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C H A P T E R   O N E

Memory as Something
That Can Be Counted
Versus Memory as Something
That Can Be Counted On

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The study of everyday memory has come a long way since Neisser's provocative address at the first Practical Aspects of Memory (PAM) conference, as the volume and scope of the research presented at the third PAM conference dearly indicates. In what way, however, does this research really differ from the traditional, laboratory-based study of memory? Although the everyday-laboratory controversy has often been quite spirited *(American Psychologist,* January 1991), it is not completely clear what the commotion is all about (Tulving, 1991). Our reading of the various commentaries identified three distinct dimensions around which the controversy has generally revolved: *what* memory phenomena should be studied, *how* they should be studied, and *where.*

Concern with the "what" issue is reflected, for example, in the title of Neisser's (1978) leading paper, "Memory: What are the important questions." Thus, everyday memory research is often characterized in terms of its content the focus on topics having "obvious relevance to daily life" (Klatzky, 1991). This concern is also implicit in discussions emphasizing the practical applications of everyday memory research (Gruneberg & Morris, 1992).

The "how" issue concerns the proper research methodology: Whereas proponents of the naturalistic study of memory have questioned the ecological validity of much laboratory experimentation (Conway, 1991), laboratory proponents have stressed the importance of experimental control and generalizability of results, which presumably can be better achieved under laboratory conditions (Banaji & Crowder, 1989).

The "where" or context-of-inquiry issue concerns the importance of studying memory in its natural contexts rather than under more artificial, laboratory conditions. Thus, many researchers have stressed the social-functional context of everyday memory (e.g., Bruce, 1989; Neisser, 1978, 1988a, 1991), pointing to Findings in which "the real-life nature of the experience made a considerable difference to memory processing" (Gruneberg, Morris, & Sykes, 1991, p. 74; see also Ceci & Bronfenbrenner, 1991).

Importantly, although the three issues are correlated in the reality of memory research, they are not necessarily interdependent. What, then, might be their common denominator? A careful examination of the everyday memory literature reveals what seems to be a common theme, a particular way of thinking about memory—a different memory metaphor than that underlying the traditional study of memory. We suggest that this metaphor can account for some of the apparent correlation between the "what," "where," and "how" aspects in terms of a more fundamental distinction. It can also provide the metatheoretical foundation for distinguishing two essentially different approaches to memory assessment. In this chapter, we summarize the work we have done that attempts to delineate the two alternative metaphors, and that examines their implications for memory assessment and for the everyday-laboratory controversy (see Koriat & Goldsmith, 1994, in press-a, in press-b).

THE STOREHOUSE METAPHOR IN TRADITIONAL MEMORY RESEARCH

Clearly, conceptual metaphors have had a pervasive influence on the study of memory (see Roediger, 1980). Prominent among these is the *storehouse metaphor,* which has dominated traditional memory research: "The conception of the mind as a mental space in which memories are stored and then retrieved by a search process has served as a general and powerful explanation of the phenomena of human memory. There is currently no other general conception of the mind or memory that rivals this view" (Roediger, 1980, p. 238). How is memory treated under this conception?

1. Memory is conceived as a storage place. Indeed, the list-learning paradigm, perhaps the hallmark of laboratory memory research (Neisser, 1991), essentially simulates the initial depositing and subsequent re trieval of memory items.
2. The contents of memory are assumed to consist of discrete, elementary units whose essential characteristic is their countability, allowing memory to be assessed in terms of the number of recovered elements.

3. Memory is assessed in an input-bound manner One begins with the input and asks how much of it was recovered in the output. This implies a definition of forgetting in terms of item loss, that is, the proportion of input items that cannot be recollected.
4. The memory items are assumed to be interchangeable, that is, equivalent as far as memory performance is concerned. It makes no difference, for instance, whether *hat* was remembered and *gun* was forgotten, or vice versa. What matters is not what is remembered, but rather how much.

The storehouse conception, then, has engendered a *quantity-oriented* approach to memory (Schacter, 1989). This approach is reflected not only in the traditional experimental paradigms (e.g., list learning, paired associates), but also in the type of phenomena investigated (e.g., serial position, retention interval), and in the memory measures employed (e.g., percent recall, percent recognition). Thus, although perhaps no investigator today would explicitly subscribe to the strict storehouse conception, much memory research is still conducted as if we did.

