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# 10 The Role of Familiarity in Cognitive Processing

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Understanding normal cognition—understanding the mechanisms underlying cognition in everyday situations—is a primary goal of cognitive science. The thesis of this chapter is that the typical modes of thinking used in everyday processes such as memory, reasoning, and question answering, involve heuristics that can be thought of as shortcuts or "sloppy matches" (or, to borrow a term from computer science, "fuzzy logic"). These short-cuts and heuristics are not an indictment of "lazy cognition"; rather, it has become clear that the only way cognition could operate is by developing heuristics that are adaptive. Given the complexities of the tasks asked of us and the knowledge base under which we must operate, it is imperative that human cognition possess tools to make short-cuts effective.

In this chapter we propose that familiarity is a measure easily computed and frequently used for judgments besides familiarity. We call this the Featural Familiarity Hypothesis. One feature of the human memory system is that it can easily confuse frequency of exposure, or familiarity, with recency of exposure. In addition, the cognitive system tends not to carefully inspect the representations in working memory to ensure a perfect match between input and what is stored in long-term memory. Gross measures of familiarity often play a role in determining the acceptability of these matches. The self-monitoring of text comprehension is an example of an area where familiarity plays a role (e.g., Maki & Berry, 1984). Another area is the role of familiarity in directing the use of question-answering strategies (e.g., Reder, 1987, 1988).

There are a number of phenomena subsumed by these areas that can be understood within our theoretical framework. That is, the illusion of comprehension, the difficulty of detecting contradictions, the inability to notice distortions in questions, and spurious feelings of knowing an answer are all influenced by partial matches and use raw familiarity. In addition, we believe that analogical reasoning, judgments of liking, judgments of validity, and judgments of fame and of recognition are all influenced by the same heuristics of sloppy cognition to be described.

In this chapter, we first briefly describe several phenomena that, at a glance, appear quite disparate, but we believe are all characterized by similar cognitive heuristics. Next, we outline a quasi-mechanistic account that incorporates these principles and we attempt to show how this account can explain these phenomena. In our account, we borrow and blend ideas from Anderson (1983, 1993), Jacoby (e.g., Jacoby, Kelley, & Dywan, 1989), and Kintsch (1988); undoubtedly others have influenced us as well. What we offer is a basic framework or sketch of a model to illustrate how these principles of sloppy match and familiarity measurement can influence so much of cognition. After describing the framework, we return to the phenomena, discussing each in more detail, and showing how each can be seen as a manifestation of the simple heuristics used in most cognitive processing.

## THE PHENOMENA

### Feeling of Knowing

*Feeling of knowing* has traditionally been used to refer to the subjective experience that the answer is on the "tip of the tongue," or to estimate the likelihood of recognizing the answer on a later test when it cannot be recalled immediately. These feeling of knowing estimates are remarkably accurate (e.g., Blake, 1973; Hart, 1965; Nelson & Narens, 1990). These ratings can also be used to accurately predict such performances as exposure duration to perceive a tachistoscopically presented word, number of trials to relearn a paired associate (Nelson, Gerler, & Narens, 1984), and time to make a lexical decision (Connor, Balota, & Neely, 1992; Yaniv & Meyer, 1987).

More recent work has indicated that the feeling of knowing phenomenon is not limited to situations where there is a recall failure (Reder, 1987, 1988; Reder & Ritter, 1992). Subjects can give very rapid estimates of whether they will be able to answer a question (prior to attempting a retrieval). These estimates are surprisingly more accurate than the estimates given after a failed recall attempt. Manipulations influencing the familiarity of the terms in the question influence feeling of knowing: people erroneously think they know the answer to a question if the question terms are familiar (e.g., Costermans, Lories, & Ansay, 1992; Reder, 1987; Reder & Ritter, 1988, 1992; Schwartz & Metcalfe, 1992). Can this possibly be an adaptive and normal part of cognition? Why should the mind work this way?



### Illusions of Comprehension

When students are asked to read textbook passages and then rate how well they have understood them, their judgments tend to be quite inaccurate. They are blissfully optimistic about how well they are comprehending passages in terms of future test performance (e.g., Beckett, Kestner, & White, 1989; Glenberg & Epstein, 1985, 1987; Glenberg, Sanocki, Epstein, & Morris, 1987; Maki & Berry, 1984; Maki & Serra, 1992; Pressley & Ghatala, 1988). Moreover, there seems to be little improvement at predicting test performance with practice at the task. In addition, when asked whether they have understood passages (either while reading or after the fact), they seem to be insensitive to contradictions that should make the passage incomprehensible (e.g., Epstein, Glenberg, & Bradley, 1984; Glenberg, Wilkinson, & Epstein, 1982; Otero & Kintsch, 1992). These are important aspects of text comprehension monitoring, and not just for students. Why then are people generally so poor at doing this? And why does practice not make this monitoring task easier?

### The Moses Illusion

When asked, "How many animals of each kind did Moses take on the Ark?" most people will answer "Two," even when they know that Noah, not Moses, built the Ark (e.g., Bredart & Modolo, 1988; Erickson & Mattson, 1981; Reder & Cleeremans, 1990; Reder & Kusbit, 1991). This failure to notice distortions is a strong tendency, and is difficult to influence. Previous study of the correct facts does not aid in the detection of this type of distortion (Reder & Cleeremans, 1990). The failure to notice these distortions is not due to a poor encoding of the target or distorted words. If subjects are asked to repeat back the question before answering it, they will repeat the distorted term (e.g., "Moses"), not noticing it is incorrect. In addition, subjects take just as long to read the distorted term when they did not notice the distortion as when they did (Reder & Kusbit, 1991). So why is it so tough for us to notice these distortions? What is the cause of this illusion and what does it tell us about how comprehension works?

### Validity Inflation

A disturbing phenomenon of human nature is that we seem to give greater credence to statements the more we hear them, regardless of whether or not they are true. That is, repeating a statement, even without any additional elaboration or support, can make people think it is true (e.g., Arkes, Hackett, & Boehm, 1989; Bacon, 1979; Gigerenzer, 1984; Hasher, Goldstein, & Toppino, 1977; Schwartz, 1982). This occurs when the entire sentence is repeated, but exact repetition of an entire statement is not required. Mere familiarity with the topic of a sentence can cause the sentence to be rated more valid than a comparable sentence on an unfamiliar topic (Begg, Armour, & Kerr, 1985). Even exposure to a word included in a sentence has been shown to increase the perceived validity of that statement (Arkes, Nash, & Joyner, 1989). This would seem to leave us vulnerable to propaganda and advertising. Why does our cognitive architecture allow us to use familiarity to judge validity?

