Distinctiveness and Memory

R. Reed Hunt
James B. Worthen,
Editors

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Preface

Distinctiveness is a concept that has been invoked either directly or indirectly in nearly every major area of research in psychology. However, in no area of psychological research is the concept of distinctiveness more fully enmeshed than in the area of memory. Laboratory research on distinctiveness began early in the history of formal psychology (e.g., Calkins, 1894) and has continued steadily since. Across that research, the concept has been defined in different ways and applied to a variety of phenomena. Thus, a main objective of our volume was to bring together leading researchers in the area of distinctiveness and memory in an effort to gain insight into the similarities and differences in the application of distinctiveness as a theoretical concept. Toward this end, the present volume includes contributions from researchers doing basic research in the core areas (cognitive, neuroscience, social, and developmental) of empirical psychology.

By providing this forum for leading researchers to share their thoughts and ideas, we hope to achieve two specific goals: (1) to report recent developments in basic research investigating the relationship between distinctiveness and memory and (2) to advance theory related to distinctiveness and memory as a result of this exchange of ideas. To reach these goals, we believed that it was imperative to address the issues that have contributed to variations in the use of the term *distinctiveness* as a theoretical construct. A fundamental issue is the very meaning of the term. What is distinctiveness in the context of memory? Is it a description of the stimulus event or of the psychological processing of that event? Can it be both? Are terms such as *distinctiveness*, *bizarreness*, *vividness*, and *novelty* synonymous with respect to memory? These questions—each seeking a more clear operational definition of distinctiveness—are addressed in the present volume. Additionally, we sought to address the fundamental theoretical issues that have remained unresolved despite years of research in the area: What is the mechanism of distinctiveness effects? Can a theory of distinctiveness help us understand age-related changes in memory as well as various manifestations of memory in social contexts? And a final question of considerable prior interest, what are the neural support systems for distinctiveness?

The first part of the book addresses basic theoretical matters concerning attention. Hunt's chapter discusses two uses of the term *distinctiveness* and the implications of the different uses. In the second chapter, Nairne continues the discussion of the meaning of the term in the context of his theory of distinctiveness. Schmidt also addresses issues of terminology in the context of a distinction between novelty and significance, where he proposes that the two differentially affect memory. McDaniel and Geraci discuss the locus of distinctiveness effects, at encoding or retrieval, and provide an argument that emphasizes the importance of the retrieval process. Schacter and Wiseman describe research suggesting that distinctive processing can be used strategically at retrieval as a heuristic to improve memory accuracy. In the final chapter in this section, Burns raises the issue of measurement and outlines a new method for indexing distinctive processing.

The second part of the book is devoted to research on bizarreness—a topic that is often inextricably linked with distinctiveness. Worthen's chapter provides a thorough review of this research along with a discussion of the relationship between distinctiveness and bizarreness. The chapter also offers a new theory of bizarreness effects on memory. In the chapter by Davidson, additional issues concerning bizarreness are raised in the context of developmental research on memory for bizarre text.

The role of distinctive processing in dissociations between explicit and implicit memory tests is the topic of the third part. Mulligan's chapter reviews literature on test dissociations and the application of the distinction between conceptually driven and data-driven processes as an explanation of dissociation. Drawing heavily on his own important work, Mulligan notes difficulties with that explanation and as an alternative applies the distinction between item-specific and relational processing. In their chapter, Geraci and Rajaram compare distinctiveness effects in explicit and implicit memory and focus on the question of whether the distinctiveness effect in memory requires conscious processing of the prior experience at the time of retrieval. Their work with new implicit test preparations suggests that it does not.

The fourth part of the book considers the role of distinctiveness in memory across the life span. Howe reviews work on distinctive processing in children's memory, both immediate and long-term retention. He considers two alternative theories to explain the development of distinctive processing, and like McDaniel and Geraci's chapter in the first part, he emphasizes the importance of distinguishing encoding and retrieval. Smith's chapter describes research on elderly subjects in which the concepts of relational and item-specific processing have been applied to age deficits in memory. She integrates this work with more recent conceptualizations of distinctiveness.

The next part addresses distinctiveness in the context of social psychology. The chapter by Coats and Smith provides a comparison and contrast between the social and cognitive perspectives on distinctiveness and memory, and then discusses two major social-psychological effects (the incongruency effect and illusory correlation) often attributed to distinctiveness. The authors conclude that both effects can be understood in terms of item-specific and relational processing. Mullen and Pizzuto's chapter discusses social phenomena that are implicitly linked to distinctiveness. Ultimately, they conclude that an approach that links distinctiveness, group composition, and cognitive representations is useful in understanding a variety of social cognition and group processes phenomena.

The neuroscience part begins with a chapter by Fabiani, who discusses multiple neural phenomena that may contribute to the relationship between distinctiveness and memory. Based on the literature reviewed, she concludes that a model that integrates encoding, rehearsal, and retrieval factors might best explain the effects of distinctiveness on memory. Michelon and Snyder's chapter discusses neuroimaging research on memory for bizarre events. The results of this work suggest that the fusiform, prefrontal, and parietal cortices may play a role in determining the effects of extreme forms distinctiveness on memory. The chapter by Kishiyama and Yonelinas makes an important distinction between recollection and familiarity in explaining the effects of novelty on memory. These authors conclude that the effects of novelty on memory are related to processes occurring in the hippocampus and prefrontal cortex.

The final two chapters provide a summary and evaluation of previous chapters as well as new ideas about research on distinctiveness. Tulving and Rosenbaum argue that the distinctiveness effect in memory is the result of poor memory for nondistinctive items rather than extraordinary memory for distinctive items, and they propose a new process to account for poor memory of the nondistinctive items. Craik provides an interesting taxonomy of four cases of distinctiveness, all of which are associated with good memory but for different reasons. Craik then applies this analysis to the research reported in previous chapters as well as to other research on distinctiveness and memory.

In the end, we hope that the work discussed in this volume will serve as a useful description of recent research on distinctiveness and memory and also will stimulate some people to join us in the effort to develop a coherent story about distinctiveness and memory. The authors of the chapters have given us a solid platform from which to launch future efforts, and it is to those authors that we which to express much gratitude. Working with them has been a great pleasure.

We were fortunate to have Catharine Carlin evaluate our initial proposal for Oxford University Press (OUP). As our acquisitions editor, she enthusiastically encouraged us and provided important guidance toward reaching the project's final form. Jennifer Rappaport of Oxford University Press assisted with details of manuscript preparation. The editorial, production, and marketing team at OUP did all one could ask for in taking the original idea for this book to its tangible end point.

Quite candidly, this entire project began as an excuse to go to New Orleans. J. W. proposed a symposium to be co-chaired by R. H. for the 2003 meeting of the Southwestern Psychological Association. The program committee not only accepted the proposal but also provided a generous eight

hours of program time. We are especially grateful to SWPA Officers Edward Kardas and Mary Brazier for obliging us to go to New Orleans and for providing the setting that put this volume in motion.

Postscript: As we were editing this work, Hurricane Katrina stormed the Gulf Coast. It is our deepest hope that by the time this book is published we all once again can be welcomed by the gracious citizens of the city of New Orleans.

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Basic Issues

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1

The Concept of Distinctiveness in Memory Research

R. Reed Hunt

Intuitions often instigate important discoveries in psychology, but left unexamined, intuitions also can become an impediment to progress. Such seems to be the case for distinctiveness and memory, where both the data and theory are intuitive. Everyone knows that distinctive events are well remembered and everyone knows why. A distinctive event attracts attention, and the additional processing enhances memory. The intuitive theory rests on a broad operational definition of distinctiveness as an event that violates the prevailing context. In this definition, distinctiveness is a property of an event; it is essentially an independent variable. The ultimate effect of this independent variable, enhanced memory, results from extraordinary attention. Why would a distinctive event attract more attention than other events? Intuitively, the event is surprising, salient, bizarre, or novel. The subjective experience recruits attention in the form of additional processing that ultimately facilitates memory.

These compelling intuitions have had an impact on the study of distinctiveness and memory. One response is to assume that there is little left to learn. This reaction is reinforced by incorporation of the intuitive theory into explanations of the paradigmatic case of distinctiveness, the isolation effect (Green, 1956; Jenkins & Postman, 1948; Schmidt, 1991), giving one the sense that distinctiveness effects have been explained satisfactorily. Another reaction has been to warn against the use of distinctiveness as an explanatory concept because that explanation would be circular (e.g., Baddeley, 1978; Schmidt, 1991). If, as the intuitive theory has it, distinctiveness is treated as an independent variable, distinctiveness does not explain why distinctiveness affects memory. Taken together, these two reactions to the intuitive approach to distinctiveness question the need for further discussion of distinctiveness and memory.

In answer to that question, this chapter offers an analysis of the term *distinctiveness* as it is used in memory research. Tulving (2000) has noted that the terms used by memory researchers rarely are subjected to careful analysis, which is unfortunate because such analysis goes to the heart of what we mean when the terms are used. The goal of the analysis is to facilitate communication and conceptual clarity. Such an analysis is especially important for *distinctiveness* because the dominant meaning of the term continues to be dictated by the intuitive theory while at the same time a contradictory, secondary meaning has entered the lexicon of memory research. The incongruous meanings of the two uses of the term can hamper communication and stunt theoretical development, the very reasons that Tulving recommended analysis of the terms we use.

