

FLUENCY ILLUSIONS IN METAMEMORY

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Metamemory—people’s knowledge about their own memory processes and how they use this knowledge to regulate their behavior—is among the most remarkable features of human memory. When reflecting on their memories, people do not directly access memory traces but infer the state of their memories on the basis of available cues and heuristics (e.g., Koriat, 2007; Schwartz, 1994; Undorf, Söllner, & Bröder, 2018). Consequently, the cues and heuristics that form the basis of metamemory have received much attention. One of the most-researched cues is fluency—the ease of processing information during learning and retrieval: More than 3,000 citations appear in PsycINFO in response to a joint query of *fluency* and *metamemory* or *metacognition* as keywords.

Fluency as a Cue in Metamemory

Metamemory can make use of fluency at various stages of learning and remembering (e.g., Koriat, 2007; Undorf & Erdfelder, 2011). *Ease-of-learning (EOL)* judgments made before studying items may be based on the fluency of processing to-be-studied information prior to encoding. *Judgments of learning (JOLs)* made during study may be based on encoding fluency and, when made after a delay, on retrieval fluency. *Feeling of knowing (FOK)* judgments made before or during attempts to retrieve information from memory may be based on retrieval fluency. Each of these fluency experiences may stem from different sources that include the ease of perception, the ease of conceptual processing, and the ease of motor processes (perceptual, conceptual, and motoric fluency, respectively, see, e.g., Alter & Oppenheimer, 2009). In any case, feelings of fluency are by-products of learning and memory processes. Feelings of fluency can give rise to direct experiences of mastery or knowledge that inform metamemory through nonanalytic inferences (e.g., Koriat, 1997; Koriat & Levy-Sadot, 1999).

Basing metamemory on fluency has several advantages. First, fluency is a generally valid cue for remembering. For instance, encoding fluency is predictive of later recall success (Koriat, 2008; Koriat, Ma’ayan, & Nussinson, 2006) and the ease of retrieving partial information about nonrecalled memory targets is predictive of recognizing targets among distractors (Koriat, 1993). Also, fluency can inform metamemory quickly and without much effort (Koriat & Levy-Sadot, 1999). Fluency-based metamemory judgments have the potential to integrate various influences on learning and remembering (Koriat, 1997; Undorf et al., 2018). Finally, relying on fluency can produce accurate metamemory judgments even when declarative knowledge about memory is incomplete or flawed (Koriat, 1997).

Illusions as a Tool to Study Fluency Contributions to Metamemory

Despite the ecological validity and usefulness of fluency, studies on the basis of metamemory frequently report that fluency dissociates metamemory and actual memory. In many cases, these dissociations are due to researchers creating contrived experimental situations in order to disentangle fluency from actual memorability and, thereby, providing a strong test of fluency contributions to metamemory (for different approaches see, e.g., Mueller, Tauber, & Dunlosky, 2013; Undorf & Erdfelder, 2015; Undorf & Zander, 2017).

One research strategy has been to manipulate fluency while keeping actual memorability constant. For instance, Rhodes and Castel (2008) elicited JOLs for words that were printed in a large, presumably more fluent font or in a small, presumably less fluent font. Results revealed higher JOLs for large-font words than for small-font words, but no effect of font size on memory performance. Other studies kept fluency constant and manipulated actual memorability. For instance, Koriat and colleagues (2004) found that whether a memory test occurred after a 10-min or 1-week delay impacted recall performance but not JOLs, presumably because the announced retention interval did not affect encoding fluency. Another research strategy has been to orthogonally manipulate fluency and actual memorability. For instance, several JOL studies manipulated font size independently of other manipulations that have a profound impact on memory performance such as word pair relatedness (Price & Harrison, 2017) or number of study presentations (Kornell, Rhodes, Castel, & Tauber, 2011; Undorf et al., 2018). In the extreme, researchers created situations in which there is an inverse relationship between fluency and actual memorability. For instance, Besken and Mulligan (2013) obtained JOLs for words that were either intact and more fluently perceived, or backward-masked and less fluently perceived. JOLs were higher for intact than for backward-masked words, whereas memory performance showed the opposite pattern.

Figure 10.1 presents an overview of the metamemory illusions that have been linked to fluency. The bulk of the illusions were obtained with JOLs, reflecting the popularity of these judgments in metamemory research (e.g., Rhodes, 2016). In most cases, it has been proposed that illusions result from basing metamemory judgments on fluency. For instance, Begg, Duft, Lalonde, Melnick, and Sanvito (1989) as well as Benjamin (2003) argued that fluency underlies the word frequency illusion in recognition memory. This illusion refers to the finding that people predict superior recognition memory for high-frequency words than for low-frequency words, whereas actual memory reveals the opposite pattern. According to the fluency account, high-frequency words receive higher JOLs than low-frequency words because they are more fluently encoded. One exception to the assumption that illusions result from fluency-based metamemory judgments is the instructor fluency illusion (Carpenter, Wilford, Kornell, & Mullaney, 2013; Toftness et al., 2018). Here, fluency is used to describe how instructors deliver lectures. Research on this illusion showed that people predict better memory performance for fluent than for disfluent instructors although memory performance is independent of instructor fluency.

In summary, researchers have intentionally produced metamemory illusions in order to uncover the contribution of fluency to metamemory. Given that illusions were often found in contrived experimental situations, their existence is not incompatible with the fact that people's metamemory is generally quite accurate (e.g., Bröder & Undorf, 2019; Dunlosky & Metcalfe, 2009; Koriat, 2007). In the following sections, I review evidence for fluency contributions to metamemory illusions.

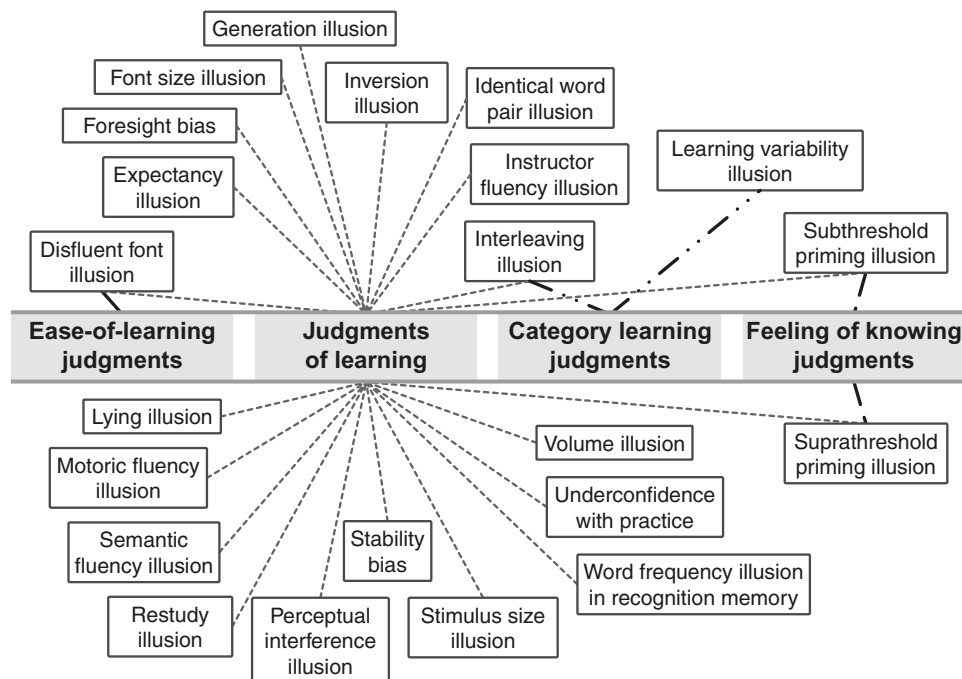


Figure 10.1 Overview of metamemory illusions that have been linked to fluency.