### Analogical Reasoning

When trying to solve a novel problem, people may attempt to use a previously solved problem as an example. In trying to recall a relevant past problem, the superficial similarity between the current problem and prior problems often appears to be more influential than the structural similarity of the current problem and potential analogical predecessors (e.g., Faries & Reiser, 1988; Ross, 1987, 1989a). This occurs despite the fact that structural similarity is vital for successful use of previous problem solutions (e.g., Clement & Gentner, 1991; Gentner, 1983; Ross, 1987, 1989a). Although the availability of analogs is critical to actually being able to use this form of problem solving, people seem maladaptive in how they select potential analogs.

### Unconscious Uses of Memory

Jacoby and his colleagues (e.g., Jacoby, 1988; Jacoby & Kelley, 1987; Jacoby, Kelley, & Dywan, 1989) have discovered a number of interesting phenomena suggesting that memory is often used unconsciously in various tasks and judgments. For example, they have found that if subjects are exposed to nonfamous names, they are likely to false alarm and rate these same names as famous at a later time when these names are embedded among new nonfamous and famous names (Jacoby, Kelley, Brown, & Jasechko, 1989; Jacoby, Woloshyn, & Kelley, 1989). They also showed that people's ability to detect spelling errors is lessened with exposure to the incorrectly spelled form of the word (Jacoby & Hollingshead, 1990). In addition, the ability to discriminate new words from old words on a recognition test is hampered when new words are tachistoscopically (subliminally flashed) prior to the recognition judgment; that is, subjects make a lot of false alarms to such pre-exposed new words (Jacoby & Whitehouse, 1989).

These phenomena are consistent with our view of the heuristics of memory. Later in this chapter, we discuss at greater length the findings from Jacoby's lab, attempt to explicate their account of these findings, and compare and contrast these ideas with our own.

## THE FEATURAL FAMILIARITY HYPOTHESIS

The phenomena just mentioned might appear to be quite disparate, with little in common but the fact that people often appear quite fallible. Why do our minds work this way? Is it really adaptive, despite appearing otherwise? Here, we offer



a modest attempt to explain why these phenomena occur, using only a few key assumptions about how our cognitive architecture is organized and memory is accessed.

1. Memory is organized into a semantic network of connected ideas, with each concept and idea in memory varying in both long-term strength and short-term activation as a function of exposure. The strength of a concept is not the same as the strength of its connection to any other concept.
2. The strength of concepts and connections between concepts is fairly stable, increasing slowly each time the concept or connection is activated, and decaying slowly from disuse; activation, on the other hand, builds and decays rapidly.
3. Strength is actually the resting activation level of a concept. Therefore people can easily misattribute recent activation to long-term strength.
4. Availability of information is a function of its current level of activation. The ease with which a fact becomes active depends on its baseline strength, and how much activation it receives from a connecting link to an associated concept.
5. Retrieval from memory involves finding partial matches between the memory probe or representation in working memory and the structure in memory. Partial matches are based primarily on shared clusters of matching features, rather than features all in the exact same relationship in the probe as in memory.
6. When matching a memory probe to memory, focus of attention influences which parts of the representation will be more carefully matched. Indeed, only those elements in the focus of attention will have activation spread out from them.

For convenience, we have named these assumptions the *Featural Familiarity Hypothesis*. The first three assumptions address the structure and characteristics of memory. Consider Assumption 1, which states that memory will vary in activation and strength as a function of exposure. By this we mean that the more often a person is exposed to an idea or concept, the more activation the corresponding representation in the semantic network will receive. Each time the concept or propositional structure is activated, there is a small boost to the long-term strength or base level of activation, although the activation itself decays rapidly, as stated in Assumption 2. Strength, too, decays over time if the concept is not rehearsed or refreshed from new exposure; however, the rate of decay is much slower than for activation. Assumption 3 notes that, when inspecting memory, a person may confuse the activation of a concept with its long-term strength. Thus, a person may think that a currently active item has been stored in long-term memory when it actually has not.

The final three assumptions are concerned with the access of information in memory. Assumption 4 states that the availability of a concept depends on its strength or baseline activation, and the number and strength of connections to other concepts. These factors determine the ease of activation of the concept. The activation of a concept may be raised by exposure to the concept itself (through self-connections or feedback loops; exposure in the environment activates the concept). Alternatively, a concept may be activated by an associated concept. In this case, the amount of activation is a joint function of the target concept's base level of activation, the associated concept's strength, the strength of the connection, and the competing connections from the associated concept. A fact that is activated above a certain threshold will be available for conscious processing in working memory. This process occurs more easily for stronger traces.

Assumption 5 asserts that a complete match is not required to retrieve information from memory. The key issue is defining the criteria that determine an acceptable partial match. Obviously, the amount of overlap between the working memory representation and the long-term memory structure affects the likelihood of accepting the partial match as sufficient. The degree of acceptable overlap is primarily a function of the amount of activation arriving at the higher level structure that is being matched. In our view, this overlap is not just computed by lexical items, but also by semantic features attached to these items. It is *clusters* of activated features that are matched to the overall representation. The structural relationship among these clusters of features is rarely inspected.

Although activation is a necessary requirement for processing a memory trace, unless the trace is *in the focus of attention*, it will not be carefully inspected. Assumption 6 states that the focus of attention determines which aspects of the memory representation will be carefully matched to long-term memory structures. The task requirements partially determine the focus of attention, and thus, the portions of the representations that are matched carefully. If a portion of the probe is not in focus, activation does not spread out from its memory representation to its associates; rather, the higher level memory structure that has been activated by the constellation of features spreads activation back to the out-of-focus element to insure that it "loosely matches." In other words, if the word *dog* is part of the memory probe, but it is not in focus, then the concept *DOG* will not activate its associates, such as *BONE* and *CAT*; however, an attempt will be made to connect *DOG* to the higher level structure.

