Language-Dependent Memory in Bilingualism

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Abstract

Language-dependent memory refers to a cognitive phenomenon in which memories are easier to access in the language in which they were formed. It was proposed by Marian and Neisser in 2000 in a study that revealed that bilinguals show better memory when the languages of encoding and recall are the same than when they are different. For both episodic and semantic memory, bilinguals remember events and general knowledge better when the language of encoding and retrieval match. Language-dependent memory effects are also present in real-world educational and clinical settings. In schools, bilingual students can benefit from being tested in the same language in which they learned the information. In psychotherapy, therapists can leverage bilingual patients' languages when discussing past experiences and/or treating trauma. Several potential mechanisms and theories can explain language-dependent memory: (1) the encoding specificity principle (which proposes that similar external and internal contexts at encoding and retrieval facilitate memory), (2) grammatical differences between languages (which facilitate encoding of unique event details), (3) dual-language activation during speech processing (which guides attention to specific items), (4) the dual coding theory (which suggests that bilinguals can access memories via two linguistic routes), and (5) connections between neurons (which are strengthened when linguistic contexts match). Here, we provide an overview of language-dependent memory, describe the circumstances under which it can be observed, and discuss theoretical frameworks. We conclude by suggesting future research directions that can further uncover the power language has in crafting our past, present, and future selves.

Keywords

Language-dependent memory, Memory, Language, Bilingualism, Episodic memory, Semantic memory, Recall, Encoding

[A]Language and Memory Intertwined

Science fiction writers have a unique love for the field of linguistics. Their stories often contain explanations grounded in real linguistic theories like functionalism, linguistic relativity, language evolution, and more. An alien language, for example, may allow its speakers to time travel or move physical objects. While this is indeed science fiction, speaking more than one language can transport us across time and space, figuratively speaking at least.

Bilinguals experience their lives in a unique combination of the languages they speak. One of us, for example, grew up in Moldova speaking Romanian, before moving to the United States at the age of 17 and switching to English. As a result, they can easily recall their childhood phone number if asked in Romanian, but if asked in English, struggle to report the digits. Another one of us went to school in Argentina and can recite the multiplication table in Spanish, but draws a blank if asked to do so in English. More poignantly, speaking our childhood languages floods all of us with vivid and emotional memories of our parents and grandparents, whereas English triggers more recent memories from our current English-speaking environments. These are all examples of **language-dependent memory**, a linguistic phenomenon in which memories are easier to access in the language in which they were formed.

In this chapter we review the discovery of language-dependent memory and describe some of the settings in which it can be found. We discuss potential mechanisms driving language-dependent memory, the variables that influence it, and promising future research directions. Throughout, we show the power language has in crafting our past, present, and future selves.

[A]What is Language-Dependent Memory?

Memory is a cognitive function that is generally conceptualized by its duration (long vs. short term) and content (implicit vs. explicit). Short-term memory is an information-maintenance system that controls access and encoding to long-term memory. It is part of the broader working memory, which also includes attention and cognitive control systems. Long-term memory contains stable representations of knowledge that can be explicit (e.g., facts, events) or implicit (e.g., skills, routines, or associations). Explicit memory can be further divided into episodic memory, one's recollection of events and their contexts, and semantic memory, one's general knowledge of the world. Research on language-dependent memory has primarily focused on episodic and semantic memory.

The discovery of language-dependent memory is tied to research on **context-dependent memory**. Godden and Baddeley (1975) and Tulving and Thomson (1973) discovered that similar contexts at encoding and retrieval improved memory. Marian and Neisser (2000) proposed that language acts as a context and tested whether matching *language* contexts at encoding and retrieval facilitated autobiographical episodic memory. In the first experiment, English-Russian bilinguals recounted personal memories based on either English or Russian word prompts. As predicted, when interviewed in English, participants were more likely to recall personal memories from a time when English was being spoken, and when interviewed in Russian, they were more likely to recall memories from a time when Russian was being spoken. In a second experiment, the language of the word prompt and the language of the interview were both found to influence autobiographical memory. The finding that matching linguistic contexts influences recall of autobiographical memories has since been replicated with Polish-Danish, Spanish-English,

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Japanese-English, Danish-English, and other bilingual populations (Larsen, Schrauf, Fromholt, & Rubin, 2002; Marsh, Kanaya, & Pezdek, 2015; Matsumoto & Stanny, 2006; Mortensen, Berntsen, & Bohn, 2015).