Metamemory Illusions for which There Is Indirect Evidence for Fluency Contributions

Metamemory illusions do not necessarily reflect fluency contributions to metamemory. The reason is that illusions could also stem from faulty explicit beliefs about memory (e.g., Dunlosky & Tauber, 2014; Mueller & Dunlosky, 2017). For instance, learners may notice differences in word frequency and base their JOLs on the belief that high-frequency words are easier to recognize than low-frequency words. Similarly, learners may base their JOLs on the belief that large-font words are easier to remember than small-font words. If this was the case, then metamemory illusions would rely on analytic processes: People would search for variation across items and would deliberately base their metamemory judgments on pre-existing or newly formed beliefs about how item characteristics or experimental manipulations affect memory (e.g., Dunlosky & Tauber, 2014; Mueller et al., 2013). Investigating people's metamemory beliefs can therefore help delimit the basis of metamemory illusions. In particular, finding that a specific illusion is unexplainable by metamemory beliefs provides indirect evidence for fluency contributions. This is the case for the illusions listed in Table 10.1. For instance, research assessing people's metamemory beliefs demonstrated that people are aware of the fact that studying results in learning (Ariel, Hines, & Hertzog, 2014; Kornell & Bjork, 2009; Kornell et al., 2011). At the same time, people neglect the value of future study opportunities in JOLs (stability bias, Kornell & Bjork, 2009). Together, these findings provide indirect evidence for fluency contributions to the stability bias.

Overall, assessing the role of explicit beliefs can constrain fluency contributions to metamemory illusions and thereby help identify an illusion's basis. At the same time, there are several reasons why this approach is incapable of providing direct evidence for fluency contributions to metamemory illusions. First, even when a specific metamemory illusion

is unexplainable by metamemory beliefs, some factor other than fluency may drive the illusion (Undorf & Erdfelder, 2015). Also, when asked about their beliefs, people may fail to report metamemory beliefs that they actually have or are developing (Undorf, Zimdahl, & Bernstein, 2017). This problem may be exacerbated by the fact that we know little about how beliefs should be assessed.

In summary, findings showing that metamemory illusions are unexplainable by people's explicit beliefs about memory provide indirect evidence for fluency contributions to the metamemory illusions listed in Table 10.1. These illusions include the stability bias and the volume illusion.

Table 10.1 Metamemory Illusions for which There Is Indirect Evidence for Fluency Contributions

	<i>Illusion</i>	<i>Unexplainable by beliefs</i>
<i>Stability bias</i>		
JOLs neglect future learning/forgetting		
Ariel, Hines, & Hertzog (2014, Exp. 4, test frame)	+	+
Koriat, Bjork, Sheffer, & Bar (2004, Exp. 4A)		–
Kornell & Bjork (2009, Exp. 3)	+	+
Kornell & Bjork (2009, Exp. 4)	+	+
Kornell, Rhodes, Castel, & Tauber (2011, Exp. 3)	+	+
Ariel, Hines, & Hertzog (2014, Exp. 1, test frame)	+	
Ariel, Hines, & Hertzog (2014, Exp. 1, study frame)	–	
Ariel, Hines, & Hertzog (2014, Exp. 2, test frame)	+	
Ariel, Hines, & Hertzog (2014, Exp. 2, test frame with quantities)	+	
Ariel, Hines, & Hertzog (2014, Exp. 2, study frame)	–	
Ariel, Hines, & Hertzog (2014, Exp. 2, study frame with quantities)	–	
Ariel, Hines, & Hertzog (2014, Exp. 3, study frame, separate predictions)	–	
Ariel, Hines, & Hertzog (2014, Exp. 3, study frame, joint predictions)	–	
Ariel, Hines, & Hertzog (2014, Exp. 4, study frame)	–	
Ariel, Hines, & Hertzog (2014, Exp. 5, study frame)	–	
Halamish, Nussinson, & Ben-Ari (2013, Exp. 1, temporally close)	+	
Halamish, Nussinson, & Ben-Ari (2013, Exp. 1, temporally distant)	–	
Halamish, Nussinson, & Ben-Ari (2013, Exp. 2, low construal)	+	
Halamish, Nussinson, & Ben-Ari (2013, Exp. 2, high construal)	–	
Koriat, Bjork, Sheffer, & Bar (2004, Exp. 1)	+	
Koriat, Bjork, Sheffer, & Bar (2004, Exp. 2)	–	
Koriat, Bjork, Sheffer, & Bar (2004, Exp. 3A)	+	
Koriat, Bjork, Sheffer, & Bar (2004, Exp. 3B)	–	
Koriat, Bjork, Sheffer, & Bar (2004, Exp. 4B)	+	
Koriat, Bjork, Sheffer, & Bar (2004, Exp. 4C)	+	
Koriat, Bjork, Sheffer, & Bar (2004, Exp. 5A)	+	
Koriat, Bjork, Sheffer, & Bar (2004, Exp. 5B)	+	
Koriat, Bjork, Sheffer, & Bar (2004, Exp. 6A)	+	
Koriat, Bjork, Sheffer, & Bar (2004, Exp. 6B)	+	
Koriat, Bjork, Sheffer, & Bar (2004, Exp. 7)	–	
Kornell & Bjork (2009, Exp. 1)	+	
Kornell & Bjork (2009, Exp. 2)	+	
Kornell & Bjork (2009, Exp. 5)	+	
Kornell & Bjork (2009, Exp. 6)	+	
Kornell & Bjork (2009, Exp. 7)	+	

(continued)

Table 10.1 (cont.)

	<i>Illusion</i>	<i>Unexplainable by beliefs</i>
Kornell & Bjork (2009, Exp. 8)	+	
Kornell & Bjork (2009, Exp. 9)	+	
Kornell & Bjork (2009, Exp. 10)	+	
Kornell, Rhodes, Castel, & Tauber (2011, Exp. 1)	+	
Kornell, Rhodes, Castel, & Tauber (2011, Exp. 2)	+	
<i>Volume illusion</i>		
JOL (louder volumes) > JOL (quieter volumes)		
Frank & Kuhlmann (2017, Exp. 2, recall test)	+	+
Frank & Kuhlmann (2017, Exp. 2, recognition test)	+	+
Frank & Kuhlmann (2017, Exp. 3)	+	+
Frank & Kuhlmann (2017, Exp. 1)	+	
Peynircioğlu & Tatz (2018, Exp. 1)	+	
Peynircioğlu & Tatz (2018, Exp. 2)	+	
Peynircioğlu & Tatz (2018, Exp. 4)	+	
Peynircioğlu & Tatz (2018, Exp. 5)	–	
Rhodes & Castel (2009, Exp. 1)	+	
Rhodes & Castel (2009, Exp. 2)	+	
Soderstrom & Rhodes (2014, Exp. 1)	+	
Soderstrom & Rhodes (2014, Exp. 2)	+	

Note. JOL = judgment of learning. Illusion = + indicates that the illusion was found and illusion = – indicates that it was not found. If an illusion is unexplainable by explicit beliefs (unexplainable by beliefs = +), this provides indirect evidence for fluency contributions. Empty cells denote that there were no relevant data.

