# Implicit Memory

DAWN M. McBRIDE

## Abstract

Implicit memory involves the influence of memory without intention and often without awareness. For example, many of the tasks we perform without conscious control are considered implicit tasks. These include tasks with which we have experience such as riding a bicycle, driving a car, or typing. In this essay, the study of implicit memory is briefly reviewed beginning with discussion of foundational studies in this area that followed either a processing or memory systems perspective on this topic. Some current, cutting edge research is reviewed with primary emphasis on questions that hold promise for new knowledge about implicit forms of memory: (i) In what ways is conceptual implicit memory (memory without intention) similar to explicit memory (memory with intention)? (ii) What roles do item-specific (focus on details of an item) and relational (focus on connections between items) processing play in implicit memory retrieval? (iii) What is the role of attention in implicit memory retrieval? Examination of these questions provides avenues for future research in this area.

## INTRODUCTION

Implicit forms of memory have interested researchers for the past several decades. While the majority of research in memory has focused, and still does focus, on explicit forms of memory (i.e., conscious and intentional retrieval of previously studied information), the number of studies examining implicit forms of memory has greatly increased over the past 40 years or so. Unlike explicit tests of memory, implicit tests are those that access memories of our experiences without intentional retrieval of those experiences. In other words, implicit memory is used in situations where our memory influences our behavior without our intention for it to do so. For example, when we improve on a skill with practice (e.g., making a free throw), we access memory for that skill each time we perform it, but we do not need to explicitly remember performing the skill in the past in order to practice the skill. In many laboratory implicit tests, implicit memory is shown by facilitation of responses to items previously studied without intentional retrieval of the information. Typical implicit tasks show greater

*Emerging Trends in the Social and Behavioral Sciences*. Edited by Robert Scott and Stephen Kosslyn.
 ISBN 978-1-118-90077-2.

or faster responses to test items corresponding to studied items compared with items on the test that do not correspond to studied items. For example, after previously studying words, subjects are faster to identify those items as words in a lexical decision task compared with words that have not been studied. Completion rates of word fragments or stems with studied items are also higher compared with items that have not been studied when subjects are asked to complete cues with the first word they think of. For more descriptions of typical implicit memory tests, see reviews by Roediger and McDermott (1993) and Schacter (1987).

## FOUNDATIONAL RESEARCH

The surge in interest in implicit memory was precipitated in large part by studies conducted by Warrington and Weiskrantz (1968, 1970, 1974). In these studies it was shown that although amnesic patients have decremented performance on typical explicit memory tests such as recognition (i.e., discriminate between studied and unstudied items) and recall (i.e., generation of information from memory), their performance on an implicit memory test (e.g., stem completion) does not differ from nonamnesic patients. These results indicate that not only can performance on explicit and implicit tests can be dissociated, but that the dissociation may have a neurological basis. These conclusions led to lines of research examining performance in implicit tests in nonpatient populations and further investigations of the neurological basis of explicit/implicit test differences. I will briefly review key findings in each of these lines of work below.

Research with nonpatient populations has revealed some interesting aspects of implicit memory that distinguish it from explicit forms of memory. For example, Jacoby and Dallas (1981) showed that implicit memory tested with a perceptual identification task (i.e., subjects are asked to identify words that are flashed on the screen for very brief intervals) is not affected by depth of processing manipulations that typically affect explicit memory. Srinivas and Roediger (1990) also reported a dissociation between implicit and explicit tests based on whether words are simply read or are generated from an associative cue during the study phase. In their study, an explicit test of free recall resulted in better memory for studied words when words had been generated than when they had been read at study, but an implicit test of word fragment completion resulted in better memory for studied words when words had been read than when they had been generated at study (see also Jacoby, 1983). Finally, Roediger and Blaxton (1987) showed that implicit memory for words was higher on a word fragment completion test when the same font (hand-printed or typed) was used at study and test than when the font was changed from study to test. Taken together, these studies (and many others like these—see Schacter, 1992) suggested that unlike explicit memory, implicit memory relies more on perceptual (i.e., surface features) processing than on semantic (i.e., meaning) processing.

