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Comparisons between explicit, implicit perceptual, and implicit conceptual memory tests: A selective review

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Abstract

The standard data concerning comparisons between explicit, implicit perceptual, and implicit conceptual tests can be summarized in five conclusions: (1) conceptual manipulations affect explicit, and implicit conceptual, but not implicit perceptual tests; (2) perceptual manipulations, conversely, affect implicit perceptual, but not implicit conceptual and explicit tests; (3) generate is better for explicit and implicit conceptual tests, but read is better for implicit perceptual tests; (4) explicit and implicit conceptual tests can be dissociated; and (5) there is not priming on implicit perceptual tests without perceptual match. Two theoretical approaches can account for these standard results: the data-driven/conceptually-driven view, and the PRS view. Recently, counterexamples have been found for each of the five conclusions emanated from the standard data. These inconsistent findings are stimulating new empirical and theoretical developments in the field of priming research.

Key words: priming, explicit tests, implicit perceptual tests, implicit conceptual tests

Many of the most important discoveries in the field of memory were originated on the comparison between different memory measures. Comparisons between recall, cued recall and recognition tests, for example, fueled fundamental theoretical developments in the 70s. During the last decade, the task-comparison methodology has became still more prominent due to the inclusion, among the tests being compared, of a new kind of tests called implicit memory tests. (Graf & Schacter, 1985). These tests measure a particular kind of memory effects called priming, which behaves quite differently than the forms of memory studied in the past. Trying to understand and explain priming phenomena, memory researchers have conducted a myriad of experiments, and proposed numerous competing theories. In recent years, this field has become even more complex due to distinction between two types of implicit tests, implicit perceptual tests and implicit conceptual tests. This review is concerned with the empirical and theoretical aspects of the comparison between explicit, implicit perceptual, and implicit conceptual tests. This review is limited in two ways. First, it does not comprise the whole field of priming research, but only those studies pertinent to the distinction between perceptual and conceptual forms of implicit tests. Second, it focus on articles published in recent years, in particular on those published after 1988, and hence not included on the two exhaustive reviews of the field of priming, Schacter (1987), and Richardson-Klavehn & Bjork (1988).

Basic Concepts

Explicit memory tests, such as recall and recognition tests, request subjects to retrieve studied items in order to complete the test; *implicit memory tests*, on the other hand, do not mention the study episode, but require subjects only to focus on the task at hand, which, however, reveals retention of the study episode in the form of priming. In a very abstract sense, *priming* can be defined as a facilitation on the

processing of a stimulus caused by a previous processing episode, without any requirement that the rememberer be aware of the first processing episode. When the two processing episodes involve the same target item, even if the perceptual form is different (e.g.,*dinosaur, D__N__SA_____*), the facilitation is known as *direct priming* ; when they involve different items (e.g., *doctor, nurse*) it is called *indirect priming*. A special case of direct priming is *repetition priming*, which involves the same item in the same perceptual form (e.g., *dinosaur, dinosaur*) (Roediger, 1990a). Both direct and indirect priming has been studied under two different experimental paradigms, called here the *prime-target paradigm* and the *study-test paradigm*. While the second paradigm belongs mainly to the field of memory, the first is also very common in other domains, such as the domain of lexical access in the field of psycholinguistics. This review is concerned with research done using the second paradigm, but in order to clarify some terminology it is convenient to make a brief description of both methods.

Two paradigms of priming research

The prime-target paradigm has two basic characteristics. First, it usually does not involve separate study and test phases; and second, the processing episode that generates the facilitation, and the one that receives it are separated only by a brief time interval. In the basic paradigm, subjects are presented with a list of words and have to make a response for some or all of them. Usually the response is to decide whether a string of letters is a word (*lexical decision task*), or to read to read a word aloud (*pronunciation task*). The critical responses are those made for some items called targets. A *target* is preceded, with or without intervening items, by another item called *prime*. Priming refers to the effects of the processing of the primes on the responses to the targets. Priming is usually a facilitation – e.g., an increase of the accuracy or speed of the responses, but sometimes it can be an inhibition.

Most research on the prime-target paradigm has focused on indirect priming. When primes and targets are different – e.g., different words, priming occur only when they have some kind of relation. They can have, for example, a pre-experimental conceptual or perceptual relation. It has been shown, for example, that the lexical decision for a word (e.g. *nurse*) is speed up when it is preceded by a semantically related prime (e.g., *doctor*). This form of priming is known as *semantic priming* (for a review see Neely, 1991). Priming is also found when the prime and the target have a perceptual relation, such as when they have similar orthography (e.g. Meyer, Schvaneveldt, and Ruddy, 1974; Hillinger, 1980). Additionally, a relation between a prime and a target can be experimental, for example, when an association between two items is established by pairing them repeatedly during a preliminary phase of the experiment. This kind of priming is called *episodic priming* (e.g., McKoon & Ratcliff, 1979, 1986; Dosher & Rosedale, 1989). Finally, the prime-target paradigm has been also used to investigate *repetition priming* (e.g., Kanwisher, 1987).

Unlike the prime-target paradigm, the study-test paradigm involves a study phase, an interval phase, and a test phase. During the *study phase* subjects are presented with a series of stimuli. The stimuli can be verbal (e.g. words, word-pairs, sentences) or nonverbal (e.g. pictures or drawings of objects, patterns of lines, faces). Learning can be intentional, but usually it is incidental, and subjects are required to perform some kind of *study task* on the items in the study list. Study tasks usually emphasize the processing of some aspects (e.g. structural, semantic) of the stimuli more than others. After a *retention interval* phase, which can vary from a few seconds to more than a year, the *test phase* starts, including one or more tests. In the implicit tests, subjects are asked to respond to a list of cues, but explicit retrieval is not required. Some of the cues correspond to studied items, the targets, and some to nonstudied items. Priming is said to have occurred when the performance on the cues of the targets is better than performance on the cues of nonstudied items, or baseline.

Implicit perceptual and implicit conceptual tests

According to their cues, implicit tests can be divided in two groups: implicit perceptual tests and implicit conceptual tests. The cues of the *implicit perceptual tests* have a perceptual relation with the targets; they are usually copies of the targets in which perceptual information has been reduced by the deletion of some parts, or by a brief presentation

time. The most common implicit perceptual tests are word completion, and perceptual identification tests. Completion tests require subjects to complete missing letters on the cues, which can be three-letter stems (e.g., DI____;*word-stem completion test* – WSC), or a combination of letter and blanks (e.g., D__N__SA____;*word-fragment completion test* – WFC). There are also nonverbal completions tests, like the *picture fragment completion test* (e.g., Snodgrass, 1989; Weldon & Roediger, 1987). In the perceptual identification test, subjects try to identify briefly presented stimuli (e.g. 35 milliseconds). The stimuli of the perceptual identification test can be words (*word identification test* – WI) or pictures (*picture naming test*).

In the *implicit conceptual tests*, in contrast, the cue-target relation is not perceptual, but conceptual. On the *general knowledge test* (GKT), subjects have to answer quiz-like questions, such as *What is the name of the gigantic reptile that became extinct during prehistory?*. The cues of the *category association test* (CAT) are category names, and subjects have to generate one or several exemplars for each of them (e.g., *reptiles: snake, crocodile, dinosaur...*). On the *free-association test*, subjects have generate one or several associates in response to the cues (e.g. *mammoth:*). Sometimes, subjects may study a related word pair like *table-chair*, and receive a free-association test with cues like *table-*____. In this cases, the cue-target relation of the free-association test involves not only a pre-experimental semantic association between *table* and *chair*, but also an experimental association between these words. Despite the superimposed episodic association, the pre-experimental conceptual association is very strong, and it would be reasonable to classify this kind of test as an implicit conceptual tests. Other times, subjects may study a unrelated word pair like *table-chair*, and receive a free-association test with cues like *table-*_____.. In these cases, the cue-target relation is fundamentally experimental, and the free -association test cannot be classified as an implicit conceptual test. It could be classified in a third group called *implicit episodic tests*.

Another classification problem exist for the hybrid implicit test used in the paradigm known as *implicit memory for new associations* (e.g., Graf & Schacter, 1985; Schacter & Graf, 1986a, 1989; Schacter & McGlynn, 1989). In this paradigm, subjects study words accompanied by unrelated context words (e.g. *mother-CALENDAR*), and then receive a word-stem completion test, in which the stems are accompanied by the same (e.g. *mother-CAL*____), or different context words (e.g. *officer-CAL*____). Typically, more priming is obtained when the original context word is reinstated at test, than when a new context word is used. The cues of the *context-stem completion test*, involve two elements. One is the pre-experimental perceptual relation between the stem and the target (e.g., *CAL*_____*-CALENDAR*). The second is the relation between the context word and the target (e.g., *mother-calendar*). The interpretation of the nature of this second component depends on the explanation of the context effect. The typical explanation of the superiority of the same-context condition is typically interpreted as evidence that a newly established association can affect priming. According this explanation, the second component is episodic, and hence the context-stem completion test could be characterized as a hybrid perceptual/episodic test.

However, according a *non-associative explanation* of context effects (e.g., Lewandowsky, Kirsner, & Bainbridge, 1989) targets words have several meanings, and context words at study bias interpretation towards one of them. For example, when subjects read *mother-calendar* they might think on Mother's Day and encode calendar as a chart of weeks and months, whereas when they read *food-calendar* they might think on crops, and encode calendar a measure of the duration of the year and the seasons. According this view, the superiority of the same-context condition (e.g. *mother-CAL* ____) is an the effect of the reinstatement of the encoded sense of the words. This view explains context effect without assuming the establishment of new associations. Since the relation between the context and target (e.g., between *mother* and *calendar*) is not episodic but a preexperimental conceptual relation, then the context-stem completion test could be classified as a hybrid perceptual/conceptual test.

From now on, this review will focus on three kinds of tests: explicit tests, and two types of implicit tests: implicit perceptual tests and implicit conceptual tests. For convenience, implicit perceptual tests are called *perceptual tests*, and implicit conceptual tests are called *conceptual tests*. In should be re-

membered, then, that the expressions "perceptual tests" and "conceptual tests" refer always to implicit tests.

Standard Data

In this section we review empirical evidence that support some original assumptions concerning priming on perceptual and conceptual tests. Comparisons between different memory tests are usually summarized in terms of two possible outcomes: dissociations or parallel effects. There are two forms of dissociations: functional or contingent. *Functional dissociations* occur when an independent or subject variable produce different patterns of results on different memory tests. *Contingent dissociations* does not involve an independent variable and are based on comparing performance on two successive tests for the same set of target items. If performance on the items of one test does not predict performance on the same items on the other test, a contingent dissociation occur, and the two tests are said to be stochastically independent. *Parallel effects* occur when an independent variable produce similar effects on the two tests.

The results are organized in four sections; the first three sections are concerned with dissociations between explicit and perceptual tests, and between perceptual and conceptual tests; the fourth is concerned with dissociations between explicit and conceptual tests. The first section reviews the effects of conceptual manipulations, the second the effects of perceptual manipulations, and the third, the effects of a procedure that involves both kinds of manipulations. The term *conceptual manipulations* refer here to procedures that affect in particular the processing of conceptual aspects of the information, such as different levels of elaboration during encoding. *Perceptual manipulations*, on the other hand, refer to procedures that affect specially the processing of perceptual features of the information, such as presenting stimuli on different modalities. The following review of the standard data focus on those conceptual and perceptual manipulations that have been investigated already on the relatively new and unexplored conceptual tests. The effects of the manipulations on explicit and perceptual tests are summarized briefly, and the corresponding studies are not referenced, because they have been exhaustively reviewed by Schacter (1987) and Richardson-Klavehn and Bjork (1988).

