Re-Examining the Role of Consistency:
The Cornerstone, not Simply an Important Factor

Patrice Terrier
Work and Cognition Laboratory
University of Toulouse-Le Mirail
5 allees A. Machado
31058 Toulouse Cedex 1
FRANCE

terrier@cict.fr

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ABSTRACT: Despite the important role of the consistency concept in various theoretical frameworks of memory research and its influence on practical investigations it remains unclear as to whether consistency has been firmly grounded as a explanatory factor. Consistency does not determine either a cognitive load or the development of automaticity. However, it does explain the nature of empirical facts that are subsumed by these terms. Consistency is not a psychological factor involved in many important and highly related topics of consciousness research including, implicit learning, and implicit memory. Rather it is the way human beings relate their various mental experiences.

1. Cognitive Load is Consistency

When are psychologists entitled to call a construct "cognitive load"? Cognitive load is a construct often found in research dealing with the dissociation between verbal reports and performance. Let us take as a first example a recent line of research placing emphasis on these terms in educational settings. The Cognitive Load Theory (Chandler & Sweller, 1991; Sweller, 1993; Sweller, Chandler, Tierney, & Cooper, 1990) considers two puzzling problems: subjects can often solve many problems based on a unique principle without being able to communicate it; schema theory is the dominant theory for expertise development, whereas novices use the means-ends strategy. Starting from these two observations, Sweller and colleagues try to make the novice remove resources usually assigned to problem-solving activities (means-ends analysis) in order to reassign them to the building of a schema. Much empirical evidence has led to several principles being proposed in order to reduce cognitive load; yet the theoretical status of the set of principles that constitute Cognitive Load Theory (CLT) has hardly been discussed (Dixon, 1991; Sweller & Chandler, 1991). Still there is at least one uncontroversial point: the different effects that constitute CLT are different ways to make a consistent mapping between a current problem-state and actions to be carried over time. In this case, cognitive load is a construct involved in a verbal-performance dissociation which has not been provoked by the experimenter. However, it is difficult to see the usefulness of this concept in that dissociations can be reduced by a consistent mapping between a current problem-state and actions to be carried over time. Dissociations between verbal reports and performance are also sometimes produced by experimental conditions. Again, cognitive load serves as an "explanatory" construct in spite of the existence of a real causative factor: the consistency of mental operations over time.

A distinction between implicit and explicit learning has attracted much attention in recent years. Reber's assertion claiming that complex knowledge could be acquired in a non-conscious manner (Reber, 1989) was based on the fact that subjects could perform quite well in several experimental situations in which the rules were unknown (or even unpredictable because they changed over time) without being able to communicate the knowledge gained during the study. This problem has been discussed with respect to search tasks (Cleeremans & McClelland, 1991; Lewicki, Czyzenska, & Hoffman, 1987; Lewicki, Hill, & Bizot, 1988; Stadler, 1989), artificial grammar learning (Dienes, Broadbent, & Berry, 1991; Matthews et al., 1989; Reber, Walkenfield, & Hernstadt, 1991), and simulated control tasks (Berry & Broadbent, 1988; Broadbent, FitzGerald, & Broadbent, 1986; Stanley, Mattews, Buss, & Kotler-Cope, 1989; Cleeremans, 1988; Marescaux, Luc, & Karnas, 1989). Each of the three experimental paradigms has occasioned criticism of the assumption of the implicit abstraction of complex rules. Results showed that subjects have partial (and sometimes explicit) knowledge in artificial grammars (Dienes, Broadbent, & Berry, 1991; Dulany, Carlson, & Dewey, 1984; Mattews et al., 1989; Cleeremans & McClelland, 1991, exp. 1). The same result was obtained with respect to search tasks (Perruchet & Amorim, 1992) in which subjects can recognize some parts of the sequences. Even in the simulated process control paradigms, it has been shown that it is not necessary to infer the abstraction of complex rules because subjects have acquired local knowledge, this knowledge being sufficient to explain the performance (Marescaux, 1992; Luc, Marescaux, & Karnas, 1989). Most of the debate has focused on this assertion of the implicit learning of rules in order to refute it or in order to re-interpret it. That is, again, interpretations of the learning conditions leading to less or more cognitive load were proposed. At a surface level, the notion of cognitive load is relevant for explaining these dissociations, and hence the development of a mode of learning. For example, in artificial grammar, unconscious processes are engaged when the situation is too complex, i.e. when it does not permit exhaustive attentional processing (Perruchet, 1988). The practical implication of the implicit vs. explicit learning distinction for cognitive load was also emphasized with the simulated control task paradigms (Myers & Conner, 1992). Researchers have mainly focused on one aspect of the dissociation problem: an increase in performance with no increase in the accuracy of verbal reports. However, the other form of dissociation was already known, as were the conditions in which performance and verbal reports increased together. What then is the important factor? Assuming that the important construct is the one which best explains the situation, the important factor is consistency in environmental situations over time. When relationships are made salient in the experimental situation (e.g., when the unpredictable relationship between input and output is made more predictable in the simulated process control paradigm; see Broadbent et al., 1986) verbal reports and performance increase in the same way. On the other hand, when the relationships are made opaque, dissociation between verbalization and performance occurs (with either progress in verbal reports only or progress in performance only). Because this factor explains both the presence and the absence of dissociation (Berry & Broadbent, 1988; Broadbent et al., 1986; Holyoak & Spellman, 1993) it follows that salience is the important factor and not cognitive load. This is a second example of research in which the notion of cognitive load is thought to be the important factor for the development of different processing modes (these processing modes being inferred on the basis of dissociation); it is also the second example in which consistency of operations is a better explanation of dissociation because the manipulation of consistency either produces or does not produce the dissociation.

