisms that happened not to be supported in our adjective-noun learning experiment but were supported later in other DCT experiments. I review key points in that DCT history and also identify the general relevance of the conceptual peg hypothesis for everyday memory and more esoteric topics such as the evolution of language.

DUAL CODING THEORY

The basic assumption of DCT is that human memory and cognition entail the interplay of an evolutionarily-ancient nonverbal system that can perceive, remember, and think directly about the "real world," and a recently evolved verbal system that uses a linguistic code to indirectly represent (symbolize) and communicate about the nonverbal world (as well as language itself). The conceptual peg task is a condensed example of dual coding activity in that it requires the user to (a) understand verbal instructions, names of objects and their attributes, (b) translate these into nonverbal images in which the entities interact in some way, (c) store the images and their names in memory, and finally (d) reinstate the images into words during recall. To do all that, the two systems must be functionally independent but flexibly interconnected so that one or other system, or both systems, can be activated and used to deal with such tasks.

The adjective-noun conceptual peg experiment was modified in ways that led directly to DCT. The learning task was first simplified (Paivio. 1963) by using word pairs (e.g., *deep-valley* versus *valley-deep*). In addition the pairs included noun members that were either concrete (e.g., valley) or abstract (e.g., place) on the theoretical rationale that the classic rhyme mnemonic technique calls for the use of nouns that readily evoke images that

can mediate verbal recall. The task was changed to paired associate learning in which study of the pairs was followed by tests in which the participants were presented only the first word of each pair and tried to recall its absent associate. The results confirmed the conceptual peg hypothesis in that subjects of different ages remembered more responses from N-A than A-N pairs. Furthermore, in keeping with the idea that concreteness and imageability are important properties of peg words (e.g., bun), recall was better when the nouns were concrete rather than abstract.

Further research (Paivio, 1965) tested additional implications of the conceptual peg hypothesis using noun-noun pairs in which the words were either concrete (C) or abstract (A), in all possible combinations, so that equal numbers of pairs were CC (e.g., coffee-shoe), CA (e.g., flower-theory), AC (e.g., fate-chair), and AA (e.g., event-duty). Following study of the pairs, subjects tried to recall the appropriate responses when presented only the stimulus nouns. The reasoning from the conceptual-peg hypothesis was that concreteness of both stimulus and response nouns would benefit recall because memorizers could generate compound images that connect pairs during study, but concreteness of the stimulus words would be especially important for later recall because concrete nouns could reintegrate (reinstate) the compound mnemonic images formed during study, which would help remind them of the missing verbal responses. Thus recall from highest to lowest for the different pair types should be CC>CA>AC>AA. This was precisely the pattern of results, with recall differences between all pair types being large and statistically significant.

Related experiments confirmed the component processes assumed to be effective in the conceptual peg hypothesis. Thus, it was consistently found that the positive effect of concreteness was due to the image-evoking value of concrete words rather than some other correlated language attribute. Even the imagery value of adjectives benefited associative recall independent of the effect of noun imageability, especially when they served as stimulus reminders for response words (e.g., Yuille. Paivio, & Lambert, 1969). Moreover, associative memory was even better when imagery was made directly available using object pictures rather than words as stimuli for verbal recall of either pictorial or noun associates.

The imagery-based conceptual peg hypothesis is relevant to a wide range of memory phenomena observed in "real life" as well as in laboratory experiments. The following examples illustrate this range. (1) A famous literary example of stimulus-evoked imaginal memories occurs in Marcel Proust's monumental novel, *A la recherche du temps perdu*. Proust's main character describes how the taste of a piece of madeleine sponge cake dipped in tea reminded him of the first time he had that taste experience. This was followed immediately by a flood of memories of his childhood home, garden, street, village, people, the pleasures experienced, all activated by a cup of tea. This is analogous to the evocation of memory images by object pictures in the DCT conceptual peg experiments. Imagining such experiences when reading about them in Proust is analogous to the redintegrative effect of concrete stimulus words in our experiments. (2) Similarly interpretable are so-called flash bulb memories elicited by cues associated with particularly salient events. For example, "nine eleven" promptly reminds us of where we were and what we were doing when we first learned of that tragic event. (3) A continuous interplay of verbally-evoked imagery and verbal thinking processes is involved in mentally solving the following problem: Think of a cube with red surfaces. Imagine cutting it into 27 smaller cubes by making two parallel cuts on each surface. How many of the small cubes have two red faces? How many have 3? How many one? How many none? The answers come most easily using interactive dual coding. (4) Many animal species use vocal signals to communicate the presence of predators or food sources. Such *referential signaling* has been much studied in vervet monkeys. An observer monkey emits different warning sounds when it has seen a leopard, eagle, or snake. Listeners that have not seen the predators respond by taking appropriate evasive action. Zuberbuhler, Cheney, and Seyfarth (1999) found evidence that such referential responding in another monkey species was mediated by the activity of "mental representations not unlike those linked to the human linguistic concepts *leopard* and *eagle*" (p. 41), an interpretation obviously analogous to the imagery-based conceptual peg hypothesis.

