

Priming Research

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What Is Priming?

Priming methods are one of the predominant experimental paradigms employed to study cognitive aspects of language learning and use. Priming methods originated in psycholinguistics, but have become increasingly common in applied linguistics over the past two decades. For example, a search in the *PsychInfo* abstract database for the period 2001 to 2010 yields 125 citations for studies investigating priming in second language (L2) learners or bilinguals, a nearly 150% increase from the number of studies (53) published on the same topic between 1991 and 2000. The term “priming” refers to the phenomenon in which prior exposure to specific language forms or meanings either facilitates or interferes with a speaker’s subsequent language comprehension or production. Priming is believed to be an implicit process that occurs with little awareness, and this implicit nature makes priming one manifestation of a larger system of human memory—implicit memory. Briefly, implicit memory involves memory for cognitive operations or procedures which are learned through repeated use, and includes memory for skills and habits, as well as priming. As an implicit cognitive phenomenon, priming suggests that language users’ prior experience with language shapes their subsequent language use, which is often interpreted as a form of implicit learning.

Although the term “priming” describes all situations in which prior language exposure influences subsequent language processing, different types of priming have been defined in the literature (McDonough & Trofimovich, 2008). For example, language users will access the meaning of the word *cat* more quickly if they recently read the word *dog* as opposed to an unrelated word, such as *shoe*. By activating the meaning of *dog* in comprehension or production, speakers more quickly activate the meaning of *cat* due to the shared meaning between the two. This kind of priming is called “semantic priming,” and it describes the tendency for speakers to process a word more quickly and/or more accurately when they have been previously exposed to a word related in meaning. In an example of a different kind of priming, if a speaker uses a prepositional dative, such as *my husband gave our lawnmower to the neighbor*, later in the conversation her interlocutor is likely to produce another prepositional dative (*my daughter sent a birthday card to her grandmother*) rather than a double-object dative (*my daughter sent her grandmother a birthday card*). This type of priming is called “syntactic priming” because it refers to the tendency for speakers to produce a syntactic structure that appeared in the recent discourse, as opposed to an equally acceptable alternative.

Historical Discussion

One of the first observations of priming as a phenomenon is attributed to James Cattell (1860–1944), an American psychologist who between 1883 and 1886 worked in Wilhelm Wundt’s psychological laboratory in Leipzig, Germany. Cattell’s time in Germany coincided with what has been called the golden age of the chronometric approach to the study of

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the human mind (Meyer, Osman, Irwin, & Yantis, 1988). The chronometric approach relies on the use of reaction times (response latencies) to study various mental processes, including language comprehension and production. While in Leipzig, Cattell conducted numerous experiments of this kind, examining the speed with which people reacted to letters, words, and sentences in their first language (L1) and their L2. In one experiment, Cattell (1885/1947) discovered that it takes people about twice as long to read words that are semantically unrelated as to read words in a sentence. This demonstration suggested that a meaningful context has a facilitatory effect on the processing of individual words.

It appears that the term “priming” was first used by Feldman and Weld (1939), who defined it as a state of attentional preparedness for perception (e.g., the decision to wake up early increases the likelihood that the alarm will be heard), and later by Lashley (1951), who used it to describe internal activation or readiness of linguistic elements in speech production (i.e., preparing a structural configuration of an utterance before producing it). However, in the sense we use it now, the term “priming” did not become mainstream until the early 1960s, when Segal and Cofer (1960) published a study which replicated and extended an earlier experiment by Storms (1958). Segal and Cofer demonstrated that when language users are exposed to a list of words, they are more likely to reuse these words to perform a subsequent task. Segal and Cofer referred to this phenomenon as priming. Since then, priming has been used as an experimental technique to address many interesting questions about how languages are organized in the human mind, and how people learn them. Examples of such questions could be found in seminal early investigations by Meyer and Schvaneveldt (1971) on semantic priming and by Bock (1986) on syntactic priming, and in recent reviews of priming literature by McNamara (2005), McDonough and Trofimovich (2008), and Pickering and Ferreira (2008). Beyond the study of language, examples of priming research in the wider context of cognitive psychology can be found in edited volumes by Bowers and Marsolek (2003), and Kinoshita and Lupker (2003).

The history of priming research is closely tied to the development of instruments that have allowed researchers to present different kinds of language materials to participants and to measure their responses to these materials. For example, Cattell used a gravity chronometer to present language materials (e.g., letters or words) to participants. The gravity chronometer was an early version of a tachistoscope, an instrument which was used for over 100 years in psycholinguistic research to present visual stimuli to participants rapidly, for a given amount of time (Benschop, 1998). The Cattell version of the gravity chronometer featured an electromagnet controlling a screen; when the electric current flowing through the spiral of the electromagnet was broken, the screen would fall and would reveal an object to be seen by the participant (for example, a card with a word written on it). To record participants' reaction times, Cattell used another sophisticated device of the day—a Hipp chronoscope (depicted in Cattell, 1886). The chronoscope was an electromechanically controlled timer which allowed researchers to record reaction times with millisecond accuracy when participants pressed a telegraphic key or even when they simply spoke in response to a stimulus (Benschop & Draaisma, 2000; Schmidgen, 2005).