Metamemory Illusions for which There Is Direct Evidence for Fluency Contributions

More direct evidence for fluency contributions to metamemory illusions comes from studies that obtained independent fluency measures. Obtaining independent fluency measures allows researchers to test for the expected fluency differences and, if so, whether fluency differences mediate metamemory illusions. Frequently used fluency measures include the speed of retrieving information from memory (retrieval latency, Benjamin, Bjork, & Schwartz, 1998; Serra & Dunlosky, 2005), the speed of identifying items at study (identification latency, Besken & Mulligan, 2014; Undorf et al., 2017), the time people allocate to studying a particular item (self-paced study time, Koriati et al., 2006; Undorf & Erdfelder, 2015, but see Undorf & Ackerman, 2017), and the speed of making lexical decisions (lexical decision latency, Mueller, Dunlosky, Tauber, & Rhodes, 2014; Undorf & Zimdahl, 2019), among others.

Table 10.2 presents metamemory illusions for which studies found direct evidence for fluency contributions. For instance, using the speed of retrieving answers to general-knowledge questions from semantic memory as an independent fluency measure, Benjamin and colleagues (1998) found that retrieval fluency contributed to the semantic fluency illusion. In their study, participants answered general-knowledge questions and then judged their chances of recalling each answer in a free recall test. Results showed that JOLs increased with retrieval fluency although actual free recall performance revealed the opposite pattern.

Combining assessments of people's metamemory beliefs with measurements of fluency contributions can provide even clearer evidence for fluency contributions to metamemory illusions. For instance, Susser and Mulligan (2015) and Susser, Panitz, Buchin, and Mulligan

Table 10.2 Metamemory Illusions for which There Is Direct Evidence for Fluency Contributions

	<i>Illusion</i>	<i>Unexplainable by beliefs</i>	<i>Mediated by fluency</i>	<i>Nonanalytic fluency use</i>
<i>Expectancy illusion</i>				
JOL (expected source-item pairs) > JOL (unexpected source-item pairs)				
Schaper, Kuhlmann, & Bayen (2019a, Exp. 1)	+	+		
Schaper, Kuhlmann, & Bayen (2019a, Exp. 2)	+	+	+	
Schaper, Kuhlmann, & Bayen (2019b, Exp. 1)	+			
Schaper, Kuhlmann, & Bayen (2019b, Exp. 2, JOLs only)	+			
Schaper, Kuhlmann, & Bayen (2019b, Exp. 2, JOLs & JOSs)	+			
<i>Generation illusion</i>				
JOL (to-be-generated items) < JOL (intact items)				
Besken & Mulligan (2014, Exp. 5)	+		+	
Besken (2016, Exp. 2)	+		+	
Besken (2016, Exp. 3)	+		+	
Besken (2016, Exp. 4)		+		
Yang, Potts, & Shanks (2017, Exp. 3)		–		
Begg, Vinski, Frankovich, & Holgate (1991, Exp. 3, mixed list)	–			
Begg, Vinski, Frankovich, & Holgate (1991, Exp. 3, pure-list generate vs. read)	–			
Begg, Vinski, Frankovich, & Holgate (1991, Exp. 4, mixed list)	–			
Begg, Vinski, Frankovich, & Holgate (1991, Exp. 4, pure-list generate vs. read)	–			
Besken (2016, Exp. 1)	+			
Besken & Mulligan (2014, Exp. 1)	+			
Besken & Mulligan (2014, Exp. 2)	+			
Besken & Mulligan (2014, Exp. 3)	–			
Besken & Mulligan (2014, Exp. 4)	+			
Besken & Mulligan (2014, Exp. 6)	+			
Matvey, Dunlosky, & Guttentag (2001, Exp. 1, learners)	–			
Matvey, Dunlosky, & Guttentag (2001, Exp. 1, observers)	–			
Matvey, Dunlosky, & Guttentag (2001, Exp. 1, judges)	–			
Matvey, Dunlosky, & Guttentag (2001, Exp. 2, learners)	–			
Matvey, Dunlosky, & Guttentag (2001, Exp. 2, pure observers)	–			
Susser, Mulligan, & Besken (2013, mixed list)	–			
Susser, Mulligan, & Besken (2013, pure list generate vs. read)	–			
Yang, Potts, & Shanks (2017, Exp. 1)	+			
Yang, Potts, & Shanks (2017, Exp. 2)	+			
Yang, Potts, & Shanks (2017, Exp. 4, informed)	+			
Yang, Potts, & Shanks (2017, Exp. 4, uninformed)	+			
Yang, Potts, & Shanks (2017, Exp. 5, immediate JOLs)	+			
Yang, Potts, & Shanks (2017, Exp. 5, delayed JOLs)	–			

(continued)

Table 10.2 (cont.)

	<i>Illusion</i>	<i>Unexplainable by beliefs</i>	<i>Mediated by fluency</i>	<i>Nonanalytic fluency use</i>
<i>Lying illusion</i>				
JOL (plausible lies) < JOL (truthful answers)				
Besken (2018, Exp. 1)	+		+	
Besken (2018, Exp. 2)	+		+	
Besken (2018, Exp. 3)	+		+	
Besken (2018, Exp. 4)	+		+	
Besken (2018, Exp. 5)	+	–		
<i>Motoric fluency illusion</i>				
JOL (write with dominant hand) > JOL (write with nondominant hand)				
Susser & Mulligan (2015, Exp. 2)	+		+	
Susser & Mulligan (2015, Exp. 3)	+	+		
Susser, Panitz, Buchin, & Mulligan (2017, Exp. 4)	+	–		
Susser & Mulligan (2015, Exp. 1)	+			
Susser, Panitz, Buchin, & Mulligan (2017, Exp. 1)	+			
Susser, Panitz, Buchin, & Mulligan (2017, Exp. 2)	+			
Susser, Panitz, Buchin, & Mulligan (2017, Exp. 3a)	–			
Susser, Panitz, Buchin, & Mulligan (2017, Exp. 3b)	–			
<i>Semantic fluency illusion</i>				
JOL (quickly retrieved items) > JOL (slowly retrieved items)				
Benjamin et al. (1998, Exp. 1)	+		+	
Benjamin et al. (1998, Exp. 2)	+		+	
Benjamin et al. (1998, Exp. 3)	+		+	
<i>Stimulus size illusion</i>				
JOL (quick size increases) > JOL (slow size increases)				
Undorf et al. (2017, Exp. 1)	+		+	
Undorf et al. (2017, Exp. 2, naming)	+		+	
Undorf et al. (2017, Exp. 2, no naming)	+		+	
Undorf et al. (2017, Exp. 3)	+	+	+	
Undorf et al. (2017, Exp. 4)	+	+	+	+

Note. JOL = judgment of learning. Illusion = + indicates that the illusion was found and illusion = – indicates that it was not found. If an illusion is unexplainable by explicit beliefs (unexplainable by beliefs = +), this provides indirect evidence for fluency contributions. If an illusion is mediated by fluency (mediated by fluency = +), this provides direct evidence for fluency contributions. If so, it is important to test whether fluency is used nonanalytically (nonanalytic fluency use = +). Empty cells denote that there were no relevant data.

