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Priming in the autobiographical memory system: implications and future directions

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ABSTRACT

Studies examining priming in autobiographical memory are fewer in number (some two dozen) compared to other areas (e.g., semantic memory priming), which have seen hundreds of studies. Nevertheless, autobiographical memory priming studies have utilised quite a number of different experimental paradigms, with many having interesting ecological implications. This paper reviews the bulk of these studies. It discusses the various theoretical implications of these studies, past and present. It suggests numerous future directions in this area, as the study of priming in autobiographical memory has had significant implications, despite the small number of studies, and it offers enormous future potential.

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Priming research has loomed large in cognitive psychology, neuropsychology, and social psychology, to name a few areas. As a whole, priming paradigms have been highly influential, spawning quite a number of theoretical notions (e.g., the concepts of implicit memory, memory systems, semantic memory organisation, and unconscious bias, DeCoster & Claypool, 2004; McNamara, 2005; Roediger & McDermott, 1993; Schacter & Tulving, 1994). Papers in these different areas number in the hundreds, and while papers in autobiographical memory priming are relatively few in number (i.e., some two dozen), they have also proved to be theoretically rich. Beyond establishing that priming does occur in autobiographical memory, studies in autobiographical memory priming have helped inform theories of autobiographical memory organisation (e.g., Conway & Bekerian, 1987), help explain the source of everyday involuntary memories (e.g., Mace, 2005), as well as signal clear linkages between autobiographical memory and semantic memory (e.g., Conway, 1990; Mace et al., 2019; Sheldon et al., 2020) (see reviews of everyday involuntary memories in Berntsen, 2009; Mace, 2007).

In this paper, I review the priming endeavour in autobiographical memory. In addition to reviewing most of the literature in this area, I review and discuss its theoretical contributions, as well as discuss how this area of research could, or perhaps should, proceed in the future. The paper begins with some basic categories, terminology, and theoretical models in autobiographical priming.

Categories of priming and theoretical models

There are two broad paradigmatic categories in autobiographical memory priming, those which have autobiographical sources as their primes, and those which have semantic sources as their primes. In the autobiographical instance, the primes are either autobiographical stimuli (e.g., *trip to Italy*, Conway & Bekerian, 1987), or autobiographical processes (e.g., reminiscing about the past, Mace, 2005). In the semantic instance, the primes are semantic stimuli and processes (e.g., category labels, Conway, 1990, or words, pictures, or other stimuli which are processed semantically, Mace et al., 2019; Mace & Unlu, 2020). An important distinction between these two sources of priming is in autobiographical-source priming the primes are overtly autobiographical and/or processing is autobiographical, whereas in semantic-source priming the primes are overtly semantic and processing is semantic. Many of the studies in autobiographical-source priming have involved examining the effects of reminiscing or preoccupations and concerns on autobiographical memories (e.g., Ball, 2015; Barzykowski & Niedzwieska, 2018; Johannessen & Berntsen, 2010; Mace, 2005). In our lab we have labelled these two areas reminiscence priming and preoccupations priming, respectively. We have further labelled semantic-source priming as semantic-to-autobiographical memory priming to denote what appears to be crossover priming between two different memory systems.

Although one study (Philippot et al., 2003) appears to have used a repetition (or direct) priming design, the study of priming in autobiographical memory has largely involved associative (or indirect) priming (see excellent reviews of direct and indirect priming in Roediger & McDermott, 1993). For example, in reminiscence priming, reminiscing about a particular lifetime period in a laboratory session has led to the subsequent production of involuntary or voluntary memories from that period, none of which were observed to be repetitions of memories from the priming session, but clear associates of them (e.g., Mace, 2005; Mace & Clevinger, 2013).

The use of involuntary and voluntary memory paradigms in autobiographical memory priming could be seen as a unique aspect of this program. While often these paradigms were used merely as vehicles to measure priming (e.g., Conway, 1990), they have also had the added benefit of enhancing our understanding of involuntary and voluntary retrieval. For example, priming may explain why certain memories are recalled (and not others), as well as why we may have some involuntary memories. These are intriguing possibilities, which may help to explain involuntary and voluntary retrieval processes, and they may implicate specific roles for priming. These ideas are discussed throughout this paper, as well as in the last major section.

Most autobiographical memory priming studies have used spreading activation models (e.g., Anderson, 1983; Collins & Loftus, 1975) to explain their results (e.g., Ball & Hennessey, 2009; Conway, 1990; Conway & Bekerian, 1987; Mace, 2005; Mace et al., 2019). Conway (e.g., Conway, 2005) has also used spreading activation to explain aspects of the self-memory system, which has often proved relevant to priming studies (e.g., Ball & Hennessey, 2009). Although other priming models may work in the place of spreading activation, and indeed there might be critics of this approach, it is important to note two important characteristics about how this approach has worked and how it has been used. One, there have been many disparate paradigms used in autobiographical memory priming (i.e., different prime sources and processes, and different measures, e.g., response times or memory production), and spreading activation models have accounted well for the results from all of these paradigms. Two, spreading activation has largely been used as working theory, an explanatory, if not, illustrative device. While certain aspects of the self-memory system may rely on this approach, most of the priming studies in autobiographical memory do not rely on the model being true, as their effects could also be explained with other approaches. However, it is important to note that self-memory system view predicts many of the priming phenomena reviewed in this paper. For example, Conway (2005) notes that spreading activation within the self-memory system occurs both between knowledge layers (e.g., from general memories to specific, episodic, memories) and within knowledge layers (e.g., among

episodic memories). Reminiscence priming is one example of this prediction, as it appears to involve activations among episodic memories. This general topic, along with priming models, are discussed further in the last major section of this paper.

Autobiographical memory priming with autobiographical sources

As noted, there are two broad paradigms in autobiographical-source priming (autobiographical stimuli or processes), and one of the paradigms (autobiographical processes) can be divided into three parts (reminiscence priming, pre-occupation priming, and self-priming). Most of the work in autobiographical-source priming has had implications for autobiographical memory organisation (e.g., Ball & Hennessey, 2009; Conway & Bekerian, 1987), most notably the self-memory system (e.g., Conway, 2005; Conway et al., 2019; Conway & Pleydell-Pearce, 2000). It has also informed involuntary remembering processes, as well as voluntary remembering processes, though the implications for the latter area need further clarity (e.g., Barzykowski & Niedziwińska, 2018; Johannessen & Berntsen, 2010; Mace, 2005; Mace & Clevinger, 2013). While the priming paradigms represent distinct methodologies, the autobiographical processes paradigms can be seen as having significant ecological validity, as the processes used in these paradigms comport well with processes found in everyday cognition (e.g., reminiscing or obsessing).