THE CORRESPONDENCE METAPHOR IN EVERYDAY MEMORY RESEARCH

Despite the productive role of the storehouse metaphor in guiding the study of memory, its shortcomings become readily apparent when considering many everyday memory situations. For instance, a courtroom witness may be asked to report what she can regarding the circumstances of a crime (Loftus, 1979), or a person may try to recount either an ordinary or a momentous, personally experienced event (Rubin, 1986; Winograd & Neisser, 1992). Such situations motivate a different way of thinking about memory, one where the basic criterion is not the quantity of items remaining in store, but rather the correspondence between what the person reports and what actually happened (see Ross, in press; Winograd, 1994). Indeed, many of the research reports and discussions appearing under the banner of everyday memory disclose a keen preoccupation with the reliability, accuracy, or faithfulness of memory that has no parallel in the traditional, quantity-oriented approach to memory. In order to capture the essential features of this alternative conception, we have explicated a *correspondence metaphor* of memory (Koriat & Goldsmith, 1994, in press-a) in terms of the following interrelated attributes:

1. Aboutness: Memory is considered to be *about* past events and states of affairs (Conway, 1991). Thus, memory reports are treated as descriptions,

consisting of prepositional statements that have truth value, rather than as mere collections of recovered items.

2. Focus on accuracy: Interest lies primarily in the extent to which the memory report is reliable, trustworthy, or accurate, that is, the extent to which it accords with reality (or some other criterion; see Ross, in press). In a sense, the correspondence metaphor implies an evaluation of memory in terms of its goodness of fit with what actually happened (see later discussion).

3. Forgetting, then, is conceived as a loss of correspondence between the memory report and the actual event, that is, as a deviation from veridicality, rather than as a simple loss of items. Thus, in addition to a concern with information loss, this view (following Harriett, 1932) leads to a focus on the many different types of qualitative memory distortions—simplification, fabrication, confabulation, and the like.

4. Content Unlike in the quantity-oriented approach, in which interest focuses on *bow much* is remembered, in the correspondence-oriented approach (and virtually all real-life memory situations) it may matter a great deal *what* is remembered and misremembered (Conway, 199D. In the courtroom, for instance, it might make a crucial difference whether the witness remembered that the assailant "carried a gun," but forgot that he "wore a hat," rather than vice versa.

5. Output-boundedness: The assessment of memory correspondence is inherently output bound. Unlike the storehouse approach, which leads one to begin with the input and ask how much of it is represented in the output, in a correspondence view of memory it is more natural to start with the output (e.g., an eyewitness report) and examine to what extent it accords with the input (e.g., a witnessed event). In general, accuracy can be measured only for what a person reports, not for what is omitted. Thus, whereas under the storehouse view subjects are held accountable primarily for what they fail to report, under the correspondence view subjects are accountable primarily for what they do report.

6. Memory as the perception of the past: The correspondence view of memory has much in common with the way we think about perception. In perception we are not concerned with how much of the impinging information is perceived, but rather, with the (output-bound) correspondence between what is perceived and what is out there. Similarly, memory may be conceived as the perception of past events, and the question then becomes to what extent is this perception dependable (cf. "memory psychophysics," Algom, 1992).

Collectively, these ingredients of the correspondence metaphor characterize an *accuracy-oriented* approach to memory. This way of treating memory is clearly seen in many areas of everyday memory, particularly in psy-

cholegal and autobiographical memory research, in which the study of memory accuracy and distortion is given a high priority (see, e.g., Brewer, 1988; Loftus, 1979; Neisser, 1988a; Ross, in press; Winograd & Neisser, 1992). This treatment appears to derive from the function of memory in everyday life (Baddeley, 1988), where what is remembered is certainly no less important than how much, and where memory is naturally seen to afford a meaningful representation of past events and states (Conway, 1991). Hence, the dependability of memory, the extent to which it can be trusted for current actions and decisions, becomes primary. Furthermore, the correspondence metaphor seems better suited than the storehouse metaphor to capture the complexity of real life. Because real-life experiences generally consist of richly structured, meaningful scenes and events (Neisser, 1988b), memory for such experiences are subject to wholistic and relational changes that cannot be captured solely in terms of the loss of "items." Hence, one can understand the special interest in memory errors, particularly in the qualitative changes that occur over time (Bartlett, 1932). Such changes often reflect social, motivational, and functional biases that have become of special interest to everyday memory researchers (e.g., Loftus, 1982; Neisser, 1981, 1988a; Ross, 1989; Ross & Buehler, 1994).

In a word, then, whereas the storehouse metaphor treats memory as something that can be counted, the correspondence metaphor treats memory as something that can be counted on.

CORRESPONDENCE-ORIENTED MEMORY ASSESSMENT

Surprisingly, although many discussions of everyday memory phenomena imply a departure from the storehouse conception toward a correspondence view, the reality and potential impact of this metatheoretical shift have not been fully acknowledged, particularly with regard to memory assessment. In fact, it is not commonly realized that the correspondence view implies a very different approach to the evaluation of memory than the traditional, quantity-oriented approach. In this section we examine several different types of assessment procedures in an attempt to explicate further the correspondence metaphor and bring to the fore some of the distinctive features of correspondence-oriented memory assessment.