(2017) concluded that fluency drives the motoric fluency illusion, that is, higher JOLs for words written with one's dominant than with one's nondominant hand despite similar memory performance. In neither study had people the belief that the writing hand would impact memory. With fluency operationally defined as writing time, Susser and Mulligan (2015) found that fluency contributed to the motoric fluency illusion. Together, these findings suggest that fluency drives the motoric fluency illusion. As will be discussed in the next section, one caveat to this conclusion is that fluency contributions may be mediated by an analytic inference.

Nonanalytic versus Analytic Fluency Use

So far, we have assumed that fluency impacts metamemory through nonanalytic processes. However, it is also possible that people use fluency differences in an analytic way (e.g., Koriat, 2007; Mueller & Dunlosky, 2017; Undorf et al., 2017). For instance, people might use the explicit belief that quickly written, quickly learned, quickly identified, or quickly retrieved items are better remembered. If so, metamemory illusions would result from people's explicit beliefs about fluency rather than directly from fluency. Thus, it is important to test whether fluency contributes to metamemory through nonanalytic inferences.

There is evidence that nonanalytic fluency use underlies the stimulus size illusion, that is, higher JOLs for visual stimuli that increase quickly rather than slowly in size although memory performance is independent of clarification speed (Undorf et al., 2017). The stimulus size illusion was absent in people's beliefs: Post-experimental questionnaires revealed that people did not believe quick clarification to help memory. Operationally defining fluency as the time it took participants to identify the stimuli, Undorf and colleagues (2017) found that quick clarification increased JOLs indirectly through higher fluency. In fact, fluency was the only basis for the stimulus size illusion, because direct effects of quick clarification reduced JOLs. To test whether fluency contributed nonanalytically to the stimulus size illusion, Undorf and colleagues (2017) compared correlations between identification time and JOLs across participants who experienced the clarification process themselves and participants who saw the largest version of each stimulus together with another participant's alleged identification time. Only participants who experienced the clarification process revealed inverse correlations between identification time and JOLs, indicating that the stimulus size illusion is due to nonanalytic fluency use. Similarly, Yang and colleagues (2018) found that identification time for smaller and larger words in a continuous identification task mediated the font size illusion on JOLs only in participants who completed the identification task themselves. Note, however, that this finding stands in stark contrast to research showing that fluency operationally defined as self-paced study time and lexical decision time does not contribute to the font size illusion (e.g., Mueller et al., 2014; Price & Harrison, 2017; Undorf & Zimdahl, 2019). Nonetheless, these findings indicate that metamemory illusions can be due to nonanalytic fluency use.

In contrast, Besken (2016) obtained findings suggesting that analytic fluency use underlies the generation illusion for pictures, that is, higher JOLs for intact than for degraded pictures. Besken (2016) showed that people had no relevant beliefs and that fluency—operationally defined as the time people needed to identify pictures—contributed to the generation illusion. However, brief presentations of matching contours increased perceptual fluency for degraded pictures but did not impact JOLs, indicating that these may not directly reflect fluency.

More generally, showing that independent fluency measures reflect fluency differences and mediate metamemory illusions can provide direct evidence for fluency underlying metamemory illusions. One important issue with this approach is that the validity of results is critically dependent on the validity of fluency measures. Fluency contributions to metamemory illusions are underestimated when fluency measures fail to capture all relevant aspects of fluency (Undorf & Erdfelder, 2015). Conversely, fluency contributions to metamemory illusions are overestimated when fluency measures reflect some portion of metamemory beliefs. Although different fluency measures often yielded the same qualitative conclusions, there are also cases in which different measures supported different conclusions, as is discussed in detail below. It therefore seems advisable to use multiple fluency measures when evaluating fluency contributions to metamemory illusions. Just as important, more research is needed

to advance our understanding of the precise nature of fluency measures and, consequently, their similarities, differences, and validities.

In summary, studies that obtained independent fluency measures provided direct evidence for fluency contributions to the metamemory illusions listed in Table 10.2. These illusions include the motoric fluency illusion and the stimulus size illusion. For the majority of these illusions, however, it has yet to be examined whether fluency contributes in a direct, nonanalytic way.

Metamemory Illusions for which There Is Little or No Evidence for Fluency Contributions

While studies provided evidence for fluency contributions to the metamemory illusions discussed in the previous two sections, there is little or no evidence for fluency contributions to the illusions listed in Table 10.3. For instance, studies found no evidence that fluency contributed to the underconfidence-with-practice effect. This effect refers to a shift in JOLs from good calibration on the first study-test trial towards marked underconfidence from the second trial onwards (Koriat, 1997; Koriat, Sheffer, & Ma'ayan, 2002). Serra and Dunlosky (2005) operationally defined retrieval fluency as retrieval latencies on the first test and found that these were unrelated to underconfidence in Trial 2 JOLs. Finn and Metcalfe (2008) operationally defined encoding fluency as participants' ease-of-encoding judgments after the first test and found that these were unrelated to Trial 2 JOLs. Together, these findings argue against fluency contributions to the underconfidence-with-practice effect. Tiede and Leboe (2009a) reached a similar conclusion when investigating the basis of the foresight bias, that is, inflated JOLs due to information that is present at study but absent at test (Koriat & Bjork, 2006a). Operationally defining encoding fluency as self-paced study time, Tiede and Leboe (2009a) found no evidence that fluency contributed to the foresight bias.

Again, it is informative to combine assessments of people's metamemory beliefs with measurements of fluency contributions. For instance, several studies showed that fluency plays a minor role in producing the font size illusion (but see Yang, Huang, & Shanks, 2018). People were repeatedly found to believe that words printed in larger fonts are easier to remember than words printed in smaller fonts (e.g., Kornell et al., 2011; Mueller, Dunlosky, Tauber, & Rhodes, 2014; Undorf & Zimdahl, 2019). Also, independent fluency measures such as self-paced study time or lexical decision time were similar for smaller 18-point and larger 48-point words (e.g., Mueller et al., 2014) and fluency differences between words printed in a wide range of font sizes did not correspond to the effects of font size on JOLs (e.g., Undorf & Zimdahl, 2019). Mueller, Dunlosky, and Tauber (2016) found that fluency may not be driving the identical word pair illusion, that is, inflated JOLs for identical word pairs (*cat—cat*) as compared to related word pairs (*cat—dog*). In their studies, people had the belief that identical word pairs are easier to remember than related word pairs. Also, Mueller and colleagues (2016) operationally defined fluency as self-paced study time and found that it did not contribute to the identical word pair illusion.

In summary, for some of the metamemory illusions that were linked to fluency, studies found little or no evidence for fluency contributions. These illusions, listed in Table 10.4, include the underconfidence-with-practice effect and the font size illusion.