Autobiographical stimuli as primes

The earliest autobiographical memory priming studies either used autobiographical stimuli as the primes (e.g., Conway & Bekerian, 1987) or semantic stimuli as the primes (e.g., Conway, 1990, reviewed in the semantic-source section). These studies were largely adapted from the traditional semantic priming paradigm (Meyer & Schvaneveldt, 1971; see McNamara, 2005, for an in-depth review of semantic priming paradigms). While they were instrumental in establishing some important organisational principles, they also showed that autobiographical memories could be used with the rigorous priming paradigms of the day, an important demonstration as this occurred at a time when there was still skepticism about the study of personal memories (e.g., Banaji & Crowder, 1989).

Conway and Bekerian (1987) adapted the traditional semantic priming paradigm to fit autobiographical memory (Experiments 2 & 3). They collected lifetime period (e.g., *primary school*) and general-event information (e.g., *first week of primary school*) from participants in one session and had them return for another session four to five months later. In the second session, the lifetime period stimuli were used as primes preceding the target general-event stimuli, which were used as cues to recall autobiographical memories. Retrieval of the autobiographical memories was faster following the lifetime period

primes compared to unrelated semantic primes or no primes. The results from Conway and Bekerian (1987) gave early support to the idea that autobiographical memories are arranged in lifetime period and general-event hierarchies (e.g., Conway, 1996, 2005; Conway & Rubin, 1993), and that lifetime periods will spread activate general-event memories, an idea which would also later inform Conway's theory of voluntary remembering (e.g., Conway & Pleydell-Pearce, 2000; Haque & Conway, 2001).

Sometime later, Ball and Hennessey (2009, Experiment 2) would also use priming data to find support for hierarchical organisation in autobiographical memory. They also adapted a traditional semantic-priming paradigm (subliminal priming) to fit personal memories. They presented lifetime period primes (e.g., *high school*) below the threshold of conscious perception followed by consciously perceived autobiographical cues (e.g., *prom*). After confirming that the prime stimuli were not perceived consciously, Ball and Hennessey (2009) observed a significant subliminal priming effect. Their results also linked lifetime periods with memories from those periods, consistent with the self-memory system (e.g., Conway, 2005). The Ball and Hennessey (2009) study appears to be the only study that used a subliminal priming paradigm with autobiographical memories. One could argue that their results also support a spreading activation account of priming in autobiographical memory, as subliminal priming results could be seen as having a better fit to such accounts than some others (e.g., see discussion in McNamara, 2005, on subliminal priming with semantic paradigms).

The last study to be reviewed in this area was among the first autobiographical memory priming experiments. Reiser et al. (1985) argued that activities played a central role in autobiographical memory organisation, as they provide the context to store and retrieve specific associated experiences. They presented participants with an activity (e.g., *went out drinking*) followed by a general action (e.g., *paid at the cash register*) and also reversed the order of this presentation. They found that autobiographical memory retrieval was faster and more successful when the activity preceded the general action compared to the reversed order. Also explaining their results from a spreading activation perspective, they argued that their results showed that activities are a central organising knowledge structure in autobiographical memory. Although Reiser et al.'s (1985) organisational view did not gain acceptance, their findings remain important in that they show that certain primes can both facilitate and make retrieval of memories more successful, while other primes might actually inhibit retrieval. Such findings may be useful in understanding the role of priming in voluntary recall.

Reminiscence priming

Reminiscence priming is a unique, if not unusual, priming paradigm, as it took a natural process (recalling the past) and used it as the primes for autobiographical memories.

One of the benefits of this approach is it allowed one to make inferences about how priming processes might work in everyday cognition, as reminiscing (or recalling the past) is a common process in everyday life. Thus, this paradigm has been used to predict how reminiscing might influence the subsequent recall of involuntary autobiographical memories in everyday life, as well as voluntary autobiographical memories in everyday life (e.g., Barzykowski & Niedzwienska, 2018; Mace, 2005; Mace & Clevinger, 2013). In its most basic form, the process of recalling personal memories is seen as causing spreading activation in autobiographical memory among memories that are conceptually or temporally related. Experimentally, when autobiographical memory tasks follow these recall processes, associative patterns can be observed, and more importantly, its effects on remembering can also be observed. The reminiscence priming paradigm differs from the more classic paradigms reviewed above in both the manner of priming and the manner in which it is measured. The classic paradigms used retrieval response latencies as their measure, whereas reminiscence paradigms have used memory production. Memory production was used as the measure of priming because most studies in this area were interested in learning how reminiscence priming might affect content and production in involuntary or voluntary recall, and this approach allowed for direct observation of this process.

Mace (2005) used reminiscence priming to study its effects on everyday involuntary autobiographical memories. Participants came into the lab on one or multiple occasions, where they were asked to freely recall memories from different lifetime periods (e.g., high school years, Study 2, the past year, Study 3) in 30-minute sessions. These same participants were also simultaneously enrolled in a diary study where they were to record their everyday involuntary memories for a period of two weeks. Examinations of the content of the diary memories revealed there was significantly more memories pertaining to the primed lifetime periods in comparison to the relevant control conditions. Further examinations of the primed memories had also shown that none were repetitions of the memories recalled in the laboratory recall session, thus fitting the associative priming model, and virtually all of the memories had occurred a day (or days) after the priming sessions, thus indicating relatively long-term priming effects. These results established that reminiscing can affect autobiographical memory retrieval, and because they occurred with naturally occurring involuntary memories, they suggested that reminiscing could be a factor in this common everyday memory process. The results also suggested that specific autobiographical memories, of which most involuntary memories are (e.g., Berntsen, 1998), were organised according to lifetime periods. While temporal organisation was not a new topic at the time, lifetime period organisation at the episodic level was a novel observation (e.g., Friedman & Wilkins, 1985; Murdock, 1962; Robinson, 1986; Thompson et al., 1988,

but see criticisms of temporal organisation in Friedman, 1993; and Hintzman, 2016; Mace & Clevinger, 2019). It was also argued in Mace (2005) that reminiscence priming could be a contributing factor in the reminiscence bump (e.g., Rubin et al., 1986; see a review in Koppel & Berntsen, 2019), and it also may be a factor in intrusive memories in PTSD (American Psychiatric Association, 2013), as repetitive remembering is typical in this syndrome (see Holmes & Bourne, 2008, who review the related trauma film paradigm and PTSD).