Let us first consider the *wholistic* approach to memory assessment, which attempts to measure the overall "goodness of fit" between the memory report and the stimulus information. What does the development of such a measure entail? As an illustrative example, consider Waterman and Gordon's (1984) attempt to measure the correspondence between a studied map and a remembered map. They had subjects draw the map of Israel from memory. The correspondence of each reproduction to the actual map was measured

with respect to eight clearly identifiable geographic points, by first applying transformations to neutralize differences in rotation, translation, and scale, and then computing an overall "distortion index" in terms of the squared distances between corresponding points on the output map and the criterion map.

Clearly, this type of memory assessment is very different from the kind of storehouse-based "counting" procedures mentioned earlier, most prominently in its attempt to evaluate the overall correspondence between the memory report and the target stimulus. Such an evaluation must always specify which features of possible correspondence are relevant (e.g., relative distances) and which are to be ignored (e.g., scale and orientation). Also, in some cases the completeness of the report (e.g., extent of mapped area, number of landmarks) may be important, and the correspondence measure will need to be adapted to take this aspect into account (e.g., Hart, 1981), whereas in other cases the experimenter may be concerned only in evaluating the accuracy of the information contained in the output without regard to its completeness (e.g., the eight geographic points used by Waterman and Gordon were those that appeared in all of the subjects' maps). Thus, a major problem in applying wholistic correspondence measures is that the proper assessment criteria are neither standard nor readily apparent.

This problem becomes even more acute in evaluating the faithfulness of verbal reconstructions of real-life events. Such events can submit to a multitude of different descriptions, each of which may be "accurate" in some sense (Neisser, 1981, 1988b; Spence, 1982), or at some level of resolution or "grain" (Neisser, 1988a; Yaniv & Foster, 1990). Thus, in order to specify the relevant dimensions of correspondence or miscorrespondence, how they are to be measured and integrated, and at what level of resolution, the assessment model must incorporate functional assumptions regarding both the reasons for remembering and the particular circumstances of the memory report. In sum, unlike traditional quantity-based memory measures (e.g., percent correct on a recall task), which have been designed as all-purpose tools, measures of overall memory faithfulness may need to be domain specific, function specific, and theory specific.

Perhaps for this reason, wholistic assessment models are relatively rare in the literature, and have generally been confined to the domain of mental maps and spatial memory (although some efforts have been directed toward event memory as well; Neisser & Harsch, 1992). One option that circumvents the need for an assessment model is to rely on subjective global accuracy ratings. Indeed, a clever variation on this idea has been used to assess the faithfulness of memory for faces in terms of the proportion of correct target recognitions that could be achieved by independent judges on the basis of the subjects' memory reports alone (see Wells & Turtle, 1988).

A more common approach is to focus on a single attribute of (mis)correspondence, typically a continuous or ordered dimension (e.g., height, angle,

speed, time). Thus, for example, a wealth of research on memory for visual form and spatial information has disclosed systematic memory biases for such attributes as closure and symmetry, orientation, angular and radial deviation, and so on (e.g., Goldmeier, 1982; Tversky & Schiano, 1989). In a similar vein, studies on the "psychophysics of memory" (see Algom, 1992, for a review) have examined how memory scale values map onto their physical referents, comparing the obtained functions to those found for perception of the same stimuli. Dimensional accuracy has been investigated for many other types of attributes as well, ranging from the date and time of past events (e.g., Baddeley, Lewis, & Ninno-Smith, 1978; Huttenlocher, Hedges, & Bradburn, 1990) to the subjects' own SAT scores (Bahrick, Hall, & Dunlosky, 1993).

It is important to note that dimensional accuracy assessment is actually quite foreign to the storehouse metaphor, and implies a correspondence metaphor instead. Unlike storehouse-inspired quantity measures that are typically based on the counting of dichotomously scored items, correspondence-based measures may be more graded in nature, tapping different degrees of deviation from veridicality.

QUANTITY VERSUS ACCURACY IN ITEM-BASED MEMORY ASSESSMENT

Despite their suitability for capturing many intrinsic aspects of memory correspondence, neither the wholistic nor the dimensional approaches just discussed yields a simple, all-purpose memory measure. Thus, most researchers interested in evaluating memory accuracy have opted to stay with the more traditional, item-based approach, segmenting both the input and the output into a set of discrete items or propositions. Typically, the reported answers are dichotomously scored as right or wrong (true or false), and are given equal weight in calculating the overall memory score. This approach allows memory accuracy to be measured using the same basic type of procedure traditionally used to measure memory quantity, but for this very reason, the differences between the two types of measures become dangerously subtle, and may in fact lead to apparent incongruities between empirical findings (see Koriat & Goldsmith, 1994, in press-a, in press-b).