Conceptual manipulations affect explicit tests and conceptual tests, but not perceptual tests

In general, conceptual manipulations tend to affect explicit, and conceptual tests, but not perceptual tests. Three conceptual manipulations are considered here: levels-of-processing, imagery, and list organization. The typical *levels-of-processing* (LOP) procedure involves two encoding conditions: a *semantic task* emphasizing the meaning of the stimuli, and a *physical task* underscoring their perceptual properties. In general, the LOP manipulation produces a clear dissociation between explicit and perceptual tests: whereas on explicit tests, the semantic task yields better performance than the physical task, on perceptual tests, both tasks generate a similar amount of priming. The data concerning the effects of LOP on conceptual tests is scarce, but it suggest that conceptual tests are sensitive to the LOP manipulation. Hamann (1990, Expts.1 & 2) investigated LOP effects on two conceptual tests, the general knowledge tests (GKT) and the category association test (CAT). In both tests, priming on the semantic task (liking rating) yielded more priming than the physical task (compare vowels between successive study list words). Likewise, Srinivas & Roediger (1990) found more priming on a different kind of CAT in the semantic (pleasantness rating) than in the physical condition (count consonants).

LOP effects have been also found on implicit episodic and hybrid tests used in the paradigm of implicit memory for new associations. Schacter and colleagues found that for an unrelated word pair to generate priming on the free-association test (e.g., Schacter & McGlynn, 1989), or the context-stem test (e.g., Graf & Schacter, 1985; Schacter & Graf, 1986a), it is necessary that the two words are encoded together by a semantic orienting task (e.g., generate a sentence linking the words). Priming does not occur when the study task is not semantic, even if it involves processing together both words (e.g., compare the number of vowels on the two words).

The second conceptual manipulation to be considered is imagery instructions at study. Blaxton (1989, Exp. 3) investigated the effect of this man-

ipulation on explicit, perceptual and conceptual tests. She found a significant effect of imagery (imagery condition > no-imagery condition) on the explicit semantic cued recall and free recall test, but not on the perceptual WFC. Like the explicit tests, and unlike the WFC, the conceptual GKT was enhanced by the imagery instruction. A puzzling result of this experiment was that an explicit test with perceptual cues, the graphemic cued recall, was not affected by the imagery manipulation. This finding will be discussed later.

Finally, the third manipulation to be considered is list organization. Organization refers to the process of grouping items on the basis of their common characteristics. Organization is guided by previous knowledge and implies conceptual processing of the information. The organization process is enhanced when the items in a list that can be grouped (e.g., animals, furniture) are presented together, rather than in random order. Rappold & Hashtroudi (1991) investigated the effect of a blocked/random organizational manipulation on explicit, perceptual and conceptual tests. Explicit performance on the free-recall and category cued-recall tests was better in the blocked condition than in the random condition (Expts. 1, 2, and 4), but priming on a word identification test (WI) was not affected by the manipulation (Exp. 5). Like explicit performance and unlike priming in the WI, priming on the category association test was larger in the blocked than in the random condition (Exp. 1, 2, 3, and 5). In sum, conceptual manipulations, such as LOP, read/generate, imagery, and list organization, tend to affect explicit and conceptual tests, but not perceptual tests.

Perceptual manipulations affect perceptual tests, but not conceptual tests and explicit tests

Perceptual manipulations usually involve a comparison between one condition in which the format of the information at study and at test is different (e.g. auditory presentation at study and visual presentation at test) with a condition in which study and test format is the same (e.g. visual presentation study and test). In general, study-test shifts on typography (e.g., handwritten vs. typewritten); modality (e.g., auditory vs. visual), symbol type (e.g., word vs picture), and language (e.g. English vs. Spanish) produce a marked reduction on priming, but almost no effect on explicit tests (for review see Kirsner & Dunn, 1985, and Roediger & Blaxton, 1987a). These findings support the idea that, unlike explicit memory, priming on perceptual tests is very sensitive to perceptual aspects of the stimuli. Blaxton (1989, Exp. 2) and Srinivas & Roediger (1990, Exp. 2) had their subjects study words in the auditory and visual modalities, and tested them in the visual modality, on different memory tests. Priming was markedly reduced in the auditory condition, but the modality manipulation neither affected the explicit tests, nor the conceptual GKT. Surprisingly, performance on the explicit graphemic cued recall was better in the visual than in the auditory condition. This result will be discussed later. Srinivas & Roediger (1990) replicated the marked effects of the modality shifts on the word fragment completion, and found no effects of modality on a different conceptual test, the category association test.

The effects of typography shifts are less evident than those of modality shifts. In general there is agreement that typography changes affect perceptual tests, but little or nothing explicit tests. Roediger & Blaxton (1987a, Exp. 1), for example, found significant effects of a uppercase/lowercase manipulation on a word fragment completion, but not on a recognition test. The effects of typography on conceptual tests were investigated by Blaxton (1990, Exp. 3). Subjects studied words in a lowercase italic type, and in a uppercase elite type, and the cues of the tests (i.e., the fragments in the WFC, and questions in the GKT) appeared also in these two typefaces. The manipulation did not affect neither the explicit tests, nor the general knowledge test. These results suggest that, like explicit tests and unlike perceptual tests, conceptual tests are not sensitive to typography shifts.

Generate is better for explicit tests and conceptual tests, but read is better for perceptual tests

The two previous sections reviewed results indicating that conceptual manipulations affect explicit and conceptual tests, but not perceptual tests, whereas perceptual manipulations affect perceptual tests, but not conceptual and explicit tests. What happens when an experimental procedure involves both kinds of manipulations? Jacoby (1983) had subjects read target items (e.g., cold) in a *no-context con-*

dition (*xxx-cold*), read them in a context condition (*hot-cold*), or provide them in a *generate condition* (*hot-???*). In a recognition test the generate condition yielded better results than the no -context condition, with the context condition falling in between. In contrast, priming on a word-identification test (WI) showed the converse pattern of results: no-context > context > generate. The superiority of the generate condition over the read condition on the recognition test is a well known phenomenon called *generation effect* (Slamecka and Graf, 1978). Jacoby's (1983) original finding was the reversal of the generation effect, or *negative generation effect* (Gardiner, 1988), on the word-identification test.

Most experimental dissociations between two tests occur when a manipulation affects one of them, but not the other. The dissociation found by Jacoby (1983) is more impressive: the read/generate procedure affected both tests, but in different directions. However, such cross-over dissociation is not surprising if we think that this procedure, as pointed out by Hamann (1990), confounds two variables. One variable is whether the item is generated or not, the other is whether it is on not seen. The first variable affect conceptual processing, the second, perceptual processing. Thus, it is reasonable to interpret the cross-over dissociation found by Jacoby (1983) as the effect of two manipulations: a conceptual manipulation that affected recognition but not WI, and a perceptual manipulation that affected WI but not recognition. In this sense, the effects of the read/generate procedure on explicit and perceptual tests is perfectly consistent with the results of the conceptual and perceptual manipulations described before.

The effect of the read/generate manipulation on conceptual tests was first studied by Blaxton (1989, Exp. 1). Her results showed a dissociation between a perceptual test and an conceptual test. In the conceptual GKT, as well as in the explicit free recall and semantic cued recall tests, performance was better in the generate than in either the context or the no-context condition (generation effect). In the perceptual WFC, in contrast, performance was better in the no-context condition, than in the generate and context conditions (negative generation effect). A puzzling finding in this experiment was that the explicit graphemic cued recall test showed the same pattern as the perceptual WFC. This finding will be discussed later. Srinivas & Roediger (1990, Exp. 1) found a similar dissociation between WFC, and the conceptual CAT. In sum, the read/generate procedure combines the effects of conceptual and perceptual manipulations. As in the case of conceptual manipulations, the condition involving more conceptual processing, the generate condition, yields better performance on explicit and conceptual tests, but not on implicit perceptual tests. As in the case of perceptual manipulations, the condition involving more perceptual processing, the read condition, enhances performance on perceptual tests, but not conceptual or explicit tests.

The last three sections can be summarized in a simple statement: whereas conceptual manipulations tend to affect explicit and conceptual tests, but not perceptual tests, perceptual manipulations tend to affect perceptual tests, but not conceptual or explicit tests. Thus, these two kinds of manipulations typically originate dissociations between explicit and perceptual tests, and between perceptual and conceptual tests, but produce parallel effects between explicit and conceptual tests. The fact that in most experiments conceptual tests behave similarly to explicit tests might suggest that the so-called conceptual tests are not authentic implicit tests, but explicit tests in disguise. Even the instructions of conceptual tests do not mention the study episode, some peculiarity of these tests, such as the conceptual nature of their cues, might induce subjects to voluntarily retrieve studied items, in order to complete the cues. In such case, putative conceptual tests would be in fact a kind of explicit tests, and the pattern of dissociations would be perfectly clear. However, conceptual tests not only can be dissociated from perceptual tests, but also from explicit tests. This dissociation evidence is reviewed in the next section.

Explicit tests and conceptual tests can be dissociated

The constitution of the domain of priming research, is in a great part a consequence of the discovery that, despite being severely impaired performance on explicit tests, amnesic patients show normal levels of priming on perceptual tests (for a review see Shimamura, 1986). The domain of preserved priming in amnesics is not limited to perceptual tests; considerable priming on amnesics has also

been found on conceptual tests, such as CAT (e.g., Gardner, Boller, Moreines, & Butters, 1973; Graf, Shimamura, and Squire, 1985). These findings support the idea that performance on both perceptual and conceptual forms of implicit tests is preserved in amnesics. Additionally, when unitized materials, such as highly related word pairs (e.g., *table-chair*; Shimamura & Squire, 1984) or two-word common idioms (e.g., *sour grapes*; Schacter, 1985), are employed, amnesics also show priming on implicit episodic tests, like the free-association test. With nonunitized materials, like unrelated word pairs, amnesic still show priming on the hybrid context-stem completion test (Graf & Schacter, 1985), although this ability seems to be limited to mild amnesics (Schacter & Graf, 1986b). However, Tulving, Hayman and Macdonald (1991) found that even a densely amnesic patient can manifest implicit memory for new associations.

As for evidence from normal subjects, there are at least two studies showing dissociations between explicit and conceptual tests. The first is the aforementioned study of Rappold and Hashtroudi (1991), in which blocked lists yielded better performance than random lists on explicit and conceptual tests, but not perceptual tests. Despite this parallel effect between explicit and conceptual tests, these authors found that the effect of list organization persisted much longer on the explicit--about 24 hr, than on conceptual tests--less than 45 min (Exp. 4). Moreover, when the frequency of category instances was manipulated (Exp. 3), results were different on these two types of tests: high-frequency instances were better recalled than low-frequency instances, but both produced a similar amount of priming on the conceptual category association test.

The second study is the one by Cabeza and Ohta (in press). In their second experiment, one group of subjects received a recognition test followed by an implicit category association test, while the other group received a recognition test followed by an explicit category association test (i.e., a cued recall test with categories as cues). The explicit category association test had the same nominal cues of the standard implicit category association test (e.g., *reptiles*:), but the instructions were explicit, that is, subjects were not instructed to freely generate category instances, but to use category names as cues to recall the studied words. The results indicated that recognition was stochastically independent of the implicit category association test, but dependent of the explicit version of this test. These results indicate, first, that conceptual tests are, in fact, different from explicit tests, and second, that, at least in some conditions, they are not contaminated by explicit strategies. Since the only difference between the two conditions was the retrieval orientation of the second test, a contamination by explicit strategies can be safely discarded. If such complication had occurred, a similar result should have been found in both conditions. To summarize this section, dissociation evidence from both amnesic and normal subjects support the idea that conceptual tests are genuine implicit tests, rather than explicit tests in disguise.