More recently, Barzykowski and Niedzwienska (2018) followed up on the results in Mace (2005) with a laboratory measure of involuntary memory. In their study, participants were primed in a manner similar to the Mace (2005) study (i.e., recalling memories from high school years), however, the effects on involuntary autobiographical memory production were tested with Schlagman and Kvavilashvili's (2008) highly successful vigilance task. In this task, participants are presented with a large number of slides containing vertical or horizontal lines with embedded phrases (e.g., *drinking from a cup*). The task is presented as a study on concentration, where participants are instructed to call out when slides contain vertical lines, and under a separate guise, participants are incidentally instructed to note if they experience involuntary autobiographical memories during the task, among other spontaneous processes. As in the Mace (2005) study, Barzykowski and Niedzwienska (2018) found that primed participants produced significantly more involuntary memories from their high school days than in unprimed conditions. Barzykowski and Niedzwienska's (2018) results also supported the associative priming model by showing that memories were associated with primed memories, and not their repetitions. Barzykowski and Niedzwienska's (2018) study is also important because it was the first to pair reminiscence priming with the vigilance task, influencing future studies using similar pairings (e.g., Mace et al., 2019; Mace & Petersen, 2020).

Mace and Clevinger (2013) used the reminiscence priming paradigm with voluntary autobiographical memory tasks. Participants in the first experiment of their study were given phrase cues (e.g., *waiting for a bus or train*) and asked to recall memories from their elementary school years. Following this, they were given unrelated word cues (e.g., *mountain*) and asked to recall memories from any period of their life. The results showed primed participants had produced more memories from elementary school years than control participants. In Experiment 2, primed participants were given 12 major news stories (e.g., the *Bill Clinton impeachment*, the *World Trade Center disaster*) from the years 1998–2005 and asked to recall personal memories surrounding these events. After this priming session, they were given phrase cues (e.g., *waiting for a bus or train*), with the instructions to recall matching memories from any time period. The results of this experiment showed primed participants had produced more memories from years 1998–

2005 than control participants. In their final experiment (Experiment 3), Mace and Clevinger (2013) had primed participants recall memories from their teenage years generally, and then primed and control participants were asked to recall memories from ages 13 to 15 under time limited conditions. The results showed that while the priming group had only recalled slightly more memories than the control group in the time period, they recalled significantly more specific memories (the measure of priming) than the control group. The results of the Mace and Clevinger (2013) further showed that autobiographical memories are organised along broad temporal lines, extending the results to additional lifetime periods (Experiment 1), as well as showing nuanced temporal organisations (Experiment 2). Additionally, this study extended reminiscence priming effects to the recall of voluntary autobiographical memories, and among other potential implications (discussed in a later section), they brought new strength to the possibility that reminiscence priming may have a role in the reminiscence bump in older adults.

Mace and Petersen (2020) used different content in their reminiscence priming procedure. Instead of lifetime periods as the content, they used generic autobiographical content as the memory primes (e.g., *remember a time when you were exercising*, *remember a time when you were with your mother*). Participants were asked to recall specific memories in accord with this content, and they were subsequently given unrelated word cues, with the instructions to recall memories from any time in their life (Experiment 1). The results showed that the priming group had more memories involving the primed content (e.g., memories about exercising) than the control group. The second and final experiment of their report used roughly the same priming paradigm, but in this case the target memory task was the vigilance task. This experiment showed that primed participants produced more involuntary memories with primed content on the vigilance task relative to controls, and such priming had lasted for 24 h, as there was an immediate and 24-hour lag condition which did not differ. Thus, the results of this study extended the priming effects to autobiographical content, and as in the other reminiscence priming studies, the memories produced on the memory tasks were associatively related to the primes, not repetitions of the primed memories. The findings supported the idea that episodic memories are also organised by common content, an idea that is consistent with Conway's (2005) larger theoretical view. The results also furthered the implications of priming for involuntary and voluntary recall, suggesting that the effects of reminiscence priming extend to content as well as temporal periods. For example, reminiscing about the past may influence both lifetime period and specific content production in everyday involuntary memories, including content that one may be preoccupied with (e.g., certain individuals or dieting, reviewed in the next section).

The final study in this area had different goals than all of the rest reviewed here. Philippot et al. (2003) had participants recall the same autobiographical memories on multiple occasions with the final occasion involving emotional intensity ratings. The memory primes involved the recall of specific or general autobiographical memories. The results showed that specific memory primes had resulted in a significant reduction in emotional intensity ratings compared to general memory primes. Philippot et al. (2003) argued that their results supported the strategic inhibition hypothesis, which proposes that specific processing inhibits the activation of emotional arousal. However, emotional intensity ratings were also reduced following a control condition, which may indicate reversed causality (i.e., that general memory primes enhanced emotional intensity, Philippot et al., 2003, also discuss this possibility). Either way, this study is interesting because it shows ways in which repetition priming might affect remembering (the potential of repetition priming in autobiographical memory is discussed further in the last section of this paper).

Preoccupation priming

In preoccupation priming, one thinks about and/or remembers some aspect of their life (past or present) repeatedly. Preoccupations certainly can run the gamut of human experiences, from goals (e.g., dieting or acquiring a skill, such as mastering a musical instrument) to activities (e.g., playing a sport) to people (e.g., a former romantic partner or spouse), and so forth. Preoccupation priming is similar to reminiscence priming in that it can involve reminiscing about the subject of one's preoccupation, but it can also involve generic thoughts on the topic, as well as imaginative future thoughts (i.e., episodic future thinking, e.g., Atance & O'Neill, 2001; Schacter et al., 2007). Preoccupation priming has implications for autobiographical memory organisation, as well as involuntary and voluntary remembering, as in reminiscence priming. Given that the processes in preoccupation priming overlap somewhat with reminiscence priming and semantic-source priming, one would expect that it would affect autobiographical memory in similar ways. Unfortunately, all of the studies that have examined this form of priming are correlational (e.g., Ball, 2015; Mace, 2005, Study 1; Johannessen & Berntsen, 2010). Nevertheless, they provided positive results, and are a good starting point.

In the first study of the Mace (2005) report, participants kept a diary of their everyday involuntary memories for two weeks. When participants turned their diaries in at the end of two weeks, they were given a questionnaire which asked them to report preoccupations, if any, in the past two weeks. Twenty-five percent of the sample reported that they had a single preoccupation over the past two weeks. When diaries of these participants were examined for content, a high degree of their involuntary memories were found to involve the contents of their

preoccupations. Similar patterns were not found in the diaries of participants who reported that they had no preoccupations, whose memories had mixed and varied content. In that study it was argued that processes like preoccupation priming, along with more generic forms of priming (i.e., semantic-source priming), could influence everyday involuntary memory production. One can also imagine that the associations observed in this process should also be reflective of autobiographical memory organisation, perhaps both long and short-term organisation.