The analysis presented here begins with four general points about the term *distinctiveness* as applied to memory. These points are abstracted from two lines of research, both of which use the term with different meanings. Along the way, we shall see that the intuitive theory has not fared well when confronted with empirical evidence. If the intuitive theory is abandoned, the argument proscribing the use of the term as an explanation loses its force, and the way is cleared at least to explore the use of distinctiveness as an explanatory concept. The second half of the chapter outlines one way to think of distinctiveness as an explanation. The value of this latter approach to distinctiveness is illustrated by testing its predictions concerning three separate memory phenomena.

Four Points About Distinctiveness

Two separate lines of research invoking the term *distinctiveness* or a near synonym have produced the data on which this discussion will be based. The first is work using the isolation paradigm, an enterprise with a long history (e.g., Calkins, 1894, 1896). The *isolation paradigm* entails presenting subjects with material to be remembered, a small proportion of which differs on some dimension from the majority of the material. The isolation effect is enhanced memory for the different material. The different material often is labeled "distinctive," and superior memory for that material becomes the distinctiveness effect. With this use of the term, distinctiveness clearly is an independent variable that is a property of the to-be-remembered material.

From the outset (Calkins, 1894, 1896; Jersild, 1929; Van Buskirk, 1932), laboratory data confirmed the intuition that distinctive events are relatively well remembered. With the publication of von Restorff's (1933) classic article, the focus of research shifted from describing the effect of the variable to attempts to explain the effect. Ironically, von Restorff's work yielded some of the most damning evidence against the intuitive theory, which had yet to be formally stated, but this fact went unnoticed probably because von Restorff's paper has never been published in English. Von

Restorff's evidence will be described subsequently. Jenkins and Postman (1948) were the first to explicitly suggest that the isolation effect results from differential attention to the isolate. Green (1956) later would emphasize the importance of subjective experience aroused by the isolate as a cue attracting attention, essentially completing the formal statement of the intuitive theory. These developments were accompanied by substantial empirical work exploring various parametric manipulations on the isolation effect and their bearing on alternative theoretical accounts, most of which is reviewed in the important papers by Wallace (1965) and Schmidt (1991).

A second major line of research invoking the term *distinctiveness* evolved from levels of processing framework (Craik & Lockhart, 1972). In response to research motivated by the original framework, distinctive processing became the progeny of depth of processing as an explanation for the effects of orienting tasks. Distinctive processing was defined as the unique processing of an item at encoding that enhances discriminability of that item at retrieval (Jacoby & Craik, 1979; Lockhart, Craik, & Jacoby, 1976). *Distinctiveness* has a very different meaning in this context than it did in the context of the isolation paradigm. *Distinctiveness* now refers to a kind of processing rather than to the material being processed. In this sense, the term denotes an abstract concept rather than an independent variable. When used as an abstract concept, distinctiveness is in principle a candidate explanation for observed phenomena. Thus, to say that the isolation effect is the result of distinctive processing is not a circular argument. To be of use, however, the concept of distinctiveness must be fleshed out, including at a minimum a description of the conditions under which distinctive processing will occur. The points that follow provide a basis for such elaboration of the concept of distinctive processing.

Point 1: Distinctiveness Is Not a Property of To-Be-Remembered Material

To say that an event is distinctive is to refer to a psychological event, not to the physical object corresponding to the event. Distinctiveness is a characteristic of perception and comprehension but is not an inherent property of the perceived event. At one level, this point is purely definitional. Distinctiveness has as its root the verb *distinguish,* whose definition includes "to separate mentally things or one thing from another; to perceive or note differences between things" (Oxford American Dictionary, 1980, p. 250). Thus, the term *distinctiveness* is defined in reference to psychological processes, not the physical objects on which the processes operate.

The definitional point is readily instantiated by various empirical observations. For example, the proper control condition for the isolation effect is to place the isolated item in a list in which it is no longer isolated. Given that there is better memory in the isolation list than in the control list, any reference to distinctiveness cannot be to a property of the item itself because it is exactly the same physical item in the two lists. As another example, enhanced memory for orthographically distinctive words occurs only when these words are in a list that also contains orthographically common words. Pure lists of distinctive and common words yield no effect of orthography. Indeed, the very perception of orthographic distinctiveness as indexed by ratings depends on the presence of orthographically common words (Hunt & Elliott, 1980).

That distinctiveness is not a property of the environment perhaps is obvious, but the subtle implications of this point are important. If the term *distinctiveness* refers to an independent variable, the variable in question is a psychological representation, not an item in a list. To determine if this variable in fact has been manipulated in any given experiment, some index of the representation must be available (Schmidt, 1991). With the variable having met this criterion, demonstration of enhanced memory for the distinctive (psychological) event then could be followed by a theoretical account proposing concepts to explain the effect, such as salience and attention. This strategy, however, will produce an incomplete account of memory phenomena because it ignores a significant aspect of encoding. There is no provision for explanation of the processes of perception and comprehension that produce the distinctive representation. If the term *distinctiveness* is used to label the processes of perception/comprehension, the distinctive representation is distinctive because it was processed distinctively, an unacceptably circular explanation.

The conundrum can be avoided by reserving the term *distinctiveness* to label abstract (theoretical) processes that are hypothesized to account for certain memory phenomena. That is, distinctive processing yields a kind of representation that, among other things, facilitates memory. In so doing, the meaning of distinctiveness has shifted importantly but subtly from that of an independent variable to an abstract concept that describes a type of processing. The abstract concept of distinctive processing theoretically applies to the operations of both encoding and retrieval, offering a general functional explanation of memory. As we shall see, good reasons exist for adopting this position and abandoning the use of *distinctiveness* in reference to independent variables.

Point 2: Salience Is Not Necessary

The term *distinctiveness* tends to be applied to events that are extremely different from the prevailing context, and in many cases these events are accompanied by a subjective experience such as surprise. Events that elicit such subjective experience often are described as salient. *Salience* refers to an event that is conspicuous; an event that invites further attention beyond its initial perception. Indeed, *salience* and *distinctiveness* sometimes are used interchangeably in psychological literature, a practice that has been encouraged by the isolation paradigm. An isolated item is conspicuous and almost always perceived as different from surrounding items, modeling circumstances outside of the laboratory of extreme violation of context. Consequently, it is understandable that subjective experience became a component of the explanation for enhanced memory of isolated items (Green, 1956). The conspicuous item is perceived as salient and arouses surprise, which draws attention and results in enhanced memory.

In fact, beginning with von Restorff's (1933) widely cited paper, evidence has accumulated against the assumption that salience is necessary for isolation effects. Contrary to most contemporary studies and inconsistent with many secondary accounts of von Restorff's procedure, she did not isolate the critical item in the middle or near the end of the list. Rather, the isolated item appeared at the beginning of the list where "the isolated item was not perceived as unusual and was not particularly salient to the subject" (p. 319). She did so because "we wanted to avoid the situation where the critical item would stand out as perceptually unique" (p. 319). Von Restorff obviously obtained the isolation effect with which her name has become synonymous but did so with a paradigm in which the isolate should not be perceived as salient. Her results have been replicated using the original procedure of isolating the critical item in the second serial position of the list (Hunt, 1995) as well in experiments placing the isolate in the first position in the list (Kelly & Nairne, 2001; Pillsbury & Rausch, 1943).

Dunlosky, Hunt, and Clark (2000) buttressed von Restorff's logical argument that early isolates are not salient by using judgments of learning as an independent index of salience. Current research on how judgments of learning are made suggests that perceived salience of an item inflates the judgment (e.g., Koriat, 1997). Dunlosky et al. presented participants with isolation lists in which the isolate occurred early in the list or halfway through the list. Following each item, the participants gave a judgment of how likely they were to remember the item. The critical results are shown in Figure 1.1 where one can see that judgments for isolates occurring late in the list were indeed inflated relative to proper controls, whereas judgments for early isolates did not differ from controls. The data are consistent with von Restorff's argument that the early isolate is not perceived as salient, but nonetheless the magnitude of the isolation effect on memory did not differ for early and late isolates.

To evaluate the possibility that the early isolate becomes salient as the list progresses, Dunlosky et al. conducted a second experiment in which the participants rehearsed the items aloud. If salience affects memory by recruiting attention to the item, then rehearsal, a prominent candidate for the additional processing in the isolation literature (Cooper & Pantle, 1967; Rundus, 1971), of the isolate should increase as the list unfolds. No such effect was found. Rehearsal of the early isolate did not differ from the pattern of rehearsal of control items. When the isolate occurred late in the list, it did receive reliably more rehearsal than its control item, indicating that rehearsal is sensitive to perceived salience. Importantly, however, the magnitude of the isolation effect was the same for early and late isolates. These data strongly suggest that neither salience nor the additional processing attracted by salience is necessary for the isolation effect in memory.