There is not different form priming on perceptual tests

As was described before, perceptual manipulations involving a change on the physical appearance of the items between study and test produce a strong effect on perceptual tests. Priming in the condition in which the physical appearance of study and test items matches (*same form priming,* Kirsner, Dunn, & Standen, 1989) is usually larger than priming in the condition in which it mismatches (*different form priming*). Moreover, several of the earliest studies on priming found that different form priming not only is smaller than same form priming, but that it is nonsignificant. They found, for example, that words presented auditorily did not produce significant priming on visual perceptual identification (e.g., Jacoby and Dallas (1981; Morton, 1979) or lexical decision tests (e.g., Monsel, 1985). Conversely, there were reports that auditory study produce only little or no priming on auditory perceptual identification (e.g., Ellis, 1982) and lexical decision tests (e.g., Kirsner & Smith, 1974).

The foregoing results showing that priming on perceptual tests disappear when modality is changed between study and test suggest that priming in these tests is extremely dependent on the reinstatement of the perceptual characteristics of the stimuli. This conclusion is supported also by studies showing that generating a word from a picture (e.g., Morton, 1979) or from a definition (e.g., Winnick & Daniel,

1970) does not produce significant priming on perceptual identification. In sum, several of the earliest studies on priming found that priming on perceptual tests occur only when there is a perceptual overlap between study and test items.

Standard Theories

Theoretical accounts of priming can be classified according how they explain the underlying mechanism of priming, or according how they explain dissociations and parallel effects between different memory tests. According the first criterion, theoretical accounts of priming can be classified in two groups: activation accounts, and episodic accounts. *Activation accounts* assume that priming is caused by a modification on a preexistent abstract memory representation. When an item is presented, its corresponding representation is activated, and this increased activation facilitates subsequent processing of the same item. The activation process has been conceptualized as a lowering on the firing threshold of a lexical unit or logogen (e.g., Morton, 1979), or as an increase on the integration of the internal organization of an schema (Graf & Mandler, 1984). A lowering of threshold can produce a record of the presentation of an item, but not of its perceptual attributes or its context. The modality of presentation of the stimuli can be registered by a system containing separate visual and auditory logogens (Morton, 1979). Unlike threshold lowering, the integration process is assumed to vary according the characteristics of the processing of the item, and hence it can leave a record of its perceptual attributes.

According *episodic accounts* (e.g., Jacoby, 1983; Jacoby & Brooks, 1984; Roediger & Blaxton, 1987a), priming is not caused by a modification on a preexistent representation, but by the establishment of a new episodic representation. When an item is presented, a record of the episode is created, and priming reflects the retrieval of such episodic record. There are different opinions concerning what is encoded in this record. Jacoby and colleagues emphasize the role of pattern analyses, and propose that priming is particularly sensitive to the repetition of perceptual operations, although context plays also a role (e.g., Allen & Jacoby, 1990; Jacoby, 1983; Jacoby, Baker & Brooks, 1989). Masson and Freedman (1990), on the other hand, consider that in skilled reading perceptual analyses are not critical, and that priming is based on a context-dependent interpretation of a target item. Priming, then, is determined by the reinstatement of the original conceptual context. Finally, procedural interpretations propose that processing an item involves a training of mental operations, a process similar to the acquisition of a motor skill (Kolers & Roediger, 1984). Priming occurs when the specific mental operations trained, are performed again.

According how they explain dissociations and parallel effects, priming theories can be divided in two big groups, transfer-appropriate processing views, and multiple memory systems views. *Transfer-appropriate processing views* are based on the *transfer appropriate processing principle*, which states that memory performance is a function of the overlap between the cognitive operations employed during study, and those tapped by the test. When the degree of overlap between study and test operations in two memory tests is different, there is a dissociation; when it is similar, there is a parallel effect. Two transfer -appropriate processing views have been proposed, one based in the distinction between data-driven and conceptually-driven processing, and the other based in the distinction between integrative and elaborative processing. The second view is not usually used to account for the distinction between implicit perceptual and implicit conceptual tests, and hence, it will not be discussed in this review.

Multiple memory systems views assume that dissociations between two memory tests occur when they tap different memory systems, whereas parallel effects occur when they tap the same memory system. Two kinds of multiple systems views have been proposed. One distinguishes between a declarative and a procedural memory system (e.g., Squire, 1987). Like the integration/elaboration view, this view is not ordinarily employed to explain the distinction between perceptual and conceptual tests, and is not considered in the present review. The other multiple memory systems view distinguishes four memory systems, including a priming system called PRS (Tulving and Schacter, 1990). In short, the present review will consider two views concerning dissociations and parallel effects between tests:

the data-driven/conceptually-driven view, the integration/elaboration view, and the PRS view. These views are briefly described below.

Data-driven/conceptually-driven view

The *data-driven/conceptually-driven view* (e.g., Roediger & Blaxton, 1987a; Roediger, Weldon, & Challis, 1989), also called transfer-appropriate procedures approach, is based on the idea that some study and test conditions emphasize data-driven processing, whereas other study and test conditions underscore conceptually-driven processing. *Data-driven processing* refers to mental operations guided by physical properties of the input, whereas *conceptually-driven processing* refers mental processes guided by previous knowledge and expectations. On the basis of this distinction, and the transfer - appropriate processing principle, the data-driven/conceptually-driven view predicts that memory performance should be better when study and test emphasize the same kind of processing, data-driven or conceptually-driven, than when they underscore different types of processing. The data-driven/conceptually-driven view seems to adhere to an episodic account of the mechanisms of priming.

Memory tests that emphasize perceptual processing are called data-driven tests, whereas tests that underscore conceptual processing are called conceptually-driven tests. The operational definition of these tests is based on the read/generate procedure: *data-driven tests* are those tests in which the no-context condition is better than the generate condition (generation effect), *conceptually-driven tests* are those in which the reverse is true (negative generation effect). Studies that have investigated this manipulation (e.g., Jacoby, 1983; Blaxton, 1989; Srinivas & Roediger; 1990) indicate that perceptual tests, such as perceptual identification and word fragment completion, are data-driven, whereas conceptual tests, like the general knowledge test and category association test, are conceptually-driven. Most explicit tests in use (e.g., free recall, cued recall, and recognition) are conceptually-driven, but a few, like the graphemic cued recall test (Blaxton, 1989), are data-driven.

Roediger & Blaxton (1987a) pointed out that the distinction between data-driven and conceptually driven tests is not a dichotomy, and suggested that memory tests can be arranged along a continuum reflecting different amounts of perceptual or conceptual processing. Among data-driven tests, for example, it has been suggested that some tests, like the perceptual identification test are "more data-driven" than other tests, such as WFC. Recently, two continua – one reflecting perceptual processing, and one reflecting conceptual processing – has been proposed instead of one (Roediger & Challis, 1992). In this second conceptualization, data-driven and conceptually-driven processing are two separate dimensions, and hence, do not necessarily trade off against each another. For example, a memory test--or a study task--can be high on both types of processing.

The main prediction of the data-driven/ conceptually-driven view, then, is that data-driven tests, such as perceptual tests, will benefit more from study conditions that emphasize data-driven processing, whereas conceptually-driven tests, such as conceptual and most explicit tests, will benefit more from study conditions that emphasize data-driven processing. This prediction is consistent with most of the standard data summarized before. It can explain why conceptual manipulations tend to affect explicit tests and conceptual tests, but not perceptual tests, whereas perceptual manipulations produce the opposite effect. Since the operational definitions of data-driven test and conceptually-driven tests are based on the read-generate manipulation, the pattern of results produced by this manipulation are, by definition, consistent with the data-driven/conceptually-driven view. This view can also account for evidence of null different format priming on perceptual tests. Since these tests depend on the reinstatement of perceptual operations, study-test perceptual shifts can eliminate priming. Finally, the data-driven/conceptually-driven view can explain why the graphemic cued recall is sensitive to perceptual manipulations, like modality shifts (Blaxton, 1989, Exp. 2), but not to conceptual manipulations, such as imagery (Exp. 3). Despite being explicit, this test is data-driven, and hence, it behaves similarly to perceptual tests. Thus, the critical distinction for this view is not between explicit and implicit tests, but between data-driven and conceptually-driven tests.

However, there are two pieces of evidence that

the data-driven/conceptually-driven view does not readily accommodate. First, it cannot easily explain evidence that, despite a severe impairment on explicit memory performance, amnesic patients show preserved priming on implicit tests. Since explicit performance is impaired, one possible explanation is that amnesic syndrome impairs conceptually-driven processing. However, preserved priming is also found on conceptual tests that are usually classified as conceptually-driven tests, such as the category association test (see Roediger, Weldon, & Challis, 1989). In other words, amnesic memory performance does not depend on whether the test is data-driven or conceptually-driven, but on whether it is explicit or implicit. Second, this view cannot easily account for dissociations between explicit tests, like recognition and cued recall, and conceptual tests, such as the category association test (Rappold and Hashtroudi, 1991; Cabeza and Ohta, in press). Since both types of tests are conceptually-driven, this view does not predict, in principle, dissociations between them.

PRS view

The *PRS view* (Schacter, 1990; Tulving & Schacter, 1990) assumes that explicit tests, perceptual tests, and conceptual tests reflects three different forms of memory: *explicit memory, perceptual priming*, and *conceptual priming* respectively. Like in the data-driven/conceptually-driven view, memory tests are not assumed to be factor-pure; implicit-perceptual tests, for example, may also show some sensitivity to conceptual priming. The PRS view proposes that explicit memory is based on an *episodic memory* system, perceptual priming on a *perceptual representation system* (*PRS*), and conceptual priming on a *semantic memory* system. Episodic memory stores information about personally experienced and temporally dated episodes; PRS is a brain system concerned with the identification of words and objects; and semantic memory is involved on the acquisition and use of factual knowledge. The model also includes a *procedural memory* system, which is responsible of skill performance.

Dissociations and parallel effects between explicit, perceptual, and conceptual tests occur because the functioning of episodic memory, semantic memory and PRS depends on different factors. Semantic factors, for example, play an important role on the operation of episodic and semantic memory, but not on PRS, which is a pre-semantic system. In contrast, the physical characteristics of the information are fundamental to PRS, but not to episodic and semantic memory. On the basis of these assumptions, the PRS view can easily explain most of the dissociations and parallel effects of the standard data. Conceptual manipulations affect explicit test and conceptual tests, but not perceptual tests, because they influence the operations of episodic and semantic systems, but not those of PRS. Perceptual manipulations, on the other hand, affect perceptual tests, but not conceptual test and explicit tests, because they alter the functioning of PRS, but not the operations of episodic and semantic memory. The effects of the read/generate manipulation can be explained as a combination of a perceptual and a conceptual manipulations. Finally, reports of nonsignificant different form priming on perceptual tests are consistent with the assumption that these tests are based on PRS, which is a pre-semantic perceptual system, and hence, highly sensitive to perceptual study-test overlap. It is important to notice that these explanations are not circular, because the hypothetical properties of the three memory systems are supported not only by priming data, but also by various kinds of neuropsychological evidence (see Tulving & Schacter, 1990).