Johannessen and Berntsen (2009, 2010) presented data that could be explained in terms of preoccupation priming, but they did not describe their results as owing to priming, although elsewhere, Berntsen (2009) argues that motivational factors and current concerns (e.g., Klinger & Cox, 2004) may be involved in the priming of involuntary memories (see Berntsen, 2009, which also includes details on the historical literature on preoccupation thought and current concerns, e.g., Klinger, 1978). Johannessen and Berntsen (2009) conducted two studies where they compared the content of voluntary autobiographical memories between dieters and non-dieters. In study 1, the participants were given diet and non-diet related cues (e.g., *food, car*) and Johannessen and Berntsen (2009) predicted that the dieting group would recall more memories with body and weight-related content than the non-dieting group. The results showed that for food-related cues, dieters retrieved more memories involving body and weight-related content. Study 2 of their report replicated the findings of Study 1 with a group of dieters who had more serious weight issues. Johannessen and Berntsen (2010) examined how current concerns might manifest in the content of involuntary and voluntary autobiographical memories. Participants in their study first listed their current concerns, followed by a diary recording period where they recorded 30 involuntary memories and 30 cue-word retrieved voluntary memories. At the completion of this process, the participants judged if their recorded memories were related to their current concerns. As predicted by the authors, the results showed that a high proportion (roughly one-half) of the involuntary and voluntary memories recorded were related to participants' current concerns. Johannessen and Berntsen (2010) explained the results as owing to the sensitisation of cues related to current concerns, arguing against views which saw involuntary memories as related to unfinished personal business.

Ball (2015) conducted an involuntary memory diary study that examined involuntary memory contents among dieters, or restrained eaters, as they were labelled. Participants recorded one to three involuntary memories in a diary for seven days. After returning their diaries, they were given a restrained eating questionnaire. Participants who had high scores on the questionnaire were deemed more likely to be a dieter and have a high body mass index. A significant positive association was found

between scores on the questionnaire and memory content involving eating and cooking. Thus, as with the studies reported above, these results are also consistent with pre-occupation priming. Ball (2015) argued that his results were a likely function of priming, and he explained the findings in terms of motivational priming (Berntsen, 2009). However, like the other studies reported in this section, the results of his study were only correlational, as there was no priming manipulation.

Self-priming

In self-priming, information about the self is primed, and then the effects of this priming can be used to draw inferences about autobiographical memory organisation (e.g., Wang & Ross, 2005). Klein and colleagues have used self-priming paradigms to test models about how one makes judgements about the self and others (e.g., Klein et al., 1992; Klein & Loftus, 1993). As this work is beyond the scope of this article, the reader is referred to a comprehensive review in Klein et al. (2002).

Wang and Ross (2005) examined the role of culture and self in autobiographical memory. In the first study of their report, participants were exposed to a private self-priming condition, where they listed individual self-attributes (e.g., I am smart, I am honest), or a collective self-priming condition, where they listed group membership attributes (e.g., I am Catholic). Following the priming conditions, they were asked to recall their earliest childhood memories. The results showed that private self-priming lead to more individually focused memories, while collective self-priming lead to more group focused memories. These results suggest that the self and self-perspectives have a role in autobiographical memory organisation (e.g., Conway, 2005), and self-perspective as a prime can influence the types of memories that one may recall (Wang & Ross, 2005, also reported on other cultural factors in their study). In an interesting, related study, Wang (2008) had Asian-American participants focus on their Asian self or their American self, and then recall important events from their lives. Participants in the American-self priming condition were more likely to recall self-focused memories than those in Asian-self priming condition, who were more likely to recall socially focused memories. These results show a role for culture in autobiographical memory (see Wang, 2008; Wang, 2019), and they, too, show that self-perspective priming can influence how we recall memories.

Lastly, Grysman and Hudson (2011) used a self-priming manipulation to examine the role of the self in autobiographical memory. Participants in a self-priming condition were given a questionnaire that was designed to prime important aspects of their past and presents selves before producing narrative recalls from before and after the age of 14. They reported that self-priming lead to a greater likelihood of connecting the current self to past episodes. Grysman and Hudson (2011) argued that

among other findings, the priming results implicated the self in autobiographical memory organisation and retrieval (e.g., Conway, 2005).

Autobiographical-source priming: summary and conclusions

A number of different paradigms have been used in autobiographical-source priming. The more traditional paradigms (i.e., those modelled after semantic priming, e.g., Conway & Bekerian, 1987) have played a role in understanding autobiographical memory organisation, as well as establishing major theories of autobiographical memory, namely the self-memory system (e.g., Conway, 2005). The less traditional, or more unique, paradigms (e.g., reminiscence priming) have also aided in understanding autobiographical memory organisation, in that they reinforced some influential views (e.g., Conway, 2005), while also showing some nuanced ways in which autobiographic memories can be organised (e.g., Ball, 2015; Mace, 2005). The processing paradigms (i.e., reminiscence and preoccupation priming) have ecological validity as an added advantage. As individuals do reminisce, as well as preoccupy themselves with the events and so forth of their lives, these paradigms can tell us something about the impact of these processes in everyday life. Thus far, they have suggested some clear implications for involuntary remembering by showing that each of them might be a source of involuntary memories, though preoccupation priming still needs to be established experimentally (Ball, 2015; Barzykowski & Niedzwienska, 2018; Johannesen & Berntsen, 2010; Mace, 2005; Mace & Petersen, 2020). The implications of these forms of priming are less clear in the case of voluntary memories. Mace and Clevinger (2013) argued that priming could play a role in the reminiscence bump if older adults engaged in reminiscence behaviour with typical bump period memories (Fitzgerald, 1996). However, this idea has not gained any traction in the literature. Reiser et al.'s (1985) findings appear to indicate that priming might both facilitate and inhibit voluntary remembering, and others have advanced this notion, as well as other ideas (e.g., Mace et al., 2019; Mace & Petersen, 2020). However, these ideas have also not gained any traction in the literature. Perhaps one of the difficulties is that voluntary recall may be seen as a purely goal-directed, willful process, making it difficult to imagine how involuntary processes like priming could influence it (this idea is discussed further in a later section of this paper). Self-priming may also have additional implications beyond those reviewed above, including practical implications.

In one way or another, each of the priming areas reviewed here lends support to the self-memory system view (Conway, 2005). For example, the self-priming studies quite obviously show the importance of the self in autobiographical memory, but the preoccupation and reminiscence paradigms also support the self-memory

system view. Preoccupation priming highlighted the role and importance of goals, while reminiscence priming has highlighted two aspects of self-memory theory, conceptual (or themed) organisation, and spreading activation at the episodic memory level.