Our assumptions bear resemblance to and build on the frameworks proposed by Anderson (1983, 1993) and Kintsch (1988). Within this framework, we think that the similarities among the phenomena discussed earlier become more salient, and the mechanisms that cause them more understandable. The key ideas concern the notion of clusters of features matching to stored representations, and not focusing on a careful structural match. We articulate the Featural Familiarity Hypothesis in more detail as we use it to explain each of these phenomena.

## FEELING OF KNOWING

Feeling of knowing refers to the subjective experience of feeling that the answer to a question is known. Most people have experienced this feeling in the context of a "tip of the tongue" experience, where the impression of knowing the answer is quite strong despite an inability to recall the information. Traditionally, this feeling or impression has been studied in situations where retrieval has failed, but there is no tip of the tongue state. Instead the experimenter merely asks the subjects to predict the probability of being able to recall or recognize the answer later. In this paradigm, subjects attempt to answer general knowledge questions, or recall memorized associates from a list of paired associates. If the desired information is not correctly recalled, the subject instead rates the probability of later recognition of this answer.

This classic paradigm has consistently resulted in highly accurate feeling of knowing estimates. More recently, an alternate paradigm has been developed in which people make speeded predictions of whether they would be able to retrieve the answer, prior to actually attempting to retrieve the answer. Use of this paradigm has resulted in even greater accuracy of these judgments (Reder, 1987; Reder & Ritter, 1988, 1992). That is, split-second first impressions of answerability are more accurate than the feeling of knowing judgments that occur after a retrieval failure. This is in part because there is not a restricted range of questions being measured, but other factors may also be involved.

Historically, it had been assumed that the feeling of knowing is based on a partial retrieval of the answer or at least reflected the strength of the memory trace. However, several recent studies have found that manipulations that affect the familiarity of terms in the question have a much greater impact on perceptions of ability to answer the question than those that affect the accessibility of the answer (Reder, 1987; Reder & Ritter, 1988, 1992; Schwartz & Metcalfe, 1992). For example, Reder and Ritter (1992) tested this hypothesis directly by manipulating the frequency of question parts, in this case, arithmetic problems. The more frequently the problem parts had been seen, the more likely subjects were to feel they could recall the answer, even when these problem parts had been recombined to form new problems. In addition, Schwartz and Metcalfe (1992) found that priming the question terms increased the feeling of knowing, whereas priming the answer terms had no effect on this measure.

We take as support of the Featural Familiarity Hypothesis the phenomenon that people estimate whether they can answer a question based on the perceived familiarity of the question terms as opposed to the strength of the answer. This estimation heuristic is remarkably accurate at predicting whether or not one will be able to answer a question, given the queried knowledge is not sampled. In fact, subjects are typically more accurate at predicting whether or not they know the answer to a question when they make a speeded judgment than when they make their decision by trying to answer the question. For example, Reder (1987, 1988) asked subjects to quickly predict whether they could answer questions. These subjects were more conservative than subjects asked to quickly answer the questions or respond "don't know." Subjects in both conditions correctly answered the same number of questions; however, subjects who were asked to quickly predict whether they could answer had fewer false alarms than subjects in the answer condition. In sum, when asked to rapidly judge their feeling of knowing, subjects were very good at recognizing all the questions that they could answer, and rarely thought they could answer questions that they could not. At the same time, they were more than 25% faster than the subjects who attempted to answer the questions directly. This rules out any account based on a speed-accuracy tradeoff.

In summary, although the experiments just discussed show that subjects can be made to err in their feeling of knowing judgments when question familiarity is manipulated, feeling of knowing judgments are generally excellent predictors of answerability. Why would the cognitive system develop this method of assessing whether questions can be answered? We believe this feeling of knowing process developed as it did because it provides a quick, easy, and relatively accurate estimate of the contents of memory. Retrieving an answer is much slower and more effortful than simply assessing the familiarity of the question terms. This result, that familiarity is a very useful heuristic, is indicative of the usefulness of familiarity as a cognitive tool more generally.

## ILLUSIONS OF COMPREHENSION

### Prediction of Test Performance

The prediction of future performance on a test based on a text passage appears at first glance to be simply the feeling of knowing judgment on a larger scale. Because people are able to accurately estimate whether they will be able to answer a question, then they should be able to predict how well they will perform on a future test based on a text. This task simply involves the added task of evaluating comprehension of the text. However, researchers have found that people are quite poor at this task, under a variety of conditions—whether they make the predictions immediately after reading or after they have had some "distance" from the material (Glenberg et al., 1987; Glenberg & Epstein, 1985). Predictions of performance on class exams are no more accurate than those given in a laboratory situation (i.e., a psychology experiment) (Beckett et al., 1989; Beckett & Kestner, 1988). People do not get better at predicting future performance on tests after having seen how poor they were initially on predicting performance. The only situation that shows any improvement is on predicting performance on a test that will be virtually the same (using the same questions) as the earlier test (Glenberg et al., 1987; Glenberg & Epstein, 1985; Maki & Serra, 1992).



There are only a few instances when subjects' estimates of future test performance are moderately accurate. Subjects who perform well on an initial test show some ability to predict their performance on a later test, whereas the poorer performing subjects show no such calibration (Maki & Berry, 1984). Another exception to the generally poor calibration of comprehension occurs when subjects who differ greatly in their knowledge in different domains make confidence judgments about comprehension across domains (Glenberg & Epstein, 1987). In such a situation, subjects predict greater comprehension and show higher performance in the domain of their expertise, resulting in significant calibration. However, these same subjects fail to show calibration when the estimates are made within a given domain, regardless of whether or not it is their domain of expertise. Maki and Serra (1992) further investigated the effects of domain familiarity on test performance predictions. Subjects' estimates of future test performance was much more accurate after reading the texts than after seeing only the title and topic of the passage. The researchers interpret this result to indicate that people have some ability to use information in the text, as well as general domain familiarity to estimate their performance on a future test. Clearly, this ability is not very good, nonetheless.

Why does the Featural Familiarity Hypothesis predict such good accuracy for prediction of feeling of knowing, but such poor accuracy for comprehension and prediction of test performance? Part of the answer is that people cannot predict what questions will appear on a test. In the case of feeling of knowing, subjects are given the question and know what they will be required to retrieve. A second reason is that the ability to recognize concepts or propositions that have been asserted is not the same as being able to answer questions that may involve conceptual integration and inferential reasoning. If subjects do not really understand the passage, they will be especially poor at predicting the types of questions that will be asked. The poor prediction may be compounded by subjects getting an illusory impression of comprehension, an issue which we now consider.