Yet another early technological invention used in psycholinguistic research was a memory drum. This device consisted of a rotating kymograph drum which showed lists of words or sentences, or series of pictures for fixed intervals of time so that participants could view them and respond to them individually (Haupt, 2001). According to Haupt, the memory drum was the standard way of presenting language materials in research on memory and language for almost 100 years, from about the 1890s to approximately the mid-1970s, when affordable computers and monitors became available (Bailey & Polson, 1975). Over the past several decades, nearly all psycholinguistic research, including priming research, has been carried out by using powerful personal computers running multifunctional psychological software which allows researchers to present various kinds of stimuli

to participants (e.g., images, texts, audio, video) and to measure participants' reactions to these stimuli (e.g., in terms of accuracy, speed, duration). Examples of common psychological presentation software are E-prime (Schneider, Eschman, & Zuccolotto, 2002), DMDX (Forster & Forster, 2003), PsyScope (Cohen, MacWhinney, Flatt, & Provost, 1993), and SuperLab (Cedrus Corporation, 2008).

Main Findings

Although a comprehensive review of the priming literature would not be possible due to space limitations, we briefly outline several main strands of semantic and syntactic priming research, with a particular emphasis on L2 processing and learning. As was discussed earlier, semantic priming is defined as the tendency for language users to process a word more quickly and/or more accurately when they have been previously exposed to a word related in meaning. For example, the word *table* will be responded to faster if the word *chair* has been heard or seen recently. This suggests that semantically related words (like *table* and *chair*) are "stored" together or are somehow linked in the mind of a language user, and that both get activated by virtue of having such links.

In the last three decades, researchers have relied on semantic priming to explore the nature of semantic networks in the mental lexicons of L1 and L2 speakers. Some researchers have investigated whether L1 and L2 speakers differ in their patterns of semantic priming in a language (e.g., Frenc-Mestre & Prince, 1997; Devitto & Burgess, 2004; for review, see McDonough & Trofimovich, 2008). For example, if L2 speakers do not show priming for word pairs like *table* and *chair*, while L1 speakers do, then this would indicate that L2 speakers store and access these words differently from L1 speakers. The findings from this strand of research indicate that L2 speakers, at least those who have reached a high level of proficiency, can access and use the semantic information as L1 speakers do. To give an example, Frenc-Mestre and Prince (1997) found that the native English speakers and the more proficient French learners of English in their study showed semantic priming for semantically related words in English (e.g., *wet-dry*). In contrast, the less proficient learners did not.

Other researchers have used semantic priming to understand how bilinguals organize words in their two languages (e.g., Basnight-Brown & Altarriba, 2007; for review, see Altarriba & Basnight-Brown, 2007). For instance, if English-French bilinguals show semantic priming for word translations (e.g., *chien-dog* in French and English), then this would indicate that they organize the meanings of words in their two languages in a shared, interdependent manner. Results from this line of research are complex; they suggest that the manner in which bilinguals organize and access the meanings of words in their two languages depends on many factors, including the specific nature of words being examined (de Groot & Nas, 1991), bilinguals' proficiency in the two languages (Grainger & Beauvillain, 1988), and the age at which they start learning their L2 (Silverberg & Samuel, 2004). To illustrate, Silverberg and Samuel (2004) showed that only early, but not late, Spanish learners of English showed semantic priming for English-Spanish word pairs such as *nail* and *tornillo* ("screw" in Spanish). Because L2 words (like *nail*) facilitated the processing of L1 words (like *tornillo*) for the early learners, these learners appear to store the meanings of semantically related words across the two languages in a shared manner. In contrast, late learners appear to store such meanings separately.

As its name suggests, syntactic priming refers to the tendency for speakers to produce a syntactic structure that appeared in the recent discourse, as opposed to an equally acceptable alternative. For instance, speakers are more likely to produce a passive sentence if they recently heard a passive sentence or if they themselves produced one earlier in the

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discourse. In fact, speakers tend to produce the recently encountered syntactic structure even if the initial and subsequent utterances do not have any of the same lexical items, phonological or prosodic properties, or shared semantic information. This implies that it is easier for speakers to access a syntactic structure that has been recently activated than to access a completely new structure, and that speakers tend to implicitly “fine tune” their use of syntactic structures in response to recent experience with language.