Language-dependent memory is found not only in episodic recall, but also in semantic recall. Semantic memory contains general knowledge of facts and concepts, like that Hawaii is an island in the Pacific Ocean or that bees pollinate flowers. To test whether semantic memory was language-dependent, Marian and Kaushanskaya (2007) asked Mandarin-English bilinguals general knowledge questions in both Mandarin and English. For example, participants were asked to "name a statue of someone standing with a raised arm looking into the distance." Possible answers could have been learned in English (e.g., *Statue of Liberty*) or in Mandarin (e.g., *Statue of Mao*) and had either one, two, or multiple correct answers. Overall, bilingual participants were more accurate and faster in accessing semantic memory when the language of testing matched the language in which the knowledge was learned. Moreover, the magnitude of the effect was influenced by the type of question asked. Questions that had multiple correct responses (e.g., *name four lakes*) were more likely to show language dependent effects than questions with a single correct answer (e.g., *the capital of Illinois*).

These early studies on language-dependent memory showed that the linguistic context of a memory could be used as a cue to facilitate episodic and semantic retrieval. Subsequent studies have expanded on these findings on the influence of language on memory.

[A]Language-Dependent Memory in Educational Settings

In educational settings, memory plays a particularly important role because students are required to learn, remember, and recall information. When students are bilingual, information can

be learned and retrieved in either of their two languages, introducing potential language-dependent memory effects. In one study, English-Spanish bilinguals learned information from different content areas (biology, chemistry, history, mythology) in either English or Spanish (Marian & Fausey, 2006). When tested, participants gave more correct answers when the language of learning and testing matched. However, this was only the case for participants with similar proficiency in both languages, also known as *balanced* bilinguals. Bilinguals with unequal proficiency in their two languages, known as *unbalanced* bilinguals, did not show language-dependent memory effects, likely because of language processing differences between the two groups. Unbalanced bilinguals experience greater cognitive and memory demands in their less proficient language, so language was likely one of many different variables, lowering its salience as a memory cue. In contrast, balanced bilinguals show similar cognitive processing across languages, and language may have been the primary differentiating factor, making it a more salient cue to retrieve memories.

Bilgin et al. (2023) tested Turkish-English bilingual students that were highly proficient in both languages on their recall of fictional stories. Students remembered the stories better when they read and recalled them in the same language than when they did so in different languages. In contrast, bilingual students with unbalanced proficiencies have a harder time learning and remembering information in their less proficient language (Vander Beken & Brysbaert, 2018). When a bilingual's second language proficiency is low, the cost of being tested in the lower proficiency language outweighs the memory benefits of matching linguistic contexts (Vander Beken, De Bruyne, & Brysbaert, 2020). These findings suggest that language proficiency mediates language-dependent memory (Esposito & Baker-Ward, 2016), with stronger effects among balanced bilinguals (Bilgin et al., 2023; Marian & Fausey, 2006).

One content area that has received particular attention from psycholinguistics is mathematics. There is a longstanding debate on the degree to which mathematical computations are language independent. In general, bilingual students are better at solving math problems in their native language (Van Rinsveld, Schiltz, Brunner, Landerl, & Ugen, 2016). Despite native language status, language-dependent memory effects in bilinguals can be observed when solving mathematical problems in either language. When bilingual students are taught in one language and then tested in a different language, they solve math problems more slowly and less accurately than when the language of learning and testing match (Kempert, Saalbach, & Hardy, 2011; Saalbach, Eckstein, Andri, Hobi, & Grabnerr, 2013; Volmer, Grabner, & Saalbach, 2018). Like with other subjects, language proficiency seems to mediate language-dependent memory effects in solving mathematical problems (Kempert et al., 2011; Volmer et al., 2018). In line with Fausey and Marian (2006), students with high proficiency in both languages benefitted the most when the language of instruction and testing matched (Kempert et al., 2011). In other words, solving mathematical problems can be subject to language-dependent memory effects and is influenced by linguistic context and language proficiency.

To conclude, the effects of language-dependent memory can be seen in educational settings across different types of content areas (Bilgin et al., 2023; Marian & Fausey, 2006; Volmer et al., 2018). Bilingual students can benefit from learning and being tested in the same language (Bilgin et al., 2023; Marian & Fausey, 2006), as long as they are highly proficient in both languages (Kempert et al., 2011). With the rise of internationalization in school settings, understanding the role of language in how bilinguals learn and retrieve information can help support bilingual students and facilitate their academic success.