### Detection of Contradictions

Another aspect of comprehension monitoring that has been studied is the detection of contradictions in a passage. Although people can easily detect nonwords and syntactic errors in passages, they are often quite poor at detecting internal contradictions, or even contradictions with well-learned prior knowledge. This has been referred to as the *illusion of knowing* (Glenberg et al., 1982). Subjects are especially vulnerable to this illusion of comprehension when the contradictory aspect of the passage must be inferred or when it is at the end of a passage, particularly a long passage (Epstein et al., 1984). Syntactically marking the contradictory information as new also reduces the detection rate (Glenberg et al., 1982).

Otero and Kintsch (1992) further explored the illusion of comprehension phenomenon. They presented subjects with passages containing contradictions, asking them to note any difficulties encountered. Subjects then recalled the passages in writing. When subjects did not detect a contradiction in the text, they often recalled only one of the two contradictory sentences, or created a plausible reason for both statements to be true. Otero and Kintsch modified Kintsch's (1988) Construction-Integration model to account for this phenomenon. The first component of this model is a construction phase, in which representations for all possible meanings of words and phrases in a sentence are activated. In the second component, the integration phase, a unified conception of the idea of a passage is created by integrating the relevant representations created in the first phase, and suppressing contradictory or irrelevant representations. Because the suppression of contradictions is a natural part of this model of comprehension, the model lends itself well to the explanation of failure to detect contradictions in a passage while claiming a good understanding.

The Otero and Kintsch model does a good job of explaining the illusion of knowing; the Featural Familiarity Hypothesis may be considered complementary to their model. As we stated earlier, the activation of a concept decays quite rapidly. In order to detect a contradiction within a passage, both of the contradictory propositions must be part of working memory at the same time. If the activation of the first concept has decayed so that it is no longer in working memory, it cannot be compared to the second, and thus, no contradiction will be noted. This account is supported by evidence that increasing the distance between the contradictory sentences decreases the likelihood that the contradictions will be detected (Epstein et al., 1984).

There are other situations, however, where contradictions are detected even when separated by many sentences. Albrecht and O'Brien (1993) found that subjects easily detected actions that violated a main character's previously described attributes. For example, in one of their stories, a character who was described as a vegetarian later ordered a hamburger for lunch. Albrecht and O'Brien assumed that concepts in the current sentence are active in working memory; they called this *explicit focus*. In addition, they assumed information pertaining to the protagonist of the story is in *implicit focus*, and thus readily available for comparison to current information. In our terms, this implicit focus would correspond to a continuing, subthreshold activation for the characteristics of the main actor. If actions related to these characteristics are mentioned or contradicted in the story, their activation will pass threshold, making the characteristics available for comparison to the current information. When people read a story or narrative text, they tend to be interested enough in the characters and events to retain this information in implicit focus, or keep it activated just below threshold. However, we do not believe this happens as frequently when processing expository texts in a psychology experiment, or in preparation for a future test.



We believe that a typical strategy, when instructions are given to "understand" an expository text in which the subject has little interest or knowledge, is to examine the local sensibility of the text. That is, the reader will evaluate the text at the word and sentence level, and not evaluate the coherence of the passage as a whole.[1] As a result, superficial filters involving lexical familiarity and syntactic acceptability are used. A focus on these superficial features of the text precludes a deeper processing of the relations between the sentences in the passage, which is necessary for the detection of the contradictions. Of course other variables such as prior knowledge of the subject matter and motivation to actually digest the content are also relevant. However, unless subjects are very motivated to make inferential connections, or are specifically told which aspects of the text to focus on, they resort to these simple strategies that focus on superficial factors such as word familiarity.

Indeed, there is evidence that many readers use primarily lexical and syntactic cues to evaluate their understanding of texts, assuming they have "understood" if the words are familiar and the sentences syntactically well formed. Baker (1985) asked subjects to identify any problems they found in comprehending some text passages, giving reasons why each was seen as a problem. Each passage contained one intentionally introduced problem, either a nonword, an internal contradiction, or a contradiction of prior knowledge. If subjects were equally sensitive to each of these types of problems, they should detect each equally often. However, consistent with the Featural Familiarity Hypothesis, lexical and syntactic problems were detected twice as often as either internal or external contradictions.

In low-verbal subjects, the tendency to rely only on lexical and syntactic understanding was even more extreme, with very few of the contradictions in the texts noted. Because these low-verbal subjects tend also to be poor readers, this focus on superficial aspects of the text could result from a lack of resources for a semantic analysis of the text. Consistent with this idea, specifically instructing subjects on the types of problems that might occur greatly improved their detection of these problems (Baker, 1985). This supports the view that people tend to focus attention at the lexical level and evaluate syntactic form rather than trying to build new structures that would be shared with previous parts of the passage or reactivate earlier portions to build deeper connections.

What does the Featural Familiarity Hypothesis have to say about the failure to detect inconsistencies? When a passage is read, the corresponding lexical ele-

[1]McKoon and Ratcliff (1992) recently detailed a similar account of text processing, which they call the *Minimalist theory*. They claimed that readers typically only monitor texts for local coherence. Although we believe this minimalist process occurs frequently, we do not think it is the only method used by subjects in processing texts, particularly those for which their knowledge and interest are high.

ments in memory become active. Only when the lexical items are unfamiliar is there a flag to the reader that he or she may not understand what is being said. That is, if the lexical elements in the passage match to fairly strong concepts in memory, then superficial reading does not flag a failure to comprehend. This explains why people are better calibrated across domains—they easily recognize when the terms are novel, and realize that they know nothing about it. In domains that do not seem very novel, however, readers are prone to the illusion that the passage will be well remembered because they confuse the current activation of the propositions with their long-term strength. This confusion, or misattribution, of recent activation with resting levels of activation or strength is a phenomenon that is seen in other paradigms that are also discussed in this chapter in the section on "Unconscious Uses of Memory."

In sum, we believe that comprehension monitoring is not calibrated because local activation gives a spurious sense of knowing that is inappropriate for predicting test performance: people may well not remember the facts; furthermore, fact availability, per se, may not be germane to the types of comprehension questions that are asked of the reader. Consistent with this position, people are much more calibrated at judging the correctness of answers to questions already asked than they are in the typical comprehension monitoring task (e.g., Beckett et al., 1989; Beckett & Kestner, 1988; Glenberg & Epstein, 1985, 1987; Maki, 1987). In fact, ability to predict performance on questions already answered (i.e., "How did I do?") is unrelated to predictive judgments of overall performance on an exam (i.e., "How will I do?") (Beckett et al., 1989; Maki, 1987).