Unlike the data-driven/conceptually-driven approach, the PRS view can easily explain why amnesic patients show poor performance on explicit tests, but normal priming on perceptual and conceptual tests. According the PRS view, the brain lesions that cause the amnesic syndrome impair the operations of episodic memory, but not those of PRS and semantic memory (Tulving & Schacter, 1990). Since semantic memory is also assumed to underlie the acquisition and use of factual information, this assumption implies that it should be possible to find evidence of learning of new factual information in amnesics. This evidence exist and has been reviewed by Tulving et al. (1991). The PRS view can also account for the dissociations between explicit and conceptual tests (Rappold & Hashtroudi, 1991; Cabeza & Ohta, in press). These two kinds of tests are assumed to be based on different systems, and hence are in principle dissociable. The weakness of

the PRS view is its difficulty to account for dissociations between conceptually-driven and data-driven explicit tests (Blaxton, 1989). Since all explicit test are assumed to depend on the episodic system no dissociations are predicted in principle between them.

In sum, both standard theoretical views can explain why conceptual manipulations affect explicit test, and conceptual tests, but not perceptual tests; why perceptual manipulations affect perceptual tests, but not conceptual test and explicit tests; why generate is better for explicit test and conceptual tests, but read is better for perceptual tests; and why there is not different form priming on perceptual tests. The data-driven/conceptually-driven view has difficulties explaining preserved priming in amnesics, and dissociations between conceptually-driven explicit tests and conceptual tests. The PRS view can account for this evidence, but it cannot readily accommodate dissociations between conceptually-driven and data-driven explicit tests. Despite these small limitations, both theories provide an excelent account for most of the standard data. Unfortunately, priming data is not so simple as it was described in the section of standard data. In recent years, many studies have found results in dissagreement with the standard data. The next section reviews some of these inconsistent findings.

Inconsistent Data

For the sake of simmetry, the results in this section are divided in five groups. Each group contains findings that represent exceptions or anomalies of the five general conclusions that summarized the standard data. For example, the first statement of the standard data was that conceptual manipulations affect explicit tests and conceptual tests, but not perceptual test, whereas the first part of this section reviews reports showing that conceptual manipulations can affect perceptual tests.

Conceptual manipulations can also affect perceptual tests

One of the most conspicuous inconsistencies with the standard data are reports of LOP effects on perceptual tests. As it was said before, there is a widely held idea that this kind of tests are insensitive to conceptual manipulations such as LOP. However, Challis & Brodbeck (1992) presented evidence showing that this idea is actually incorrect. They reviewed sixteen experiments that examined LOP effects on perceptual tests, and found that in most experiments priming in the semantic condition was greater than in the physical condition, and that in many of them this difference was also significant (e.g., Squire, Shimamura & Graf, 1987; Srinivas & Roediger, 1990; Bowers & Schacter, 1990; Graf, Squire & Mandler, 1984). Challis and Brodbeck themselves investigated the LOP manipulation on the word fragment completion test, and found significant LOP effects in three different experiments. According the authors, reports of LOP effects on perceptual tests were disregarded for three reasons. First, in some cases, the effects were relatively small, and the statistical power of the experiments was not enough to detect them. Second, the absence of LOP effects on perceptual tests was consistent with original reports (e.g., Jacoby & Dallas, 1981; Graf & Mandler, 1984) and with dominant theoretical accounts. Third, significant LOP effects were attributed sometimes to a contamination of the perceptual test by explicit retrieval strategies (e.g., Bowers & Schacter, 1990; Squire, et al., 1987).

An interesting additional finding of Challis and Brodbeck (1992) is that significant LOP effects on WFC appear in conditions in which subjects perform the same kind of task with all items in a list (semantic and physical tasks are varied between-subjects, or within-subjects in blocked lists), but not when the task changes randomly for each item (within-subjects with mixed lists). Significant LOP effects were due to a decrease in physical condition (Expts. 1, 2 and 3), or to an increase in the semantic condition (Exp. 4). Challis and Brodbeck discussed these results in relation with three possible explanations of LOP effects in perceptual tests. The first explanation is that LOP effects reflect the use of explicit retrieval strategies. Since semantically encoded items are better recalled than physically encoded items (e.g., Craik & Tulving, 1975; Graf & Mandler, 1984), if subjects try to recall study items during the implicit test, the semantic condition will surpass the physical condition. This explanation was used to account for significant LOP effects on perceptual tests (e.g., Bowers & Schacter, 1990; Squire et al., 1987), but it

cannot accommodate the results of Challis and Brodbeck (1992) first three experiments, where LOP effects in the unmixed list condition were due to a decrease on the physical condition, rather than to an increase in the semantic condition. The results of the fourth experiment, on the other hand, are compatible with this explanation.

The second explanation is that the LOP manipulation affects not only conceptual, but also perceptual processing of the stimuli. It is possible, for example, that the shallow task of the physical condition does not allow the minimum of perceptual processing necessary for lexical access, which seems to be a necessary condition for priming (Weldon, 1991). This effect could be more severe when subjects perform the physical task with all the items in the list, than when the task vary in an unpredictable fashion. According this interpretation, LOP should appear in the unmixed list condition due to a decrease in the physical condition. This interpretation is consistent with the results of the first three experiments. Conversely, it is possible that the semantic condition enhance not only conceptual, but also perceptual processing (see Mandler, Hamson, & Dorfman, 1990) generating in this way more priming on perceptual tests. This interpretation is consistent with the results of the fourth experiment. Finally, the third explanation is that perceptual tests are not factor-pure measures sensitive only to perceptual processes, but that they are also sensitive to conceptual processing. This hypothesis can account for significant effects of conceptual manipulations, such as LOP, on perceptual tests. It can also account for several reports—to be reviewed later—that priming on perceptual tests can occur even in the absence of perceptual match between study and test items.

Challis and Brodbeck pointed out that if any of the three explanation is valid, LOP effects on perceptual tests would be consistent with contemporary theories of implicit and explicit memory. If LOP effects are caused by a fortuitous contamination by explicit strategies, by a perceptual component on the LOP manipulation, or by a conceptual component on perceptual tests, they would be compatible with the idea that perceptual tests are basically immune to conceptual manipulations. The third explanation, however, imply a risk for theoretical accounts of priming. Neither of two theoretical accounts described assume that memory tests are factor-pure measures, and hence they can account for LOP effects on perceptual tests by claiming that these tests not only involve data-driven, or PRS processing, but also conceptually-driven, or semantic processing. However, if the mixture of processes involved by a particular test cannot be estimated, and precise predictions cannot be made, then there is a risk that some assumptions of the two views become impossible to falsify, because inconsistent data can be explained in term of a mixture of components in the test.

In sum, Challis and Brodbeck showed that the widely held idea that perceptual tests are immune to conceptual manipulations is actually wrong. The reason to summarize at length their article is that several points of their discussion are relevant in general to all the group of findings inconsistent with the standard data, and standard theoretical approaches. First, Challis and Brodbeck suggested that LOP effects on perceptual tests were overlooked because they were not consistent with original reports and the main theoretical accounts. The same phenomenon might have occurred for many of the inconsistent data described in this section. Second, Challis and Brodbeck found that the outcome of a experimental manipulation may depend on apparently minor methodological factors, such as whether study lists are mixed or unmixed. This second point too is pertinent to other inconsistent data. Third, they suggested different ways in which an inconsistent finding can be explained without abandoning standard theoretical accounts. An account in terms of a contamination by explicit strategies can be applied to any inconsistent finding in which an implicit test behaves as an explicit test, when it is not supposed to do so. The proposal that a conceptual manipulation is also perceptual, or that a perceptual manipulation is also conceptual, can be used to account many other inconsistent findings. Finally, the notion that memory tests are not factor-pure but involve a mixture of components can explain many inconsistent outcomes.

Perceptual manipulations sometimes do not affect perceptual tests and affect conceptual and explicit tests

According the standard data, perceptual manipulations affect perceptual tests, but not conceptual tests and explicit tests. However, there are reports showing counterexamples to each of these three conclusions. Sometimes, perceptual manipulations do not affect perceptual tests, but affect conceptual tests and explicit tests. These three group of counterexamples are discussed in order. One perceptual manipulation that usually does not affect priming on perceptual tests is the change of surface features of the information (e.g., case, script, typefont, typography, voice) between study and test. In most of the studies that have manipulated surface features different form priming was as large as same form priming (e.g., Carr, Brown, & Charalambous, 1989; Clarke & Morton, 1983; Levy & Kirsner, 1989; Scarborough, Cortese, & Scarborough, 1977).

It would be possible to argue that among perceptual manipulations, study-test shifts on surface form are the ones that involve the slightest form of study-test perceptual mismatch. Nevertheless, even surface manipulations preserve modality and the basic structural components of the items (e.g., the letters of a word), the change in perceptual appearance they involve is not insignificant. For example, when the case of a word is changed (e.g., dinosaur, DINOSAUR) the appearance of most letters (e.g., d-D; n-N; a-A) changes considerably. Thus, findings showing that surface manipulations does not affect priming on perceptual tests is inconsistent with the idea that priming in these tests is extremely dependent on the reinstatement of perceptual features of the information.

Second, evidence that perceptual manipulations can affect conceptual tests has been found by Cabeza (1992) on the conceptual sentence completion test. This test is similar to the general knowledge test, but its cues are not questions (*What is the name of the gigantic reptile that became extinct during prehistory?*), but sentences with blanks (*The cave man fled terrified when he saw the shadow of an enormous* _____.). Cabeza (1982) changed the script in which Japanese targets were presented at study and completed at test. In Japanese, most words can be written both in an ideographic script called *kanji*, and in a phonographic script called *hiragana*. The same semantic information seems to be accessed when a word is read in kanji or in hiragana, and hence, the manipulation of script seems to be fundamentally perceptual.

If the study-test shift on script is a perceptual manipulation it should affect perceptual tests, such as completion tests, but not conceptual tests, such as the sentence completion test. Confirming the first prediction and in agreement with the transfer-appropriate processing principle, Cabeza (1992) found that words presented in hiragana produced more priming on a hiragana completion test than words presented in kanji, and that the opposite was true in a kanji completion test. Surprisingly, the script manipulation affected also the sentence completion test: hiragana words generated more priming in a hiragana sentence completion test than kanji words. One possible explanation of this result is that manipulation of Japanese writing system is not purely perceptual, and affects also conceptual processing. However, this hypothesis is inconsistent with another result of the same experiment showing no effects of the script manipulation on an explicit version of the sentence completion test. Since explicit tests are supposed to be sensitive to conceptual factors, if the script manipulations has an important conceptual component it should have affected also the explicit test.

Finally, there exist also findings showing the effects of perceptual manipulations on explicit tests. One of this findings was reported by Graf and Ryan (1990, Exp. 3), who investigated the effect of a typeface study-test shift on word identification and recognition. At study, words were presented in a shadow, or in a pudgy font, and at test, words were displayed either in the same (S-S, P-P), or in a different font (S-P, P-S). During study, subjects either rated the readability of the words, or rated how much they liked them. In the liking rating condition, the font manipulation did not affect any of the two tests, but in the readability affected both of them. Both priming in the word identification test, and recognition performance was higher when format at study and test was the same, than when it was different. Two results are pertinent for the present section. First, the finding that the font manipulation affected a perceptual test is an exception to the conclusion,

discussed before in this section, that surface form manipulations do not usually affect perceptual tests. Second, the effects of the font manipulation on the recognition test are inconsistent with the idea that explicit tests are immune to perceptual manipulations. Graf and Ryan provided explanations for both results.