In 1990, however, Roediger described results from different kinds of implicit tests that could be dissociated with study processing manipulations (meaning-based semantic processing versus surface feature-based perceptual processing). Roediger proposed that two key classification categories of implicit tests should be considered: implicit tests relying on perceptual processing such as perceptual identification and fragment completion tasks and implicit tests relying on semantic processing such as category production and verification tasks. Unlike perceptual implicit tests, semantic implicit tests are affected more often by semantic encoding manipulations like depth of processing than by perceptual encoding manipulations. He suggested that a transfer-appropriate processing (i.e., a match in processing type for study and test results in better memory for information) perspective (see Morris, Bransford, & Franks, 1977) on these tests revealed a different classification of tests where type of processing was more important than whether the retrieval was intentional or not.

In contrast to this processing approach, researchers who focused more on the neurological aspects of implicit and explicit memory differences suggested that implicit and explicit memory differences are because of the reliance on separate memory systems (see the brief review by Squire, 2004). Driven by studies showing that amnesic patients with damage to the hippocampus and related brain structures in the medial temporal lobes show decrements in explicit but not implicit memory tests, neuropsychologists began to explore the brain areas responsible for performance on implicit tests that were intact in such patients. These studies have shown that neocortical areas are involved in completion of implicit tests (see Schacter, Chiu, & Oschner, 1993, for a review). In 1994, a seminal work from the systems perspective was published in the form of a book titled *Memory Systems 1994*. In this book, authors proposed various memory systems responsible for implicit and explicit memory based on neurological and psychological studies that preceded it.

A final key publication that focused on how researchers should be measuring implicit and explicit forms of memory should be discussed as foundational in the study of implicit memory. Jacoby (1991) proposed that researchers should not be equating performance on implicit and explicit memory tests with the processes underlying the tests, as these tests typically involve a mixture of processes. As an alternative to assuming that explicit memory tests measure intentional, conscious forms of memory and that implicit memory tests measure automatic, unconscious forms of memory, Jacoby proposed a process dissociation procedure to allow for measurement of the processes underlying these tasks. His procedure estimates conscious (i.e., intentional) and automatic (i.e., unintentional) memory processes through the use of an exclusion task that sets conscious and automatic processes as opponent processes in completion of the task. In the exclusion task, subjects are to exclude items they consciously recollect as studied. Given these instructions, responses that match studied items are assumed to rely on automatic memory. The process dissociation procedure relies on an assumption of independence between conscious and automatic memory, which has been criticized (see Curran & Hintzman, 1995; Hintzman & Curran, 1997, and response by Jacoby & Shrout, 1997), but this procedure has been highly influential in work in implicit memory (see Yonelinas & Jacoby, 2012, for a recent review) and in other areas of psychology as a method of estimating underlying conscious and automatic processing in different cognitive tasks (e.g., in judgment and decision making, see Ferreira, Garcia-Marques, Sherman, & Sherman, 2006). Jacoby's process dissociation procedure has also led to the development of more complex models of implicit and explicit memory tasks with a goal of estimating the conscious and automatic processes that underlie these tasks (see McBride, 2007, for a review of estimation techniques).

## CUTTING EDGE RESEARCH

In the past decade, research in implicit memory has slowed. Fewer memory studies have focused on these types of tests than in the preceding three decades. However, some notable studies have taken the field of implicit memory in new directions. One area of exploration has considered the connection between embodied cognition (i.e., the idea that cognition arises from bodily interaction with the world) and implicit memory. In his paper that discussed what memory is for, Glenberg (1997) suggested a contribution of embodiment to unintentional forms of memory such as implicit memory. Recently, Topolinski (2012) examined these ideas in a study that showed that motor movements specific to the target stimuli affect implicit memory. Subjects were asked to perform motor tasks that were in the same (oral) or different (manual) modality as the study stimuli (words). Performing the motor task of the same modality during study reduced implicit memory in fragment completion tasks. This study represents a unique perspective on implicit memory and has the potential to yield new knowledge in this area.