## THE MOSES ILLUSION

The Moses illusion has strong similarities to the failure to detect contradictions in passages. The Moses illusion is so named because people fail to notice that some elements of a question do not really belong, such as the name "Moses" in the question, "How many animals of each kind did Moses take on the Ark?" Even when warned that distortions might be present in questions to be answered, people still frequently fail to notice the distorted elements. The degree of semantic similarity between the normal term and distorted target can influence the detection of the distortion. The more closely related the distorted target was to the word it replaced, the more frequently the illusion occurred (Erickson & Mattson, 1981). Studying, or even memorizing the correct version of the queried facts before attempting to answer the questions does not aid in this detection (Reder & Cleeremans, 1990; Reder & Kusbit, 1991). Word reading times for the distorted term were not shorter (in fact, they were somewhat longer) when subjects failed to notice the distortion (Reder & Kusbit, 1991).

Increasing the salience of the inconsistent portion of a statement reduces the effect of the illusion. Bredart and Modolo (1988) created inconsistent statements with either consistent or inconsistent portions of the statements as the focus of the sentence. They used cleft sentences such as, "It was Moses who brought two animals of each kind into the ark," and, "It was two animals of each kind that Moses brought into the Ark." When the inconsistent portion of the statement was in focus, subjects noticed the discrepancy much more than when the consistent portion was in the focus. Similarly, when Baker and Wagner (1987) embedded the discrepant word in a subordinate clause, thus syntactically marking it as given information, subjects were much less likely to notice the discrepancy than when it was syntactically marked as new. These results are consistent with the findings of Hornby (1974) that people tend not to process given information as deeply as new information.



The Moses illusion can be taken as support for the Featural Familiarity Hypothesis and reinforces several of the assumptions described earlier. We assume that when a person is asked a question, processes (e.g., productions) operate to find the queried element. The speed with which the queried element can be located and given as an answer depends on the activation level of the proposition that contains the queried element. At the same time that a person is trying to answer the question, a second process is trying to monitor for distortions. If the answer is easily available, it is more difficult for a person to note the distortion and answer "can't say" before generating the otherwise correct answer. Consistent with this view, people find it significantly more difficult to detect distorted sentences (i.e., make more errors of giving the undistorted answer) when the questions contain many terms related to the knowledge structure than when there are just a few (Reder & Kusbit, 1991). In other words, the more terms in the question that are consistent with the script or knowledge structure associated with taking animals on the Ark, the harder it is to notice that Moses is the wrong term.

An important aspect of the structure of the memory representation is the number of features shared by the correct and distorted term that are also strongly associated to the script in question. For example, Moses and Noah share semantic features as biblical characters; these are the central features that relate Noah to the Ark story. Surprisingly, even the name "Jesus" can produce the illusion. In an informal survey (of the few people the authors could find that did not know of the Moses research) of the form, "I've got a quick Bible question for you: How many animals of each kind did Jesus take on the Ark?" people often failed to detect the distortion. However, we suspect that people more easily recognize the distortion once brought to their attention. We had expected a better detection rate because the concept "Jesus" has so much baseline strength and so many connections to other concepts. Apparently, the amount of strength and number of associates of the distorted element does not matter. The important factor in this illusion is that the distorted element share semantic features with the proposition and the term it is replacing.[2]

[2]We have sometimes thought that one would not be fooled by a substitution of a different name if one of the names is known very well; however, we note that people often substitute other family members' names when trying to retrieve one for a sentence, suggesting that lots of knowledge of an individual or concept does not make one immune to these types of errors.

Given that people fall for the illusion even when a highly familiar name such as Jesus is used as the distorted term suggests that perhaps all that matters is the amount of activation arriving at the correct memory structure. However, this cannot be the complete story, because certain types of distorted terms are very easy to detect regardless of the number of terms that activate the correct structure. For example, subjects easily recognize that "Nixon" does not belong in the Ark sentence (Erickson & Mattson, 1981). We doubt that the number of terms priming the Ark story would make much difference in how easily Nixon is detected as a distorted term. So, if the terms are totally unrelated with respect to the script that is queried, as in the case of Noah versus Nixon, the discrepancy will be noticed.

There are two key factors in understanding the Moses Illusion. The first is the apparent discrepancy between the target term and the distorted element, and the second is the activation level of the answer. This task can be viewed as one where subjects are asked to answer the question, and at the same time monitor for distortions in the question. The ease of detecting the distortion depends not only on the semantic similarity between the distorted term and the original, but also on the amount of attention that is directed at the distorted element. Whether a distortion is detected is partially a function of the speed with which the answer becomes available, and partially a function of how quickly the distorted element can be noticed. Reder (1992) had subjects study the relevant facts before answering the questions, and varied whether the answer was capitalized (e.g., "Noah took TWO animals of each kind on the ark."), the target term was capitalized (e.g., "NOAH took two animals of each kind on the ark."), or neither term was capitalized. She found that subjects were significantly less likely to notice the distortion if the answer had been capitalized during study. Previously capitalizing the target word made subjects more sensitive to the distortion, but this effect was smaller and not reliable.

A second factor that must be considered is the instructions given to the subjects. The task instructions to monitor for distortions gives more attention or processing resources to this detection process, but not enough to make the detection easy. Placing the distorted target in the focus of the statement ensures more attention is focused on it, whereas placing it in the given portion of the sentences deflects attention from it (Hornby, 1974). Only the terms in the focus of attention are compared to the memory structure. Normally the queried element is the focus of attention and the match process deflects attention from the distorted term.