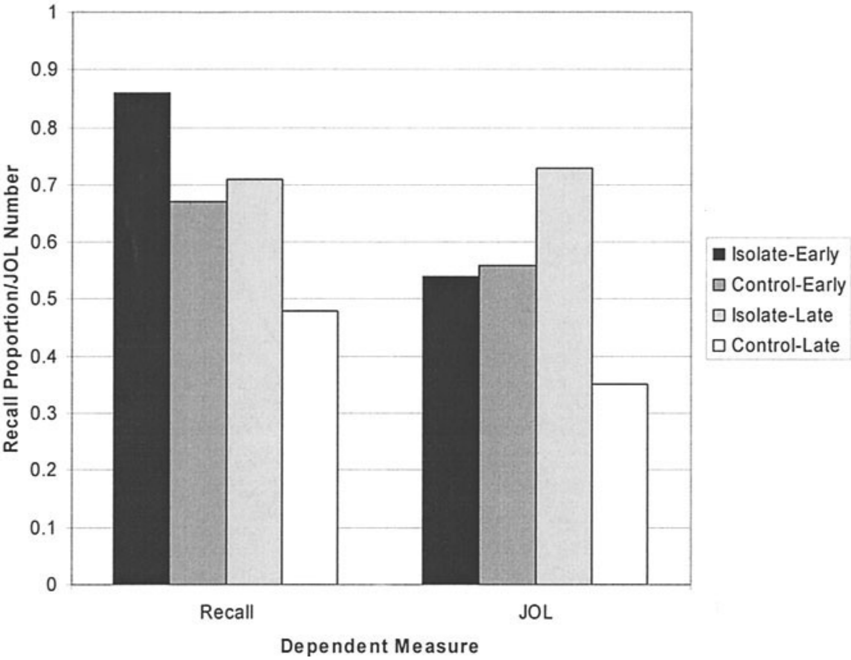

Figure 1.1 Proportion correctly recalled and average judgments of learning (scale of 100) as a function of early versus late list position and isolation versus control list (adapted from Dunlosky et al., 2000).

Given that the isolation effect is the prototypic preparation for studies of distinctiveness effects in memory, the data clearly indicate that salience is not necessary for distinctiveness to enhance memory. Disassociating salience and distinctiveness is important for clarification of the term *distinctiveness*. Because intuitions about distinctiveness are drawn from extreme violations of context and because much of our laboratory evidence is derived from the isolation paradigm that models this extreme incongruity, distinctiveness is assumed to cause surprise and salience, which in turn cause good memory. This theory not only is wrong about the necessity of salience but it also implicitly blurs an important distinction between *difference* and *distinctiveness*. These two terms cannot be used as synonyms in discussions of memory, as is illustrated by the third point.

Point 3: Difference Is Not Sufficient

Distinctiveness effects on memory require the processing of differences among items, but difference alone is not sufficient to describe distinctiveness effects. Again, the lesson begins with von Restorff. To make her point, she contrasted the standard isolation list with a heterogeneous control list in which each item is different. Suppose the isolation list consists of nine digits and one nonsense syllable. The difference between the syllable and the digits is substantial, but is it this difference that produces enhanced memory for the syllable relative to the control condition? Suppose we substitute a line drawing for one of the nine digits in the isolation list, giving us two isolated items and the eight digits. The drawing and the syllable are both different from the numbers, but they are also different from each other. We can continue to substitute items of different materials for the remaining digits, but the difference between the syllable (the original isolate) and the other items is just as great as the difference between the syllable and the digits. "In the end, the difference between all other items among themselves and the syllable is equivalent to the initial difference between the syllable and number" (von Restorff, 1933, p. 314). If the isolate were remembered better than the same item in the same serial position of an unrelated list, "then one could argue that other factors besides the difference between one item and other items is important" (von Restorff, p. 314). She, of course, did find that the item was better remembered in the isolation list than in the control list.

Research from the levels of processing tradition converges on the same point. In similar experiments, Epstein, Phillips, & Johnson (1975) and Begg (1978) asked subjects to perform orienting tasks on word pairs that were strongly or weakly associated, e.g., *dog-cat* versus *dog-beer*. The orienting tasks required listing either the similarities or the differences between the words. Subsequent recall of the related pairs was better following difference judgments, but recall of unrelated pairs was better following similarity judgment. The latter result indicates that difference alone is not particularly beneficial to memory, otherwise the unrelated words judged for differences would have yielded superior memory. Likewise, the fact that related pairs were better recalled when rated for difference than when rated for similarity indicates that similarity alone is not optimal for memory. Comparable data from recall of categorized lists were reported subsequently by Einstein and Hunt (1980) and Hunt and Einstein (1981).

Thus, research from both the isolation and levels of processing paradigms converge on the point that distinctiveness effects in memory cannot be captured by reference to difference alone. Differences among materials are an important setting operation for situations that have been described by the term *distinctiveness*, encouraging a strong connotation of difference when the term is used. However, the data suggest that the psychological processing underlying beneficial effects on memory that are described as distinctive involve more than the processing of difference.

Point 4: Distinctiveness Is Relative

The final point, that the term *distinctiveness* is relative, supervenes the preceding three points and consequently has been implicit in their discussion. The relativity of distinctiveness has long been emphasized by those who are serious about using distinctiveness as an explanatory concept rather than as an independent variable (Jacoby & Craik, 1979), and as obvious as the point may be, it is fundamentally important to discussion of what the term *distinctiveness* denotes.

With a paper by Lockhart et al. (1976), distinctiveness began to replace depth of processing as an explanation of differences in retention. In this paper, discriminability of memory traces was argued to be an important determinant of retention, and trace discriminability was the result of qualitative differences in processing. Highly discriminable traces were the result of distinctive processing. Jacoby and Craik (1979) suggested that the memory trace is a functional description of an item. The utility of a trace at retrieval depends on its descriptive contrast with other items. On this view, distinctiveness is inherently relative because a description is necessarily relative to a given context: "Distinctiveness requires change against some background of commonality" (p. 3).

That distinctive processing is relative to the context in which an item occurs is evident from numerous phenomena to which the term *distinctiveness* has been applied. The isolation effect describes better memory for an item in one context relative to memory for the same item in a different context. Orthographically distinctive words are better remembered than orthographically common words only if presented in mixed lists (Hunt & Elliot, 1980). The same holds for bizarre sentences under most circumstances (Einstein & McDaniel, 1987; McDaniel, Einstein, DeLosh, May, & Brady, 1995). Many other examples exist (Schmidt, 1991).

However obvious the relativity of distinctiveness may be, the implications for the use of the term in memory research are instructive. As Jacoby and Craik (1979) argue, relative concepts such as distinctiveness are used differently than are absolute terms such as *strength*. For example, the word *trumpet* is better remembered when embedded in a list of fruit names than when it occurs in a list of musical instruments. This result could be explained by saying that the representation of *trumpet* in the fruit list is "stronger" than is the representation of *trumpet* in the musical instrument list. In so doing, however, the term *strength* merely serves as a description of the data. Explanation of the memory phenomenon requires an answer to the obvious question of why "strength" should differ. One such explanation comes from the intuitive theory of distinctiveness where "strength" of the isolate is enhanced by additional processing attracted by the item's salience. As we have seen, however, the data have not been kind to the intuitive theory.

Alternatively, the relative concept of distinctiveness can be applied to situations in which the qualitative dimensions giving rise to distinctive processing have been described—dimensions including materials, the subject's intent, and the relationship between the study-test contexts. Description of these qualitative dimensions specifies the necessary relative context for distinctive processing. Applied to the preceding example, the dimensions along which *trumpet* in the isolation list is more distinguishable are specified easily, satisfying the criterion for the use of the term *distinctive processing*. When used in these circumstances, *distinctiveness* is a description of processes underlying performance and thus is an explanatory concept, not a term for describing the setting operations (independent variables) or the performance resulting from those operations.

Distinctiveness as a Theoretical Concept

The use of distinctiveness as an explanatory concept began with refinements to levels of processing, but the development of the concept benefited from a contrast between the literature on levels of processing and the literature on organization. Organization, a prominent topic in the transition from verbal learning to memory (Miller, 1956; Tulving, 1962), was conceived as a process of developing a common code for a set of discrete items. Organization thus places a premium on the relationships among items in explaining memory performance. The focus of levels of processing, in contrast, was on the individual item. Relational processing among the items was not in the purview of levels of processing: “It is now possible to entertain the hypothesis that optimal processing of individual words, qua words, is sufficient to support good recall” (Craik & Tulving, 1975, p. 270).

The gap between the literatures was bridged by a distinction between item-specific and relational processing, first drawn by Humphreys (1976). Relational processing captured the importance of organization in that it refers to the processing of dimensions common to all items within an event. The dimensions can range from semantic to fundamental spatial/temporal commonality. Item-specific processing refers to the processing of properties of individual items not shared by other items within the event. The combination of relational and item-specific processing should potentiate accurate memory because it specifies both the context defining an event and unique properties of a particular item within that event. This prediction was confirmed by research showing much higher levels of memory following combined relational and item-specific processing than following either type of processing alone (Einstein & Hunt, 1980; Hunt & Einstein, 1981). The precise specification (or *description,* to use Jacoby and Craik’s term) of an item provided by relational and item-specific processing seems capture the important discriminative function of distinctive processing (Hunt & McDaniel, 1993).

At a fundamental level, the organization and levels of processing literatures, as well as the relational/item-specific distinction, represent contrasting emphases on the importance of similarity and difference. Consequently, research on similarity judgment became important to the development of the concept of distinctive processing. Discoveries about difference judgments were especially informative. In particular, it is now clear that the production of differences depends on similarity. Markman and

Gentner, (1993) report that when participants were asked to produce differences between two items, the number of differences produced and the speed with which they were produced are positively related to the similarity of the items.