Another recent perspective on implicit memory suggests that implicit and explicit tasks should not be categorized according to whether or not consciousness is needed for the task, but rather if the task involves the formation of a new association between concepts. Reder, Park, and Kieffaber (2009) proposed that the mainstream view of distinct memory systems for explicit and implicit forms of memory does not accurately represent the brain systems that are involved in memory tasks. They reviewed the evidence for the memory systems view of implicit and explicit memory and showed that much of this evidence is inconsistent. They proposed instead that implicit and explicit memory tasks access the same representations of concepts and described an activation model of processing in these tasks that can explain many of the dissociations that have been relied on as evidence for distinct systems. This new perspective can lead researchers in new directions in the study of implicit memory that do not rely on traditional classifications of tasks (see Erdelyi, 2010, for a similar argument).

## KEY ISSUES FOR FUTURE RESEARCH

Simply because research in implicit memory has slowed is by no means an indication that we have answered many of the open questions regarding these tests. Some key questions that future research will address are: (i) In what ways is conceptual (i.e., meaning-based) implicit memory similar to explicit memory? (ii) What roles do item-specific (i.e., focus on details of information) and relational (i.e., focus on connections between information) processing play in implicit memory retrieval? and (iii) What is the role of attention in implicit memory retrieval? Each of these questions is being explored by current research in implicit memory.

### Conceptual Implicit and Explicit Memory

Owing to findings showing similar effects of semantic and attention manipulations on both conceptual implicit memory and explicit memory, researchers have suggested that these forms of memory may be similar and/or are controlled by the same areas of the brain. For example, Yonelinas *et al*. (e.g., Diana, Yonelinas, & Ranganath, 2007; Wang, Lazzara, Ranganath, Knight, & Yonelinas, 2010; Yonelinas, Aly, Wang, & Koen, 2010) have shown that both recognition familiarity (see Yonelinas, 2002, for a review of processes involved in explicit recognition tests) and conceptual implicit memory are connected to activity in the perirhinal cortex. Further, Wang and Yonelinas (2012) recently reported results indicating correlations between recognition familiarity and conceptual implicit memory, supporting past studies showing similarities between these two forms of memory (e.g., Wagner & Gabrieli, 1998). Wang and Yonelinas concluded that "it is likely that the cognitive process that supports familiarity judgments also supports conceptual implicit memory" (p. 1161). However, some limitations to testing this hypothesis exist. As described above, there are multiple methods of measuring implicit memory processes, and there are also multiple methods for measuring recognition familiarity (see Yonelinas, 2002). Thus, it is unclear how much the support for this hypothesis depends on the specific process measurement techniques employed by researchers. Further, recognition and conceptual implicit memory tests require different decision processes making it likely that familiarity and conceptual implicit memory do not completely overlap. In fact, Wang and Yonelinas reported that in one of their experiments, familiarity only accounted for 22% of the variance in conceptual implicit memory. Thus, researchers will need to circumvent such issues in their exploration of this question.

## Item-specific and Relational Processing in Implicit Memory

The item-specific/relational processing (Humphreys, 1976) distinction has been a focus of numerous research studies in memory in the past few decades. Item-specific processing involves processing features unique to an item, whereas relational processing involves processing of the common features across items. It appears to be an important distinction in explaining distinctiveness effects in explicit memory (see Hunt, 2006, 2012) and recently has been investigated in implicit memory tests. Mulligan (2006) suggested that the item-specific/relational processing distinction explains some dissociations across implicit and explicit tests. He points to differences across implicit and explicit tests as responsible for dissociations found between these tests. Explicit memory tests such as free and cued recall are thought to rely on both relational and item-specific processing: Relational processing aids in the generation of items for response and item-specific processing aids in distinguishing studied from unstudied items. Because there is no need to distinguish between studied and unstudied items in conceptual implicit tests, there is no need to rely on item-specific processing. However, item generation for responses is still important; thus, relational processing is important in these tests. Mulligan (2012) recently showed that conceptual implicit and explicit tests can be doubly dissociated when different category sizes of studied items changed the amount of item-specific and relational processing needed to complete the test. Results supported the idea that relational processing was important for the conceptual implicit test, but a condition that emphasized item-specific processing resulted in better memory in the conceptual explicit test. Parker, Dagnall, and Munley (2012) supported these ideas in a recent study as well.