Graf and Ryan (1990) interpreted their results on the basis of an activation view based on the concept of integration (e.g., Mandler, 1980; Graf, Mandler, & Haden, 1982; Graf & Mandler, 1984; Mandler, Hamson, & Dorfman, 1990). Integration is an intra-event process that occurs automatically whenever an event (e.g., a word) is presented, and consist on an increase on the organization of the features that constitute the schema of the event. Integration is differentiated from elaboration, which is a inter-event process (Mandler, Hamson, & Dorfman, 1990). For example, when a list of words is studied, integration involves processing the features composing each word into an organized unit, whereas elaboration involves associating each word with other words, with situational cues, with prior knowledge, etc. Priming on perceptual tests is assumed to depend on integrative processing, whereas explicit performance depends primarily on elaborative processing.

According Graf and Ryan, skilled reading involves minimal feature processing, and is based primarily on pre-existing representations. Therefore, representations encoded while reading contains few details about surface features of the information. This explain why in most studies surface manipulations do not affect perceptual tests. However, when feature processing increases, e.g., due to an unfamiliar format or a physical study task, integrative processing yields a distinctive representation containing format-specific information. Such representation is more likely to be redintegrated at test when items are presented in the same, than in a different format. This assumption explain the effects of the font manipulation in word identification in Graf and Ryan's (1990) third experiment. The integration/ of elaboration view can also explain the effects of the study-test font shift on recognition performance, because according this view integration plays also a role in recognition, particularly at short delays (Mandler, 1980, 1988): recognition cues trigger a reintegration process, originating a feeling of familiarity that is used as a basis for recognition judgments.

In sum, Graf & Ryan (1990) showed that a perceptual manipulation can affect recognition performance. According the integration/elaboration view, these effects occur because, under certain conditions, recognition judgments are based on familiarity, which reflects the same redintegrative processes underlying priming. The idea that recognition judgments can influenced by priming effects was also proposed by Jacoby & Dallas (1981). In tests like word identification, priming effects appear as perceptual fluency, i.e. an increased accuracy or speed to identify some words. In a recognition test too, primed words will be perceived more fluently, producing a feeling of familiarity that induce subjects to judge these words as old. Johnston, Dark, & Jacoby (1985) corroborated this idea by having subjects first identify an item, and then judge it old or new. Items judged old were identified faster than items judged new, suggesting that the probability to judge an item old depends on the fluency with which it is perceived. If the effects of perceptual manipulations on the recognition test occur because this test is also sensitive to priming, then they are not inconsistent with the main theoretical accounts of priming. In the same way LOP effects in word fragment completion can be explained by assuming that this test involves also a conceptual component (Challis & Brodbeck, 1992), the effects of perceptual manipulation on recognition can be accounted by the hypothesis that recognition has a perceptual component.

More difficult will be to explain significant effects of a perceptual manipulation in an explicit test unlikely to have a perceptual component, such as free recall. Such finding was recently reported by Hunt and Toth (1990). These authors investigated the effect of orthographic distinctiveness on word fragment completion, perceptual identification and free recall. The manipulation of orthographic distinctiveness involves a comparison between orthographically common (e.g., *sleet*) and orthographically distinctive words (e.g., *sphinx*). Since orthography is a surface feature assumed to influence visual sensory processes, this manipulation can be classified as a perceptual manipulation. In conformity with accepted notions, orthographic distinctiveness pro-

duced a marked effect on word fragment completion, with orthographically distinctive words yielding more priming than orthographically common words. Priming on the perceptual identification test was not affected by the manipulation. The surprising result of this experiment was that the free recall showed the same patter as word fragment completion: orthographically distinctive words were better recalled than orthographically common words. Although puzzling, the effect orthographic distinctiveness on free recall is a reliable phenomenon.

According Hunt and Toth (1990), the effects of this manipulation occur because orthographically distinctive words are easier to discriminate, and hence, are accessed more precisely during retrieval. They suggest that both free recall and fragment completion require the production of a particular word, and benefit by enhanced precision of lexical reproduction. In perceptual identification, this effect is neutralized by the fact that orthographically distinctive words require more processing time, and are in disadvantage in brief presentations. The effects of a perceptual manipulations on free recall are inconsistent with the two main theoretical accounts to implicit memory. Unlike recognition, the free recall test does not provide perceptual information, and hence it is difficult to assume that it involves redintegrative processing, or is affected by perceptual fluency. An alternative explanation is that the orthographic distinctiveness manipulation is not a purely perceptual manipulation. Hunt and Toth (1990) acknowledge that the idea that orthographic distinctiveness effects depends on conceptual processing is difficult to eliminate, but discarded it on the grounds that the clustering of OD and OC words was not significant (Hunt & Mitchell, 1982), and reports that WFC does not depend on semantic search (Nelson, Keelaean, and Negrao, 1989). The moderate assumption that orthographic distinctiveness involves a conceptual component is probably still more difficult to exclude.

The three types of inconsistent findings reviewed in this section are difficult to account for both of the two standard theoretical accounts. The data-driven/conceptually-driven view cannot easily explain why surface form manipulations do not usually attenuate priming on perceptual tests. As discussed later, Roediger & Blaxton (1987b) suggested that the amount of mismatch produced by this manipulations is minimal compared to other study-test shifts such as modality, and hence, considerable different form priming after surface manipulations is consistent with the data-driven/conceptually-driven notion. However, as noticed before, the change in perceptual form involved in surface manipulations is considerable. As for the effect of script on the conceptual sentence completion test, the data-driven/conceptually-driven view could argue that the script manipulation involve a conceptual factor, or that conceptual tests involve a perceptual component. However, the first idea is inconsistent with the null effects of script on an explicit test, and the second with findings showing that conceptual tests are not affected by other perceptual manipulations, such as modality (Srinivas & Roediger, 1989). Finally, the effects of a font shift on recognition and an orthographic distinctiveness manipulation on free-recall are inconsistent with the notion that explicit tests is basically conceptually-driven. A data-driven component could be assumed in recognition, but is implausible in a free-recall test.

The PRS view has also difficulties to account for the inconsistent findings reviewed in this section. First, failures to find a reduction of priming on perceptual tests as an effect of surface form shift does not harmonize with the idea that perceptual priming is based on a pre-semantic, hyperspecific memory system. Second, script effects on the sentence completion test does not agree with the idea that conceptual priming is based on semantic memory, a system assumed to store abstract representations. Finally, the effects of perceptual manipulations on explicit test does not fully harmonize with the idea that episodic memory is affected primarily by the meaning of the information. However, like the data-driven/conceptually-driven view, the PRS view could partially account for many of the aforementioned findings on the basis of the notion that memory tests are not factor-pure, but involve a mixture of components. For example, explicit tests might reflect also perceptual priming, and hence, be sensitive to perceptual shifts.

Generate can be better than read also on perceptual tests

A third group of evidence inconsistent with the standard data were provided by studies showing

that, under certain circumstances, the generate condition can produce equal or more priming than the read condition on perceptual tests. One of these circumstances occur when words are generated from perceptual cues. In the typical generation paradigm, subjects generate words from conceptual cues, like an antonym (e.g., Jacoby, 1983;*hot-* ???), a related word and the first letter of the target (e.g., Blaxton, 1989; *hawk-e*:); a short sentence with a blank and the initial letter of the target (e.g., Srinivas and Roediger, 1990; *Heroin is related to c*____). Nevertheless, a generation effect (generate >read) can be also found when subjects generate words from perceptual generation cues, like word fragments (e.g., BRO__M). Using this generation paradigm, Glisky and Rabinowitz (1985), found a generation effect on a recognition test. They also found that this generation effect increased when, before making each recognition judgment, subjects generated the targets from the same fragments used at study. The authors proposed that in addition to a general encoding factor, generation effects may also reflect the overlap between study and test operations.

Following Glisky and Rabinowitz (1985), Gardiner (1988) investigated the effect of the generating from fragments on the WFC. He found that, unlike generation from conceptual cues (e.g., Blaxton, 1989), generation from fragments produce as much priming as the read condition, even when the same conditions produce a generation effect in a recognition performance. Moreover, when generation and test cues are identical, the typical negative generation effect in WFC is reversed, and the generate condition produces more priming than the read condition. Gardiner (1988) interpreted these result as supporting the transfer-appropriate principle. When words are generated from conceptual cues, priming is larger in the read condition, because study/test match is greater in that condition. In contrast, when words are generated from the same fragments used at test, priming in the generate condition surpass priming in the read condition, because there is more study-test overlap in the generate than in the read condition.

Toth and Hunt (1990, Exp. 1) found in the perceptual identification test results similar to those of Gardiner (1988) . Read (*dinosaur*) and generation (*d nosaur*) at study was ortogonally crossed with identification of complete words (*dinosaur*) or fragments (*d nosaur*) at test. Identification of complete words (*dinosaur*) was not affected by the study manipulation, but identification of fragments (*d nosaur*) was better for words generated (*d nosaur*) than for words read (*dinosaur*). This experiment indicate that generation effects in word identification, as in the case of WFC (Gardiner, 1988), depends on the reinstatement of perceptual operations (*d nosaur-d nosaur*). According the authors, reinstatement was not critical for complete words, because what is facilitated are the sublexical processes involved in the completion of fragments.

Other evidence suggest that reinstatement of perceptual operations is not the only factor mediating the effects of generation on perceptual tests. Some studies, for example, have found that generate can produce as much priming as read in perceptual tests, even when words are generated from conceptual cues. Schwartz (1989), for example, investigated the effects of the read/generate manipulation on a cued recall test, a perceptual identification, and a version of the word stem completion, she called *letter addition test*. In the cues of the last test, only the last letter have to be added (e.g.,*chim*__) to complete one of two possible words (e.g., *chimp, chime*). In the generation condition, words were generated from short questions and the first letter of the target (e.g., *the opposite of sour*-S). Consistently with the standard notions, generation enhanced recall, but attenuated priming on perceptual identification. Surprisingly, in the letter addition test, the generate condition produced as much priming as the read condition. Schwartz suggested that, unlike the perceptual identification which is basically data-driven, the letter addition test relies on both data-driven and conceptually-driven processing (Challis & Brodbeck's third explanation). Schwartz acknowledged, however, that this interpretation does not harmonize well with the fact that the similar word stem completion test is usually affected by perceptual (e.g., Graf, Shimamura, & Squire, 1985) but not by conceptual manipulations (e.g., Graf & Mandler, 1984).

Even Schwartz' (1989) finding is suggestive, the fact that the letter addition test is not a typical perceptual test allows the possibility to attribute her finding of to a particularity of this test. Nevertheless, similar results have been found with common

perceptual tests, such as WFC. In Hirshman, Snodgrass, Mindes and Feenan (1990), for example, the generate condition yielded better free recall than the read condition (Exp. 5), but both conditions produced similar priming on the WFC (Expts. 4 and 5). Hirshman et al. (1990) suggested the failure to replicate negative generation effects in WFC (e.g., Blaxton, 1989) could be related to a difference on the generating procedure: instead of generating from a word, their subjects generated from a sentence with a blank. Hirshman et al. (1990) speculated that the sentence generation paradigm could involve more or different semantic information so as to equal the read condition, even in the absence of perceptual overlap. Hirshman et al. (1990) explained their results by assuming the existence of two conceptual representations. This hypothesis will be described later.

The role of conceptual factors were also emphasized by Hunt and Toth (1990). In their second experiment, subjects read or generated words in the context of associatively related words (e.g., mop-BROOM; mop-BRO__M), and later identified them paired either with the same or with different, though associated, context words (e.g., mop-BROOM; dirty-BROOM). Identification was better when the study context was reinstated, and a generation effect occurred, but only in the "same context" condition. That is, when the conceptual context was reinstated, the generate condition produce more priming than the read condition, even though there was less perceptual overlap in the generate (mop-BRO__M; mop-BROOM) than in the read condition (mop-BROOM; mop-BROOM). According Toth and Hunt (1990) these results indicate that, in addition to the overlap of perceptual operations, generation effects in word identification reflect also a repetition of conceptual operations.