Metamemory Illusions for which Fluency Contributions Have Remained Untested

Finally, for some metamemory illusions that have been linked to fluency, fluency contributions have so far remained untested. For example, it has yet to be examined whether fluency contributes to the word frequency illusion in recognition memory and to the restudy illusion,

Table 10.3 Metamemory Illusions for which There Is Little or No Evidence for Fluency Contributions

	<i>Illusion found</i>	<i>Unexplainable by beliefs</i>	<i>Mediated by fluency</i>
<i>Disfluent font illusion</i>			
JOL (hard-to-read fonts) <= JOL (easy-to-read fonts)			
Magreehan, Serra, Schwartz, & Narciss (2016, Exp. 4, Study-test trial 1)	+		–
Magreehan, Serra, Schwartz, & Narciss (2016, Exp. 4, Study-test trial 2)	+		–
Geller, Still, Dark, & Carpenter (2018, Exp. 1)	+		
Geller, Still, Dark, & Carpenter (2018, Exp. 2)	+		
Geller, Still, Dark, & Carpenter (2018, Exp. 3)	+		
Magreehan, Serra, Schwartz, & Narciss (2016, Exp. 1, Study-test trial 1)	–		
Magreehan, Serra, Schwartz, & Narciss (2016, Exp. 1, Study-test trial 2)	–		
Magreehan, Serra, Schwartz, & Narciss (2016, Exp. 2, Study-test trial 1)	–		
Magreehan, Serra, Schwartz, & Narciss (2016, Exp. 2, Study-test trial 2)	–		
Magreehan, Serra, Schwartz, & Narciss (2016, Exp. 3, Study-test trial 1)	–		
Magreehan, Serra, Schwartz, & Narciss (2016, Exp. 3, Study-test trial 2)	–		
Magreehan, Serra, Schwartz, & Narciss (2016, Exp. 5, Study-test trial 1)	+		
Magreehan, Serra, Schwartz, & Narciss (2016, Exp. 5, Study-test trial 2)	+		
Pieger, Mengelkamp, & Bannert (2016)	+		
Pieger, Mengelkamp, & Bannert (2017)	+		
Rosner, Davis, & Milliken (2015, Exp. 4A, 10% blur)	–		
Rosner, Davis, & Milliken (2015, Exp. 4A, 15% blur)	–		
Yue, Castel, & Bjork (2013, Exp. 1a, List 1)	+		
Yue, Castel, & Bjork (2013, Exp. 1a, List 2)	+		
Yue, Castel, & Bjork (2013, Exp. 1a, List 3)	+		
Yue, Castel, & Bjork (2013, Exp. 1a, List 4)	+		
Yue, Castel, & Bjork (2013, Exp. 1b, List 1)	+		
Yue, Castel, & Bjork (2013, Exp. 1b, List 2)	+		
Yue, Castel, & Bjork (2013, Exp. 2a, List 1)	+		
Yue, Castel, & Bjork (2013, Exp. 2a, List 2)	+		
Yue, Castel, & Bjork (2013, Exp. 2a, List 3)	+		
Yue, Castel, & Bjork (2013, Exp. 2a, List 4)	+		
Yue, Castel, & Bjork (2013, Exp. 2b)	+		
Yue, Castel, & Bjork (2013, Exp. 3, List 1)	+		
Yue, Castel, & Bjork (2013, Exp. 3, List 2)	+		
Yue, Castel, & Bjork (2013, Exp. 3, List 3)	+		
Yue, Castel, & Bjork (2013, Exp. 3, List 4)	+		
<i>Font size illusion</i>			
JOL (larger fonts) > JOL (smaller fonts)			
Hu et al. (2015, Exp. 1, learners)	+	–	
Hu et al. (2015, Exp. 1, observers)	+	–	

(continued)

Table 10.3 (cont.)

	<i>Illusion found</i>	<i>Unexplainable by beliefs</i>	<i>Mediated by fluency</i>
Hu et al. (2015, Exp. 2, learners)	+	—	
Kornell et al. (2011, Exp. 3)		—	
Price, McElroy, & Martin (2016, Exp. 2, young adults)		—	
Price, McElroy, & Martin (2016, Exp. 2, older adults)		—	
Luna, Nogueira, & Albuquerque (2018, Exp. 3)	+		—
Mueller, Dunlosky, Tauber, & Rhodes (2014, Exp. 1)	+		—
Mueller, Dunlosky, Tauber, & Rhodes (2014, Exp. 2, limited study time)	+		—
Mueller, Dunlosky, Tauber, & Rhodes (2014, Exp. 2, unlimited study time)	+		—
Mueller, Dunlosky, Tauber, & Rhodes (2014, Exp. 3A)	+	—	
Mueller, Dunlosky, Tauber, & Rhodes (2014, Exp. 3B)	+	—	
Mueller, Dunlosky, Tauber, & Rhodes (2014, Exp. 4)	+	—	
Price & Harrison (2017, Exp. 1, List 1)	+	—	
Price & Harrison (2017, Exp. 1, List 2)	+	—	
Price & Harrison (2017, Exp. 2, List 1)	+	—	
Price & Harrison (2017, Exp. 2, List 2)	+	—	
Price & Harrison (2017, Exp. 2, List 3)	+	—	
Price & Harrison (2017, Exp. 3, List 1)	+	—	—
Price & Harrison (2017, Exp. 3, List 2)	+	—	—
Su et al. (2018, Exp. 1)	+		—
Su et al. (2018, Exp. 2a)	+	—	
Su et al. (2018, Exp. 2b)	+	—	
Undorf & Zimdahl (2019, Exp. 1)	+		—
Undorf & Zimdahl (2019, Exp. 2, chin rest)	+		—
Undorf & Zimdahl (2019, Exp. 2, no chin rest)	+		—
Undorf & Zimdahl (2019, Exp. 3, belief assessed before study)	+	—	—
Undorf & Zimdahl (2019, Exp. 3, belief assessed after study)	+	—	—
Undorf & Zimdahl (2019, Exp. 3, belief assessed after test)	+	—	—
Undorf & Zimdahl (2019, Exp. 4)	+		—
Yang, Huang, & Shanks (2018, Exp. 1)	+		+
Yang, Huang, & Shanks (2018, Exp. 3)	+	+	+
Ball, Klein, & Brewer (2014, Exp. 2)	—		
Blake & Castel (2018, Exp. 1A, weak belief, List 1)	+		
Blake & Castel (2018, Exp. 1A, weak belief, List 2)	+		
Blake & Castel (2018, Exp. 1A, medium belief, List 1)	+		
Blake & Castel (2018, Exp. 1A, medium belief, List 2)	+		
Blake & Castel (2018, Exp. 1A, strong belief, List 1)	+		
Blake & Castel (2018, Exp. 1A, strong belief, List 2)	+		
Blake & Castel (2018, Exp. 1B, weak belief, List 1)	+		
Blake & Castel (2018, Exp. 1B, weak belief, List 2)	+		
Blake & Castel (2018, Exp. 1B, medium belief, List 1)	+		
Blake & Castel (2018, Exp. 1B, medium belief, List 2)	+		
Blake & Castel (2018, Exp. 1B, strong belief, List 1)	+		
Blake & Castel (2018, Exp. 1B, strong belief, List 2)	+		
Blake & Castel (2018, Exp. 2, large-is-easy belief, List 1)	+		
Blake & Castel (2018, Exp. 2, large-is-easy belief, List 2)	+		
Blake & Castel (2018, Exp. 2, small-is-easy belief, List 1)	+		
Blake & Castel (2018, Exp. 2, small-is-easy belief, List 2)	+		
Bröder & Undorf (2019, Exp. 5)	+		

Table 10.3 (cont.)