Autobiographical memory priming with semantic sources and processes

Semantic-source priming differs from autobiographical-source priming in that semantic stimuli are used as the primes, but most importantly, the primes are processed semantically without any reference to one's past. Research in this area can be marked by two different periods: the early period, and the later (or contemporary) period. In the early period, the focus was on autobiographical memory organisation (Conway & Bekerian, 1987), with some reference to the relations between autobiographical memory and semantic memory (Conway, 1990). In the later period, the focus was on the widespread nature of this type of priming, where it was reasoned that generic stimuli cause constant activation in the autobiographical memory system, which from time to time cause involuntary memory production (e.g., Conway, 2005; Mace, 2005; Mace et al., 2019). As in autobiographical-source priming, work in the later period has had implications for both involuntary and voluntary remembering by showing, at least in the former case, that semantic processing can cause autobiographical memory production (e.g., Mace et al., 2019). The ubiquitous nature of semantic-source priming has sparked some questions about the potential functional role of autobiographical memory in cognition, where it was reasoned that autobiographical memories may be a part of concept comprehension (e.g., Mace et al., 2019; Mace & Unlu, 2020). Though studies have not been conducted to test this idea directly, the notion is one additional intriguing aspect of semantic-source priming.

Early period research

Like autobiographical-source priming, early work in semantic-source priming was also modelled after the typical semantic priming paradigm. Semantic stimuli are processed in a priming phase, followed by different cue types, which are used to recall autobiographical memories (e.g., Conway, 1990). The priming measure is retrieval latencies. There are only two studies from this epoch (Conway, 1987, 1990; though Conway & Bekerian, 1987, could be counted as another), and both were used primarily to establish some basic principles of autobiographical memory organisation, functioning as early precursors to the self-memory system (Conway, 2005).

In the last study from the early period, Conway (1990) presented participants with taxonomic categories (i.e., category labels such as *Birds* or *Vegetables*) or goal-derived categories (i.e., category labels such as *Birthday Presents* or *Camping Equipment*). Participants simply read the

semantic primes, and they were then given exemplar cues from each of the primed category labels (e.g., *Sparrow* or *Potato* for taxonomic categories, or *Jewellery* or *Sleeping Bag* for goal-derived categories), with the instructions to recall past personal experiences. The results showed that goal-derived categories had significantly shorter retrieval times relative to unprimed conditions, but priming was not significant in the taxonomic category conditions. Conway and Bekerian (1987) also had conditions in their study similar to the taxonomic category conditions in Conway (1990), and they, too, did not find significant priming. However, the taxonomic category conditions did trend in the direction of priming, in all cases showing shorter retrieval latencies than the controls. Conway (1990) argued that the results indicated that some semantic knowledge is more closely related to autobiographical memories than others, an idea which would find support in the current era (e.g., Sheldon et al., 2020). However, later work would also show that semantic knowledge of all sorts would prime and activate autobiographical memories (e.g., Mace et al., 2019; Mace & Unlu, 2020, reviewed in the next section), and an earlier study of Conway's would also suggest this (Conway, 1987).

Conway (1987) used semantic categories (mostly taxonomic categories as well as other general categories, e.g., furniture, clothes, fruits, banks) as the primes preceding an autobiographical memory task. Participants read the category primes, and then they were asked semantic questions (e.g., is an orange a fruit), or autobiographical questions (e.g., are apples your favourite fruit; do you have a desk in your room). Again, using time as the priming measure, the results showed that the semantic primes caused faster responding relative to controls for both the semantic and the autobiographical questions. Conway (1987) indicated that the results were in sharp contrast to the failed results in Conway and Bekerian (1987), and he also discussed a spreading activation account of the data, which aligned semantic knowledge with autobiographical knowledge. Thus, this study, as well as Conway (1990), established links between semantic and autobiographical memory.

Later period research: semantic-to-Autobiographical memory priming

In more recent times, the focus of semantic-source priming changed considerably. Mace (2005) argued that one's thoughts should prime autobiographical memories, sometimes resulting in involuntary memories, and in a more full-throated fashion, Conway (2005) argued that generic stimuli are continuously causing autobiographical memories to form in the background, which occasionally manifest as involuntary memories (see also Conway, 2001). While this formulation still highlighted the relationship between autobiographical memory and semantic memory, perhaps a functional one (e.g., Mace et al., 2019), the emphasis shifted to establishing the priming

phenomenon, and gauging its effect on involuntary and voluntary remembering. Mace et al. (2019) labelled this form of priming semantic-to-autobiographical memory priming, and they used this term in their study and in all subsequent studies involving this paradigm (reviewed below). The priming paradigms used in these studies had participants semantically process different types of semantic primes (e.g., words or pictures), followed by an involuntary or voluntary memory task, mostly the former, where memory production was used as the priming measure.

Using a free association paradigm, Ball (2007) had participants free associate to semantic cues (e.g., *rain*), and then examined the types of memories that they produced. The results showed that participants produced semantic associations as well as autobiographical associations in their stream of associations. Ball (2007) described the autobiographical associations as fitting well within the concept of involuntary autobiographical memories. Although this study was not a priming study, it nevertheless used a classic paradigm, one which has historically been used to demonstrate associative organisation, with the results suggesting that semantic and autobiographical associations are commonplace, and they may give rise to involuntary memories (for traditional associative organisational studies, see Battig & Montague, 1969; Deese, 1965, and see interesting empirical findings and discussion in Nelson et al., 2000).

As noted, Conway (2005) argued that autobiographical memories are constantly being formed in the background in response to stimuli, occasionally giving rise to an involuntary memory. Mace et al. (2019) argued that because one processes massive amounts of information from many different sources (e.g., reading a newspaper or a book, watching television, engaging in conversation, etc.), that the effect of this sort of priming on remembering could be considerable. Thus, Mace et al. (2019) worked from the notion that all stimulus processing causes unconscious activations of autobiographical memories, and that the only modulating factor is a stimulus' relation to personal experience (i.e., are there autobiographical memories associated with it).

In the first study to test this notion, Mace et al. (2019) used semantic primes (words) and a word-cue voluntary memory task, as well as the vigilance task. Participants in the first experiment of the study rated words for the familiarity of their meanings (e.g., *music*, *summer*, etc.) and then recalled autobiographical memories in response to unrelated word cues (e.g., *flower*). The results showed that primed participants produced significantly more autobiographical memories involving the content of the primes (e.g., a memory about *music* or, *summer*) than unprimed participants. Experiment 2 used the same priming procedure, but instead coupled with the vigilance task, and the results also revealed significant autobiographical memory priming involving the semantic stimuli. In a third experiment, priming was observed on the word-cue task following familiarity ratings or lexical decision (e.g.,

decide if *music*, *summer*, *quip*, *pulel* are words). The results of these experiments supported the fundamentals of semantic-to-autobiographical priming, and because the results were obtained with primes that belonged to taxonomic categories (e.g., *music*, *sports*), they also suggested that the priming process is ubiquitous, and that it is not limited to a specific set of stimuli, as one might infer from Conway (1990) and Conway and Bekerian (1987). Mace et al. (2019) argued that retrieval latencies used in those studies may have been too weak of a measure, possibly explaining their statistical failures. They also argued that because priming occurred following deep (familiarity ratings) and relatively more shallow processing (lexical decision), that it should be independent of processing depth, occurring with just mere incidental processing. Apart from these observations, the study also implicated semantic-to-autobiographical priming as another influential source for involuntary remembering and voluntary remembering, though its role in the later is less clear, as in the cases of the priming phenomena discussed in the previous section (this issue is discussed further in the final section of this paper).

