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Replication and extension of long-term implicit memory: Perceptual priming but conceptual cessation[☆]

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ABSTRACT

We endeavored to replicate Mitchell's (2006) finding of 17-year implicit memory priming. Subjects saw word and picture stimuli in 1999–2000 (*M* age = 18.9) and were retested after 11–14 years (*M* = 13.2; *M* age = 32.1). Via the internet, they completed four implicit memory tasks: picture fragment identification, word fragment completion, word stem completion, and category exemplar generation. Relative to control subjects (matched on stimuli, age, and education), longitudinal subjects revealed priming on picture and word fragment identification (perceptual tasks), but no priming on word stem completion or category exemplar generation (conceptual tasks). Four longitudinal subjects who failed to recall participating in the prior laboratory session had priming similar to the 10 subjects who did remember. Thus, we replicated the longevity of perceptual priming for pictures, and extended this to word fragment priming as well.

Mitchell (2006) discovered picture fragment priming 17 years after a brief exposure to pictures. Subjects who had named intact pictures in the laboratory (Mitchell, 1989) subsequently identified picture fragments. Priming (correctly identifying fragments corresponding to the original pictures minus novel fragments) was 12.5%–significantly above chance—and comparable to the magnitude of priming typically found in short-term single-session studies (Mitchell & Bruss, 2003; Weldon, Roediger, Beitel, & Johnston, 1995).

The purpose of the present study was to replicate and extend Mitchell's (2006) finding of very long-term implicit memory. The replication involved picture fragment identification (PFI) priming from prior naming of intact pictures more than a decade earlier. Our extension of Mitchell's finding involved three aspects: 1) Testing PFI priming for items previously tested as picture fragments; 2) Evaluating a second perceptual task, word fragment completion (WFC); 3) Adding two conceptual tasks, category exemplar generation (CEG) and word stem completion (WSC). Mitchell's (2006) earlier study was "low-tech"—paper-and-pencil sheets sent to subjects via snail-mail. The internet program used in the present investigation (Qualtrics) allowed us to virtually mimic the stimulus format used in the lab. In contrast to Mitchell's use of 70 (small) picture fragments printed on a page, our picture fragments were presented full-size, one at a time, as experienced years earlier. Likewise, the CEG, WSC, and WFC stimuli were displayed in the same font as originally experienced.

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Based on previous findings, we predicted that both perceptual tasks (PFI and WFC) would reveal priming, but we were less optimistic about our conceptual tasks (CEG and WSC). In theory, perceptual processes are engaged when physical features overlap between targets (e.g., *asparagus*) and test cues (a_p_r_gu_ in WFC). Thus, priming in perceptual tasks is enhanced by physical similarity, and can be diminished or even eliminated by changes between study and test. Both WFC and PFI have been classified unequivocally as perceptual implicit tasks (Roediger & McDermott, 1993). Priming in perceptual tasks is theorized to be mediated by a *perceptual representation system* (Tulving & Schacter, 1990), and appears to be less affected by long intervals than conceptual processes (Roediger & Geraci, 2005). Indeed, the majority of studies reporting long-term priming ranging from months (Beatty, English, & Winn, 1998; Drummey & Newcombe, 1995; Sloman, Hayman, Ohta, Law, & Tulving, 1988) to years (Kennedy, Rodrigue, & Raz, 2007; Mitchell, 2006) employed perceptual tasks. Incidentally, priming has been found for both picture naming at 3–48 weeks (Cave, 1997; Mitchell & Brown, 1988; Mitchell, Brown, & Murphy, 1990) and famous face naming after 22 months (Maylor, 1998), but their conceptual versus perceptual classification remains unclear (Bruss & Mitchell, 2009; Francis, 2014).

In contrast, *conceptual* processes presumably operate when only semantic features overlap between study and test (e.g., "vegetables" as a cue for *asparagus* in CEG). Conceptual tasks have been assumed to be very temporally limited, with priming declining over minutes (e.g., Hamann, 1990; Shimamura & Squire, 1984). However, later studies have extended conceptual priming longevity to weeks (Goshen-Gottstein & Kempinsky, 2001) and months (Thomson, Milliken, & Smilek, 2010). Thus, our study provided an opportunity to check for conceptual priming over a much longer period spanning years. Regarding taxonomy, CEG is acknowledged as the quintessential conceptual task (e.g., Roediger & McDermott, 1993). The classification of WSC, however, is less clear. While a number of early studies found parallel effects for WFC and WSC—implicating perceptual processes in the latter—later studies suggest that WSC may have both perceptual and conceptual components (see Bruss & Mitchell, 2009). In particular, WSC is more likely to behave conceptually at test when the stimuli are pronounced at study (as opposed to levels-of-processing manipulations; cf. Mitchell & Bruss, 2003). Recent work has classified WSC as conceptual when production processes (Gabrieli et al., 1999) are engaged (Soler, Dasi, & Ruiz, 2015; Spataro, Cestari, & Rossi-Arnaud, 2011). As Spaan and Raaijmakers (2011) put it, "perceptual components of the WSC task may be reduced when stimuli are articulated" (p. 88). In the current study, all stimuli (whether words or pictures) had simply been pronounced at input during the 1999–2000 original session.

1. Method

1.1. Subjects

The 48 adults who served in the original laboratory study at Loyola University Chicago in 1999 and 2000 were between 18 and 28 years old at that time (Mitchell & Bruss, 2003). The original study also included a sample of older adults, but the current analyses focus solely on younger adults to be comparable with Mitchell (2006) (see Table 1).

We compared longitudinal subjects' performance to controls who had not seen the original stimuli. Controls (recruited from faculty and staff at Kennesaw State University) were matched as closely as possible on age and education, and their stimuli were yoked to longitudinal subjects' stimuli vis-à-vis counterbalancing (see below).

From November 1999 through March 2000, the original subjects participated in a laboratory setting in five implicit memory tasks: picture naming, picture fragment identification, category exemplar generation, word fragment completion, and word stem completion (see Mitchell & Bruss, 2003). From 2009 through 2013, these individuals received requests (via email and snail-mail) to participate again via the internet (Qualtrics). Of those we found, no one refused but most ($n = 34$) never replied. Fourteen (29%) did respond, and were re-tested with a mean retention interval of 13.2 years (11.6–14.7, $SD = 1.1$). Our longitudinal subjects did not differ significantly from non-responders in mean age (19.8), years of education (13.4), or vocabulary (48.3).

1.2. Materials

In 1999–2000, 54 words and 54 pictures were presented for 2 s each, with a minimum ISI of 1 s. In addition to the 108 targets, 54 baseline (or comparison) items were presented at test. For pictures, complete black-and-white line drawings (Snodgrass & Vanderwart, 1980) constituted the original target stimuli. For each of the five tasks, Mitchell and Bruss (2003) tested priming in both

Table 1
Subject samples characteristics: means (SDs).

	Age	Years Ed.	Vocabulary
Mitchell and Bruss (2003)			
Longitudinal subjects ($n = 14$)	18.9	13.1	51.1 [W]
	(0.7)	(0.7)	(6.1)
Current study (2011–2014)			
Longitudinal retest ($n = 14$)	32.1	17.8	33.9[S]
	(1.3)	(1.5)	(2.1)
Control group ($n = 14$)	32.9	18.6	35.5[S]
	(3.4)	(1.9)	(2.7)

Notes. Years Ed. = Years of Education; Vocabulary scores: W = *WAIS-V*; S = *Shipley-2*.