A further question remains to be answered concerning the nature of salience. What do salient versus non-salient tasks imply at the psychological level? Observation of the characteristics of these learning modes may support the re-interpretation of implicit learning research (IL) in terms of consistency of operations conducted under both study and test conditions (Berry & Dienes, 1991; Lewandowsky, Bainbridge & Kirsner, 1989; Perruchet, 1992). Conditions that were thought to develop explicit learning processes and those leading to implicit processes differed according to the nature of the operations conducted during study. Implicit learning conditions lead to more shallow processing than explicit learning conditions. When the test phase required a fairly deep knowledge (verbal reports on rules assessed by a questionnaire) the knowledge gained by subjects in the implicit learning condition could not be transferred. However, when the test permitted the transfer of pieces of knowledge (performance measure) the knowledge transferred during the test, and hence the increase in performance was observed. In other words, experiments on implicit learning have "artificially" separated shallow and deep processing when creating relationships which are non-salient or salient. Various studies have supported this account of implicit learning in artificial grammar (Dienes, Broadbent, & Berry, 1991; Dulany, Carlson, & Dewey, 1984; Mattews et al., 1989; Cleeremans & McClelland, 1991, exp. 1), in sequence learning tasks (Perruchet & Amorim, 1992), and in simulated control tasks (Marescaux, 1992; Luc, Marescaux, & Karnas, 1989). The explicit nature of knowledge gained by subjects during these studies was discussed in subsequent and more recent papers (Seger, 1994; Dienes, Altmann, Kwan, & Goode, 1995; Knowlton & Squire, 1996) but the relative specificity of this knowledge has not been disputed. For example, Dienes et al. (1995) clearly indicated that the participants in their experiments (exp. 1-5) could mentally reinstate the specific context of one grammar to ensure the application of that grammar. However, the insightful suggestion made by

Lewandowsky et al. (1989) placing emphasis on the transfer-appropriate processing explanation was not fully considered.

Clearly, it is difficult to admit that implicit learning is mostly perceptual when substantial transfer has been shown to occur with different letter sets in the artificial grammar paradigm (e.g. Matthews et al., 1989), although transfer occurs significantly less often with letter sets which are different than with those which are the same! But this transfer across surface characteristics has been explained (Matthews et al., 1989), and effects of perceptual embodiment have been noted in other paradigms (e.g., Stadler, 1989). More significant is the similarity of dissociation which is discussed in the implicit learning literature with that in the literature on implicit memory (Berry & Dienes, 1991; Wittlesea & Donker, 1993). Berry and Dienes (1991) reported different results on the sensitivity to surface characteristics and highlighted the role of the processing explanation. They also pointed to a modified Transfer-Appropriate Processing view (Lewandowsky, Kirsner, & Bainbridge, 1989). Grounded on the role that item-specific and relational information have in explaining dissociation between measures of retention (see also Jacoby & Hollingshead, 1990; MacLeod & Bassili, 1989; Nelson, Canas, & Bajo, 1987), it has been shown that a modified processing view may account for the learning of new associations and be able to deal with effects which are difficult to interpret in the initial TAP framework. The controversy raised by the literature on IL was possibly due to an insufficient awareness of the role consistency of processing operations during study and testing has in explaining these dissociations.