We have not yet explained why a term that bears some semantic similarity might well go undetected as a distortion, but another term with no semantic similarity is almost always detected as a distortion regardless of whether or not it is in focus. Our explanation involves the notion that activation spreads *from* the distorted element *only when it is in focus*. Otherwise, activation spreads from the knowledge structure *to* the distorted element through any available connecting path. In other words, activation will spread from propositional representation of the theme of the sentence (e.g., the Ark script) to the distorted element (e.g., Moses, or Jesus, if that name is used), finding a connection through shared semantic features (e.g., Bible stories). Only when the distorted term (e.g., Moses) is in focus will activation spread from that term to its own scripts and primary associates (e.g., the Ten Commandments story becomes active), causing the mismatch to be noted. The reason people always detect unrelated terms (e.g., Nixon) as distorted is that there is no semantic similarity and therefore no connecting path between the theme of the sentence and this distorted term (e.g., between the Ark script and Nixon). Consistent with this hypothesis, when subjects studied paired associates consisting of the unrelated term and a term in the sentence (e.g., "Nixon-animals"), they often failed to detect the distorted term in the sentences (van Oostendorp & Kok, 1990).



All the research on the Moses illusion makes it clear that people can find distortions, but find this difficult if the distorted element is semantically related to the theme of the sentence. The odds of noticing the distortion are reduced by increasing the number of elements that need some kind of match (lowering the odds that the distorted element will be in focus). Why should our cognitive system be so tolerant of distortions and find it so difficult to do careful matches to memory? We believe that this partial match process enables useful communication and comprehension. Very few things that we see or hear will perfectly match the representation that we already have stored in memory. In order to answer questions, we need to be able to use an *acceptable* match. In order to understand a new situation and map it onto something we have already seen or done, we must accept slight variations. Every day, at many levels, we accept slight distortions without noticing them. We notice some and ignore them, but many we do not even realize occur. These variations also occur in our speech production; many of these variations are not errors. Our selection of lexical entries may vary from moment to moment, reflecting the wide range of options and flexibility in our means of expression. We occasionally generate slips of speech in which we substitute a semantically related element. A rigid comprehension system would have a difficult time indeed.

## VALIDITY INFLATION

Validity inflation, like feeling of knowing, is a phenomenon where the familiarity of words in a statement affects a reader's judgment about that statement. For both of these phenomena, prior exposure to words that appear in the to-be-judged statement increases the illusion of relevant knowledge concerning that statement. When judging validity, subjects rate a repeated statement as more valid than a statement that has not been previously exposed (in some surreptitious task or even in the same rating task) (e.g., Hasher et al., 1977). Experiments in this paradigm have varied the delay between first exposure to a statement and its validity rating—some have been minutes, some weeks (e.g., Bacon, 1979; Schwartz, 1982). The subjects may have seen the whole sentence (e.g., Hasher et al., 1977), the topic of the sentence (Begg et al., 1985), or even just a word or two from the sentence (Arkes, Nash, & Joyner, 1989). Both college students and older adults have been tested, in both psychology labs and in their own homes (e.g., Gigerenzer, 1984; Hasher et al., 1977). Regardless of the details of the procedure, the pre-exposed sentences are consistently rated more valid than new sentences. Note that this increase in validity, although robust, is always quite small.

These data are consistent with and support the Featural Familiarity Hypothesis. That the effects occur at long delays as well as short delays suggests that the exposure is increasing long-term strength of the relevant terms, and is not just a transient priming effect. This increased strength, or higher resting activation level, means that the concepts are more easily activated to a high level, giving the illusion that (a) the statement seems very familiar (e.g., "I must have learned/heard this before") and (b) there must be a lot of knowledge stored in memory concerning the topic under discussion. In other words, propositions with perceived strength are assumed to be stored in memory, and propositions that are stored in memory are assumed to be true. Without carefully inspecting stored knowledge, this feeling of familiarity causes a person's first guess to be that he or she knows something about the seemingly familiar topic, making it seem likely to be true.

Of course, in an experiment that is designed to give irrelevant familiarity to statements that will later be judged for plausibility, such heuristics are not adaptive. On the other hand, in most everyday situations, things that we have heard many times are much more likely to be true. Typically, learning occurs through repetition, from one's own name, to the multiplication tables, to the fact that leaves turn color in autumn. Thus, the repetition-truth link is an important one. We claim, therefore, that such heuristics are adaptive, just as are the feeling of knowing heuristics. We are not claiming that this is the only method ever used to judge the truth of an assertion, just that it is a quick and simple heuristic that is employed frequently.

Sadly, it is not just in psychological experiments that there exist attempts to subvert the usefulness of this heuristic. Advertisers take advantage of this phenomenon and advertise frequently. A metro corridor in Paris may have 20 or 30 copies of the same poster—you cannot miss it and are likely to remember and be influenced by it. Of course, this is also one reason why propaganda can be so effective. A Chinese colleague informed us of a pattern that frequently occurred in Communist China: a billboard would appear with a seemingly outrageous message; after some time, the message no longer seemed so strange; finally, people accepted it as truth.

In order to deal with these frequent attempts to subvert the usefulness of a heuristic, people often develop specific strategies for situations that are likely to be suspect. When we are aware of familiarity manipulations that will give us spurious feelings of familiarity, we tend to shift our criterion for accepting the statements (e.g., Jacoby & Whitehouse, 1989; Reder, 1987). People also develop specific strategies to block the effects of familiarity in suspect situations. For example, whenever the second author of this chapter finds herself listening to an advertisement that asserts something like, "This just might be the best car on the market today," she is motivated to analyze the structure and also rehearse to herself, "This just might not be the best car on the market—what kind of claim is that?"



Clearly, people need to be able to counter these automatic effects of familiarity on validity judgments, to use other strategies in questionable situations. We tested whether requiring subjects to provide a reason for believing a statement, not just judging how valid it seems, might not discourage reliance on familiarity. As in most validity inflation experiments, subjects were asked to judge the truth of trivia statements, and we varied how often these statements were rated. Half of the subjects were required to give reasons for judging the sentence as they did for the final rating, whereas the others followed the standard paradigm. Those subjects who were required to justify their ratings did not show the usual increase in the perceived validity of the repeated statements. People can avoid being fooled by simple repetition, but this requires much more effortful processing than usual.

## ANALOGICAL REASONING

When trying to solve a problem, people will often draw on previous problem solving experience, using an old problem to help solve the current one. What factors govern which problems come to mind as candidates for analogy during a problem solving attempt? We claim this analogical reminding process is governed by the same sloppy cognition that characterizes the other areas of cognition that have been discussed. That is, a problem will be retrieved for use through a partial match process, based on the similarities between the current problem and the previous problem.