[A]Language-Dependent Memory in Clinical Settings

In clinical settings, language-dependent memory can impact the assessment and treatment of bilingual patients. For example, bilingual psychotherapists are finding success in leveraging bilingual patients' languages to discuss past experiences and treat trauma. Studies of bilingual psychotherapy show that communication in the native language is more emotionally charged than communication in the second language. A foreign language creates more emotional distance than one's native language (Harris, Ayçiçeği, & Gleason, 2003) due to the emotionally rich environments associated with the native language (Ivaz, Costa, & Duñabeitia, 2016). Bilingual psychotherapists can switch between languages to increase or decrease emotional distance, depending on the needs of their clients (Das, 2020; Verkerk, Backus, Faro, Dewaele, & Das, 2021). Using a second language can help bilinguals distance themselves emotionally, feel safer, and not become overwhelmed when discussing past trauma (Cook & Dewaele, 2022; Dewaele & Costa, 2013). In other cases, bilinguals may benefit from the emotional release that comes with speaking about trauma in their native language (Schwanberg, 2010; Szoke, Cummings, & Benuto, 2020). Moreover, recalling traumatic events in the language in which they occurred can help with memory retrieval, especially if memories are hard to access due to their emotional nature (Tehrani & Vaughan, 2009).

Considering the important roles that memory and language play in our everyday lives, it is not surprising to find language-dependent memory in clinical settings. A bilingual's choice of language can influence not only what they remember, but also the emotionality, vividness, and intensity of the memory. Retrieving memories in a different language may provide emotional distance from a memory, whereas using the same language at encoding and retrieval can lead to more emotionally charged memories. Bilingual providers could leverage language-dependent

memory to help clients navigate emotional conversations and reframe memories in therapeutic settings. In the next section, we discuss *how* language may affect memory in bilinguals, highlighting five proposed mechanisms contributing to language-dependent memory.

[A]Theories and Mechanisms Driving Language-Dependent Memory

[B]Encoding Specificity Principle

The first and most established explanation for language-dependent memory is the **encoding specificity principle**. Introduced by Thompson and Tulving in 1973, the encoding specificity principle proposes that similar contexts at encoding and retrieval facilitate memory. In other words, remembering events can be easier if the context in which the memory was formed is the same as the context in which the memory is recalled. When a memory is formed, contextual information is encoded along with it, which can later be used as a cue that makes accessing the memory easier. Crucially, the language of an event can serve as a linguistic cue that if later replicated can facilitate memory retrieval.

When encoding a memory, language can be an external and/or internal context. External contexts refer to the physical or environmental information of an event. For example, Godden and Baddeley (1975) found that scuba divers remembered lists of words learned underwater better if they were recalled underwater. This type of **context-dependent memory** has been extended to language, in which the language(s) spoken in an environment can cue memory at retrieval. Cues can also be internal, reflecting the physical and mental state of a person, resulting in **state-dependent memory**. For example, people have an easier time remembering information they learned while intoxicated if they are again intoxicated when recalling the information (Weingartner, Adefris, Eich, & Murphy, 1976). Similarly, **mood-dependent memory** occurs

when a person's mood (e.g., sad) is the same at encoding and retrieval (Eich, Macaulay, & Ryan, 1994). Since a bilingual's mental state can change across languages, language can also be thought of as an internal context. In sum, language can aid recall in a similar way to context-, state-, and mood-dependent memory.

[B]Language Structure

Bilingualism can influence memory through the unique grammatical structures of a given language. During an encoding event, the grammar of a particular language can guide attention in a way that influences memory. Attention is a fundamental component of memory, as information that we devote attention to is better encoded and retrieved (Aly & Turk-Browne, 2016). For example, languages differ in how they express motion events, which can subsequently impact how well they are remembered (von Stutterheim, Andermann, Carroll, Flecken, & Schmiedtová, 2012). In English, speakers prefer to express the manner of the motion with a verb and the path of the motion with a preposition (e.g., *Claudia leaped onto the court*). In Spanish, speakers use a different grammatical pattern where the path is expressed in the verb and the manner can be an adverb (e.g., *Claudia entró a la cancha saltando / Claudia entered the court jumping*). Filipović (2022) examined whether proficiency in Spanish and English influenced memory for motion events in monolinguals and bilinguals. English monolinguals were able to verbalize complex motion events more easily and as a result remembered them better. In comparison, speakers of Spanish (both monolinguals and bilinguals) seemed to be constrained by the grammatical structure of Spanish and showed worse recognition memory for the manner of the motion events. These findings mirror monolingual studies that show that when the grammar of a language makes it harder to verbalize certain aspects of an event, memory can suffer (Boroditsky, Ham, & Ramscar, 2002). Explicitly

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teaching the grammatical nuances of how a language encodes event features can facilitate memory for specific event details (Koster & Cadierno, 2019), suggesting that being aware of a language's grammar plays a role in episodic memory.

In sum, bilinguals' memory for some events may be better because the structure of one of their languages is better suited for describing some events. Therefore, bilinguals may benefit from both encoding and retrieving a memory using a specific language structure. Just like matching linguistic contexts at encoding and retrieval can serve as a memory cue, using the same language structures may act as a scaffold that helps bilinguals remember certain events better.