How do standard views of priming account for the foregoing evidence? As was said before, the data-driven/conceptually-driven view assumes that perceptual tests, which are data-driven, should be favored by study conditions that emphasize data-driven processing, like read, rather than for those that underscore conceptually-driven processing, such as generate. This view could argue that the perceptual tests employed in the foregoing experiments were primarily conceptually-driven, rather than data-driven, or that the generation paradigms utilized was primarily data-driven, rather than conceptually-driven (Challis & Brodbeck's second and third explanations). The first argument can be easily applied to Schwartz' (1989) finding, inasmuch as the letter addition test is a largely unexplored test. Yet, this argument cannot easily account for Hirshman et al's (1990) results, because the WFC has been classified as data-driven, on the basis of the read/generate manipulation (Blaxton, 1989). The second argument seems to account well for generations effects found by using a generation-from-fragments paradigm (Gardiner, 1988; Toth and Hunt, 1990). It seems reasonable to assume that when generation is done from fragments rather than from conceptual cues, generation involves more data-driven, than conceptually-driven processing. Nevertheless, this hypothesis is inconsistent with the fact that generation-from-fragments produces generation effects also on recognition (e.g., Glisky & Rabinowitz, 1985; Gardiner, 1988), which is supposed to depend primarily on conceptually-driven processing. Moreover, the generate condition can yield more priming than the read condition in word identification, even when the generate condition involves less perceptual reinstatement than the read condition (Toth & Hunt, 1990).

As for the PRS view, it assumes that perceptual tests reflects perceptual priming, which is based on a pre-semantic system, extremely sensitive to perceptual aspects of the stimuli. Generation effects on perceptual tests that appear only when study and test cues involve the same perceptual information (BRO__M; BRO__M) are consistent with this view. Generation effects when perceptual information is different (mop-BRO__M; mop-BROOM) can be explained on the assumption that when a context word is included, the test involve also conceptual priming, and like conceptual tests, it shows generation effects (Blaxton, 1989). In sum, the PRS view seems to be able to accommodate the inconsistent findings reviewed in this section.

Tests belonging to the same group can be dissociated

The standard data comprise dissociations between explicit tests, perceptual tests, and conceptual tests. These dissociations support the distinction be-

tween these two types of tests, and, in general, the three standard theoretical accounts. However, dissociations have not only been found between tests belonging to different groups, but also between tests that are usually classified within the same group. According to the standard accounts of priming, dissociations between memory tests occur when they tap different forms of processing, or different memory systems. Dissociations, then, are not predicted between tests assumed to tap the same kind of processing, or the same memory system. Nevertheless, four groups of such dissociations are reviewed in this section. Dissociations between different explicit tests (e.g., dissociations between recall and recognition) are not reviewed here due to space limitations.

First, several studies have reported dissociations between different perceptual tests, in particularly between completion tests and identification tests. One of these reports was mentioned before: Schwartz (1989) found more priming on the read than on the generate condition on a word identification test, but comparable priming on these conditions on a letter addition test. She suggested that priming in identification relies more on data-driven than on conceptually-driven processing, whereas priming in completion relies on both kinds of processing. Completion and identification test has been diverged also by contingent dissociations. Witherspoon and Moscovitch (1989), for example, found stochastic independence between a word fragment completion and a perceptual identification test. Similarly, Perruchet & Baveux (1989) found low correlation between these two perceptual tests.

Second, dissociations between two perceptual tests can occur even when both tests are based on the same kind of cues. Weldon and Roediger (1987, Exp. 4), for example, found a dissociation between a WFC, and a picture fragment identification test. The cues of both tests are fragments; fragments of words in the former, or fragments of pictures in the latter. Subjects studied words and pictures, and then performed one of the two tests. The results showed that words generated more priming than pictures on the WFC, whereas the reverse was true on the picture fragment identification. According the authors, this cross-over dissociation supports the transfer appropriate processing principle, because performance was better in the conditions with greater study-overlap. It is interesting to notice, however, that despite supporting the TAP principle, this dissociation is not predicted by the data-driven/conceptually-driven view.

Third, dissociations have been found even between two versions of the same test. Hayman and Tulving (1989) found stochastic independence between to successive WFC, that differed only on the letters provided by their fragments. For example, in the first WFC the word AARDVARK was cued by A____D___RK, whereas in the second, it was cued by the complementary fragment__AR__VA____. When the same tests were presented with explicit instructions (cued recall tests), the two tests were moderately dependent. According the authors, these results support the idea that, unlike episodic and semantic memory, the system that supports priming is not based on unitized or integrated traces, but on the "strengthening of particular stimulus-response connections" (p. 953). When there are focal traces the same information can be accessed through different cues, but when they do not exist, access depends on the particular perceptual structure of the cues. This assumption can also explain the contingent dissociation between WFC and WI found by Witherspoon & Moscovitch (1989), because the perceptual structure of the cues of these two tests is quite different.

Finally, dissociations can be found between different data-driven tests, and between different conceptually-driven tests. As was said before, amnesic show impaired performance on explicit tests, but not on implicit tests, regardless the data-driven or conceptually-driven nature of the tests used. Evidence from normal subjects was recently provided by Tenpenny & Shoben (1992). They found a dissociation between two conceptually-driven tests. Subjects studied atypical exemplars of categories paired with a string of Xs, with a typical, or with an atypical member of the same category, and then received on of two tests. In the semantic cued recall test, subjects used typical or atypical members of the target's category as a cue for the target. In the *category membership verification task* they saw a category label followed by the target and a typical or atypical exemplar of the same category, and had to indicate whether both items belonged to the category. The results showed a dissociation between the two

tests: semantic cued recall was greater with atypical test cues than with typical ones, whereas the opposite was true in the verification task. These effects were localized on the conditions in which typicality at study and test matched. In the semantic cued recall test, atypical cues were superior only for words studied with an atypical context word; in the verification task, typical cues were better only for target studied with typical context words.

Tenpenny and Shoben (1992) also found a dissociations between two data-driven tests, graphemic cued recall and WFC. Graphemic cued recall showed better performance for words studied in the context of a graphemically related word, than for those studied in the context of a semantically related word, whereas WFC was not affected by the manipulation. Moreover, graphemic cued recall tended to be better on low-frequency words, whereas WFC was better for high-frequency words. Tenpenny and Shoben interpreted their results as supporting the transfer appropriate processing notion, but undermining the data-driven/conceptually-driven distinction: performance was a function of the overlap between study and test operations, but dissociations were found between two conceptually-driven tests, and between two data-driven tests.

Dissociations between tests assumed to belong to the same group represent a problem for all the two standard theoretical accounts of priming. As Schwartz (1989) suggested, the data-driven/ of conceptually-driven view can account for dissociations between identification and completion tests on the assumption that the former is fundamentally data-driven, whereas the latter involves both data-driven and conceptually-driven processing. This assumption could be also used to explain contingent dissociations between these two tests (Witherspoon & Moscovitch, 1989). This explanation is less convincing when the tests dissociated are very similar, like the word fragment completion and the picture fragment identification (Weldon and Roediger, 1987), and even less they are two versions of the same test (Hayman & Tulving (1989). Finally, the data-driven/conceptually-driven view cannot easily account for the dissociations between two conceptually-driven, and between two data-driven tests found by Tenpenny & Shoben (1992).

The PRS view could account for dissociations between identification and completion tests by assuming that identification tests depend primarily on PRS, whereas completion tests depend on both PRS and semantic memory. In other words, identification tests reflect mainly perceptual priming, whereas completion tests reflect both perceptual and conceptual priming. As was said before, this view can account for dissociations between two versions of WFC on the assumption that PRS does not store integrated memory traces. This view can also explain the dissociations found by Tenpenny & Shoben (1992) because these dissociation occurred between explicit and implicit tests, which are assumed to depend on different memory systems. In sum, the PRS view seems to provide a somewhat more consistent theoretical account for dissociations between tests that belong to the same group.

There is different form priming on perceptual tests

As was said before, earliest studies failed to find priming in the absence of perceptual overlap. They showed, for example, that perceptual identification was not facilitated by hearing a word (Jacoby & Dallas, 1981; Morton, 1979), or generating it (Morton, 1979; Winnick & Daniel, 1970). These original reports were consistent with the idea that perceptual tests reflect primarily data-driven processing, or are based in a pre-semantic perceptual representation system. However, several studies have shown that significant priming can be found not only when surface form, modality, symbol type and language of study and test items match, but also when the do not match. These results suggest that priming in perceptual tests is not mediated exclusively by perceptual operations. Manipulations that involve study-test perceptual mismatch can be divided in five groups: surface form, modality, generation and inference, symbol type, and language. Different form priming has been found in all of them.

First, study-test shift on surface form within the same modality are assumed to involve the slightest form of perceptual mismatch between study and test items. Most of the studies that manipulated case, script, typefont, typography, or voice, have found significant different form priming. Moreover, in many of them priming in the different form priming was as large as in the same form priming (e.g., Carr,

Brown, & Charalambous, 1989; Clarke & Morton, 1983; ; Levy & Kirsner, 1989; Scarborough, Cortese, & Scarborough, 1977). In the study reviewed before, Graf and Ryan (1990) suggested that appearance shifts attenuate priming only when there is an extensive perceptual analysis during encoding, as an effect of the unfamiliar format of the stimuli, to the study task.

Second, a more radical form of perceptual mismatch occurs in study-test modality shifts. Unlike the previous group of manipulations, modality shifts generally produce a marked attenuation on priming in the mismatching condition (e.g., Clarke & Morton, 1983; Blaxton, 1989; Jacoby & Dallas, 1981). Nevertheless, in most studies, priming in the different-modality condition, although smaller, was still significant. For example, Bassili, Smith, & MacLeod (1989, Exp. 1) performed a complete manipulation of modality and compared the effect of visual and auditory presentations on visual and auditory stem completion tests. Results showed more priming in the same-modality conditions (36.5 %), but also a significant amount of priming in the different-modality conditions (22.9%). According the authors, these results underscore the role of non-perceptual processing in priming. An alternative hypothesis is that cross-modal priming occurs because subjects form an image of the stimuli in the other modality (Jacoby & Witherspoon, 1982). In fact, Roediger & Blaxton (1987b) found that auditorily presented words produced more priming in a WFC when subjects were instructed to imagine the words in print. The imagery explanation is difficult to eliminate, but some methods have been proposed, and are discussed later. At any rate, the imagery explanation cannot account for priming in the mismatching condition in surface form manipulations. It is unlikely, for example, that subjects that see a word in lowercase would imagine it in uppercase, or vice versa.

A third type of perceptual mismatch occur when subjects do not actually perceive the targets during the study phase. One of these conditions is the generate condition of the read/generate manipulation, which apparently does not involve any perceptual input, but usually produces significant priming on perceptual tests. It would be possible to argue, however, that perceptual input in the generate condition is not completely absent. First, subjects typically say generated words aloud, and hence, there is an auditory input; and second, generation cues, even conceptual ones, usually provide a portion of the target (e.g., *hawk; e:*). Nevertheless, these two factors does not seem to have a critical effect on priming in the generation condition. Schwartz (1989), for example, compared generation aloud with silent generation (Exp. 1), and conceptual cues with or without the first letter of the target (Expts. 2a and 2b) and did not found any significant effect of these manipulations.