Two subsequent studies in semantic-to-autobiographical priming further investigated the ubiquity question by employing a variety of different stimuli as primes. Mace and Unlu (2020) used words (e.g., *sports*), sentences (e.g., *Jim likes sports*), and pictures (e.g., an image of American football) as primes preceding the vigilance task (Experiments 1 and 2). They found that all three prime types had equally primed the production of involuntary memories on the vigilance task. Mace et al. (2023) followed up on these findings with additional prime types. They used sounds (e.g., a lawnmower) and their spoken verbal counterparts (Experiment 1), tactile primes (i.e., feeling objects, e.g., button) and their written verbal counterparts (Experiment 2), as well as video primes (i.e., various action scenes, e.g., marching band) and their written verbal counterparts (Experiment 3) as primes on the vigilance task. They found that all of the prime types had led to significant semantic-to-autobiographical priming on the vigilance task, and also non-verbal primes (e.g., sounds) were shown to produce as much priming as verbal primes in all comparisons. Taken together, the results from Mace and Unlu (2020) and Mace et al. (2023) suggest that semantic-to-autobiographical priming is universal, as hypothesised, as the findings were obtained with wide array of different stimuli. Mace et al. (2023) argued that in addition to supporting the basic premise of semantic-to-autobiographical priming, that the universality found in this set of studies lends support to the idea that autobiographical memories might have a functional role in general cognition, as their implicit activations may shape and colour the way concepts and other general knowledge are perceived.

Using the semantic-to-autobiographical priming paradigm with the vigilance task, Mace and Kruchten (2023) examined a classic variable pursued in priming studies,

prime repetition. They presented primes one or three times, and they found that primed involuntary memory production on the vigilance task was significantly greater following three repetitions compared to one repetition, with the three-repetition priming group producing more than two times the number of memories than the control group. The results of their study suggest that concept (or prime) repetition may be a factor in determining if routine semantic-to-autobiographical memory activations transform into conscious autobiographical memories (i.e., involuntary memories). Accordingly, the more one experiences a particular prime, the greater the likelihood that its unconsciously activated autobiographical knowledge can enter consciousness, where one becomes aware of such content, and it is experienced as a spontaneous memory (see Barzykowski and colleagues' awareness threshold, e.g., Barzykowski & Staugaard, 2016; Barzykowski, Niedźwieńska, et al., 2019).

Also looking at factors that may influence semantic-to-autobiographical priming's effect on involuntary remembering, Mace and Hidalgo (2022) argued that the duration of this form of priming may also be a factor in conscious involuntary memory production. If, for example, priming only lasted for minutes to hours, then the probability that it will result in the conscious retrieval of involuntary memories may be low compared to activation durations of days to weeks, as one should be more likely to encounter multiple subsequent retrieval cues in this case. Obtaining evidence on the long-term nature of semantic-to-autobiographical priming, Mace and Hidalgo (2022) found semantic-to-autobiographical priming on the vigilance task did not diminish after a delay of one week compared to a delay of several minutes. Mace and Hidalgo (2022) further argued that semantic-to-autobiographical priming may last several weeks or even months, as priming in the one-week condition was as strong as it was in the immediate condition. Their results were also consistent with findings reported for reminiscence priming (Mace, 2005 and Mace & Petersen, 2020), though the durations in those studies were one to a couple of days. However, because those studies did not systematically evaluate priming durations (Mace, 2005), or they limited their evaluations to 24 h (Mace & Petersen, 2020), the Mace and Hidalgo (2022) findings should be taken as the better indicator of how long priming might last in autobiographical memory. Whether these durations are unique to semantic-to-autobiographical priming, or apply to any form of autobiographical memory priming has yet to be determined (see also Coane & Balota, 2009, who reported long-term semantic priming, and Kvavilashvili & Mandler, 2004, who reported long-term priming with involuntary semantic memories).

Some of the semantic-to-autobiographical priming studies also examined the characteristics of the vigilance task cues that were found to be involved in priming. Mace et al. (2019) reported that most of their cues were unrelated to the primes, but this may have been because

very few of the cues used in their version of the vigilance task contained cues related to the primes, in an effort to be consistent with the voluntary memory task used in that study.¹ Mace and Hidalgo (2022) and Mace et al. (2023) employed more vigilance task cues that either overlapped with the primed content (e.g., for the prime *pet*, *getting a pet*) or contained associated content (e.g., for the prime *pet*, *visiting an animal shelter*). They found that the majority of the cues involved in priming either overlapped or were associated with the primes, though unrelated cues still had a respectable showing in many instances. In those studies, it was argued that the results were consistent with the encoding specificity principle (Tulving & Thomson, 1973). However, there are additional ways to interpret these results. For example, these findings also suggest that there is considerable cue flexibility in this form of priming, probably because the critical factor in priming is the raised activation levels of primed memories.

In the last study to review, Sheldon et al. (2020) investigated the relationship between different types of semantic knowledge and autobiographical memory, general semantics (e.g., the concept of a restaurant) and two forms of personal semantics (context independent, e.g., I like restaurants, and context dependent, e.g., I eat in a particular restaurant). They presented participants with general semantic primes (e.g., *an establishment where one pays to eat a meal is a restaurant*), context-independent personal semantic primes (e.g., *I enjoy eating in a restaurant*), context-dependent personal semantic primes (e.g., *for special occasions, I have celebrated at a restaurant*). Following the priming task, participants were required to retrieve a specific autobiographical memory using the target information of the prime as a cue (e.g., *restaurant*). The results showed that retrieval time for all three priming conditions was faster than a control condition, but context-dependent personal semantic primes led to faster retrieval than general semantic primes and context-independent personal semantic primes. This study was motivated by a line of research that investigates the relationship between different types of semantic knowledge (e.g., general, and personal) and autobiographical memory (e.g., Renoult et al., 2012). Researchers in this area argue that these different knowledge forms are in an interdependent continuum, and Sheldon et al. (2020) described their results as supporting the idea that personal semantics are more closely related to episodic autobiographical memories than general semantics. The results can also be seen as consistent with Conway (1990) if one sees goal-derived categories as similar to personal semantics and taxonomic categories as general semantics, and they also appear to support the other semantic-source priming studies reviewed here.