Importantly, the differences that were produced differed qualitatively as a function of the similarity of the items. What are the differences between *dog* and *cat*? What are the differences between *gasoline* and *tree*? In the case of related items such as *dog* and *cat*, the differences tend to be conceptually related to the dimension of similarity. For example, one might say that dogs bark and cats meow. These are differences along the dimension of sounds that animals make, and the combination of the dimension of similarity with the differences is highly diagnostic of particular items. Differences between unrelated items, such as *gasoline* and *tree,* are more difficult to produce because there is no obvious dimension of similarity. Thus, one might say that gasoline is a liquid and a tree is solid. This information has little diagnostic value with respect to the particular items because the stated differences correspond to a large number of possible items.

Extrapolating from research based on intentional judgment of similarity and difference, let us assume that the normal course of perception and comprehension involves the processing of similarity among items of an event. The dimension of similarity confers coherence to the event. We label these events at various grain sizes—for example, *lunch, vacation, last year*—but regardless of grain size, the constituent items share one or more dimensions of similarity. The dimensions of similarity do not, however, specify particular items. Precise specification of an item within an event requires processing of differences between that item and other elements of the event. In accord with research on difference judgments, processed differences are dependent on the dimension of processed similarity. The combined processing of similarity and difference yields a precise description of the item. I suggest that this is exactly what we mean by the term *distinctiveness*: the processing of difference in the context of similarity.

This view of distinctive processing follows the precedent established by levels of processing of treating memory as a by-product of perception and comprehension. The perceived dimensions of similarity and the processing of differences within those dimensions are determined by contextual constraints imposed by materials and intentions. At the time of retrieval, perception and comprehension of the memory query reinstate earlier processing. To realize the benefits of distinctive processing, the cue context must reinstate the processing of the original dimensions of similarity and the differences within those dimensions. The retrieval environment is an extremely important contextual consideration for understanding distinctiveness as defined here. In addition to the cues, the demands of the task will influence the probability of distinctive processing at test. The following three examples illustrate the application of the concept of distinctive processing.

The Cause of the Isolation Effect

We have reviewed evidence showing that the isolation effect cannot be explained as the result of differential attention drawn by salience of the isolate. What is the cause of the isolation effect? A plausible answer comes directly from the application of the concept of distinctive processing to the isolation paradigm. In the isolation list, all of the items save one are similar on some dimension. The similarity of the background items exerts two effects that influence memory for the isolation list itself. The first is the obvious effect of establishing a dimension of similarity within which the difference of the isolated items is processed—that is, the isolated item is processed distinctively. The second effect is that the processing of the background items is largely confined to similarity. The background items essentially are a categorized list, and we know that lists containing at least four items from the same category encourage the processing of similarity (Hunt & Seta, 1984). Without processing of differences among these items, distinctive processing does not occur for categorized lists.

The isolation effect is indexed by comparison of memory for the isolated item in the isolation list with the same item in a control list. Control lists can be of two types. A *homogenous* control is one in which the critical item from the isolation list shares categorical similarity with all of the other items in the list. A *heterogeneous* control is one in which there is no obvious similarity among the items. Applying the concept of distinctive processing to memory for the control lists, the critical item in the homogeneous control is not processed for difference, just as is the case for background items in the isolation list. In the heterogeneous control list, no dimension of similarity is available against which to process difference. Thus, distinctive processing does not occur for the items in either type of control list. On this analysis, the isolation effect is due to impoverished processing of the critical item in the control list relative to the isolation list.

According to this analysis, the isolation effect should be eliminated if the processing of control items is properly supplemented. Hunt and Lamb (2001) conducted a series of experiments comparing memory for isolation lists with homogeneous control lists. In the first experiment, subjects studied these lists either under intentional memory instructions or by performing an orienting task requiring a difference judgment between the current word and the previous word. If the failure to process differences hampers memory in the homogeneous control, the addition of the orienting task should remedy the problem and eliminate the isolation effect. The results were in accord with this prediction. Memory for the critical item did not differ in the control and isolation lists for the groups performing a difference orienting task. The groups receiving standard intentional memory instructions showed a typical isolation effect. Importantly, memory for the isolate following intentional memory instructions was comparable to that for the same item in both the isolation and control conditions following difference judgments. This latter finding is important because it suggests that the orienting task was redundant with spontaneous processing elicited by an isolation list.

A second experiment demonstrated that the results were not peculiar to the use of an orienting task under incidental memory instructions. In this experiment, subjects performed either the difference judgment task or a similarity judgment task that required judging the similarity of the current item and the previous item. The similarity judgment task should be redundant with the spontaneous processing of similarity engaged by the homogeneous control list, and thus the isolation effect should persist following similarity judgment. The results are shown in Figure 1.2. Performance on isolation and control lists following similarity judgments showed a standard isolation effect, but as in the first experiment, the difference judgment task eliminated the effect.

The isolation effect has become the prototypical distinctiveness effect in memory, yet as we have seen, the effect has resisted interpretation from the intuitive theory driven by salience and differential attention. The simple experiments reported by Hunt and Lamb (2001) were motivated by the assumption that distinctive processing is the processing of difference in the context of similarity. This concept of distinctive processing predicted the circumstances under which the isolation effect would and would not occur. The data were consistent with these predictions, lending credibility to the use of distinctive processing as a concept.

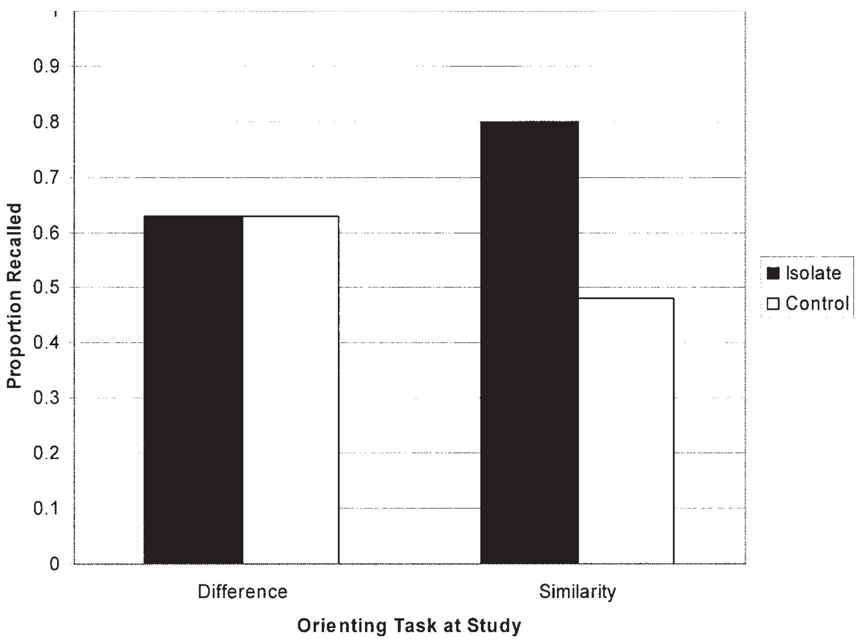

FIGURE 1.2 Proportion recalled as a function of orienting task at study and isolation versus control item from (adapted from Hunt & Lamb, 2001).

Retrieval

In accord with the principle of transfer-appropriate processing, distinctive processing exerts its effect only if the original processing is reinstated at the time of test. That processing is initiated by comprehension of the cue. When that cue corresponds directly to the dimension of distinctive processing, extremely impressive levels of recall ensue as first demonstrated by Mantyla's research (1986; Mantyla & Nilsson, 1988). For example, in one experiment (Mantyla, 1988), participants were asked to generate three attributes of each of 600 unrelated words at study. Subsequent recall cued by the self-generated attributes was 90% correct! Mantyla and Nilsson (1988) provided evidence that cue-target uniqueness was the principal contributor to this effect. Can these findings be explained by the concept of distinctive processing?

Hunt and Smith (1996) applied the concept of distinctive processing to the analysis of cue effects. In experiments inspired by Mantyla's research, subjects were asked to study categorized lists by providing either similarity or difference judgments. The lists were presented blocked by category, with five instances from each category. The orienting tasks required that the subject generate one thing about the first instance in the block that was similar to or different from the other four instances. The reasoning was that the categorical structure would encourage processing of similarity among the five items and that the difference judgment would occur in the context of this similarity. The result would be distinctive processing. The similarity-judgment task was assumed to be redundant with the processing encouraged by list structure and would produce poorer memory than the difference-judgment condition. Following study, subjects were asked to recall the single item from each category on which the judgment had been made. A cue was provided for each item consisting of either the subject's similarity or difference judgment or the similarity or difference judgments generated by another subject. Thus, the experiments allowed comparison not only of distinctive and nondistinctive processing but also of self versus other cued memory.

The results, shown in Figure 1.3, indicated that regardless of cue type, distinctive processing (difference judgment of categorized items) led to better performance than nondistinctive processing (similarity processing of categorized items). Self-generated difference cues produced much higher performance than did self-generated similarity cues; indeed, performance was near perfect with the difference cues. This result is consistent with the idea that subjects in the difference-judgment condition distinctively processed the items and that this processing was reinstated by the difference cues.