To illustrate, consider an experiment reported by Neisser (1988a), examining memory for real-life events that took place during the course of a seminar that he taught. Memory was assessed using either a cued recall or a multiple-choice recognition procedure. Neisser found recall memory to be much more accurate than recognition memory, and pointed out that such a finding might come as a surprise to traditional memory researchers, who are accustomed to the general superiority of recognition memory found in laboratory studies.

Neisser's finding brings to the fore some of the potential sources of confusion in the interpretation of empirical results that cut across the everyday

and laboratory research contexts. On the one hand, this finding may reflect the effects of *research context,* supporting the claim that memory behaves differently in real-life than in laboratory settings. On the other hand, however, it may also implicate the concern with two different *memory properties,* accuracy versus quantity: In Neisser's study, as in many naturalistic studies, the focus is on memory accuracy, in contrast to traditional memory research, which has focused almost invariably on memory quantity. Thus, Neisser's recall subjects were more accurate than the recognition subjects in the sense that what they reported was almost never wrong but, as Neisser also pointed out, they did not provide much information either. Neisser's finding could therefore reflect an interaction between memory property and *test format* (recall vs. recognition) that would be obtained, perhaps, regardless of the research context: Recognition yields better quantity performance than recall testing, but recall yields better accuracy. This hypothesized pattern (which we have called the "recall-recognition paradox"; Koriat & Goldsmith, 1994) is consistent with the established wisdom in eyewitness research, that directed-testing procedures such as recognition testing can have contaminating effects on memory (see, e.g., Boon & Davies, 1988; Hilgard & Loftus, 1979; Lipton, 1977; Loftus, 1979, 1982), and therefore that free-narrative modes of interrogation are preferable to directed-questioning modes in eliciting reliable—although less complete—information (see Hilgard & Loftus, 1979; Neisser, 1988a).

A further complication, however, stems from the common confounding between test format and *report option,* free versus forced reporting. This confounding is evident in the reality of both naturalistic and laboratory research: In naturalistic contexts, for instance, free-narrative reporting not only guards against "leading" or contaminating information (a test-format variable), it also allows the witness the freedom to choose what information to report, and at what level of generality. Directed questioning, on the other hand, often involves explicit or implicit demands that an answer be provided. Similarly, traditional item-based laboratory research almost invariably implements recognition testing as forced recognition in two distinct respects: Not only are subjects confined to the alternatives presented (test format), they are also forced to answer each and every item (report option). In contrast, recall testing typically allows subjects the freedom to decide both how and whether to report what they remember.

Report option is an important factor to consider not only because of its common confounding with test format, but also—and more important—because of its crucial role in the operational distinction between accuracy-based and quantity-based memory measures within the item-based framework. To clarify this point, let us first examine how these two types of measures are defined: As a measure of memory correspondence, accuracy is inherently output bound, reflecting the likelihood that each reported item of information

is correct. Thus, it translates into the percentage of reported answers that are correct. Quantity-based measures, in contrast, are input bound, reflecting the likelihood that each input (stimulus) item is reproduced in the output. This, of course, translates into the percentage of studied items correctly reproduced. Thus, whereas the output-bound accuracy-based measures evaluate the dependability of the memory report, the input-bound quantity-based measures reflect the amount of input information recovered.

Despite their different definitions, however, the accuracy and quantity measures can be distinguished operationally only when subjects are given the option of free report. When a forced-report test is used, the input-bound quantity and the output-bound accuracy percentages are necessarily equivalent. For instance, if a subject answers correctly 60 out of 100 questions, we may conclude either that the likelihood that each item is remembered is .60 (quantity), or that the likelihood that each reported item is correct is .60 (accuracy). The difference between the two measures is entirely a matter of intention—whether the experimenter intends to measure quantity or accuracy. In contrast, assume that the same test is administered under free-report conditions, and that the subject feels confident enough to provide answers to 80 items, 60 of which turn out to be correct. In this case, the quantity score would again be .60 (60/100), but the accuracy score would now be .75 (60/80). Clearly, then, differences in report option can complicate the interpretation of empirical findings.

Overall, the preceding discussion implicates potential confusions between four basic factors: memory property, report option, test format, and context of inquiry. We conducted several experiments designed to disentangle these factors, and to demonstrate the utility of the distinction between the accuracy-oriented and quantity-oriented approaches to memory. In one experiment (Koriat & Goldsmith, 1994, Experiment 1), we had subjects answer 60 general-knowledge questions in a recall or a multiple-choice recognition format (all items required a one-word answer in order to equate the "grain" of the answers across the two test formats). In addition to the standard tests of free recall and forced-choice recognition, however, two relatively uncommon procedures were added: forced recall (requiring subjects to respond to all questions), and free recognition (permitting subjects to skip items). In this design, then, test format and report option were orthogonally manipulated. A payoff schedule provided all subjects with a common performance incentive, essentially rewarding them for each correct answer, but penalizing them by an equal amount for each incorrect answer. Performance was scored for both quantity (input-bound percent correct) and accuracy (output-bound percent correct). The results are presented in Table 1.1.