Semantic-source priming: summary and conclusions

The early semantic-source priming studies focused on the relationship between semantic knowledge and

autobiographical memory (e.g., Conway, 1990), and they were instrumental in establishing some interdependent relationships, though this was not a novel idea at the time (e.g., McKoon & Ratcliff, 1979; Tulving, 1985). They were also instrumental in establishing some early fundamentals of the self-memory system theory of autobiographical memory (Conway, 1996, 2005). Priming studies in the current era brought more definition to the interdependency of semantic and autobiographical memory, an idea that has been gaining ground in the current era (Sheldon et al., 2020, see other studies and papers in this general area, e.g., Irish & Piquet, 2013; Klein et al., 2002; Renoult et al., 2012), with the semantic-to-autobiographical priming studies adding a new dimension, the notion that autobiographical memory might play a functional role in cognition (e.g., Mace et al., 2019, 2023, and see earlier theories in Schank, 1999; as well as Barsalou, 1999, 2008, and related ideas in Klein et al., 2002). As with some of the other priming paradigms reviewed, semantic-to-autobiographical priming studies (e.g., Mace et al., 2019) also suggest that this form of priming can impact involuntary and voluntary memory production. In this instance, again, it is unclear how priming might play out with voluntary remembering, while there is more clarity in its potential role in involuntary remembering. In the case of involuntary remembering, the findings suggest that semantic-to-autobiographical priming may be another source of involuntary remembering in everyday life. Because this form of priming is associated with general cognition (e.g., perceiving, reading, listening, and so forth), one might expect that it plays the largest role of the priming phenomena in everyday involuntary remembering. However, it is possible that there may be circumstances where this is not the case (this idea is discussed here (i.e., prime repetition, time-course factors, and subliminal presentations), there remains work to be done in these areas (e.g., on time-course limits), and there are still a large number of variables to be studied (e.g., processing variables, such as depth of processing). The work done in implicit memory and semantic priming can be used as a guide to select relevant variables in future autobiographical memory priming studies (see McNamara, 2005; Roediger & McDermott, 1993).

Finally, the semantic-to-autobiographical priming studies as a whole have supported at least two of Conway's (2001, 2005) claims, that the autobiographical memory system is highly cue sensitive, and autobiographical memories are constantly forming in the background in response to these cues. In our lab we have viewed the ubiquity of semantic-to-autobiographical priming as perhaps the most important aspect of this program for its potential implications for cognition and unconscious processing (discussed further below).

Future directions in autobiographical memory priming

With only a small number of studies, autobiographical memory priming has made many strides. Autobiographical memory priming has been used as a surrogate variable to study autobiographical memory organisation (e.g., Conway & Bekerian, 1987; Reiser et al., 1985), and it has been used functionally to study its role in aspects of remembering (e.g., Mace, 2005; Mace et al., 2019). When priming was used to draw inferences about its effects on remembering, it still had implications for autobiographical

memory organisation (e.g., Barzykowski & Niedzwinska, 2018; Mace, 2005; Mace & Petersen, 2020). And, when priming failed to produce long-lasting theories of autobiographical memory organisation, it still had implications for remembering (Reiser et al., 1985). One promising aspect of the work in autobiographical memory priming has been its potential for applications in everyday life. As many of the priming paradigms were designed with everyday cognitive processes in mind (e.g., Mace, 2005; Mace et al., 2019), their ecological validity has been readily apparent. Ecological validity in autobiographical memory priming appears to be uniquely tied to some of the natural questions that have flowed from it, and this aspect of autobiographical memory priming should hold great appeal for future research.

Although work in autobiographical memory priming has had considerable implications, it has only scratched the surface, as there remains a large number of open questions and variables to be researched. For example, as noted, preoccupation priming has yet to be demonstrated with experimental means. It should not be difficult to employ innocuous or pleasant content as the primes in a preoccupation priming paradigm, and then observe their effects on remembering. Repetition priming may also hold significant potential, as the one study that used a repetition-like paradigm (Philippot et al., 2003) has suggested that repeated retrieval of the same memories can impact remembering and memory content in important ways. Many of the paradigms used in classic repetition priming studies can be adapted to study this form of priming in autobiographical memory (see Roediger & McDermott, 1993). Although classic priming variables have been used already in the association priming paradigms reviewed here (i.e., prime repetition, time-course factors, and subliminal presentations), there remains work to be done in these areas (e.g., on time-course limits), and there are still a large number of variables to be studied (e.g., processing variables, such as depth of processing). The work done in implicit memory and semantic priming can be used as a guide to select relevant variables in future autobiographical memory priming studies (see McNamara, 2005; Roediger & McDermott, 1993).

In the sections below, I discuss four broad areas of future research for autobiographical memory priming: priming models, priming functions, involuntary remembering, and voluntary remembering. With the exception of one area (models), these areas focus on functions and functional aspects of priming, and have some degree of interdependency. The modelling area can be seen as independent from all the rest, so long as questions in the other areas do not turn on a particular model. Absent from below are questions on autobiographical memory organisation. This area was left out because autobiographical organisation has developed significantly over the past 30 years, and continues to do so, with a variety of different research paradigms. This is not to suggest that work should not proceed in this area, or in other areas not

covered, as the list below should not be taken as exhaustive, but as broad areas of consideration.

Models of priming

Where models of priming have been discussed, studies in autobiographical memory priming have generally invoked a spreading activation account to explain their priming effects (e.g., Conway, 1987, 1990; Ball & Hennessey, 2009; Mace et al., 2019). As noted earlier, this type of model appears to fit well with all of the paradigms used in autobiographical memory priming. For example, in our lab, we have described reminiscence priming and semantic-to-autobiographical priming using a spreading activation account, noting that the data could be explained in terms of unconscious and conscious activations. That is, a stimulus (the prime) at point A causes unconscious activations of multiple related memories, which in turn become conscious activations at point B when the same or similar stimuli are processed again. This is a rather bare-bones description of the priming phenomena, which makes few theoretical assumptions. While we have presented more detailed accounts (e.g., Mace, 2010; Mace et al., 2019), this description may at least serve as an illustrative example of the phenomena, if not the starting point for tests of a spreading activation model, or versions of it.

Of course, there are other possibilities, and it is also possible that different models might explain different phenomena (e.g., associative versus repetition priming). There have been multiple theoretical models used to explain various forms of priming (associative, conceptual, perceptual, semantic, and so forth, e.g., see Balota & Coane, 2008; Bowers & Marsolek, 2003; McNamara, 2005). Some of these models might also explain autobiographical memory priming (e.g., distributed network models, see discussion in Rueckl, 2003), and some may not be suitable (e.g., compound cue theory, Ratcliff & McKoon, 1988). However, it is important to consider that in other areas of priming, there has been no resolution among the many models put forward, despite multiple experimental efforts. This dilemma may stem from the fact that many of the theoretical views in question contain implicit references to neural processes and structures, and behavioural tests might simply be inadequate. Perhaps the best way forward in autobiographical memory priming is to wait until adequate tests are developed, ones which can test at the level of brain processes. Following this strategy may avoid potential stalemates, if not outright distractions, allowing researchers to instead focus on phenomena and applications.