The effects of others' cues yielded an informative interaction between the type of study task and the type of cue. Someone else's difference cue led to relatively low levels of recall regardless of how the items were originally processed. The reason that someone else's distinctive cue is of little use for one's own memory lies in the original difference judgment. Very lit-

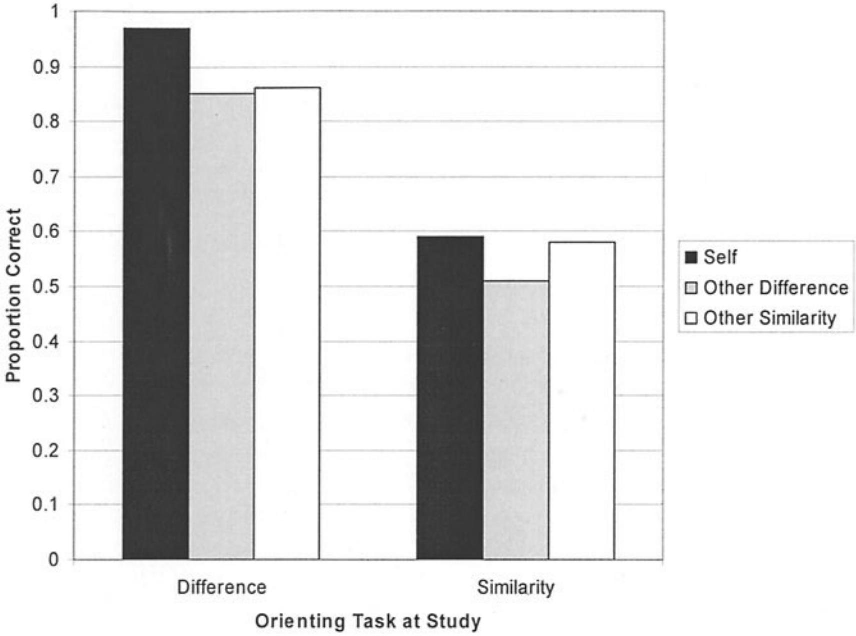

FIGURE 1.3 Proportion recalled as a function of orienting task at study and type of cue from (adapted from Hunt & Smith, 1996).

tle consensus existed on difference judgments across subjects; less than 15% of the judged differences were shared. Thus, perception and comprehension of particular differences can be quite idiosyncratic, and the cue corresponding to that judgment is incapable of reinstating the original processing even though the same cue supports near perfect memory for the person who produced it. On the other hand, the effect of someone else's similarity judgment as a cue depends on how one processes the original list. If one's original processing was through similarity judgment, someone else's similarity-judgment cues yielded levels of recall equivalent to that produced by one's own similarity judgment. This result is not mysterious because, unlike the difference judgments, the similarity judgments were highly consensual. Interestingly, when the original processing was the difference-judgment task, someone else's similarity cue produced the same high level of recall as did a self-generated difference cue. A subsequent study that required within-subject judgments of both similarity and difference showed that the subject's own similarity and difference cues were equally effective when they followed the difference judgment task at study.

Hunt and Smith's (1996) results follow directly from the assumptions in the concept of distinctive processing. The fact that difference judgments on categorized materials lead to better performance than similarity judgments can be understood as the beneficial effect of processing difference in the context of similarity. The advantage of a self-generated difference cue over a self-generated similarity cue is consistent with the expectation that the difference cue reinstated distinctive processing at the time of recall. Note that this effect is not adequately described by simply referring to the cue itself as distinctive because for each cue—similarity or difference—only one item had to be recalled and no cue had multiple target items.

The differential effect of other people's cues offers insight into what could be a rather puzzling situation. Distinctive processing followed by a self-generated difference cue produces very high levels of recall, but the perception of difference as reflected by the judgments is highly variable across people. Someone else's difference judgment does not work for one's own memory. Does this mean that the beneficial effects of distinctive processing are restricted to self-cued memory? The answer clearly is no because someone else's similarity cue produces high levels of memory when one's own original processing was distinctive. Distinctive processing involves both similarity and difference, and a cue corresponding either to the originally processed dimension of similarity or to a particular difference will be effective. Perception and labeling of similarity among familiar events is highly consensual, probably as a function of a shared social and linguistic development. You and I will comprehend the similarity among items defining events such as a lunch, faculty meeting, and wedding in the same way, and cues delineating the dimension of similarity reinstate any original distinctive processing. Through the use of these consensual cues, other people can offer cues that reengage one's own particular, idiosyncratic processing underlying highly accurate memory.

Memory Accuracy

Virtually all uses of the term *distinctiveness* refer to enhanced memory of a to-be-remembered item. Memory accuracy, however, requires not only accepting or producing correct items but also rejecting or withholding incorrect items. Distinctive processing as described thus far has nothing to say about correctly rejecting incorrect items. After all, incorrect items were not present in the targeted event and could not have been processed distinctively or otherwise. Nonetheless, there are two lines of research that have invoked distinctive processing as an important factor for correctly rejecting incorrect items; but the research presents a puzzle for the concept of distinctive processing in that the manipulations of distinctiveness that affect rejection of incorrect items have no effect on memory for correct items.

One of these lines stems from research on false memory using the Deese/Roediger/McDermott (DRM) paradigm. The paradigm entails presentation of a list of words that are all associated with a critical, nonpresented item. The result of interest is that the probability of remembering the nonpresented item is as high as that of the presented items. However, some variables associated with list presentation are now known to reduce false memory for the critical nonpresented item. Smith and Hunt (1998) discovered that visual presentation of the study list leads to fewer false responses to the critical item in both recognition and recall than does auditory presentation of the study list, a result now replicated several times (Cleary & Greene, 2002; Gallo, McDermott, Percer, & Roediger, 2001; Kellogg, 2001). This result was interpreted as an effect of distinctive processing. Smith and Hunt argued that visual processing is less like thought than is auditory processing, which allows better discrimination of studied and nonstudied items in the DRM paradigm. Schacter and his colleagues (e.g., Dodson & Schacter, 2002; Israel & Schacter, 1997) discovered that pictorial presentation of the study items in the DRM paradigm reduces false responses relative to auditory presentation. They proposed that distinctiveness could be used as a heuristic to avoid false responding. The idea is that all of the items of the original event share some property—for example, all studied items were pictures—and memory for items appearing on a recognition test can be examined for evidence of this property. In the absence of such evidence, the item will be rejected. Thus, in studies of false memory, distinctiveness has been invoked to describe the ability to correctly reject incorrect items, but unlike all of the previous discussion of distinctiveness in this chapter, the manipulation of distinctiveness had no effect on memory for correct items in any of these studies.

Similar results have emerged from research on the effects of distracter familiarity in recognition memory. Most laboratory studies of recognition use distracter items that appear only on the test, but we quite commonly are required to make recognition decisions about incorrect items that are highly familiar in the context of the test query. Suppose you sometimes, but not always, have chicken salad for lunch. When asked what you had for lunch two days ago, you might respond "chicken salad" because it is a familiar choice even if you had a hamburger that day. To model this situation, Dobbins, Kroll, Yonelinas, and Lieu (1998) asked subjects to perform an orienting task on a list of unrelated words. The subjects then were given a second list of unrelated words on which they also performed an orienting task. They also were told to remember this list for a later test. Some of the words in the first list were in the second list as well. The recognition test included words from the second list, words from the first list that were not in the second list, and novel distracters. Subjects were instructed to recognize only those words that had appeared in the second list. Distinctive processing was manipulated by requiring either the same orienting task on the two lists or different orienting tasks on the lists. The idea was that performing two different orienting tasks on the list would increase the discriminability of the lists.

Memory accuracy (hits–false alarms) was higher in the condition requiring two separate tasks on the list, but this effect was due entirely to differences in false alarms to familiar distracters. Performing separate tasks on the lists led to fewer errors on items that appeared only on the first list than did performing the same task on the two lists. Dobbins et al. (1998)

interpret their results through Jacoby's (1991) distinction between conscious and automatic processing, but the spirit of the interpretation is much the same as the distinctiveness heuristic. The assumption is that subjects performing two different tasks examine test items with the goal of detecting evidence from memory that the item was processed through the orienting task applied to the second list. In the absence of such evidence, the item is rejected. This strategy obviously would be totally ineffective for subjects performing the same orienting task on the two lists. As with the research on false memory, the manipulation of orienting tasks had no effect on hit rate. This raises the question of whether the term *distinctiveness* refers to the same thing when used to describe acceptance of correct items and rejection of incorrect items.

The concept of distinctive processing advocated here can be applied to both circumstances, but the application requires serious consideration of contextual influences, which in this case are the subtle differences in test demands for acceptance and for rejection. In all of the cited research using the term *distinctiveness* to describe effects of a variable on correct rejection of incorrect items, the correct items have been processed differently from the incorrect items. For example, in the Dobbins et al. (1998) study, *distinctive processing* refers to the use of two different orienting tasks on the two lists. The concept of distinctive processing describes this situation as the processing of differences between the two lists in the context of the similarity conferred by the spatial/temporal similarity of the experiment. The *lists* have been distinctively processed. Importantly, the conceptual analysis implies that distinctive *list* processing does not entail distinctive processing of *items within the list*. The orienting task applied to the target list may or may not encourage processing of differences among items within the context of the list.