As shown by an analysis of two recent lines of research (CLT, IL) cognitive load is a construct often invoked in accounting for the dissociation between performance and verbal report measures. However, a more precise account of this dissociation would replace the notion of cognitive load by the notion of consistency of operations, assuming that some operations are mostly data-driven and others mostly conceptually driven. This post-hoc structuring of the data shall be developed further in the following sections. Since we suspect that a single construct could explain several controversies, a better account of the theoretical value of consistency would be made by showing that consistency can explain dissociation where its theoretical importance has been widely admitted. In respect to the above data (CLT, IL) the empirical evidence in favour of automatic versus controlled processing and the still developing evidence on dissociations between implicit and explicit measures of retention are of greatest interest. Is consistency really different from the mental processes involved in producing the data which lead cognitive analysts to infer memory systems and processes? The answer is "no". First, memory systems, whether in the broad sense or not, are inferred on the basis of a dissociation procedure (section 2): single dissociation, double dissociation (uncrossed or crossed). However, because consistency is a good candidate for explaining these dissociations, there is little necessity to use other concepts. Second, recent data argue for a reinterpretation of the dissociation between automatic and controlled processing (section 3). In sections 2 and 3, we elaborate further the proposed post-hoc structuring of data on dissociation. These two sections will emphasize that the continued postulation of memory systems to account for dissociations between tests may not be the most fruitful approach in explaining test differences.

2. Dissociations Between Measures of Retention: Consistency as a Theoretical Account

Dissociations between explicit and implicit measures of retention have been widely documented in the past decade. This distinction is now sufficiently entrenched in the field of memory research that entire books have been devoted to it (Lewandowsky, Dunn, & Kirsner, 1989; Graf & Masson, 1993; Schacter & Tulving, 1994a). Explicit measures of memory are those that involve conscious recollection, most typically recall or recognition (Graf & Schacter, 1985; Schacter, 1987). In explicit tests, subjects are given a memory test in which they select (recognition) or produce a response (recall). Implicit measures of memory are those in which no act of conscious recollection is necessary to accomplish the task (Graf & Schacter, 1985). In implicit tests subjects are instructed to perform the task at hand as well as possible, and they are not instructed to think back to the study episode, whereas in explicit tests of memory, attention is directed to prior episodes. For example, when having studied the word "REASON", subjects can be given a stem completion test (REA____) or a word fragment completion test (_E_SO_) in which they are simply told to complete the missing letters in order to form a word. Fragment completion and word stem completion are two examples of implicit tests of memory. If the observer collects a baseline measure, memory can be revealed through easier performance which can be attributed to information processing during the prior episode. Experimental variables that have substantial effects on performance for one type of test nevertheless often have negligible impact on performance for the other type of test. For example, level of processing has little influence on implicit memory tests performance although its influence on recall and recognition is largely recognized (Jacoby, 1983, exp. 2 and 3; Jacoby & Dallas, 1981; Graf & Schacter, 1985; Light & Singh, 1987, exp. 1 and 3; Schacter & McGlynn, 1989; Roediger, Weldon, Stadler, & Riegler, 1992, exp. 1; Light et al., 1992). On the other hand, modality shifts between study and test phases have a negligible impact on explicit tests and a great impact on implicit tests (Bassili, Smith, & MacLeod, 1989; Jacoby & Dallas, 1981; Graf & Ryan, 1990; Light et al., 1992; Roediger & Srinivas, 1993). Implicit tests are often affected even by more subtle variations of surface characteristics (e.g. Graf & Ryan, 1990; Wiggs & Martin, 1994). Performance on implicit tests is better when study and test modalities correspond rather than when they differ. Extensive evidence on modality effects and other surface variations have been provided elsewhere (Kirsner, Dunn, & Staden, 1989; Schacter, 1994). The experimental variables dissociating memory tests have been well documented in recent years, and the interested reader will find that these dissociations as a function of experimental variables also parallel dissociations observed as a function of subjects' characteristics (e.g., Light et al., 1992). This amount of data and the theoretical proposals have forced researchers to consider the following question: what does dissociation really mean?

In past research dissociation was thought to be the mark for the existence of different memory systems. The general understanding was that memory could be broken down into a small number of systems, such as declarative and procedural memory (Cohen &

Squire, 1980), or episodic and semantic memory (Tulving, 1985). The notion of memory systems was accepted in this broad sense on the basis of single dissociation and double dissociation (uncrossed or crossed). The weakness of this position is now more evident (Dunn & Kirsner, 1988, 1989; Lockhart, 1989; Olton, 1989; Ostergaard & Jernigan, 1993; Shinamura, 1993) and traditional constructs such as working memory will soon suffer the same criticism one could apply to the notion of multiple memory systems. For the sake of clarity, and because the processing explanation (discussed further below) can be found in the above references, we only consider here the arguments provided by Dunn and Kirsner (1988, 1989).