Similar to the semantic priming studies that explore how bilinguals organize their L1 and L2 lexicons, bilingual syntactic priming research has investigated how syntactic information is represented. One possibility is that bilinguals store L1 and L2 syntactic information separately, while another possibility is that at least some syntactic information used in both languages is shared. The separate-syntax account predicts that cross-language priming would not occur since activation of linguistic information in one language would not affect the linguistic information of the other language. However, the shared-syntax account predicts that cross-language priming would occur as activation of the syntactic structure in one language would facilitate production of the related structure in the other language. Cross-language syntactic priming research has demonstrated that syntactic priming occurs cross-linguistically, which supports the shared-syntax account (e.g., Hartsuiker, Pickering, & Veltkamp, 2004; Bernolet, Hartsuiker, & Pickering, 2007; Salamoura & Williams, 2007; Schoonbaert, Hartsuiker, & Pickering, 2007). Current research is exploring how L2 proficiency impacts the development and strength of shared syntactic representations.

Other researchers have explored the occurrence of syntactic priming in L2 speech production, which is within-language priming. The initial question asked in within-language L2 syntactic priming research was simply whether it occurred, as the previous research had been carried out with L1 speakers. Researchers initially focused on demonstrating that priming occurred in L2 speech production for a variety of structures, such as dative constructions (Gries, 2005; McDonough, 2006; Schoonbaert, Hartsuiker, & Pickering, 2007, Experiment 1), passives (Kim & McDonough, 2008), and alternation between adjective + noun phrases and relative clauses (Bernolet, Hartsuiker, & Pickering, 2007, Experiment 2). Subsequent studies have explored whether syntactic priming occurs with alternation between a developmentally advanced structure and an interlanguage form (McDonough & Mackey, 2008; McDonough & Kim, 2009). In this line of research, syntactic priming is being used to encourage L2 learners to produce the developmentally-advanced structures as opposed to the less advanced or non-targetlike forms.

Future Directions

There are several possible avenues of research which have yet to be explored using priming methods. With respect to semantic priming, it is important to investigate how L2 speakers access and use semantic information not only in comprehending and speaking individual words, but also in processing phrases, sentences, or longer units of discourse. Indeed, when listening or speaking, L1 speakers activate semantic information for several words simultaneously or near-simultaneously, and use this information in real time. Would L2 speakers also activate multiple sources of semantic information simultaneously when comprehending and producing sentences? How does the activation of semantic information unfold as L2 speakers comprehend or produce sentences in their two languages? (See Elston-Güttler & Friederici, 2005, for some preliminary answers.) It is also important to study how individual differences in L2 speakers’ cognitive abilities influence their use of semantic information. It is possible that individual difference factors, including the size of working memory or ability to efficiently allocate attention between processing tasks, might influence the particular kind of processing involved in semantic priming. Understanding

the influence of individual differences on semantic priming may clarify why some L2 speakers do not process and use semantic information efficiently, and may explain what kinds of experiences may be beneficial to help them do so.

With respect to syntactic priming, it would also be interesting to explore whether individual differences in working memory capacity and temporal auditory processing abilities might predispose L2 speakers to benefit, or not, from the implicit learning processes associated with syntactic priming. In particular, it would be useful to determine whether priming activities that provide different types of exposure and practice positively impact L2 speakers with specific aptitude profiles. Since the majority of syntactic priming research has targeted individual speakers or interaction between L2 speakers and scripted interlocutors, future syntactic priming research might explore whether it occurs in less-controlled interactions, such as when learners carry out pair and small-group activities in classroom contexts. Future research might also increase the methodological diversity of syntactic priming research by incorporating additional technological tools, such as eye-tracking systems (Arai, van Gompel, & Scheepers, 2007) and event-related potentials (Ledoux, Traxler, & Swaab, 2007), as a way to gain further insight into the impact of priming on speakers' mental representations.

Although some priming methods can be carried out with minimal use of technology, technological advances in neuropsychology may shape future priming research, just as Cattell pioneered technology to capture reaction times. For example, studies employing technologies such as positron-emission tomography (PET) and functional magnetic-resonance imaging (fMRI) have revealed that priming is associated with decreases in brain activity in parts of the visual cortex (involved in perceptual processing) and in some areas of the frontal lobe (involved in semantic and conceptual processing). Neuropsychological investigations of L2 priming may help answer questions about priming as an implicit learning phenomenon, and generate research that explores the pedagogical applications of priming.

SEE ALSO: Bilingualism and Cognition; Implicit Learning in Second Language Acquisition; Interaction Approach in Second Language Acquisition; Lexical Access in Bilingual Visual Word Recognition; Models of Lexical and Conceptual Representations in Second Language Acquisition; Online Psycholinguistic Methods in Second Language Acquisition Research

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Suggested Readings

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