An important limitation in exploring this question is that conceptual implicit tests are more susceptible to explicit retrieval contamination (i.e., intentional retrieval of an experience despite instructions for the task that do not connect to previous experiences), making it difficult to interpret the results from some studies employing these tasks (see Jacoby's, 1991, argument against equating tasks with processes described above). Thus, it may be important for future studies to include multiple measurement methods to provide converging evidence for the relative importance of item-specific and relational processing in implicit memory tests.

### Attention and Implicit Memory

Mulligan (e.g., Mulligan & Hartman, 1996) has also explored the role of attention in implicit memory tests. Past research has shown that like explicit memory, conceptual implicit memory is affected by dividing attention. However, perceptual implicit memory tests are not typically affected by manipulations of attention. In more recent studies, Lozito and Mulligan (2010) and Spataro, Cestari and Rossi-Arnaud (2011) explored effects of attention on implicit memory. Spataro *et al*. conducted a meta-analysis of studies that examined effects of manipulations of attention at encoding in implicit memory tests. They found a small effect of attention manipulations in both perceptual and conceptual implicit tests with greater effects in production than identification implicit tests. Lozito and Mulligan examined the effect of dividing attention at retrieval in implicit tests and found no difference between divided and full attention conditions in the implicit tests.

In addition to some of the limitations raised for the first two questions above, examinations of attention effects in implicit tests must address the issue of the degree to which the manipulations affect attention. Different tasks can tax attentional resources to varying degrees and when no effects of attentional manipulations are found, results may be because of the use of tasks that require fewer cognitive resources. Thus, evidence from studies that include different attentional manipulation tasks is needed to provide converging evidence for such findings.

## SUMMARY

Much has been learned in the past several decades about implicit memory and how it is similar to and different from explicit memory. However, the three questions described above regarding the similarity of conceptual implicit and explicit memory, the role of item-specific and relational processing in implicit tests, and the role of attention in implicit tests are some of the questions researchers are currently attempting to answer to gain further understanding about the processing involved in implicit memory. The examination of these questions and the unique perspectives on research in implicit memory reviewed in the two sections above hold promise in the attainment of new knowledge in this field of study.

## REFERENCES


Curran, T., & Hintzman, D. L. (1995). Violations of the independence assumption in process dissociation. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *21*, 531–547.

Diana, R. A., Yonelinas, A. P., & Ranganath, C. (2007). Imaging recollection and familiarity in the medial temporal lobe: A three-component model. *Trends in Cognitive Sciences*, *11*, 379–386.

Erdelyi, M. H. (2010). The ups and downs of memory. *American Psychologist*, *65*, 623–633.

Ferreira, M. B., Garcia-Marques, L., Sherman, S. J., & Sherman, J. W. (2006). Automatic and controlled components of judgment and decision making. *Journal of Personality and Social Psychology*, *91*, 797–813.

Glenberg, A. M. (1997). What memory is for. *Behavioral and Brain Sciences*, *20*, 1–55.

Hintzman, D. L., & Curran, T. (1997). More than one way to violate independence: Reply to Jacoby & Shrout (1997). *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *23*, 511–513.

Humphreys, M. S. (1976). Relational information and the context effect in recognition memory. *Memory & Cognition*, *4*, 221–232.