The finding that two tasks may be dissociated in some ways is usually taken as evidence that they reflect the operation of functionally independent processes. However, Dunn and Kirsner (1988, 1989) have demonstrated the weakness of this logic. Functional dissociation by itself is sufficient neither to exclude the possibility that levels of performance for the two tasks depend upon the same source of information, nor, if it is granted that two processes are operative, to show that each selectively affects performance for only one task. All that may be concluded with any certainty from the measurement of performance for two tasks is that they depend upon the operation of more than one process or source of information. The logic of dissociation holds that if performance for two tasks depends upon the operation of a common underlying process, then it should not be possible to selectively affect performance on either task. However, because overt task performance need only be monotonically related to the output of an underlying process, any failure to observe a change in performance, as a function of a change in the experimental situation, cannot be used to infer that no underlying process is affected. In consequence, although two tasks may be dissociable, they may still reflect a single source of information. The logic of Reversed Association (RA) is better suited to infer that more than one process contributed to performance on both tasks.

In order to infer that more than one process has contributed to performance it is necessary to observe an RA (Dunn & Kirsner, 1988). This occurs when both a positive and a negative association between two tasks is observed under different experimental conditions. In other words, a reversed association occurs when the relationship between two tasks is non-monotonic. If two memory tasks depend solely upon the accessibility of a common memory representation, any experimental manipulation that increases or decreases this level of access will affect performance on both tasks in similar ways. These tasks will either both increase or decrease. In this case, in which the tasks are positively associated, it is impossible that one should increase and the other decrease. Therefore, if this normally positive association between the tasks were reversed in some way, the single process account can be rejected. Experiments (Gillund & Schiffrin, 1981; Graf & Schacter, 1985, 1987; Schacter & Graf, 1986, among others) were re-examined using the logic of RA. Dunn and Kirsner (1988) showed that there was a strong positive relationship between the two tasks (paired-associate cued recall vs. word completion, $r = 0.70$; letter cued recall vs. word completion, $r = 0.82$). These relationships showed that far from reflecting only the operation of separated and independent processing systems, there is considerable similarity in function between the tasks. Another example of the RA logic is given with data on recall vs. recognition, now showing a reversed association (see

Gillund & Shiffrin, 1981, in Dunn & Kirsner, 1989, pp. 27-28). As revealed in their analysis, Dunn and Kirsner show that different explicit memory tests must draw upon a number of different sources of information. Finally, the authors re-examined the crossover interaction observed by Graf and Schacter (1985). Because these data contained both a dissociation and a positive association (and consequently a reversed association) Graf and Schacter could have been more confident that more than one process effectively contributed to memory performance; a conclusion which is not permitted with a crossover dissociation. Not only does RA logic show that dissociation (single, double, uncrossed or crossed) could be replaced by a simpler and stronger method, but it also forces one to address the following question: if dissociation cannot be taken as evidence of different memory systems, how can one explain dissociation obtained between explicit and implicit measures of retention? This is a fundamental problem for the cognitive disciplines. Our conviction is that the explanation reported in the next paragraph might also be invoked as a possible account for other dissociations between "systems" that have attended the cognitive disciplines for years. For the moment, let us restrict the discussion to dissociation within the topic of implicit memory. Since the primary focus of most studies has been to compare implicit and explicit memory, there has been little work directed to elucidating the similarities and differences of distinct implicit memory tasks. However, in recent years it appeared that the relationship between cognitive operations conducted at study and at test is a good candidate for explaining dissociation between measures of retention. The concept of consistency of operations has proven its ability to explain dissociation between explicit and implicit measures.