When comparing the standard memory measures, free recall and forced recognition, our results replicated the recall—recognition paradox: Recall was superior to recognition on the accuracy measure *(e* vs. *b),* but recognition

TABLE 1.1.
Memory Quantity and Memory Accuracy as
a Function of Test Format and Report
Option

	Quantity		Accuracy	
	Recall	Recognition	Recall	Recognition
Free	(a) 47.8	(b) 61.5	(e) 76.6	(f) 76.9
Forced	(c) 47.6	(d) 67.0	(g) 47.6	(h) 67.0

Note. The quantity and accuracy scores are operationally equivalent under forced-report conditions. From Koriat and Goldsmith, 1994, Experiment 1.

was superior to recall on the quantity measure *(d* vs. *a).* However, examination of the remaining means indicates that although memory quantity performance does vary with test format, recognition better than recall *(b* vs. *a,* and *d* vs. c), it is report option that is critical for memory accuracy: The option of free report increased accuracy performance for both recall and recognition testing *(e* vs. *g,* and *f* vs. *h).* In fact, under free-report conditions (in which memory accuracy and quantity measures can be operationally distinguished), test format had no effect at all on memory accuracy: Given equal opportunity to screen their answers, the recall and recognition subjects achieved virtually identical accuracy scores *(e* vs. *f)!*

This same basic pattern was replicated in several further experiments, employing both list-learning (episodic) and general knowledge (semantic) memory tasks (Koriat & Goldsmith, 1994, in press-b). Because the superior accuracy of free recall over forced recognition characteristic of naturalistic research was obtained in these experiments within a typical laboratory setting, it would appear that at least some of the underlying dynamics are not uniquely tied to real-life contexts. The findings are also problematic for the general belief that recognition testing per se is inherently detrimental to memory accuracy. More generally, the results highlight the need to distinguish between the accuracy-oriented and quantity-oriented approaches to memory assessment even within the item-based framework, and underscore the crucial importance of subject control over memory reporting for output-bound memory accuracy performance.

THE STRATEGIC REGULATION OF MEMORY ACCURACY

The issue of subject control figures prominently both when comparing everyday and laboratory research in general, and when considering accuracy-oriented versus quantity-oriented memory assessment in particular. As al-

luded to earlier, the investigation of many real-life memory phenomena often calls for a compromise between the need for strict experimental control and the desire to remain true to the natural dynamics of the memory phenomena being investigated (Gruneberg & Morris, 1992). Hence, there is generally a greater willingness among students of real-life memory to allow subjects control over their memory reporting, as is seen, for instance, in the use of free-narrative and other open-ended questioning techniques that have little parallel in traditional memory research.

In addition, the effects of subject control appear to differ markedly for quantity-oriented and accuracy-oriented memory assessment. On the one hand, subjects do not seem to be able to increase their memory quantity performance when given incentives to do so (e.g., Nilsson, 1987), nor does encouraging or forcing subjects to produce more items generally improve their memory quantity performance much or at all beyond that obtained under standard instructions (e.g., Erdelyi, Finks, & Feigin-Pfau, 1989: Roediger & Payne, 1985). On the other hand, such results contrast sharply with our accuracy-based findings (Koriat & Goldsmith, 1994, in press-b): Not only can subjects improve their accuracy when given the option of free report, they can also increase their accuracy even further when given stronger incentives to be accurate. For example, in one experiment (Koriat & Goldsmith, 1994, Experiment 3), we used the same free report procedure described earlier, but this time subjects sacrificed all winnings if they volunteered even a single incorrect answer. Accuracy increased substantially compared to our earlier experiment, averaging over 90% for both recall and recognition (fully one fourth of the subjects were successful in achieving 100% accuracy!). This improvement, however^ was attained at a cost 'in quantity performance (about a 25% reduction for both recall and recognition). Similar results were obtained using a 10:1 penalty-to-bonus payoff ratio (Koriat & Goldsmith, in press-b).

Thus, subject control over memory reporting should present a special challenge to researchers interested in memory accuracy. In recounting their experiences, people clearly can regulate their reporting in order to enhance its correspondence (among other goals; see Neisser, 1988a; Ross & Buehler, 1994): They may report only information about which they are confident, or adopt a level of generality at which they are not likely to be wrong (Neisser, 1988a; Yaniv & Foster, 1990). Two questions then emerge: How can subject regulation of memory correspondence be made amenable to experimental study, and how can "memory" be sensibly assessed given that memory performance is under the subject's control?