As a final example, a DCT evolutionary hypothesis asserts that language originated as a mnemonic device (Paivio, 2007, pp. 281-282; Paivio & Begg, 1981, p. 171). If everything our distant ancestors learned to talk about were always present, there would have been no need for a language. Pointing to significant objects or events would have been sufficient. Spoken language is especially useful for prompting listeners to remember past events that are currently relevant. This is a functional theory of language origins that emphasizes why language began rather than how it began (e.g., from gestures, imitation of natural sounds, and so on, as summarized in Paivio, 2007, chapter 12).

THE CODING INDEPENDENCE/ADDITIVITY MEMORY HYPOTHESIS

We turn now to a DCT explanation of memory effects that do not involve explicit retrieval cues (reminders). Free verbal recall is a prototypical example in which the DCT analysis led to further bilingual memory experiments with Lambert. In free recall, participants are presented a list of words or nameable objects and then verbally recall as many as they can in any order, either orally or in writing.

The pertinent result here is that correct recall increases from abstract words, to concrete words, to objects or their pictures. These results are counterintuitive. First, names are more directly available to printed words than to nonverbal pictures, so why should verbal recall be easier for pictures than words? Second, concrete and abstract words matched on familiarity are equally easy to recognize and name, so why should concrete words have the memory advantage? The DCT explanation, first proposed and tested beginning more than 40 years ago (summarized, e.g., in Paivio.1986) is that (a) the probability that items will be stored in memory both verbally and nonverbally during list presentation increases from abstract words, to concrete words, to pictures; (b) the two codes are stored independently in memory so that one or the other, or both codes, might be reactivated during recall; and (c) the nonverbal (image) code is mnemonically "stronger" (i.e., is more memorable) than the verbal code. If correct, these assumptions taken together would explain the pattern of free recall results for the three types of items.

The code additivity hypothesis was tested and supported by a series of experiments (e.g., Paivio & Csapo, 1973) in which recall was compared for items presented or coded both verbally and nonverbally (e.g., by presenting pictures and their labels, or having subjects generate images to words) and items presented or coded only verbally or only nonverbally, either once or twice. Consistent with DCT, dual verbal-nonverbal coding had additive effects on recall relative to various control conditions. Moreover, the contribution of pictures or mental images to the additive effect of dual coding was twice that of the verbal code, justifying an empirically based image-superiority addendum to the DCT hypothesis.

VERBAL-NONVERBAL AND BILINGUAL VERBAL-VERBAL LANGUAGE INDEPENDENCE

The above can now be put in the context of Lambert connections to the DCT research program. Even before the experimental tests of the dual-coding independence/additivity hypothesis, I had wondered about the relative memory value of the verbal and nonverbal codes. Are they of equal value as memory codes or is one code worth more than the other? I thought that the question could be answered by comparing verbal-nonverbal dual coding with bilingual verbal-verbal dual coding if it can be assumed that the bilingual's two language codes are mnemonically independent rather than interdependent, a contentious general issue in bilingualism research at that time (e.g., see Paivio, 1991; Paivio & Desrochers, 1980}.

The language independence hypothesis specifically implies that translation equivalents such as *horse* and *cheval* would have an additive memory effect for French–English bilinguals. Moreover, each word should contribute equally to their additive effect as compared to a greater contribution of the image code, as in the verbal-nonverbal dual coding studies described above. The prediction was tested (Paivio & Lambert, 1981) using French–English bilinguals who were (a) shown pictures, French words, and English words one at a time and were required to write the English name of each picture, translate each French word into English, or simply copy each English word; or (b) shown only English words accompanied by cues that prompted them to image to one third of the words, translate one third into French, and copy the remainder. Participants in both conditions were then given an unexpected memory test in which they were required to recall the English words they either had written down or were presented.

The results of both experiments clearly showed that recall was highest for items in the verbal–nonverbal dual coding conditions, intermediate for translated items, and lowest for copied items. Especially relevant here is the fact that the bilingually coded items were recalled twice as well as the monolingually coded (copied) items, supporting the hypothesis that the two language codes were independent and additive in their joint effect on recall. The equally large further increase with verbal–nonverbal dual coding buttresses the image-superiority addendum to the additivity hypothesis; that is, pictures or images contributed more to recall than did an additional verbal code. (The critical results were replicated by Jyotsna Vaid,1988, thus adding to the Lambert connection in that she, too, was Lambert's student). A subsequent experiment (Paivio, Clark, & Lambert, 1988) completed the case for memory independence of bilingual verbal codes in that abstract translation equivalents (e.g., *truth-veracité*) also showed additive effects, but overall recall was lower than for concrete translation equivalents, presumably because the latter were more likely also to evoke nonverbal mental images.

An extension of DCT to bilingualism (Paivio & Desrochers, 1980) explains numerous other aspects of bilingual cognition that indirectly implicate a Lambert connection. Rather than review those, I conclude with a speculative extension of the preceding analysis to Lambert's direct contribution to the understanding of bilingual intelligence. Peal and Lambert (1962) were the first to show that bilingual education was associated with advantages in tests of general intelligence. This has been further supported by subsequent research, including studies of brain function (e.g., Bialystok, Craik, & Freedman, 2007). The Paivio and Lambert DCT research suggests that the general bilingual intelligence advantage might be due in part to additive memory for information processed in two languages in educational settings and in everyday life. Experiments could be devised to test this hypothesis.

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