Hunt (2003) used this conceptualization in a continuation of the research of Dobbins et al. (1998). The experiments were similar to those of Dobbins et al. in that two lists were presented with instructions to remember the second of the lists, and either the same or different orienting tasks were performed on the lists. However, two important modifications were made to the Dobbins et al. procedure. First, all items (target, pre-exposed distracters, and novel distracters) were drawn from the same set of categories. Second, the orienting tasks were selected to encourage processing of similarity or of difference among the items within a list. The similarity task required a judgment about category membership for each item and the difference tasks was pleasantness rating. These changes from Dobbins et al.'s procedure allowed examination of both list-based distinctive processing and item-based distinctive processing.

The pleasantness rating task should produce distinctive processing because within-list differences were processed in the context of categorical similarity. Thus, correct memory for the second list (hits) was predicted to be higher when the pleasant-rating task was performed on that list than when the category-judgment task was performed on the second list. The particular orienting task used on the second list should have no effect on false alarms to first-list items because the second-list orienting task does not discriminate between first- and second-list items. That discrimination would be controlled by list-based distinctive processing—namely, the use of different orienting tasks on the two lists regardless of which type of task is used on the target list. List-based distinctive processing should reduce incorrect acceptance of familiar distracters that were present in the first list but at the same time have no effect on correct acceptance of second-list target items.

The results are shown in Figure 1.4 as a function of conditions, which were defined by the particular combination of orienting tasks used on the two lists. The data were consistent with the predictions of distinctive processing. The hit rate—correct acceptance of second-list items—was determined solely by the orienting task performed on that list: pleasantness rating led to higher hit rates than category judgment. The false alarm rate to familiar distracters—incorrect acceptance of first-list items—was determined solely by whether the same or different orienting tasks were used on

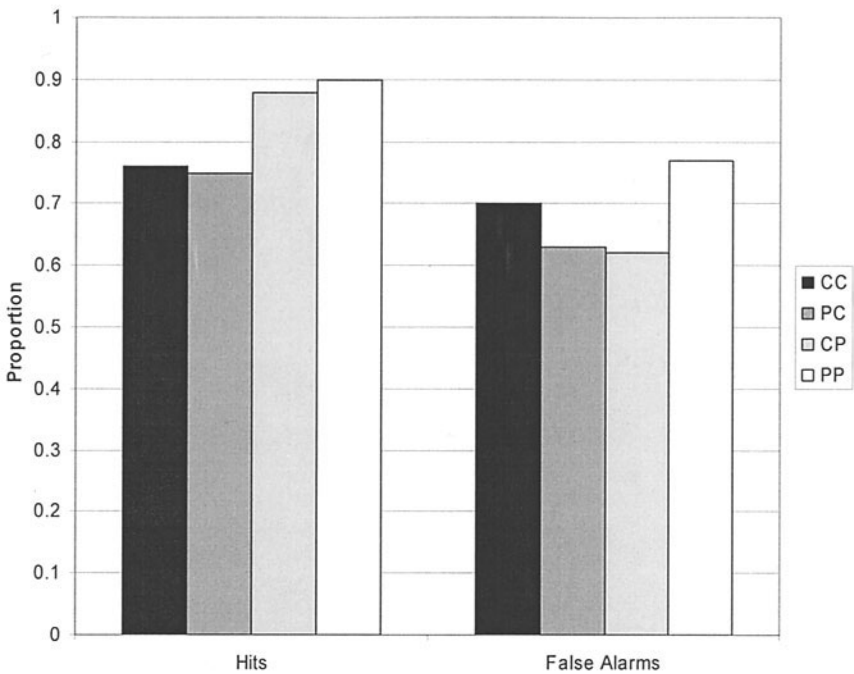

FIGURE 1.4 Proportion of hits and false alarms as a function of orienting task condition (adapted from Hunt, 2003). The conditions are labeled C = category judgment task and P = pleasantness rating task. The first letter is the task applied to list 1 and the second letter is the task applied to list 2. List 2 items were the targeted memory items.

the two lists. As was the case with Dobbins et al. (1998) and the cited research on false memory, the manipulation affecting false alarms had no effect on hits.

One might be tempted to interpret all of these data in terms of source monitoring by assuming that the distinctiveness manipulation reduces false alarms by facilitating correct attribution of the list source. But if this were true, would we not expect the same manipulation to affect hit rates? That is, if I can reject incorrect items because I have access to accurate source information, then I also should be able to accept correct items on the basis of that same source information. On the other hand, if performance is interpreted in terms of processing differences in the context of similarity, processing of differences between lists is not the same as processing differences among items within a list. The former affects false alarms to familiar distracters and the latter affects hits. But both are distinctive processing.

The analysis recommends a corollary distinction between event-based (list) and item-based (item within list) processing. Prior processing can facilitate the decision that an item was not a constituent of the cue-defined event without exerting an effect on the decision that an item was in the event. Like the concept of distinctive processing, the distinction between event-based and item-based processing is totally dependent on context, in this case largely defined by the cues. That is, I am not proposing that perception is parsed into events and items at encoding and stored for subsequent retrieval; after all, we rarely know what we will have to remember from a current experience. Rather, the cues for memory circumscribe some event in the form of a dimension of similarity shared by some set of particular items.

Thus, when applying the concept of distinctive processing, one must keep in mind that the target item and the event in which it is embedded are defined by the cues for memory. The grain size of events and targets can vary with the cue, as illustrated by the following examples:

- *What did you do yesterday?* In this case, the event is yesterday and the targets are anything you did yesterday.
- *What did you do at work yesterday?* Now the event is work yesterday and the targets are things you did at work. Notice that work yesterday could have been a target item for the query about what you did yesterday as well as serving as the event for the things done at work.
- *What did you have for lunch yesterday?* Lunch yesterday now becomes the event for the targeted items. Again, lunch yesterday could have been a target for either of the previous queries.

The point here is that conceptual analysis in terms of distinctive processing begins by identifying the targets and events defined by a particular cue. Then one determines the nature of the original processing for those elements. Distinctive processing will enhance memory accuracy for whatever information is targeted by the cue, but it appears that the effect on accuracy—correct acceptance of correct items versus correct rejection of incorrect items—differs for distinctive processing of cue-defined events and cue-defined items.

Conclusions

If *distinctiveness* is to be a useful term in memory research, we must attempt an answer to the question "What is distinctiveness?" Obtaining an answer requires analysis of the term by examining definitional and logical nuances as well as how the term is used by researchers. As Tulving (2000) points out, the "what" question is just as important as the "how" and "why" questions that dominate normal research activities. After all, the answer to the "what" question will shape the experiments and their interpretations. Most important, the conceptual analysis required to address the "what" question will add clarity and reduce needless disagreements in our discussions.

The analysis of distinctiveness offered here has yielded two very different meanings of the term in memory discourse. In one case, *distinctiveness* refers to a characteristic of an event. In common usage, the characteristic is attributed to an object in the environment, but analysis of the term indicates that careful application requires *distinctiveness* to refer to a characteristic of a psychological event. Thus the answer to the "what" question is that distinctiveness is a psychological representation that is notably different from other representations. This answer then dictates the approach to the questions "Why is memory affected by distinctiveness?" and "How is this effect accomplished?" On this meaning, *distinctiveness* essentially refers to an independent variable. The traditional explanation of the effect of the variable assumes that the distinctive representation attracts attention and extraordinary processing. Unfortunately, the data raise serious questions about this interpretation. Thus, continued use of the term with the connotation of an independent variable will be fruitful only if a more satisfactory explanation for its effect is forthcoming. In any event, this meaning of *distinctiveness* precludes the use of the term as an explanation for memory phenomena.

The second meaning of *distinctiveness* identified here is an explanatory concept. "What" distinctiveness is is the processing of difference in the context of similarity. Such processing facilitates memory because it precisely specifies items within events—the answer to the "why" question. "How" this happens is that similarity delineates the episodic context of the item and combines with diagnostic differences among items. As an abstract concept, distinctive processing can be applied as an explanation for a range of memory phenomena (Hunt & McDaniel, 1993). The utility of the concept rests with the success of these applications in increasing our understanding of extant issues. To the extent that this success is achieved, distinctive processing can be a valuable explanatory concept in memory research.

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2

Modeling Distinctiveness: Implications for General Memory Theory

James S. Nairne

The capacity to remember, to use the past in the service of the present, is a highly adaptive component of cognitive functioning. Although one need not reproduce the past, either consciously or unconsciously, in order to benefit from the service of memory, reproduction is clearly an important design feature (Anderson & Schooler, 2000; Nairne, 2005). Telephone numbers, street addresses, medication times, passwords—each needs to be recovered exactly, with the components in sequence, and inferential or reconstructive processing is unlikely to suffice.

To explain the specificity of retention, students of memory appeal often to the concept of distinctiveness, the focus of the present volume. Mnemonic distinctiveness can be defined in various ways—for example, as a property of a stored trace, a retrieval cue, or as a type of processing (see Hunt, Chapter 1 this volume; Schmidt, 1991). I define it here as the extent to which a particular cue (or set of cues) specifies a particular stored event (or target response) to the exclusion of others. Framed in this way, distinctiveness is not a fixed property of a cue, or a target trace, or even of an interaction between a given cue and a given target. It is a property of a cue in context: given a fixed set of alternatives, a measure of distinctiveness can be assigned to a particular cue with respect to a particular alternative. Change the context—for example, by changing how the cue is perceived or the range of possible responses—and the measure of distinctiveness changes as well.