[B]Linguistic Co-Activation

Another linguistic mechanism that can influence attention to and memory of an event is **linguistic co-activation**. When hearing a word, listeners automatically activate similar-sounding words, which can influence what objects they look at in a visual scene (Allopenna, Magnuson, & Tanenhaus, 1998). For example, when tested in an experimental setting, people asked to search for a *clock* will also look at other objects with similar-sounding names, like c*lown* and *block*. In bilinguals, hearing a word activates both of their languages, resulting in greater attention to objects that overlap within a language (e.g., *clock-clown*) but also between languages (e.g., for English-Spanish bilinguals, clock-*clavo*; Marian & Spivey, 2003). Recent findings suggest that this dual-language co-activation can influence memory for objects in a visual scene (Fernandez-Duque, Hayakawa, & Marian, 2023; Marian, Hayakawa, & Schroeder, 2021). Fernandez-Duque et al. (2023) tested English monolinguals and English-Spanish bilinguals on their recognition memory for objects that overlapped phonologically during a visual search task. Participants heard an English word and found the target item in an array of four objects. Monolinguals and bilinguals

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remembered objects that overlapped within-language with an English target better than control objects without linguistic overlap. In bilinguals, high Spanish proficiency improved memory for competitor objects that overlapped *across* languages, like *clock* and *clavo* (nail in Spanish). The enhanced memory was associated with greater attention to competitor objects (i.e., more looking time) while looking for the target object. These findings show how the linguistic context of an event can promote attention to specific objects and later influence memory for those objects in bilinguals. Episodic memory may therefore depend on the linguistic context of the event, but also on the names of objects seen during the event. For example, the objects that bilinguals remember seeing may depend on the language of encoding, the language of retrieval, *and* what the objects are called in each of their languages. Research in this area is in its infancy; future studies are needed to understand how the lexical form of an item influences memory.

[B]Dual Coding Theory

According to the *dual coding theory* (Paivio, 1991), memory is represented through both sensory and linguistic information. For example, our knowledge of what a dog is has sensory components (i.e., the way a dog looks, sounds, smells, etc.) and verbal components (i.e., the word "dog"). When accessing memories, both sensory and verbal information can be used. Paivio (1986) proposes that the sensory and verbal components of a memory are interconnected.

The bilingual extension of dual coding theory (Paivio, 2014) proposes that bilinguals can encode information through *two* verbal routes, one in each language (e.g., for English-Spanish bilinguals: dog and *perro*). This suggests that for those who know more than one language, information stored in memory can be accessed through multiple linguistic routes. Having two possible verbal routes through which to access memories may facilitate memory in bilinguals.

The additional verbal route can help bilinguals retrieve memories when the other route is unavailable due to experimental or clinical reasons (e.g., Alzheimer's disease).

[B]Neural Networks

These proposed mechanisms for language-dependent memory are not exclusive and likely work in tandem. Underpinning the cognitive mechanisms are neural architectures that are shared by memory and language processes. At its simplest, long-term memories rely on a network of associated neural pathways that are strengthened due to frequent activity. The more frequently these connections are activated, the stronger they become, and the easier it is to retrieve stored information. Language can strengthen these neural pathways and facilitate memory retrieval. When a memory is formed, the language used becomes part of the neural network associated with a memory. In other words, the connections between the memory and the specific language used at encoding are strengthened. As a result, retrieving that memory with the same language becomes easier. When the retrieval and encoding languages of a memory match, its linguistic component is reactivated more easily, which helps activate the rest of the neural network required to retrieve the memory.

[A]Conclusion and Future Directions

Bilinguals' episodic and semantic memories are often encoded within a linguistic context. When retrieving a memory, using the same linguistic context can help bring the memory to mind. In both experimental and real-world settings, language proficiency seems to play a role in this process. The effects of language-dependent memory are strongest among bilinguals with similar proficiencies in both languages (Marian & Fausey, 2006; Vander Beken et al., 2018).

However, bilingualism is not a categorical variable, but rather a complex combination of factors stemming from the spectrum of language experiences. For example, bilinguals vary in their proficiency, age and manner of acquisition, language environment and use, cultural and social backgrounds, and many more variables, and it remains to be uncovered how their individual and combined interactions contribute to language-dependent memory.

It may also be helpful to go beyond bilingualism and examine how the variables that make up a person's language history influence language dependent memory in other populations, such as trilinguals, multilinguals, monolinguals, speakers of multiple dialects, and speakers of sign languages. Future studies may also want to examine whether language-dependent memory extends to implicit and prospective (i.e., remembering to do things in the future) memory.

In closing, our memories are at the core of who we are. Embedded into them is a language soundtrack, one that may shape what and how we remember. Its power is far-reaching, influencing on a scale that ranges from neurons to entire societies (Marian, 2023).

See also

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