Hunt, R. R. (2006). The concept of distinctiveness in memory research. In R. R. Hunt & J. B. Worthen (Eds.), *Distinctiveness in memory* (pp. 1–25). New York, NY: Oxford University Press.

Hunt, R. R. (2012). Precision in memory through distinctive processing. *Current Directions in Psychological Science*, *22*, 10–15.

Jacoby, L. L. (1983). Remembering the data: Analyzing interactive processes in reading. *Journal of Verbal Learning and Verbal Behavior*, *22*, 485–508.

Jacoby, L. L. (1991). A process dissociation framework: Separating automatic from intentional uses of memory. *Journal of Memory and Language*, *30*, 513–541.

Jacoby, L. L., & Dallas, M. (1981). On the relationship between autobiographical memory and perceptual learning. *Journal of Experimental Psychology: General*, *3*, 306–340.

Jacoby, L. L., & Shrout, P. E. (1997). Toward a psychometric analysis of violations of the independence assumption in process dissociation. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *23*, 505–510.

Lozito, J. P., & Mulligan, N. W. (2010). Exploring the role of attention during implicit memory retrieval. *Journal of Memory and Language*, *63*, 387–399.

McBride, D. M. (2007). Methods for measuring conscious and automatic memory: A brief review. *Journal of Consciousness Studies*, *14*, 198–215.

Morris, C. D., Bransford, J. D., & Franks, J. J. (1977). Levels of processing versus transfer appropriate processing. *Journal of Verbal Learning and Verbal Behavior*, *16*, 519–533.

Mulligan, N. W. (2006). Conceptual implicit memory and the item-specific-relational distinction. In R. R. Hunt & J. B. Worthen (Eds.), *Distinctiveness in memory* (pp. 183–209). New York, NY: Oxford University Press.

Mulligan, N. W. (2012). Differentiating between conceptual implicit and explicit memory: A crossed double dissociation between category-exemplar production and category-cued recall. *Psychological Science*, *23*, 404–406.

Mulligan, N. W., & Hartman, M. (1996). Divided attention and indirect memory tests. *Memory & Cognition*, *24*, 453–465.

Parker, A., Dagnall, N., & Munley, G. (2012). Encoding tasks dissociate the effects of divided attention on category-cued recall and category-exemplar generation. *Experimental Psychology*, *59*, 124–131.

Reder, L. M., Park, H., & Kieffaber, P. D. (2009). Memory systems do not divide on consciousness: Reinterpreting memory in terms of activation and binding. *Psychological Bulletin*, *135*, 23–39.

Roediger, H. L., III, (1990). Implicit memory: Retention without remembering. *American Psychologist*, *45*, 1043–1056.

Roediger, H. L., & Blaxton, T. A. (1987). Effects of varying modality, surface features, and retention interval on priming in word fragment completion. *Memory & Cognition*, *15*, 379–388.

Roediger, H. L., III, & McDermott, K. B. (1993). Implicit memory in normal human subjects. In J. Grafman & F. Boller (Eds.), *Handbook of neuropsychology* (Vol. 8, pp. 63–131). Amsterdam, The Netherlands: Elsevier.

Schacter, D. L. (1987). Implicit memory: History and current status. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *13*, 501–518.

Schacter, D. L. (1992). Priming and multiple memory systems: Perceptual mechanisms of implicit memory. *Journal of Cognitive Neuroscience*, *4*, 244–256.

Schacter, D. L., Chiu, C.-Y. P., & Oschner, K. N. (1993). Implicit memory: A selective review. *Annual Review of Neuroscience*, *16*, 159–182.

Spataro, P., Cestari, V., & Rossi-Arnaud, C. (2011). The relationship between divided attention and implicit memory: A meta-analysis. *Acta Psychologica*, *136*, 329–339.

Squire, L. R. (2004). Memory systems of the brain: A brief history and current perspective. *Neurobiology of Learning and Memory*, *82*, 171–177.

Srinivas, K., & Roediger, H. L., III, (1990). Classifying implicit memory tests: Category association and anagram solution. *Journal of Memory and Language*, *29*, 389–412.