When confronted with a problem, a person may be reminded of another problem because certain features of the current problem match features of the previously solved problem. Ross' (1987, 1989a) work on analogical reminding has shown that students are not very good at retrieving appropriate problems that could be used to help solve novel problems. His beginning students attempting to solve basic probability problems were often reminded of, and attempted to use, problems with surface similarities to the test problems. For example, a student trying to solve an algebra problem about boats going upstream may recall another problem about boats. However, unless the underlying structure, or principles, of the two problems are the same, the recalled problem will not be useful in finding a solution. To continue this example, the recalled boat problem may be about boats carrying passengers for pay, and a problem about airplanes flying against head winds would actually be more useful in guiding the solution of the current boat problem. As one would expect, these attempts to use problems with superficial similarities often resulted in incorrect problem solutions. Even when subjects are given problems with their solutions and told to use them as examples for solving new problems, their success at this task depends on the degree of similarity between the sample problem and the test problem (Reed, Dempster, & Ettinger, 1985).

Faries and Reiser (1988) further found that after several lessons, beginning computer programmers retrieved a mixture of superficially similar and structurally similar problems for use as analogies. These latter problems were more useful to the students in terms of number of correct solutions, than the former. Why do beginners rely so much on the surface similarities of problems? And what causes the shift toward use of more structurally similar problems apparent in the Faries and Reiser study? Evidence from several domains indicates that experts in a domain represent problems differently than novices; the experts notice structural features of the problems more readily than novices (Chi, Feltovich, & Glaser, 1981; Schoenfeld & Hermann, 1982). For instance, Chi, Feltovich, and Glaser (1981) compared physics experts and novices in a task where they were asked to sort a set of physics problems. The novices sorted the problems based on their superficial features, whereas the experts sorted them by the underlying principles. Consequently, the more experienced problem solvers were able to access structurally similar problems in the above experiments on analogical reasoning, whereas the novices had trouble seeing past the surface features.

The Featural Familiarity Hypothesis posits that reminding occurs because memory retrieval is based on partial matching to the memory probe. Thus, a superficially similar problem will be retrieved if the representation of the problem that is used to probe memory is based on surface features of the problem. A problem that matches in underlying structure, and can be successfully used in solving the current problem, will not be recalled unless the representation of the problem to be solved includes these structural elements. More experienced solvers will focus their attention on the underlying structural representation and the match will go from the underlying representation to a corresponding one in memory. Novices will focus on superficial features, and the corresponding superficial features will be activated in memory, causing a superficially related problem to be retrieved.

Others have proposed models of analogical reasoning similar to our current account. For example, Reed (1987) proposed that an analogy consists of a mapping of the nodes and relations between the two problems. This mapping may occur at any or all of the several levels of representation of the problem



(e.g., at the level of the principle involved in the problems, or the frame level of the problems, or the quantity level). The success of the mapping is influenced by the isomorphic structure of the problem, and the base specificity and transparency of the relationship between the two problems. By base specificity, he means the degree to which the student understands the example problem, whereas transparency refers to how well the underlying structure of the problems can be seen to correspond. Ross (1989b) also proposed a general framework for remindings. The four components of his model are noticing an earlier problem, reconstruction of that problem and its solution, analogy from that problem and solution to the current problem, and generalization from the analogical process. His conception of noticing is much like our own: memory is probed, and what is retrieved depends on the match between this probe and the contents of memory. He also points out the tendency of novices to include only superficial aspects of the problems in their memory probes.

The task demands in analogical reasoning also influence the focus of attention, and thus, the way the problem representation is matched to memory. For example, when the task is to use a problem as an analogy, or to generate a conclusion based on an analogy, a match on surface features of the problem is less prevalent. For instance, Clement and Gentner (1991) asked subjects to make an analogy to an earlier text in order to draw conclusions from the current text. They found that the conclusions produced by subjects were based on the structure of the problems more often than on surface similarities. The task demands focused attention on the analogy itself, rather than on the use of the analogy, so that a more careful matching process is used instead of the usual sloppy match process. The sloppy match process is used primarily when the task demands direct the focus toward other portions of the problem, and not directly on those parts important for recall or the generation of an analogy.

In summary, problems are retrieved for use as analogies based on a partial match of salient features of the problem to memory. Experts and novices in a domain differ on which features are salient, with novices paying more attention to the surface features. In addition, task demands influence the focus of attention, and thus which portion of a problem is matched to memory structures. This retrieval of problems for analogical use based on superficial features is certainly not an adaptive method of problem solving. However, the data indicate that this is merely a passing phase, an artifact of learning which features of problems in a given domain are important for use in problem solving.

## UNCONSCIOUS USES OF MEMORY

Jacoby (e.g., Jacoby, 1988; Jacoby & Kelley, 1987, 1992; Jacoby, Kelley, & Dywan, 1989) proposed that the unconscious use of memory affects behavior in surprising ways. If a subjective feeling of remembering does not occur, the influence of memory may be misattributed to other processes. Jacoby and his colleagues found examples of this in situations ranging from perceptual recognition (e.g., Jacoby & Dallas, 1981) to fame judgments (e.g., Jacoby, Kelley, Brown, & Jasechko, 1989; Jacoby, Woloshyn, & Kelley, 1989). The false fame effect involves asking subjects to read a list of nonfamous names. The next day, the subjects must judge the fame of a new list of names, which includes some of the previously seen nonfamous names, as well as new nonfamous names, and (new) famous names. The previously seen nonfamous names are more likely to be considered famous than the new nonfamous names. A related effect shows that subjects are misled when attempting to discriminate previously studied words from new words when a new word is flashed tachistoscopically just prior to the old/new judgment. This subliminal perception of the new word increases the chances of calling it old (Jacoby & Whitehouse, 1989). If subjects are aware of this manipulation and of the attempts to subvert their judgments, they will try to adjust their threshold to counteract the manipulation.

According to Jacoby and his colleagues, these effects are due to the familiarity of the name or word being misattributed, in one case to fame, and in the other to prior study in the experiment. Unless people consciously recollect the source of the feeling of familiarity, they will adopt the currently most plausible explanation (fame or prior exposure in the experiment). The Featural Familiarity Hypothesis is also supported by these findings. In our view, the false fame attributions occur because the name (e.g., Sebastian Weisdorf or Pearl Miller) has been activated recently. The subject detects the strength or activation of the name, and attributes this to an old, moderately strong association rather than a recent exposure. Even when the first and last names are recombined (e.g., Pearl Weisdorf and Sebastian Miller), subjects will indicate these novel names are famous (Squire & McKee, 1992). This occurs because the memory match process matches on clusters of features, and not necessarily the relation of the features to each other. Likewise, in the recognition task, the prior tachistoscopic flash elevates the activation of the word, but the subject is unaware of why it is elevated (is unaware of the flash) and therefore assumes that the familiarity must be because of a recent presentation of the word.