	<i>Illusion found</i>	<i>Unexplainable by beliefs</i>	<i>Mediated by fluency</i>
Halamish (2018, Exp. 1)	+		
Halamish (2018, Exp. 2)	+		
Halamish (2018, Exp. 3)	+		
Halamish (2018, Exp. 4)	+		
Halamish (2018, Exp. 11A)	+		
Halamish, Nachman, & Katzir (2018, 1st Graders)	+		
Halamish, Nachman, & Katzir (2018, 5th-6th Graders)	+		
Hu et al. (2016, Exp. 1)	+		
Hu et al. (2016, Exp. 2)	–		
Hu et al. (2016, Exp. 3)	–		
Kornell et al. (2011, Exp. 1)	+		
Kornell et al. (2011, Exp. 2)	+		
Luna, Albuquerque, & Martín-Luengo (2018, Exp. 1, related sentences)	+		
Luna, Albuquerque, & Martín-Luengo (2018, Exp. 1, unrelated sentences)	+		
Luna, Albuquerque, & Martín-Luengo (2018, Exp. 2, related sentence pairs)	–		
Luna, Albuquerque, & Martín-Luengo (2018, Exp. 2, unrelated sentence pairs)	–		
Luna, Albuquerque, & Martín-Luengo (2018, Exp. 3, short sentences)	+		
Luna, Albuquerque, & Martín-Luengo (2018, Exp. 3, long sentences)	–		
Luna, Albuquerque, & Martín-Luengo (2018, Exp. 4, high load)	+		
Luna, Albuquerque, & Martín-Luengo (2018, Exp. 4, low load)	+		
Luna, Nogueira, & Albuquerque (2018, Exp. 1)	+		
Luna, Nogueira, & Albuquerque (2018, Exp. 2)	+		
McDonough & Gallo (2012, Exp. 1)	+		
McDonough & Gallo (2012, Exp. 2, color-oriented retrieval)	+		
McDonough & Gallo (2012, Exp. 2, size-oriented retrieval)	+		
McDonough & Gallo (2012, Exp. 3, CR test)	+		
McDonough & Gallo (2012, Exp. 3, 2AFC test)	+		
Miele, Finn, & Molden (2011, Exp. 2, entity theorists)	+		
Miele, Finn, & Molden (2011, Exp. 2, incremental theorists)	+		
Peynircioğlu & Tatz (2018, Exp. 1)	+		
Peynircioğlu & Tatz (2018, Exp. 2)	+		
Peynircioğlu & Tatz (2018, Exp. 4)	+		
Peynircioğlu & Tatz (2018, Exp. 5)	–		
Price, McElroy, & Martin (2016, Exp. 1, young adults, List 1)	+		
Price, McElroy, & Martin (2016, Exp. 1, young adults, List 2)	–		
Price, McElroy, & Martin (2016, Exp. 1, older adults, List 1)	+		
Price, McElroy, & Martin (2016, Exp. 1, older adults, List 2)	+		
Rhodes & Castel (2008, Exp. 1)	+		
Rhodes & Castel (2008, Exp. 2, List 1)	+		
Rhodes & Castel (2008, Exp. 2, List 2)	+		
Rhodes & Castel (2008, Exp. 3)	+		
Rhodes & Castel (2008, Exp. 4)	+		

(continued)

Table 10.3 (cont.)

	<i>Illusion found</i>	<i>Unexplainable by beliefs</i>	<i>Mediated by fluency</i>
Susser, Mulligan, & Besken (2013, Exp. 1, mixed list)	+		
Susser, Mulligan, & Besken (2013, Exp. 1, pure-list large vs. small)	–		
Undorf, Söllner, & Bröder (2018, Exp. 1)	+		
Undorf, Söllner, & Bröder (2018, Exp. 3)	+		
Undorf, Söllner, & Bröder (2018, Exp. 4)	+		
<i>Foresight bias</i>			
Information present only at study inflates JOLs			
Tiede & Leboe (2009a, Exp. 1, self-paced study)	+		–
Koriat & Bjork (2005, Exp. 2)	+		
Koriat & Bjork (2005, Exp. 3)	+		
Koriat & Bjork (2006a, Exp. 1, Study-test trial 1)	+		
Koriat & Bjork (2006a, Exp. 1, Study-test trial 2)	–		
Koriat & Bjork (2006a, Exp. 1, Study-test trial 3)	–		
Koriat & Bjork (2006a, Exp. 1, Study-test trial 4)	–		
Koriat & Bjork (2006a, Exp. 2, study experience, last study-test trial)	+		
Koriat & Bjork (2006a, Exp. 2, test experience, first study-test trial)	+		
Koriat & Bjork (2006a, Exp. 2, test experience, last study-test trial)	–		
Koriat & Bjork (2006a, Exp. 3, study experience, last study-test trial)	+		
Koriat & Bjork (2006a, Exp. 3, test experience, first study-test trial)	+		
Koriat & Bjork (2006a, Exp. 3, test experience, last study-test trial)	–		
Koriat & Bjork (2006a, Exp. 4)	+		
Koriat & Bjork (2006a, Exp. 5)	+		
Koriat & Bjork (2006b, Exp. 1, mnemonic debiasing, same list, Block 1)	+		
Koriat & Bjork (2006b, Exp. 1, mnemonic debiasing, same list, Block 2)	–		
Koriat & Bjork (2006b, Exp. 1, mnemonic debiasing, different list, Block 1)	+		
Koriat & Bjork (2006b, Exp. 1, mnemonic debiasing, different list, Block 2)	+		
Koriat & Bjork (2006b, Exp. 1, theory debiasing, same list, Block 1)	+		
Koriat & Bjork (2006b, Exp. 1, theory debiasing, same list, Block 2)	–		
Koriat & Bjork (2006b, Exp. 1, theory debiasing, different list, Block 1)	+		
Koriat & Bjork (2006b, Exp. 1, theory debiasing, different list, Block 2)	–		
Tiede & Leboe (2009a, Exp. 1, fixed-paced study)	+		
Tiede & Leboe (2009a, Exp. 2)	+		
Van Overschelde & Nelson (2006)	+		

Table 10.3 (cont.)