Topolinski, S. (2012). The sensorimotor contributions to implicit memory, familiarity, and recollection. *Journal of Experimental Psychology: General*, *141*, 260–281.

Wagner, A. D., & Gabrieli, J. D. E. (1998). On the relationship between recognition familiarity and perceptual fluency: Evidence for distinct mnemonic processes. *Acta Psychologica*, *98*, 211–223.

Wang, W. C., Lazzara, M. M., Ranganath, C., Knight, R. T., & Yonelinas, A. P. (2010). The medial temporal lobe supports conceptual implicit memory. *Neuron*, *68*, 835–842.

Wang, W. C., & Yonelinas, A. P. (2012). Familiarity is related to conceptual implicit memory: An examination of individual differences. *Psychonomic Bulletin & Review*, *19*, 1154–1164.

Warrington, E. K., & Weiskrantz, L. (1968). A new method of testing long-term retention with special reference to amnesic patients. *Nature*, *217*, 972–974.

Warrington, E. K., & Weiskrantz, L. (1970). Amnesic syndrome: Consolidation or retrieval? *Nature*, *228*, 628–630.

Warrington, E. K., & Weiskrantz, L. (1974). The effect of prior learning on subsequent retention in amnesic patients. *Neuropsychologia*, *12*, 419–428.

Yonelinas, A. P. (2002). The nature of recollection and familiarity: A review of 30 years of research. *Journal of Memory and Language*, *46*, 441–517.

Yonelinas, A. P., Aly, M., Wang, W. C., & Koen, J. D. (2010). Recollection and familiarity: Examining controversial assumptions and new directions. *Hippocampus*, *20*, 1178–1194.

Yonelinas, A. P., & Jacoby, L. L. (2012). The process-dissociation approach two decades later: Convergence, boundary conditions, and new directions. *Memory & Cognition*, *40*, 663–680.

## FURTHER READING

Jacoby, L. L. (1991). A process dissociation framework: Separating automatic from intentional uses of memory. *Journal of Memory and Language*, *30*, 513–541.

McBride, D. M. (2007). Methods for measuring conscious and automatic memory: A brief review. *Journal of Consciousness Studies*, *14*, 198–215.

Reder, L. M., Park, H., & Kieffaber, P. D. (2009). Memory systems do not divide on consciousness: Reinterpreting memory in terms of activation and binding. *Psychological Bulletin*, *135*, 23–39.

Roediger, H. L., III, & McDermott, K. B. (1993). Implicit memory in normal human subjects. In J. Grafman & F. Boller (Eds.), *Handbook of neuropsychology* (Vol. 8, pp. 63–131). Amsterdam, The Netherlands: Elsevier.

Schacter, D. L., & Tulving, E. (1994). *Memory systems 1994*. Cambridge, MA: MIT Press.

Yonelinas, A. P., & Jacoby, L. L. (2012). The process-dissociation approach two decades later: Convergence, boundary conditions, and new directions. *Memory & Cognition*, *40*, 663–680.

## DAWN M. McBRIDE SHORT BIOGRAPHY

**Dawn M. McBride** is a Professor of Psychology at Illinois State University. Her research includes work in implicit memory, false memory, forgetting, and prospective memory. She is the author of a number of journal articles in these areas and the introductory methods textbook *The Process of Research in Psychology*. She also coedited the book *The Concepts of Consciousness: Integrating an Emerging Science* with J. Scott Jordan. More information can be found at: http://about.illinoisstate.edu/dmmcbri

## RELATED ESSAYS

The Inherence Heuristic: Generating Everyday Explanations *(Psychology)*, Andrei Cimpian

Social Aspects of Memory *(Psychology)*, William Hirst and Charles B. Stone

Memory Gaps and Memory Errors *(Psychology)*, Jeffrey S. Neuschatz *et al.*

Attention and Perception *(Psychology)*, Ronald A. Rensink