Jacoby has avoided mechanistic explanations involving activation or priming, preferring instead the explanatory construct *perceptual fluency*. He avoided priming types of explanations because it is known that decay of activation is rapid. In other words, he reasonably argued that priming can not account for his results, as his effects occur over long periods. We find Jacoby's explanation compatible with ours and believe that our account is satisfactory in that it can handle relatively long-term effects. Although activation decays rapidly, exposure gives a boost to the strength of the concept. Of course, low frequency words get more of a boost from a single presentation than would a high frequency word, in terms of affecting the resting level of activation. When the concept is reactivated at the next presentation, it reaches a higher level of activation and is processed faster and, in Jacoby's terms, seems more perceptually fluent. In our terms, the higher level of activation is attributed to strength or recent activation, depending on what seems most plausible in the current context.



The unconscious use of memory can also influence perceptual judgments (Jacoby, Allan, Collins, & Larwill, 1988; Jacoby & Dallas, 1981). In one experiment, subjects judged the loudness of background noise while listening to sentences read aloud. Half of the sentences that were read had been previously studied. Equivalent background noise was rated as quieter when the sentence being read aloud had been previously studied (Jacoby et al., 1988). A similar effect occurs when subjects identify words flashed tachistoscopically. If a word has been previously studied, it can be identified after a shorter exposure than that required for a new word (Jacoby & Dallas, 1981).

## The Role of Focus in These Phenomena

In our previous discussions on the illusion of comprehension, feeling of knowing, and the Moses illusion, we noted that the focus of attention in a task influences which parts of the memory representation (if any) are carefully inspected.

The phenomena uncovered by Jacoby and his colleagues are sensitive to focus manipulations in a similar way. The phrase *unconscious use* of memory implies lack of attention. Jacoby means by this that subjects do not correctly attribute the source of the current high level of activation. When it is easier to hear a sentence in white noise, they do not realize it is because they have heard the sentence before—they assume that it was louder or the background noise was quieter. When subjects are not conscious of a manipulation, when the strength of the terms is not overly strong to make the connections to the source link salient (e.g., subjects do not remember where they heard the name Pearl Miller), the illusion of fame occurs; however, if they think about why the term seems familiar and make a correct attribution, there is no effect of the manipulation.

Jacoby (Jacoby, Woloshyn, & Kelley, 1989) was able to manipulate the probability of retaining source information by sometimes requiring subjects to do two tasks simultaneously. For instance, when subjects are distracted from the task of rating the fame of a list of names, by simultaneously performing another task, they are more likely to false alarm to the previously presented nonfamous names. The split of attention in this task prevents subjects from carefully examining their memories, and so they instead rely on quick estimates of the familiarity, or baseline strength, of the name. Divided attention during initial study can also affect these false impressions, in that subjects are less likely to lay down a trace of the context of presentation in the dual task situation. In our terms, the activation/strengthening occurs automatically, whether there is a secondary task or not.

Can these findings of Jacoby be considered an example of a useful adaptation of the cognitive system? We think so. As with the phenomena discussed earlier in this chapter, these findings result from heuristics used by the cognitive system to free resources for other uses. For example, in Jacoby's false fame effect, subjects are more likely to call the previously studied names famous if they are in a divided attention task (Jacoby, Woloshyn, & Kelley, 1989). In order to free the resources needed for the second task, familiarity is used as a rough measure of the fame of the name. In everyday situations when people believe it is very important not to false alarm (make false fame judgments), they will not just rely on familiarity, but also make sure that an appropriate referent for the individual can be retrieved from memory.

## CONCLUSIONS

In this chapter, we have tried to illustrate that several disparate phenomena are all manifestations of some basic mechanisms that operate on memory. Our general thesis is that many of our cognitive operations are driven by familiarity based heuristics rather than careful matching operations. We have described several phenomena that use these heuristics, and have argued for the adaptiveness of these techniques in each case. We believe that the use of these heuristics extends far beyond the few instances described earlier.

In other words, we contend that everyday cognitive processing *must* be based on simple heuristics such as matching sets of features rather than exact matches, as very few tasks require exact matches. Very little that we see from one day to the next remains in the exact same shape and form as it was the last time we saw it. People wear different clothes from day to day, wear their hair in different ways, sport different facial expressions, and so on. Even concrete sculptures are seen in different light and from different perspectives. Verbal information is even less likely to be presented in the exact form in which it was stored, yet we must connect it with our stored knowledge. It only makes sense that people do sloppy, partial matches as the normal course of matching to memory.

Consistent with this view, Hintzman, Curran, and Oppy (1992) found that even with massive exposure to words, people were often unable to discriminate the singular from the plural form. Unless they had initially encoded the state of plurality as an important feature, continual exposure to the word did not improve their ability to discriminate the singular from the plural. A similar phenomenon was noted by Nickerson and Adams (1979) in that people are extremely poor at identifying the correct rendition of the common penny among foils. We see the penny every day, but our familiarity with the coin does not enable us to match features in a specific relationship. We match on familiarity of clusters of features and thus are unable to detect foils that have large numbers of the same chunks of features in slightly different configurations. Only if some of the features seem to violate our general familiarity with the stimulus do we reject that instance of it. Bransford and Franks (1971) reported another example of recognition based on familiarity with the parts and not on the specific relationships between the parts. Their subjects rated statements as old, and had higher confidence in these ratings, when the foil contained more propositional units that had been seen earlier. That is, subjects never heard a sentence containing all the propositional phrases; nonetheless, a new sentence that contained many familiar elements seemed especially familiar.



We have called the set of heuristics used by the cognitive system the Featural Familiarity Hypothesis because they operate at the level of shared features that give a sense of familiarity to an input that is matched to memory. The term *hypothesis* has two meanings here: Our speculations are essentially an hypothesis about how memory and our cognitive processes work; we also use the term *hypothesis* because our thesis about cognitive operations is that people continually make hypotheses about what they do and do not know, what they do and do not understand, based on the similarity of the input to what is already stored in memory.

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