In our work, we tried to tackle these issues by focusing on one specific type of subject regulation—the tendency to withhold or volunteer particular items of information under conditions of free report option. As a framework for investigating such regulation, we proposed a model of monitoring and control processes that merges ideas from signal-detection theory with ideas

from metamemory research (Koriat & Goldsmith, in press-b). We assume that people monitor the subjective likelihood that a candidate memory response is correct, and then set a control threshold on the monitoring output to determine whether to volunteer that response or not. The setting of the control threshold depends on the relative utility of providing complete versus accurate information. Several results supported the model: First, the tendency to report an answer was very strongly correlated with subjective confidence in the correctness of the answer (the intrasubject gamma correlation averaged .93 for recognition and .97 for recall!). Second, subjects given a high accuracy incentive (a 10:1 penalty-to-bonus ratio) adopted a stricter criterion than subjects given a more moderate incentive (a 1:1 ratio). Third, subjects were able to increase their memory accuracy at the expense of quantity performance by screening out low confidence answers. Importantly, however, the extent and even existence of the quantity-accuracy trade-off was shown to depend critically on both accuracy motivation and monitoring effectiveness: When monitoring is very effective (or when the incentive for accuracy is relatively low), accuracy may be improved significantly at little or no cost in quantity performance.

The second issue raised by subject control is how such control should affect our methods of assessing memory. The approach that we proposed (Koriat & Goldsmith, in press-b) allows the incorporation of metamemory processes into memory assessment by charting memory performance profiles that take retention, monitoring, and control into account. Thus, rather than seek a single point estimate of "true" memory, subjects' memory performance on a particular test is described in terms of a quantity-accuracy profile (QAP), which plots the quantity and accuracy performance that would ensue from the adoption of different control criteria. This method allows the ongoing regulation of memory performance to be treated as an integral aspect of memory functioning (cf. Nelson & Narens, 1990), while also permitting an evaluation of the specific contribution of metamemory processes to memory performance.

In sum, even within the somewhat restricted domain of item-based memory research, the focus on memory accuracy raises a new set of issues involving memory variables that have either been overlooked, or else treated quite differently in traditional, quantity-oriented memory research.

TOWARD A PSYCHOLOGY OF
MEMORY CORRESPONDENCE

In this chapter, we have argued that the study of everyday memory may harbor an implicit departure from the traditional storehouse approach to memory toward a correspondence-oriented approach. This divergence can

be seen in the preference for complex stimulus materials having an internal structure, in the focus on the many qualitative ways in which memory can change over time, in allowing for the contribution of subject variables and subject control to memory performance, in the study of motivational and functional factors that may affect such contributions, and, of course, in the memory property of interest Some of these biases are also becoming more apparent in mainstream, laboratory-based experimentation. Indeed, signs of a general shift toward a correspondence-oriented metatheory may be discerned in a wide variety of theoretical formulations, including the reconstructive, attributional, ecological, functional, nonmediational, procedural, and connectionist approaches to memory (see Koriat & Goldsmith, in press-a).

What are the implications of this analysis for the everyday-laboratory controversy? To the extent that the controversy reflects, at least in part, a difference in the underlying memory metaphor, then there really should be no reason for commotion. Metaphors are conceptual tools that respond to certain aspects of the phenomena of interest and guide the development of viable theories and research methods. Unlike the theories that they breed, however, metaphors are neither right nor wrong; their worth entirely depends on their productivity. Not only is there no real conflict between metaphors, but, in fact, it should be desirable to entertain a variety of different metaphors in order to capture the full richness of memory phenomena.

Clearly, the storehouse metaphor has many advantages that have made it immensely productive in generating memory research and theory. At the same time, however, we believe that the correspondence metaphor (perhaps in alliance with the emerging "brain" metaphor; see Rumelhart, 1989) has much to offer in capturing those aspects of memory functioning that lie outside the storehouse metaphor's "focus of convenience." Exploited to its fullest, the correspondence metaphor could engender a full-fledged psychology of memory correspondence to parallel the quantity-oriented tradition. For instance, the systematic development of wholistic correspondence measures might enable researchers to trace the course of forgetting over time in the sense of a reduction in the faithfulness of memory, to examine the effects of different factors on the rate of such forgetting, to study individual differences in memory accuracy, to explore the effectiveness of different questioning procedures and subject control in improving the faithfulness of memory reports, and so forth. This is the type of approach that would seem to follow most naturally from many discussions of everyday memory. Instead, however, there is often a tendency to force accuracy-oriented research into the storehouse mold (as, of course, we ourselves have done). Thus, many memory researchers today talk correspondence, but still practice storehouse (see Neisser, 1988b). This discrepancy may derive in part from the conceptual and technical difficulties inherent in correspondence-oriented memory assessment, but it may also reflect a desire to maintain

continuity with the traditional laboratory approach (Klatzky, 1991; Winograd, 1988). We would advocate otherwise: Rather than seeking a compromise, we believe that the psychology of memory will be better served if the differences between the correspondence-oriented and quantity-oriented approaches are sharpened rather than reconciled, so that the most can be made of what each approach has to offer.