To facilitate our discussion, and to add some formality to the preceding definition, I introduce a simple retrieval model below (borrowed from my feature model of immediate retention; Nairne, 1990a) and show how it helps account for some of the phenomena classically associated with the study of distinctiveness. For example, I show how the model informs us about the particulars of the von Restorff effect (Hunt, 1995;

von Restorff, 1933) and about the paradoxical effects of processing similarity and difference on episodic retrieval (Hunt & McDaniel, 1993). I then consider the role of time in the calculation of distinctiveness and contrast the retrieval model with certain extant models of temporal distinctiveness (e.g., Brown, Neath, & Chater, 2002; Neath, 1993). Finally, I end the chapter by discussing how the retrieval model forces us to reassess some widely held beliefs about memory, particularly the notion that memory is directly related to the match between an encoded cue and an encoded target.

A Simple Model

Directed retrieval reduces ultimately to a matter of response selection. There is a vast storehouse of information in the brain; the retrieval problem is to select appropriate content based on information available in the present. When we forget an item from a memory list, we are not really forgetting the item—-we are forgetting that it occurred in a particular space and time defined by the memory list; when we forget where we parked our car, we are not forgetting our car, we are forgetting the position our car occupied today as opposed to yesterday or the day before. Retrieval cues help us solve these kinds of discrimination problems. They provide us with the information we need to pick and choose from the wide variety of responses that are potentially available.

To formalize the response selection process, I adopt a simple retrieval, or choice, rule of the type often found in categorization and some memory models (e.g., Nosofsky, 1986; Nairne, 1990a, 2001). Under this formulation, an item is chosen for recall by comparing, or matching, the operative retrieval cue(s) to possible candidates in long-term memory (see also Raaijmakers & Shiffrin, 1980). The probability that any particular event, E_1, will be selected as the recall candidate depends on how well the retrieval cue, X_1, matches E_1 to the exclusion of other possible recall candidates (e.g., E_2, E_3, . . . ,E_N):

$$P_r\ (E_1|X_1) = \frac{s(X_1,E_1)}{\Sigma s(X_1,E_i)} \tag{1}$$

The quantity $s(X_1,E_1)$ refers to the similarity of X_1 to E_1, which in turn varies as a function of the number of matching or mismatching features between the two terms (a distance measure). Shepard (1987) recommends relating distance (d) to similarity in the following manner:

$$s(X_1, E_1) = e^{-d(X_1,E_1)} \tag{2}$$

This means that nearby items in psychological space (e.g., those that contain few mismatching features) will be deemed the most similar (and thereby produce the largest effects), and similarity will fall off rapidly with increasing distance.

Equations 1 and 2 are not meant to suffice as a complete model of memory. Among other things, one needs to specify how event traces are represented in memory, how probabilities translate into actual output (Nairne, 1990a; Raaijmakers & Shiffrin, 1980), and the similarity and distance measures need to be scaled appropriately as well (Nosofsky, 1986; Shepard, 1987). However, as I demonstrate below, this simple ratio model provides a nice conceptual framework for interpreting the empirical patterns of concern in the distinctiveness literature. Note that equation 1, which expresses the probability that a particular target event will be selected, doubles as our measure of distinctiveness. Distinctiveness is therefore a property of a cue, but only with respect to a particular retrieval candidate. By itself, the measure tells us nothing about whether the retrieval candidate is correct or incorrect, or good or bad from a mnemonic standpoint.

If the goal is to recover event E_1 in the presence of a particular cue X_1, then equation 1 isolates the factors that promote successful sampling. To maximize the probability of selecting E_1, it needs to be similar to the cue, X_1, and dissimilar to other possible retrieval candidates (E_2, E_3, . . . ,E_N). The numerator of equation 1 tells us that retrieval will depend importantly on the match between the retrieval cue and the target (Thomson & Tulving, 1970); the denominator quantifies cue overload, or the extent to which a cue is predictive of many things (Earhard, 1967; Watkins & Watkins, 1975). Successful recovery, put generally, will be proportional to the cue–target match and inversely proportional to the amount of cue overload. Note that because of the ratio form, neither the cue–target match nor the amount of cue overload, alone, will be sufficient to predict successful retention; successful recovery of a target will always depend on both. As I discuss later, this conclusion has a number of implications for general memory theory.

The von Restorff Effect

To illustrate how the retrieval rule works, I begin by applying it to the von Restorff effect—the so-called mother of all distinctiveness effects (Hunt & Lamb, 2001). The *von Restorff effect* (or isolation effect) refers to the memory enhancement that is found for events that differ, or deviate, from their context. In von Restorff's original experiments, participants recalled 10-item lists containing either 10 unrelated items (list 1), nine numbers and one nonsense syllable (list 2), or nine nonsense syllables and one number (list 3). The discrepant items were remembered best (e.g., the number in the list of syllables)—even better, in fact, than the unrelated items occupying similar list positions (e.g., items from list 1), or the "background" homogenous items (e.g., the syllables in list 3).

In experiments of this type, items become distinctive by virtue of their list context; that is, items are "isolated" only relative to particular backgrounds. To consider a specific case, if the number 43 was presented in each of the three von Restorff lists, we would expect its retention to be enhanced only in list 3, where it stands out from the other list items. For the effect to emerge, typically, the nonisolated (or background) items need to share some measure of similarity—that is, the detection of "difference" depends on a background of similarity (see Hunt, Chapter 1 this volume; Smith & Hunt, 2000). As I will discuss later, it is possible to reduce or eliminate the isolation advantage simply by asking people to focus their processing on how items differ from one another in a typical von Restorff list (Hunt & Lamb, 2001).

The isolation advantage also remains robust when the isolate occurs early in the list, even in the first serial position (Kelley & Nairne, 2001; Pillsbury & Rausch, 1943). This is an important finding because it suggests that the locus of the effect should be placed at retrieval. Encoding-centered accounts have been proposed over the years, and it seems reasonable to argue that isolates sometimes do capture more attentional resources (Schmidt, 1991), but encoding-centered accounts have difficulty explaining why the effect is found when the isolate occurs in the first or second serial position. At this point, no list context has been established, so there is no background of similarity against which the item can be considered unusual or especially salient. Instead, as embodied in the retrieval model, it makes more sense to assume that the isolate leads to the encoding of features that potentially help one discriminate its prior occurrence at retrieval, after all of the list items have been presented.[1]

To implement the model, it is necessary to make some assumptions about how items are represented in memory, about how similarity is calculated, and about the nature and generation of retrieval cues. Following Nairne (1990a), one can represent items as lists of features and distance derived by comparing features across each position. The number of mismatching features is summed and the total is then divided by the number of compared features. For example, suppose memory trace A is represented by a vector of five features, [C C 2 3 1], and memory trace B by a second vector, [C X 2 2 1]. A feature-by-feature comparison reveals two mismatching features—in positions 2 and 4. Dividing the number of mismatching features (2) by the number of compared features (5) gives us the distance measure (.40). This distance measure is then plugged into equation 2, yielding a similarity value of .67. (For further numerical examples, see Nairne, 1990, 2001.).

In the retrieval model, the critical similarity comparisons are between cues and viable retrieval candidates stored in long-term memory. Like most memory theorists, I assume that the immediate present is used to recover the past—that is, memories do not spontaneously appear, but rather are cue-driven (Tulving, 1983). In the feature model, which deals primarily with remembering over the short term, the operative retrieval cues are lingering records of the immediate past, which can be accessed directly (from primary memory) or recovered through context. When one is remembering over the longer term, a comparable process occurs: some version of the original encoding record is recovered via context and "interpreted" by sampling from a candidate set of possible responses. Equation 2 specifies how the recovery process proceeds: the record is compared to each possible item in the candidate set and, based on the relative similarity values, a candidate is selected for recall (see Nairne, 2001, 2002a).

A Numerical Example

Table 2.1 shows similarity and sampling probabilities for some hypothetical three-item lists. Encoded list items are represented by trace vectors of five features (e.g., a sequence of letters and digits). The first list, labeled "Control," is meant to contain three unrelated items, although, importantly, some measure of similarity is assumed (e.g., overlapping contextual features). The cue, shown to the left, is an intact version of the second list item; under normal conditions, this cue would presumably be a blurry or degraded record of the encoding, but it is presented intact here for the sake of simplicity. The last two columns show the similarity and sampling calculations based on the comparisons between this cue and each of the three list traces. Correct recall, given this cue, occurs when the second list item is sampled and successfully recovered (see Nairne, 1990a, for details).