According Hirshman et al. (1990), significant priming in the generate condition in word and picture fragment completion tests is mediated by a conceptual representation. Since priming and free recall performance in their experiments were not correlated, they suggested that the conceptual representation that mediates generation priming on completions tests is not the same the mediates generation effects on free recall. According the authors, the generation task involve two component search processes: an initial *elaborative search process* based on the information provided by the generation cue, and a subsequent *perceptual search process* based on the information generated by the previous search. The first search strengthens associations between the elaborated information originating an *elaborative semantics* representation; the second search strengthens the representations of the simultaneously activated semantic, visual, and phonological information, and constitute a *perceptual semantics* representation. Whereas generation effects on free recall depends primarily on elaborative semantics, generation priming in identification test is based mainly on perceptual semantics.

Another condition that produce priming in the absence of perceptual input occurs when words are inferred at study. In Bassili et al. (1989, Exp. 2) subjects saw or heard sentences like "The *boat* traveled underwater" and inferred the subject noun (*submarine*), or sentences like "The *submarine* traveled underwater" and categorized the subject noun (*boat*). Presented words produced more priming (22.4%) in visual and auditory stem-completion tests, but inferred words produced significant priming (15.3%), in a level comparable to the cross-modality conditions (16.7%). The authors concluded that priming in the inference and cross-modality condi-

tions "reflect the effect of the same conceptually driven processing operations" (p. 451). However,, as in the case of cross-modality priming, priming in the generate and the inference condition can be accounted in terms of an imagery explanation.

Fourth, a radical form of mismatch occurs when subjects are presented with pictures and tested on words, or vice versa. Weldon and Roediger (1987) found that words produce more priming than pictures on the WFC, but pictures produce also a significant amount of priming. As in the cases of modality, generation, and inference, an imagery explanation is also applicable here: pictures produced priming in WFC because subjects were covertly labeling them. In order to investigate this possibility, Weldon and Roediger's (1987, Exp. 2) had instructed their subjects either to label the pictures, or to perform a study task that obstructed labeling, to study carefully the details of the pictures. Even the label condition yielded better free recall performance than the picture -details condition, both produced a similar amount of cross-symbol priming on WFC. They also found (Exp. 3), that picture priming in WFC was similar regardless whether the names of the pictures were thought, mouthed silently, or said aloud (see also Brown, Neblett, Jones, and Mitchell, 1991). These experiments suggest that cross-symbol priming is not the effect of covert labeling.

Cross-symbol priming has been also found when study items are words and test items are pictures. Hirshman et al. (1990), for example, found priming on a picture fragment identification test for words generated from sentences with blanks, but not for words read in the context of a sentence (Exp. 2 & 3). These results suggests that cross-symbol priming is mediated by conceptual processing, but the imagery explanation is also possible. In the generation condition, subjects could have constructed mental images of the referents of the words, which are "data-driven representations" (Hirshman et al., 1990, p. 640) similar to the pictures of the test. However, if generation priming occurs because subjects imagine objects similar to the cues of the test, it should not occur when test cues are verbal like in the standard WFC, but it does (Hirshman et al., 1990, Exp.4). Like Weldon & Roediger's (1987, Expts. 2 & 3) experiments, this suggest that the imagery explanation is not enough to account for cross-symbol priming on perceptual tests.

Even significant in many cases, cross-symbol priming is usually much smaller than intra-symbol priming—about one fourth, according Weldon & Roediger (1987). However, Brown et al. (1991) found that this difference exists when, as in most studies, symbol type is manipulated within-subjects with mixed lists (Expts. 2, and 6), but not when it is varied between-subjects with unmixed lists (Expts. 1, 1a, and 5). According Brown et al. (1991), when word and pictures are presented in unmixed lists, subjects attention is not particularly drawn by the perceptual features of the stimuli, and there is a general lexical activation of word units, regardless the symbol-type of the prime. In contrast, when words and pictures are presented in mixed lists condition, subjects attention is focused on perceptual features of the stimuli to the detriment of lexical processing, and hence, the test is affected by perceptual overlap.

Finally, priming has also been found in bilinguals when words are presented in one language and tested in a different language. Most studies that investigated language manipulations did not find significant long-term interlingual priming on perceptual tests (e.g., Durgunoglu & Roediger, 1987; Kirsner, Smith, Lockhart, King, & Jain, 1984; Scarborough, Gerard & Cortese, 1984). However, Smith (1991) has recently demonstrated that interlingual priming occur in WFC when words are read in sentences (Exp. 1), or inferred from sentences (Expts. 1 & 2), but not when words are studied in a random list (Exp. 2). The critical factor seems to be the sentence context, rather than degree of elaboration, because Durgunoglu & Roediger (1987) failed to found interlingual priming in WFC, even when words were studied elaboratively (forming images study task). According Smith (1991) the two languages of a bilingual are represented separately at the lexical level, but feed into a common semantic representation. Cross-language transfer is difficult to find in perceptual tests, such as lexical decision or WFC, because they rely primarily on lexical representations. However, sentence processing involves a kind of conceptual integration that encourages subjects to recruit semantic information while performing the WFC, and hence, interlingual priming occurs in this test.

The foregoing studies about surface form, modality, generation and inference, symbol type, and language have reported significant different form priming in different perceptual tests. Roediger and Blaxton (1987b) and Kirsner and Dunn (1985) tried to find an pattern in the results of such manipulations. Roediger and Blaxton (1987b) reviewed the effect of typography, modality, symbol, and language manipulations on WFC, and proposed that the magnitude of priming depends on the similarity between data processed at study and the fragments of the test. Priming is maximal when presentation is visual and typography matches the one of the test (0.27). It decreases slightly when typography mismatches (0.23), but considerably when words are presentated auditorily (0.16). Finally, it is very small for pictures (0.07), and almost null for words presented in other language (0.02). According Roediger and Blaxton (1987b), these results support the notion the WFC is a data-driven test.

Kirsner and Dunn (1985) summarized the results of 28 experiments involving lexical decision, naming, fragment completion, and semantic classification tests, by means of an index called *relative priming*, obtained by dividing the amount of priming in the mismatching condition by the amount of priming in the matching condition. Their results indicated that priming is essentially unaffected by changes in voice ($RP = 0.98$), or case ($RP = 0.84$), is markedly attenuated by changes in modality ($RP = 0.38$), and typically eliminated by changes in language ($RP = 0.05$). The arrangement of the effects of study-test manipulations is similar to the one found by Roediger and Blaxton (1987b), but Kirsner and colleagues proposed a different explanation.

Kirsner, Milech, and Standen (1983) proposed that different languages involve separate lexical representations, and that within each language lexical representations have two levels: *modality-specific*, and *modality-independent* . When study and test items are in the same language and modality, even if they differ in voice or case, both modality-specific and modality-independent representations operate and hence priming is maximal. When they differ in modality, only modality-independent representations operate, and priming is intermediate. Finally, when they differ in language, neither of the two levels operates, and there is no priming.

Kirsner, Dunn and Standen (1991) proposed a more complex model in which the attributes of a stimulus are automatically analyzed through successive levels of increasing abstraction. The first level is sensitive to surface form (e.g., case, voice), modality and language; the second level is sensitive to modality and language; the third is sensitive only to language; and the fourth level is sensitive only to meaning, so that words expressing the same concept in different languages have a common representation. Changes in case or voice affect only the first level and produce little or no attenuation on priming. Changes in modality affect the first and second level and produce a marked reduction on priming. Cross-modality priming is based on the third level. Finally, changes in language usually eliminates priming, but the fourth level can account for some cases of interlingual priming (e.g., Kirsner et al., 1984).

How do standard theories of priming account for the existence of priming effects on perceptual tests in conditions in which there is not perceptual overlap between study and test stimuli? As said before, Roediger & Blaxton (1987b) interpreted the effect of study-test manipulations on WFC as supporting the data-driven nature of this test. The fact that in these manipulations priming declines as perceptual overlap decreases is consistent with the data-driven/conceptually-driven view. However, to arrange manipulations in a continuum according the proportion of perceptual overlap they involve is a problematic task. For example, it is difficult to say that spoken and printed words are more perceptually similar than words in different languages, because the"similarity" between spoken and printed words is not perceptual but lexical. At any rate, the main difficulty for the data-driven/conceptually-driven view is to explain different form priming. If priming in perceptual tests reflects transfer of data-driven processing, why does it occur in the absence of perceptual overlap. One possible answer is the "mixture explanation": perceptual tests are not pure data-driven measures, but involve also conceptually-driven processing. However, if different form priming is mediated by conceptual processing, why does it rarely occur between words expressing the same concept in different languages?

The PRS view cannot easily explain different form priming on perceptual tests either. Since PRS is

assumed to be pre-semantic system extremely sensitive perceptual attributes of the stimuli, it follows that even small changes on surface form should eliminate priming based on this system. One possible answer again is the mixture hypothesis: different form priming on perceptual tests is not perceptual priming based on PRS, but conceptual priming based on semantic memory. Since semantic memory is usually assumed to stores abstract representations, it is reasonable to assume also that conceptual priming might occur in the absence of perceptual overlap. However, as said before, if different form priming is based on semantic representations, why is interlingual priming so difficult to obtain.

It seems that the main difficulty of the two standard theoretical accounts to explain different form priming is the perceptual-conceptual dichotomy. Since different form priming is obviously not a perceptual phenomenon, it should be a conceptual one, but then, it should occur across language, when it seldom does. A solution of this problem could be to incorporate a third factor in the discussion. This was done recently by Weldon (1991), who pointed out that priming on perceptual tests depends not only on perceptual and conceptual factors, but also on lexical factors. She arrived to this conclusion after a systematic comparison of the roles of surface encoding, lexical access, and conceptual encoding in priming on two perceptual tests, WFC and perceptual identification. In her first experiment, she compared priming produced by words read, heard, or generated, and by pictures. Priming was maximal in the condition involving perceptual, lexical, and conceptual overlap (read: 0.25), decreased markedly in the conditions entailing only lexical and conceptual overlap (auditory: 0.08; generate: 0.12), and was not significant in the condition assumed to embroil only conceptual overlap (picture: 0.03). These results suggest that lexical access is critical for priming.

In her second experiment, she contrasted the roles of surface encoding and lexical access. Subjects read words (e.g., *tropics*) and anagrams (e.g., *tripocs*). Half of the subjects read the anagrams as nonwords, but half were instructed to mentally interchange the vowels to form words (e.g., *tripocs*). Since the vowels were absent in the fragments of the WFC (e.g.,__*r*__*p*__*cs*), study-test perceptual overlap was identical for words and for anagrams. In the perceptual identification test, in contrast, words (e.g., *tropics; tropics*) had a better match, than anagrams (e.g., *tripocs; tropics*). The results indicated that priming in the anagram condition occurred only when subjects transposed the anagrams into words, and not when they studied the anagram as nonwords. This result, again, underscore the role of lexical access. Perceptual overlap, however, is also important, because in the perceptual identification test, words produced more priming than transposed anagrams.

In her fourth experiment, she compared the effects of lexical access and conceptual processing. In this experiment, lexical access was kept constant, and study-test conceptual overlap was manipulated. Target words (e.g., *black, scotch*) were studied in compounds that preserved the individual meaning of the target (e.g., *backbird, scotch bottle*) or in compounds that altered the individual meaning of the target (e.g., *blackmail, scotch tape*). Priming in WFC was better for the same-meaning compounds than for the different-meaning compounds. In contrast, priming in perceptual identification was not affected by the manipulation of meaning. These results suggest that WFC is more sensitive to conceptual factors than perceptual identification, and that is inadequate to claim that priming depends only on lexical access or only on conceptual processing. According Weldon (1991, p. 538) "surface processing, lexical access, and conceptual processing can all affect priming to different degrees, depending on the particular encoding conditions and priming tests under consideration."