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REFERENCES

Algom, D. (1992). Memory psychophysics: An examination of its perceptual and cognitive prospects. In D. Algom (Ed.), *Psychophysical approaches to cognition* (pp. 441-513). Amsterdam: Elsevier Science Publications.

American Psychologist. (1991). 46(7).

Baddeley, A. D. (1988). But what the hell is it for? In M. Gruneberg, P. Morris, & R. Sykes (Eds.), *Practical aspects of memory: Current research and issues (Vol.* 1, pp. 5-18). Chichester, England: Wiley.

Baddeley, A. D., Lewis, V., & Ninno-Smith, I. (1978). When did you last. . . ? In M. Gruneberg, P. Morris, & R. Sykes (Eds.), *Practical aspects of memory* (pp. 77-83). London: Academic Press.

Bahrick, H. P., Hall, L. K., & Dunlosky, J. (1993). Reconstructive processing of memory content for high versus low test scores and grades. *Applied Cognitive Psychology, 7,* 1-10.

Banaji, M. R., & Crowder, R. G. (1989). The bankruptcy of everyday memory. *American Psychologist, 44,* 1185-1193.

Bartlett, F. C. (1932). *Remembering.* Cambridge, England: Cambridge University Press.

Boon, J. C. W., & Davies, G. (1988). Attitudinal influences on witness memory: Fact and fiction. In M. Gruneberg, P. Morris, & R. Sykes (Eds.), *Practical aspects of memory: Current research and issues* (Vol. 1, pp. 53-58). Chichester, England: Wiley.

Brewer, W. F. (1988). Memory for randomly sampled autobiographical events. In U. Neisser & E. Winograd (Eds.), *Remembering reconsidered: Ecological and traditional approaches to the study of memory (pp.* 21-90). Cambridge, England: Cambridge University Press.

Bruce, D. (1989). Functional explanations of memory. In L. W. Poon, D. C. Rubin, & B. E. Wilson (Eds.), *Everyday cognition in adulthood and late life* (pp. 44-58). Cambridge, England: Cambridge University Press.

Ceci, S. J., & Bronfenbrenner, U. (1991). On the demise of everyday memory: "The rumors of my death are much exaggerated" (Mark Twain). *American Psychologist, 46,* 27-32.

Conway M. A. (1991). In defense of everyday memory. *American Psychologist 46,* 19-27.

Erderyi, M. H., Finks, J., & Feigin-Pfau, M. B. (1989). The effect of response bias on recall performance, with some observations on processing bias. *Journal of Experimental Psychology: General, 118,* 245-254.

Goldmeier, E. (1982). *The Memory Trace: Its formation and its fate.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Gruneberg, M. M., & Morris, P. E. (1992). Applying memory research. In M. Gruneberg & P. Morris (Eds.), *Aspects of memory,* 2nd ed. (Vol. 1, pp. 1-17). London: Routledge.

Gruneberg, M. M., Morris, P. E., & Sykes, R. N. (1991). The obituary on everyday memory and its practical applications is premature. *American Psychologist, 46,* 74—76.

Hart, R. A. (1981). Children's spatial representation of the landscape: Lessons and questions from a field study. In L. S. Liben, A. H. Patterson, & N. Newcombe (Eds.), *Spatial representation and behavior across the life span* (pp. 195-233). New York: Academic Press.

Hilgard, E. R., & Loftus, E. F. (1979). Effective interrogation of the eyewitness. *The International Journal of Clinical and Experimental Hypnosis, 27,* 342-357.

Huttenlocher, J., Hedges, L V., & Bradbum, N. M. (1990). Reports of elapsed time: Bounding and rounding processes in estimation. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 16,* 196-213.

Klatzky, R. L. (1991). Let's be friends. *American Psychologist, 46,* 43-46.

Koriat, A., & Goldsmith, M. (1994). Memory in naturalistic and laboratory contexts: Distinguishing the accuracy-oriented and quantity-oriented approaches to memory assessment. *Journal of Experimental Psychology: General, 123,* 297-315.

Koriat, A., & Goldsmith, M. (in press-a). Memory metaphors and the real-life/laboratory controversy: Correspondence versus storehouse views of memory. *Behavioral and Brain Sciences.*

Koriat, A., Sc Goldsmith, M. (in press-b). Monitoring and control processes in the strategic regulation of memory accuracy. *Psychological Review.*

Upton, J. P. (1977). On the psychology of eyewitness testimony. *Journal of Applied Psychology, 62,* 90-95.

Loftus, E. F. (1979). *Eyewitness testimony.* Cambridge MA: Harvard University Press.