The second list, labeled "Isolate," instantiates the isolation manipulation: A new nonoverlapping feature, *X*, is represented in the trace for item 2, replacing one of the shared contextual features (we might assume, for example, that the second list item was presented in a unique color or voice). In all other respects, items remain the same. Note that the similarity value between the cue and its long-term memory representation remains the same, 1.0, but the probability of sampling that target increases. This is the isola-

Table 2.1 Similarity Values and Sampling Probabilities Generated by the Retrieval Model for a Hypothetical Three-Item List

	Cue	*Traces*	*Similarity*	*Samp. Prob.*
Control	[C C 2 3 1]	[C C 1 2 3]	.55	.26
		[C C 2 3 1]	1.0	**.48**
		[C C 3 1 2]	.55	.26
Isolate	[C X 2 3 1]	[C C 1 2 3]	.45	.24
		[C X 2 3 1]	1.0	**.53**
		[C C 3 1 2]	.45	.24
Iso/Sim	[C C 2 3 1]	[B B B B 3]	.37	.21
		[C C 2 3 1]	1.0	**.58**
		[B B B B 2]	.37	.21

Note: All of the calculations are based on a cue vector representing the second item on the list. Sampling probabilties may not add to one because of rounding.

tion effect, and it is caused here by a reduction in cue overload: the correct target is more likely to be sampled because the cue is now less similar to other candidates. The addition of feature *X*, which is unique to the encoding of the second list item in this list context, reduces the number of matching features between the cue and the target's competitors.

The third list, labeled "Iso/Sim," shows what happens when the control item from the first list is presented against a background of highly similar items. This is the same target representation and cue as in the first list, and the cue–target match remains perfect, but the probability of correctly sampling the target increases substantially. Once again, what determines performance is the overlap between the features of the target item and those of the background items. As the similarity among the background items increases, their match with the operative retrieval cue decreases. Note, however, that it is not background similarity per se that mediates performance; what matters is the overlap between the cue and the nontarget competitors. If the similarity of the background items increases, but in a way that also increases their match with the retrieval cue, then performance would suffer rather than improve.

Of course, recovery of the isolated item in the model also depends on how well the cue matches the relevant target. The cue–target match is held constant in Table 2.1, but it easy to imagine isolation improving the functional cue–target match. For example, by definition an isolated item contains features that are unusual in that list context; consequently, those features, once encoded, are probably less susceptible to interference (i.e., overwriting) from subsequently presented items. This should help guarantee an intact cue at retrieval, one that better matches its representation in long-term memory. Moreover, when the isolated item occurs after the list context has been established, its appearance is surprising, which in turn could enrich the overall encoding (or hurt encoding in some circumstances—see Schmidt, Chapter 3 this volume). Richer or more elaborate encodings tend to be matched better by relevant retrieval cues and more protected from interference. In any given situation, it will be difficult to disentangle the relative contributions of the cue–target match and changes in the amount of cue overload; the presence or absence of unusual features is likely to affect both.

Background Recall

It is also of interest to consider how the presence of an isolated item affects recall of the nonisolated (background) items in the list. In principle, one can conceive of the isolate acting in several ways: enhancing recall of the isolate itself, reducing memory for the background items, or leading to both outcomes. The literature is somewhat equivocal in regard to background recall; sometimes the presence of an isolate hurts the retention of the other list items (e.g., Schmidt, 2002; Schulz, 1971), sometimes recall of those items improves (Farrell & Lewandowsky, 2003), and often there is no effect (e.g., Kelley & Nairne, 2001).

Theoretically, it is easy to justify any of these outcomes. From an organizational perspective, some theorists have argued that the isolate promotes the formation of two list-based categories, one containing the isolated item and a second category comprising the background items (Bruce & Gaines, 1976; Fabiani & Donchin, 1995). Because it is easier to recall items from smaller categories, better memory is expected for both the isolate and the background items. Alternatively, if the isolate captures more attentional resources, or is more likely to be rehearsed, then recall of the background items should suffer because they receive a smaller proportion of the allocated resources. One could argue as well that isolated items, because of their superior mnemonic value, will tend to be recalled early during output, rendering the remaining items subject to more output interference (e.g., Cunningham, Marmie, & Healy, 1998; Schmidt, 1985).

The retrieval model makes no explicit assumptions about encoding, organizational processing, or selective rehearsal; it merely assumes that the recall of an item (isolate or background) will depend on the cue, its match to the relevant target, and the composition of the competitor set. Table 2.2 shows the similarity and sampling values for a background item in our three hypothetical lists. In this case, the cue is for the first list item instead of the isolate, and the correct response is to sample the first of the three list vectors. (Identical values hold for the third item.) Note that the sampling probabilities for this background item change across the three conditions.

Of initial interest is the comparison between lists with and without an isolate. The probability of correctly sampling the first list item in the Control condition is .48 compared to .50 in the Isolate condition. This slight increase, which is predicted by a grouping or organizational account, is caused here by a net decrease in the amount of cue overload (the overall

TABLE 2.2 Similarity Values and Sampling Probabilities for the Background Items in a Hypothetical Three-Item List

	Cue	*Traces*	*Similarity*	*Samp. Prob.*
Control	[C C 1 2 3]	[C C 1 2 3]	1.0	**.48**
		[C C 2 3 1]	.55	.26
		[C C 3 1 2]	.55	.26
Isolate	[C C 1 2 3]	[C C 1 2 3]	1.0	**.50**
		[C X 2 3 1]	.45	.23
		[C C 3 1 2]	.55	.28
Iso/Sim	[B B B B 3]	[B B B B 3]	1.0	**.46**
		[C C 2 3 1]	.37	.17
		[B B B B 2]	.82	.37

Note: All of the calculations are based on a cue vector representing the first item on the list. Sampling probabilities may not add to one because of rounding.

value of the denominator in equation 1 goes down). Because there are fewer overlapping features between the isolate and everything else, the isolate is less likely to be sampled when cued by traces left by any of the other list items. Interestingly, the presence of an isolate actually increases the distinctiveness of the remaining items on the list. The effect is small because the decrease in the denominator is caused only by the comparison between the cue and the isolate; with longer lists, this contribution is less important—-it is proportionally smaller—which may help explain why a null effect of the isolate on background recall is often reported.

The same reasoning applies to the third condition, Iso/Sim, although background recall is low relative to the other two conditions. Cues for the background items are less distinctive in this condition because the members of the competitor set (with the exception of the isolate) share lots of features. Despite the low sampling probability, however, background performance is not actually hurt by the presence of the isolated item; in fact, for the same reasons discussed in the preceding paragraph, having an isolate in the list improves the sampling probabilities for background items, at least relative to a list containing all similar items. From the model's perspective, any manipulation that decreases the overlap among traces will increase the likelihood of correct cue–target sampling (assuming the cue–target match remains constant). Consequently, whether background items will show a benefit, no effect, or a loss will depend on the control condition and on other factors such as the length of the lists employed.

Processing Effects

As noted, in its simplest form the retrieval model makes no assumptions about encoding or processing. The isolation effect, as well as background recall, is determined solely by the state of cues, targets, and competitors at the point of recall. However, any encoding manipulation that affects trace composition is likely to influence performance. As discussed earlier, when an isolate occurs late in a list, its surprise value could easily lead to additional processing (or more rehearsal), which in turn could produce a more elaborate memory trace. Moreover, any orienting task that causes participants to focus on common or unique features across to-be-remembered items should have significant effects on performance as well.

In one relevant study, Hunt and Lamb (2001) examined how various orienting tasks affect the isolation advantage. Participants were given lists containing either 10 related items (e.g., a list of vegetables) or 9 related items and 1 item from a different category (e.g., a tool). The standard isolation advantage was produced across the lists—that is, the tool in the list of vegetables was remembered best. Of main interest, however, were several orienting tasks that induced participants to compare item characteristics during presentation. In one condition, participants were asked to state how each item differed from the one immediately preceding it in the list;

in another condition, judgments of similarity were required. Once again, these judgments were made on lists either containing an isolate or not.

Two major findings emerged. First, when participants were asked to focus on item differences, the isolation effect was eliminated; second, when the orienting task was similarity-based, a robust isolation effect occurred. If we assume that the "difference-based" orienting task created list traces with little or no feature overlap, then the results follow nicely from the retrieval model. If traces already contain few, if any, matching features, then inserting an isolate—that is, an item with little or no matching features—should not enhance retention compared to a control. On the other hand, if the orienting task substantially increases the amount of feature overlap, by focusing attention on item similarities, then the isolate should be remembered especially well. It is interesting to note that recall of the background items followed the pattern predicted by the model as well. Difference processing led to a significant increase in background recall compared to the condition requiring similarity processing. Again, difference processing reduces the amount of feature overlap, and therefore the amount of cue overload, for both isolates and background items.

Other empirical patterns in the isolation-effect literature can be explained by reasoning of this sort. For example, it has been reported that the isolation effect is sometimes reduced or eliminated when participants report using elaborative rehearsal strategies during study (see Fabiani & Donchin, 1995). To the extent that elaborative processing leads to richer traces, ones that contain unique individual item information, then the isolation advantage should be reduced for the reasons discussed above. However, the predicted pattern will depend on the type of elaborative processing engaged. If participants relate items together, such as linking them into a cohesive story, then a very different pattern might well emerge. If the net result is an increase in feature overlap, because the processing emphasis has been placed on similarity rather than difference, the isolation advantage could increase.

The Paradox of Similarity and Difference

Our discussion up to this point has centered on the importance of difference. For a given retrieval cue, sampling probabilities are inversely proportional to the amount of cue overload; consequently, manipulations that reduce feature overlap will increase the chances of correct target sampling. However, analysts of memory have known for decades that memory often benefits from the processing of similarities as well. For example, items from categorized lists are usually recalled better than items from unrelated lists (Tulving & Pearlstone, 1966); for unrelated word lists, relational processing, or the processing of commonalities among list items, can benefit recall substantially (e.g., Hunt & Einstein, 1981).