In sum, several studies concerned with the effects of surface form, modality, generation, inference, symbol type, and language manipulations have found significant priming on perceptual tests in the absence of study-test perceptual overlap. The standard data-driven/conceptually-driven and PRS views cannot easily account for this evidence of different form priming. Different form priming cannot be a perceptual phenomenon, but it does not seem to be always a conceptual phenomenon. Weldon's (1991) results suggest that different form priming depends also on lexical access. This idea is not incompatible with the standard views of priming. On the contrary, they can be reformed to incorporate lexical access as an important factor. The main modification required is an integration of the episodic and the activation

accounts of priming mechanisms. The episodic account can explain why priming wanes when study-test perceptual overlap decreases, but the activation account can explain why it does not disappear, even when perceptual overlap is null. The PRS view, for example, can incorporate the lexical factor without much effort, because semantic memory is assumed to store not only factual knowledge, but also the lexicon. Thus, different form priming could reflect conceptual priming, which can be assumed to be sensitive not only to semantic, but also to lexical factors.

Epilogue

Comparisons between explicit, perceptual and conceptual tests have produced a complex pattern of results. At a certain stage of the development the priming research, this pattern could be summarized in five statements: (1) conceptual manipulations affect explicit, and conceptual tests, but not perceptual tests; (2) perceptual manipulations affect perceptual tests, but not conceptual and explicit tests; (3) generate is better for explicit tests and conceptual tests, but read is better for perceptual tests; (4) explicit and conceptual tests can be dissociated; and (5) there is not different form priming on perceptual tests. These fundamental notions constituted the grounds in which the standard theoretical accounts of priming were built. The data-driven/conceptually-driven view assumes that memory performance reflects the transfer of data-driven and conceptually-driven processing, and the PRS view attributes performance on different memory tests to different memory systems. Both views can account for most of the standard data.

Unfortunately, findings inconsistent with the standard data became more and more common, and today there are counterexamples to each of the five basic notions of the standard data: (1) conceptual manipulations can also affect perceptual tests; (2) perceptual manipulations sometimes do not affect perceptual tests and affect explicit tests; (3) generate can be better than read also on perceptual tests; (4) tests belonging to the same group can be dissociated; and (5) there is different form priming on perceptual tests. Some of these inconsistent findings can be accommodated by the standard theoretical accounts by the introduction of small modifications. Other findings are in a more serious disagreement with the standard theories, and point out to the need of new theoretical accounts. At any rate, inconsistent findings are stimulating research on priming, and inspiring new theoretical developments. A personal selection of some enticing issues is presented below.

Perceptual and conceptual factors

As was said before, both the data-driven/ of conceptually-driven view and the PRS view assume in certain extent a basic perceptual-conceptual distinction. Likewise, most empirical work on priming has assumed this polar distinction. Findings inconsistent with the standard data, however, suggest that this distinction should be reconsidered. First, the distinction does not provide a neat classification of encoding and retrieval manipulations. It is questionable, for example, that perceptual manipulations affect only perceptual aspects of processing, and conceptual manipulations affect only conceptual ones. Challis & Brodbeck (1992), discussed the possibility that the LOP manipulation is not purely conceptual, but that it affects also perceptual processing. Conversely, some perceptual manipulations, such as symbol-type shifts, could affect also conceptual factors. As for retrieval manipulations, several authors have suggested that perceptual tests involve also conceptual factors. The difficulty to manipulate perceptual and conceptual factors independently could reflect a intrinsic property of mental operations--changes on perceptual processing always affect conceptual processing and vice versa, or simply a limitation of the present experimental methodology. In both cases, it would necessary to reexamine implicit assumptions about perceptual and conceptual components of processing, and develop different experimental procedures.

Second, the perceptual-conceptual dichotomy cannot easily accomodate different form priming data. Different form priming is not a perceptual phenomenon, but it does not seem to be solely a conceptual phenomenon either. If different form priming were mediated exclusively by conceptual processing, cross-language Priming should be as easily to obtain as cross-modality priming, but it is not. The difference between different modalities and different languages seems to be that different modalities involve the same set of lexical representations, whereas

different languages do not. The study of Weldon (1991) provide strong support for the idea that lexical factors play an important role on priming, and a method to examine the relation perceptual, lexical, and conceptual factors. The shift from a perceptual-conceptual framework, to a perceptual-lexical-conceptual one would involve important changes on the conceptualization of priming phenomena. It could entail, for example, an approximation of the study-test paradigm and the prime-target paradigm. Lexical factors were somewhat neglected in the former, but were always central on the latter. An increased attention on lexical factors could also boost activation accounts of priming, and also hybrid accounts assuming both activation and episodic mechanisms of priming. In sum, a reexamination of the perceptual-conceptual dichotomy could be the origin of one of the most important advances in the field of priming.

Increased attention on neglected factors and interactions

Some of the studies reviewed in the section concerned with inconsistent finding have shown some factors that are not usually considered to affect priming, actually do so. One of this factors is whether the study list is mixed or unmixed. As reviewed before, Challis and Brodbeck (1992) found that LOP effects in WFC tend to occur when items to be studied physically or semantically are presented in separate lists, but not when they are presented in a mixed list. Challis and Brodbeck (1992) discussed the possibility that LOP WFC are due to a deficiency of perceptual processing in the physical condition, and that this insufficiency worsen when all the items in the list are processed physically. Conversely, they also considered the alternative that LOP effects are caused by enhanced perceptual processing in the semantic condition, and that this improvement occurs specially in the unmixed list condition. Challis and Brodbeck (1992) found that the critical factor is whether the study list is mixed or unmixed, and not whether the manipulation is within-or between-subjects.

The effects of the mixed-unmixed factor is not limited to LOP manipulations. Standard data suggested that the manipulation of symbol type (word vs. picture) produced a radical decrement of priming. Weldon and Roediger (1987) estimated that cross-symbol priming is only about one fourth of intra-symbol priming. Study-test symbol type shifts, then, seemed to produce a very large effect. However, Brown et al. (1991) found that changing the symbol type between study and test attenuates priming when, as in most studies, study list are mixed, but not when word and pictures are presented in separate study lists. According Brown et al. (1991), when lists are unmixed, both words and pictures produce a general lexical activation that obscure the effects of perceptual mismatch. In contrast, when lists are mixed, subject attention focus on perceptual features of the stimuli to the detriment of lexical processing, study-test perceptual match becomes critical, and cross-symbol priming suffers a radical reduction.

Brown et al.'s (1991) explanation is related to findings showing an interaction between encoding operations and the effects of study-test perceptual manipulations. Typically, the studies concerned with study-test shift on surface form, modality, symbol type, or language focused on the properties of the stimuli and not on what subjects do when encode them. Recently, however, some studies have shown that subjects' operations during encoding have an important modulatory effect on study-test manipulations. Graf and Ryan (1990) found a reduction on priming on word identification as an effect of a font manipulation when subjects rated the readability of the words, but not when they rated how much they liked them. According these authors, feature processing during skilled reading is minimal, and hence, details about surface features are encoded only when subjects focus their attention on them.

Likewise, Masson and Freedman (1990) proposed that surface processing is critical on word identification when the reader encounter difficulties on the visual analysis of the word--e.g. because of an unfamiliar font--but not when reading is fluent. This idea was challenged by Jacoby, Levy and Steinbach (1992), who found a decrement of priming on rereading as an effect of modality and typography shifts in conditions in which reading was fluent and meaning based, but not when reading was more word-oriented. Whether perceptual specificity effects are larger on meaning based or perceptual based encoding task, the foregoing studies underscore the

modulatory effects of subjects operations. This idea is also supported by Smith (1991), who found interlingual priming for words read or inferred in the context of sentences, but not for words read in a random list. In sum, recent studies have shown that factors that were not considered critical, such as whether the study list is mixed or unmixed, can have an important effect on priming, and that manipulations that were not usually studied together, such as study-test perceptual shifts and orienting tasks during encoding, can actually interact.

New theoretical developments

The difficulty of standard theoretical accounts to explain several puzzling findings have forced priming researchers to consider alternative theoretical accounts. One of this new approaches can be described as adopting of the transfer-appropriate processing principle without assuming the data-driven/conceptually-driven distinction. As reviewed before, Tenpenny and Shoben (1992) found dissociations between two data-driven tests, and between two conceptually-driven tests. Both dissociations followed the transfer-appropriate processing principle, but not the data-driven/conceptually-driven distinction. On the basis of these results, they "advocate formulating explanations at the level of the processes themselves rather than at the level of types of processes (i.e., conceptually-driven vs. data-driven)". For example, Blaxton (1989) found that the visual WFC and graphemic cued recall tests are better after visual than auditory study, and interpreted this results as evidence that both tests depends on data-driven processing. According Tenpenny and Shoben (1992), these results can be explained by assuming that WFC and graphemic cued recall tests have a process in common that is sensitive to modality of presentation. Likewise, McAndrews and Moscovitch (1992) supported a "general framework of transfer of component processes" (p.786) focused on "identifying task components more precisely" (p.786).

A second kind of theoretical account involves the postulation of multiple or complex representations. As reviewed before, Hirshman et al. (1990) proposed that generation priming effects on WFC are based on a conceptual representation, and that this conceptual representation is not the same conceptual representation that supports generation effects on free recall. The assumption of multiple conceptual representations can explain different form priming that does not correlate with explicit performance. Typically, findings of no statistical association between priming and explicit performance has been interpreted as supporting a multiple memory systems view. Hirshman et al. (1990), in contrast, postulate multiple conceptual representations without assuming that they are stored on different memory systems. Another recent theoretical account in terms of complex representations was advanced by Jacoby et al. (1992). They postulated that data-driven and conceptually-driven processing are integrated in an episodic representation. "The episodic representation contains both perceptual and conceptual information, and these are integrated into a processing "package". The proposals Hirshman et al. (1990) and Jacoby et al. (1992) promise new ways of conceptualizing the memory representations involved in priming.

Finally, there has been in recent years a progressive approximation of different competing theoretical accounts of priming. Representatives of the PRS view have suggested, for example, that "The systems approach combined with appropriate processing theories seems to provide the most direct route to the future" (Tulving & Schacter, 1990, p.305). Theorists of the data-driven/conceptually-driven view, in contrast, does not seem to agree with such integration: "Some rapprochement between the 'systems' view and transfer appropriate processing ideas may be advisable (Hayman & Tulving, 1989b), but for now we prefer to pursue the processing approach to see how far it will take us" (Roediger et al., 1989, p.79). However, some representatives of the data-driven/conceptually-driven view are introducing modifications in the basic assumptions of this view that could lead in the future to a constitution of a new hybrid view. For example, the incorporation of the lexical factor within the data-driven/ of conceptually-driven distinction proposed by Weldon (1990) might eventually involve the introduction of some kind of activation mechanism.

In sum, findings inconsistent with the standard data have stimulated new theoretical developments. One of them has been the postulation of a transfer-appropriate processing view not based on type of processes (data-driven vs. conceptually-driven; in-

tegration vs. elaboration) but on the processes themselves. This view advocate for a detailed analysis of the component processes of encoding and retrieval conditions, rather than relying on generalizations about type of manipulations and type of tests. Another kind of theoretical account involve the postulation of multiple representations, or representations that integrate different forms of processing. Finally, there has been modifications on the standard theories that might eventually originate hybrid theories. At the present, however, most of these new theoretical constructions are still on their foundations.

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