Loftus, E. F. (1982). Memory and its distortions. In A. G. Kraut (Ed.), *G. Stanley Hall Lectures* (pp. 119-154). Washington DC: American Psychological Association.

Neisser, U. (1978). Memory: What are the important questions? In M. M. Gruneberg, P. Morris, & R. Sykes (Eds.), *Practical aspects of memory (pp.* 3-24). London: Academic Press.

Neisser, U. (1981). John Dean's memory: A case study. *Cognition, 9,* 1-22.

Neisser, U. (1988a). Time present and time past. In M. M. Gruneberg, P. Morris, & R. Sykes (Eds.), *Practical aspects of memory: Current research and issues* (Vol. 2, pp. 545-560). Chichester, England: Wiley.

Neisser, U. (1988b). What is ordinary memory the memory of? In U. Neisser & E. Winograd (Eds.), *Remembering reconsidered: Ecological and traditional approaches to the study of memory* (pp. 356-373). New York: Cambridge University Press.

Neisser, U. (1991). A case of misplaced nostalgia. *American Psychologist, 46,* 34-37.

Neisser, U., & Harsch, N. (1992). Phantom flashbulbs: False recollections of hearing the news about Challenger. In E. Winograd & U. Neisser (Eds.), *Affect and accuracy in recall- Studies of "flashbulb memories"* (pp. 9-31). New York: Cambridge University Press.

Nelson, T. O., & Narens, L (1990). Metamemory: A theoretical framework and some new findings. In G. Bower (Ed.), *The psychology of learning and motivation* (pp. 125-173). San Diego, CA: Academic Press.

Nilsson, L.-G. (1987). Motivated memory: Dissociation between performance data and subjective reports. *Psychological Research, 49,* 183-188.

Roediger, H. L. (1980). Memory metaphors in cognitive psychology. *Memory & Cognition, 8,* 231-246.

Roediger, H. L, & Payne, D. G. (1985). Recall criterion does not affect recall level or hypermnesia: A puzzle for generate/recognize theories. *Memory & Cognition, 13,* 1-7.

Ross, M. (1969). Relation of Implicit theories to the construction of personal histories. *Psychological Review, 96,* 341-357.

Ross, M. (in press). Validating memories. In N. L Stein, P. A. Omstein, B. Tversky, *& C.* Brainerd (Eds.), *Memory for everyday and emotional events.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Ross, M., & Buehler, R. (1994). Creative remembering. In U. Neisser & R. Fivush (Eds.), *The remembering self: Construction and accuracy in the self-narrative* (pp. 205-235). New York: Cambridge University Press.

Rubin, D. C. (1986). *Autobiographical memory.* Cambridge, England: Cambridge University Press.

Rumelhart, D. E. (1989). The architecture of mind: A connectionist approach. In M. I. Posner (Ed.), *Foundations of cognitive science* (pp. 133-159). Cambridge, MA: MIT Press.

Schacter, D. (1989). Memory. In M. I. Posner (Ed.), *Foundations of cognitive science* (pp.687-725). Cambridge, MA: MIT Press.

Spence, D. P. (1982). *Narrative truth and historical truth.* New York: Norton.

Tulving, E. (1991). Memory research is not a zero-sum game. *American Psychologist, 46,* 41—43.

Tversky, B., & Schiano, D. J. (1989). Perceptual and conceptual factors in distortions in memory for graphs and maps. *Journal of Experimental Psychology: General, 118.* 387-398.

Waterman, S., & Gordon, D. (1984). A quantitative-comparative approach to analysis of distortion in mental maps. *Professional Geographer, 36,* 326-337.

Wells, G. L, & Turtle, J. W. (1988). What is the best way to encode faces? In M. Gruneberg, P. Morris, & R. Sykes (Eds.), *Practical aspects of memory: Current research and issues (Vol.* 1, pp. 163-168). Chichester, England: Wiley.

Winograd, E. (1988). Continuities between ecological and laboratory approaches to memory. In U. Neisser & E. Winograd (Eds.), *Remembering reconsidered: Ecological and traditional approaches to the study of memory(pp.* 11—20). Cambridge, England: Cambridge University Press.

Winograd, E. (1994). The authenticity and utility of memories. In U. Neisser & R. Fivush (Eds.),*The remembering self: Construction and accuracy in the self-narrative (pp.* 243-251). New York: Cambridge University Press.   ,

Winograd, E., & Neisser, U. (Eds.). (1992). *Affect and accuracy in recall: Studies of 'flashbulb memories."* New York: Cambridge University Press.

Yaniv, I., & Foster, D. P. (1990). Judgment, graininess, and categories. In *Proceedings of the Twelfth Annual Cognitive Science Society (pp.* 130-140). Hillsdale, NJ: Lawrence Erlbaum Associates.