	<i>Illusion found</i>	<i>Unexplainable by beliefs</i>	<i>Mediated by fluency</i>
<i>Identical word pair illusion</i>			
Inflated JOLs for identical word pairs			
Mueller, Dunlosky, & Tauber (2016, Exp. 1)	+		—
Mueller, Dunlosky, & Tauber (2016, Exp. 2)	+		—
Mueller, Dunlosky, & Tauber (2016, Exp. 3)	+	—	
Mueller, Dunlosky, & Tauber (2016, Exp. 4)	+	—	
Castel, McCabe, & Roediger (2007, Exp. 1)	+		
Castel, McCabe, & Roediger (2007, Exp. 2)	+		
<i>Inversion illusion</i>			
JOL (inverted items) <= JOL (upright items)			
Besken, Solmaz, Karaca, & Atilgan (2019, Exp. 1)	+		—
Besken, Solmaz, Karaca, & Atilgan (2019, Exp. 2)	+		—
Sungkhasettee, Friedman, & Castel (2011, Exp. 1)	+		
Sungkhasettee, Friedman, & Castel (2011, Exp. 2)	+		
<i>Suprathreshold priming</i>			
JOL (primed items) > JOL (control items)			
Susser, Jin, & Mulligan (2016, Exp. 2)	+		—
<i>Underconfidence with practice</i>			
Underconfident JOLs starting with the second study-test trial			
Finn & Metcalfe (2008, Exp. 4)			—
Serra & Dunlosky (2005, Exp. 1)	+		—
Serra & Dunlosky (2005, Exp. 2)	+		—
Serra & Dunlosky (2005, Exp. 3)	+		—
Diaz & Benjamin (2011, Exp. 2)	+		
England & Serra (2012, Exp. 1)	+		
England & Serra (2012, Exp. 2, ostensibly easy task)	+		
England & Serra (2012, Exp. 2, ostensibly hard task)	+		
Finn & Metcalfe (2008, Exp. 1)	+		
Finn & Metcalfe (2008, Exp. 2)	+		
Finn & Metcalfe (2008, Exp. 3)	+		
Finn & Metcalfe (2014, Exp. 1, 3rd Graders)	—		
Finn & Metcalfe (2014, Exp. 1, 5th Graders)	—		
Hanczakowski, Zawadzka, Pasek, & Higham (2013, Exp. 1)	+		
Hanczakowski, Zawadzka, Pasek, & Higham (2013, Exp. 2)	—		
Hanczakowski, Zawadzka, Pasek, & Higham (2013, Exp. 4)	+		
Hertzog, Hines, & Touron (2013)	—		
Karpicke (2009, Exp. 3)	+		
Koriat (1997, Exp. 1, same list)	+		
Koriat (1997, Exp. 1, different list)	+		
Koriat (1997, Exp. 2, feedback)	+		
Koriat (1997, Exp. 2, no feedback)	+		
Koriat (1997, Exp. 3)	+		
Koriat, Sheffer, & Ma'ayan (2002, Exp. 1)	+		
Koriat, Sheffer, & Ma'ayan (2002, Exp. 2)	+		
Koriat, Ma'ayan, Sheffer, & Bjork (2006, Exp. 1)	+		
Koriat, Ma'ayan, Sheffer, & Bjork (2006, Exp. 2)	+		
Koriat, Ma'ayan, Sheffer, & Bjork (2006, Exp. 3)	+		
Lipko, Dunlosky, Lipowski, & Merriman (2012, Exp. 1A)	—		
Lipko, Dunlosky, Lipowski, & Merriman (2012, Exp. 1B)	+		
Lipko, Dunlosky, Lipowski, & Merriman (2012, Exp. 1C)	—		

(continued)

Table 10.3 (cont.)

	<i>Illusion found</i>	<i>Unexplainable by beliefs</i>	<i>Mediated by fluency</i>
Meeter & Nelson (2003)	+		
Rast & Zimprich (2009, Exp. 1, young adults)	+		
Rast & Zimprich (2009, Exp. 1, older adults)	–		
Rast & Zimprich (2009, Exp. 2, young adults)	+		
Rast & Zimprich (2009, Exp. 2, older adults)	–		
Scheck & Nelson (2005)	+		
Schnitzspahn, Zeintl, Jäger, & Kliegel (2011, 1 encoding trial)	+		
Schnitzspahn, Zeintl, Jäger, & Kliegel (2011, 3 encoding trials)	+		
Tauber & Rhodes (2012, young adults)	+		
Tauber & Rhodes (2012, older adults)	+		
Tiede, Derksen, & Leboe (2009, Exp. 1, positively informed)	–		
Tiede, Derksen, & Leboe (2009, Exp. 1, negatively informed)	–		
Tiede, Derksen, & Leboe (2009, Exp. 2)	–		
Tiede & Leboe (2009b, Exp. 1, with explicit estimate)	+		
Tiede & Leboe (2009b, Exp. 1, without explicit estimate)	+		
Zawadzka & Higham (2015, Exp. 1)	+		
Zawadzka & Higham (2015, Exp. 3)	+		
<i>Interleaving illusion</i>			
CLJ (interleaved study) < CLJ (blocked study)			
Wang & Xing (2019, Exp. 2, information about interleaving)		–	–
Wang & Xing (2019, Exp. 2, no information)		–	
Yan, Bjork, & Bjork (2016, Exp. 1A)	+	–	
Yan, Bjork, & Bjork (2016, Exp. 1B)	–	–	
Yan, Bjork, & Bjork (2016, Exp. 2)		–	
Yan, Bjork, & Bjork (2016, Exp. 3)		–	
Yan, Bjork, & Bjork (2016, Exp. 4)		–	
Yan, Bjork, & Bjork (2016, Exp. 5)		–	
Eglington & Kang (2017, Exp. 2)	+		
Eglington & Kang (2017, Exp. 3)	–		
Eglington & Kang (2017, Exp. 4)	–		

Note. JOL = judgment of learning, CLJ = category learning judgment. Illusion = + indicates that the illusion was found and illusion = – indicates that it was not found. If an illusion is not mediated by fluency (mediated by fluency = –), this argues against fluency contributions. Empty cells denote that there were no relevant data.

that is, higher JOLs for repeatedly studied than for repeatedly tested items (Karpicke, 2009). Table 10.4 presents an overview of the illusions for which fluency contributions have remained untested.

In summary, although it is theoretically plausible that fluency contributes to the metamemory illusions listed in Table 10.4, fluency contributions have yet to be examined. Among these illusions are the word frequency illusion and the restudy illusion.

Future Directions

Studies that investigated fluency contributions to metamemory illusions have greatly expanded our knowledge about metamemory. For several metamemory illusions, such as the stability bias or the volume illusion, there is indirect evidence for fluency contributions (see Table 10.1). For other metamemory illusions, including the motoric fluency illusion and

Table 10.4 Metamemory Illusions For Which Fluency Contributions Have Remained Untested

	<i>Illusion found</i>
<i>Disfluent font illusion</i>	
EOL (hard-to-read fonts) < EOL (easy-to-read fonts)	
Pieger, Mengelkamp, & Bannert (2016)	+
Pieger, Mengelkamp, & Bannert (2017)	+
<i>Instructor fluency illusion</i>	
JOL (fluent lectures) > JOL (disfluent lectures)	
Carpenter, Wilford, Kornell, & Mullaney (2013, Exp. 1)	+
Carpenter, Wilford, Kornell, & Mullaney (2013, Exp. 2)	+
Toftness et al. (2018, Exp. 1)	+
Toftness et al. (2018, Exp. 2)	+
Carpenter, Mickes, Rahman, & Fernandez (2016, Exp. 1)	–
Carpenter, Mickes, Rahman, & Fernandez (2016, Exp. 2)	–
Carpenter, Mickes, Rahman, & Fernandez (2016, Exp. 3)	–
<i>Interleaving illusion</i>	
JOL (interleaved study) <= JOL (blocked study)	
Abushanab & Bishara (2013)	+
Benjamin & Bird (2006, Exp. 1)	+
Dunlosky & Nelson (1994, Exp. 2, immediate JOLs)	+
Dunlosky & Nelson (1994, Exp. 2, delayed JOLs)	–
Jacoby, Wahlheim, & Coane (2010, Exp. 1, young adults)	+
Jacoby, Wahlheim, & Coane (2010, Exp. 2, young adults)	+
Jacoby, Wahlheim, & Coane (2010, Exp. 2, older adults)	–
Kornell & Bjork (2008, Exp. 1)	+
Kornell & Bjork (2008, Exp. 2)	+
Logan, Castel, Haber, & Viehman (2012, Exp. 1, List 1)	+
Logan, Castel, Haber, & Viehman (2012, Exp. 1, List 2)	+
Logan, Castel, Haber, & Viehman (2012, Exp. 1, List 3)	+
Logan, Castel, Haber, & Viehman (2012, Exp. 2, List 1)	+
Logan, Castel, Haber, & Viehman (2012, Exp. 2, List 2)	+
Logan, Castel, Haber, & Viehman (2012, Exp. 2, List 3)	+
Logan, Castel, Haber, & Viehman (2012, Exp. 3, List 1)	+
Logan, Castel, Haber, & Viehman (2012, Exp. 3, List 2)	+
Logan, Castel, Haber, & Viehman (2012, Exp. 3, List 3)	+
Logan, Castel, Haber, & Viehman (2012, Exp. 4, before warning)	+
Logan, Castel, Haber, & Viehman (2012, Exp. 4, after warning)	+
Pyc & Rawson (2012, Exp. 1)	+
Pyc & Rawson (2012, Exp. 2)	+
Simon & Bjork (2001)	+
Simon & Bjork (2002)	+
Son (2004)	–
Son & Kornell (2009)	+
Wahlheim, Dunlosky, & Jacoby (2011, Exp. 1, young adults)	+
Wahlheim, Dunlosky, & Jacoby (2011, Exp. 2, young adults)	+
Wahlheim, Dunlosky, & Jacoby (2011, Exp. 2, older adults)	–
<i>Perceptual interference illusion</i>	
JOL (masked items) < JOL (intact items)	
Besken & Mulligan (2013, Exp. 1)	+
Besken & Mulligan (2013, Exp. 2)	+