Functions of priming

The question of function has also tended to elude resolution in many areas of cognitive psychology. Ideas have been put forth about the functions of priming in a

number of areas (e.g., perceptual priming, semantic priming, Bowers & Marsolek, 2003; Tulving, 1995). For example, in semantic priming, it has been argued that the function of priming is to make recently activated information readily available for quick future access (e.g., Anderson & Milson, 1989). This sort of functional explanation could be applied to autobiographical memory priming. For example, one could see autobiographical memory priming serving this role in remembering (i.e., making recently activated memories available for future access). An additional, or alternative, view sees the primes (or activated memories) in autobiographical memory as playing a behind the scenes role in the understanding of stimuli and events. As noted, a functional account of semantic-to-autobiographical priming has postulated that unconsciously activated autobiographical memories (e.g., memories associated with a particular stimulus) play a role in the perception of a stimulus, in that they may colour or in other ways contribute to its understanding (e.g., Mace et al., 2019; Mace & Unlu, 2020, also see similar roles for autobiographical knowledge in Barsalou, 1999, 2008; Schank, 1999; and Klein et al., 2002, whose work on the self suggests that episodic memories contribute to judgements about the self and others). This type of account emanates from the view that unconscious processes continually shape conscious ones (e.g., Baars, 1988, 2019); indeed, they may do most of the cognitive work by some accounts (e.g., Kihlstrom, 1987; Reber, 1993; Reber & Allen, 2022). This type of functional account can be applied to the other forms of priming reviewed here, and it may prove amenable to testing if, for example, one could show that priming had actually contributed to the perception of events or stimuli.

However, these types of theories contrast sharply with ones which do not view priming as functional. For example, in autobiographical memory, priming may merely be a function of the sensitivity of the system (e.g., Conway, 2005). In a broader sense, it has been argued that priming is not adaptive, but merely a by-product of neural systems (see review and interesting discussion in Klein et al., 2002). Such theories need to be considered against functional ones, and while not all theories of function may be immediately testable, some might be immediately viable.

Involuntary remembering

In involuntary remembering, one goal of priming research is to ascertain the relative contributions of the various priming types, and to determine their overall contribution to involuntary remembering. As noted, one might expect semantic-to-autobiographical priming to have the largest contribution to involuntary remembering, considering the ongoing nature of this process, but that might not turn out to be the case, or at least not all the time. For example, preoccupation and reminiscence priming may have a larger role if other factors, such as the goals of

the self (e.g., Conway, 2005), are involved in the conscious production of involuntary memories (see below). More simply, sheer repetition could cause these priming processes to result in more conscious memory production. However, these scenarios may depend on how much and whether one engages in these processes.

Relatedly, another goal in the area of involuntary remembering is to ascertain why primed memories become conscious at all. As described above, priming can be characterised as a process where a stimulus causes unconscious activations of autobiographical memories at one point, which become conscious at some point later in time when similar stimuli are encountered. Prime (or stimulus) repetition has been shown to be one factor (Mace & Kruchten, 2023), but it seems likely that others factors are involved. Involuntary memory researchers have already identified a number of factors that are likely to be involved in the elicitation of involuntary memories (e.g., Barzykowski, Radel, et al., 2019; Berntsen et al., 2013; Vannucci et al., 2015), but these studies did not examine primed and unprimed involuntary memories. Conway (2005) hypothesised that when activated memories align with the current goals of the self, they will then become conscious as spontaneous memories. However, this hypothesis has also not been tested. Thus, there are a number of variables to be investigated on both the primed and unprimed side of involuntary remembering. If Conway's (2005) idea proves correct, it may have interesting implications for the potential functions of involuntary memories. It would also be interesting to see if there are different factors causing the elicitation of primed and unprimed involuntary memories, if they interact, or if the same factors are involved in both primed and unprimed memories.

Voluntary remembering

Questions of priming in voluntary remembering could be seen as having very different implications. As noted earlier, it may be hard to imagine priming's role here because voluntary remembering is typically seen as a willful, goal-directed process. Mace and Clevinger (2013) proposed that priming might be involved in the reminiscence bump, and work should proceed in this area. However, this idea, and the general idea of priming per se in voluntary remembering, suggests an interesting conclusion that should figure in future research. That is the idea that unconscious processes, such as priming, can influence conscious processes and behaviours. While this notion is generally not a new idea (e.g., Jacoby, 1991), it is a fairly new idea for voluntary autobiographical remembering. Thus, one way to interpret the existing priming literature on priming and voluntary remembering, is to conclude that priming can influence what one "chooses" to remember, as well as causes one to engage in the act of remembering. This might be a difficult concept for some researchers to accept, but it seems that a major

part of the future work on priming and voluntary remembering should focus on delineated the topic that voluntary remembering may not be so intentional or consciously driven. Viewed in this way, the role of priming in voluntary remembering may not be so different from its role in involuntary remembering.

Another area of future research stems from the findings in Reiser et al. (1985). As noted previously, their findings suggest that there may be ways in which priming can facilitate voluntary retrieval. Research along these lines might have both practical and theoretical implications. On the flip side of this question, priming might also inhibit voluntary retrieval (e.g., when related primed content blocks the target information from being retrieved). Research on this question could also have practical and theoretical implications.

Final thoughts

The study of priming in autobiographical memory has had some interesting implications, and future study in this area appears to hold great potential. Continued study of autobiographical memory priming may augment our understanding of the processes of remembering, as well as shape new ideas here and in other areas. For example, if autobiographical knowledge is shown to play a role in the understanding of concepts, this would indicate an additional function for autobiographical memory, a cognitive function. The study of priming in other areas of memory (e.g., semantic memory) has shaped those areas in many ways. Autobiographical memory researchers may wish to follow some of the traditions pursued in those areas, as there is still much work to do to get a complete understanding of priming processes in autobiographical memory. The study of priming in memory, generally, as well as in other areas (e.g., social cognition), has contributed to the notion of the cognitive unconscious, and many of the ideas pioneered by researchers in that tradition should also prove useful in research on autobiographical memory priming. Looked at from the other way, research on autobiographical memory priming has already shown that unconscious processes are at work in this memory system, as in others (e.g., perceptual and semantic memory), and thus this work demonstrates that autobiographical memory processes may also be seen as part of the cognitive unconscious, an idea that has largely been absent from that area.

Note

1. Unrelated cues still show sensible relationships with primed memories. For example, the cue *playing in the rain* might evoke a memory about *running in the rain*, where *running* was the prime.

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Data availability statement

As this is a review paper, there are no data associated with this paper.

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