(continued)

Table 10.4 (cont.)

	<i>Illusion found</i>
<i>Subthreshold priming</i>	
JOL (primed items) > JOL (control items)	
Narens, Jameson, & Lee (1994, Exp. 1)	+
Narens, Jameson, & Lee (1994, Exp. 2)	+
Palma, Santos, & Garcia-Marques (2018, Exp. 3)	+
Susser, Jin, & Mulligan (2016, Exp. 1)	–
<i>Word frequency illusion in recognition memory</i>	
JOL (high-frequency words) >= JOL (low-frequency words)	
Begg, Duft, Lalonde, Melnick, & Sanvito (1989, Exp. 1)	+
Begg, Duft, Lalonde, Melnick, & Sanvito (1989, Exp. 3)	+
Benjamin (2003, Exp. 1)	+
Benjamin (2003, Exp. 2, List 1)	+
Benjamin (2003, Exp. 2, List 2)	–
Tullis & Benjamin (2012, young adults, List 1)	–
Tullis & Benjamin (2012, young adults, List 2)	–
Tullis & Benjamin (2012, older adults, List 1)	+
Tullis & Benjamin (2012, older adults, List 2)	–
<i>Restudy illusion</i>	
JOL (restudied items) > JOL (tested items)	
Karpicke (2009, Exp. 1)	+
<i>Learning variability illusion</i>	
CLJ (high learning variability) < CLJ (low learning variability)	
Wahlheim, Finn, & Jacoby (2012, Exp. 1)	+
Wahlheim, Finn, & Jacoby (2012, Exp. 2)	+
Wahlheim, Finn, & Jacoby (2012, Exp. 3)	+
Wahlheim, Finn, & Jacoby (2012, Exp. 4)	+
<i>Subthreshold priming</i>	
FOK (primed items) > FOK (control items)	
Jameson, Narens, Goldfarb, & Nelson (1990, Exp. 1)	–
Jameson, Narens, Goldfarb, & Nelson (1990, Exp. 2)	–
Kinoshita (1997, Exp. 2)	–
Kinoshita (1997, Exp. 3)	–
Kinoshita (1997, Exp. 4)	+
Kinoshita (1997, Exp. 5)	+
<i>Suprathreshold priming</i>	
FOK (primed items) > FOK (control items)	
Hanczakowski, Zawadzka, & Cockcroft-McKay (2014, Exp. 1a)	+
Hanczakowski, Zawadzka, & Cockcroft-McKay (2014, Exp. 1b)	+
Hanczakowski, Zawadzka, & Cockcroft-McKay (2014, Exp. 2)	+
Liu, Su, Xu, & Chan (2007)	+
Reder (1987, Exp. 6)	+
Schwartz & Metcalfe (1992, Exp. 1)	+
Schwartz & Metcalfe (1992, Exp. 2)	+
Schwartz & Metcalfe (1992, Exp. 3)	+
Schwartz & Metcalfe (1992, Exp. 4)	+

Note. EOL = ease-of-learning judgment, JOL = judgment of learning, CLJ = category learning judgment, FOK = feeling of knowing judgment. Illusion = + indicates that the illusion was found and Illusion = – indicates that it was not found.

the stimulus size illusion, there is direct evidence for fluency contributions (see Table 10.2). For the majority of these illusions, however, it has yet to be examined whether fluency contributes in a direct, nonanalytic way. In contrast, there is little or no evidence for fluency contributions to several metamemory illusions, including the underconfidence-with-practice effect and the font size illusion (see Table 10.3). Also, there are still metamemory illusions for which fluency contributions have remained untested (see Table 10.4). Examples include the restudy illusion and the word frequency illusion. Overall, further research on fluency contributions to metamemory illusions is needed.

Drawing valid conclusions about fluency contributions to metamemory illusions requires the use of valid fluency measures. In the research reviewed here, different fluency measures usually supported the same conclusions, indicating that these are likely robust. In a few cases, however, different fluency measures suggested very different conclusions. For instance, while self-paced study time and lexical decision latency indicated that fluency did not contribute to the font size illusion, identification latency in a continuous identification task suggested the opposite (Mueller et al., 2014; Undorf & Zimdahl, 2019; Yang et al., 2018). These disagreements call for research on the nature of the fluency measures used in previous studies and for the development of new and improved fluency measures. For instance, it may be important that the fluency measures in use capture the same type of fluency that presumably contributes to a metamemory illusion (e.g., perceptual or conceptual fluency, see Undorf & Erdfelder, 2015).

It is unlikely, however, that differences between fluency measures alone are responsible for different conclusions on the role of fluency for metamemory illusions. Thus, investigating potential moderators of fluency contributions will be an intriguing avenue for future research. Variables such as time pressure or the way of JOL elicitation, for instance, might impact fluency contributions to metamemory illusions (e.g., Nussinson & Koriat, 2008; Undorf & Zander, 2017). Also, most research has evaluated fluency contributions to metamemory illusions by manipulating only one or two cues. It may be that fluency contributions increase when multiple varying cues are available and, consequently, relevant beliefs are more difficult to use (Undorf & Erdfelder, 2013; Undorf et al., 2018, but see Undorf & Bröder, 2019).

Conclusion

In recent years, there has been a great deal of interest in the contribution of fluency to metamemory and, more specifically, metamemory illusions. This research has resulted in the current gold standard for testing fluency contributions to metamemory illusions. Conclusive evidence for fluency contributions can be obtained by showing that explicit metamemory beliefs alone cannot account for an illusion and, more importantly, that independent fluency measures mediate the illusion. Additionally, when results suggest that fluency plays a role, it should be verified that fluency contributes in a direct, nonanalytic way. Using this approach, it has been found that fluency likely underlies some metamemory illusions, including the stimulus size illusion. In contrast, there is little evidence that fluency contributes to other illusions, including the underconfidence-with-practice effect. For many other metamemory illusions, the question of fluency contributions is not yet resolved.

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