Consistency of operations can explain dissociations between measures of retention. Consistency has been shown to provide a better theory than the multiple memory systems hypothesis, at least for explaining dissociation obtained with normal subjects. Some of the most impressive data reported by proponents of the Transfer-Appropriate Processing view (Morris, Brandsford & Franks, 1977; Jacoby, 1983) was given in a review (Roediger, Weldon & Challis, 1989). The experiments reported upon clearly indicate that it was as easy to discover experimental dissociation within memory systems, either episodic vs. semantic or procedural vs. declarative, as it was to find dissociation between systems. Blaxton's experiments (Blaxton, 1985, in Roediger et al., 1989) showed that a confused comparison had been used to produce dissociations between episodic and semantic memory: the episodic test (free recall) is conceptually driven and the semantic test (fragment completion) is data driven. When an episodic test which is data driven and a semantic test which is conceptually driven are added together, results show that the same dissociation used as the evidence of the existence of separate systems (Tulving, 1985) -- i.e., no effect of modality shifts on free recall and an effect on fragment completion -- is in fact orthogonal to the putative distinction of memory systems: modality had large effects on the data driven tests, either "episodic" or "semantic", and no effect on conceptually driven tests, either "episodic" or "semantic" (Roediger et al., 1989, fig. 1.8, p. 22). Thus, the distinction between modes of processing, the balance of conceptually driven vs. data driven processing operations, provides a better account of the obtained dissociation than does the postulation of memory systems. Along with other numerous studies (see for example Roediger, Srinivas & Weldon, 1989; Roediger & Srinivas, 1993), these results lessen one's enthusiasm for considering dissociations between measures as crucial evidence in the debate about memory systems and their nature.

Clearly, there is no necessity to accommodate the above facts. One can ignore both the evidence of a promising account of conditions that give rise to, or suppress, dissociations between classes of measures and within the same class of measures, the consistency of operations conducted during test and study, as well as the weakness of the logic of dissociation as an identifier of distinct systems. However, and this is a definitive point favoring the notion of Transfer-Appropriate Processing, an often-dismissed problem arises if one still adheres to notion of multiple memory systems. For the proponents of the multiple memory systems view, it is essential to characterize the nature of the distinct mental operations invoked in tasks that are thought to reflect the operation of these different systems (Naito & Komatsu, 1993). Skeptics may consult the definition of memory systems generally used (Sherry & Schacter, 1987; Schacter & Tulving, 1994b). And because this characterization results in the use of the TAP framework (see Naito and Komatsu, 1993) a paradox appears. In our view, beside the logical difficulties just discussed, this paradox can be taken as definitive evidence of the superiority of processing explanations: the characterization of processes is necessary for the memory systems proposals (Naito & Komatsu, 1993; Schacter & Tulving, 1994b; Sherry & Schacter, 1987) while the consideration of memory systems is not necessary for processing accounts.

The point, in this section, was to highlight that a model must explain the conditions that produce dissociations. Traditional procedures for identifying cognitive structures and/or operations relied on the dissociation framework without making this implication clear. Recent results have demonstrated that dissociations are the by-product of the inconsistency of mental operations. This explanation is also useful in re-interpreting past research on memory systems. Let us consider the kind of data used in inferring more classical distinctions between systems such as working memory vs. long term memory. Concessions may be made with respect to three points: (i) if there is no other index of systems and subsystems, than dissociations, (ii) if this logic is insufficient and may be replaced by a unitary one such as the processing view, as shown within the domain of implicit memory, (iii) there is a need for re-examining these more traditional distinctions between systems. In fact, we see some published data that may perhaps contribute to such a re-examination. For example, the use of the expression "long term working memory" (Ericsson & Kintsh, 1995) shows that contrary to the definition of working memory -- the temporary retention of information which is currently relevant for an ongoing activity -- there are cases in which processing can become more independent from the delay between a study phase and a test phase. Clearly, this fact resembles the well known body of results produced under the Transfer-Appropriate Processing approach: an important characteristic of many data-driven tests is their relative insensitivity to the study-test delay (e.g. Jacoby & Dallas, 1981; Weldon, 1993). This is not an unique example. In their review of the working memory notion, Roulin and Monnier (1995) show that, in explaining cross-over dissociation, processing operations conducted at test and at study could replace the distinction between sub-systems in working memory. Considering the influence of the working memory concept, the reader may question the above considerations on the possible role of consistency in traditional constructs of cognitive research. Although we suspect that this question is now necessary, this paper will not go into it in further detail. Rather, the next section will develop this idea of re-examination by discussing the automatic vs. controlled processing distinction. This distinction is known to be more intimately linked to the current discussion of the repetition priming phenomenon (see Logan, 1988a; Hasher & Zachs, 1979; Kirsner, Speelman, and Schofield, 1993) and this line of research has a major role in understanding the mechanism under investigation here, namely consistency. Far from seeing implicit memory as a mere example of automaticity, the converse relation is preferred here: automaticity is seen to be an example of the implicit memory phenomenon. Roughly speaking, dissociation occurs because test conditions require processing operations that differ from those conducted at study.

3. Limited Capacity vs. Automaticity: Confounding Cause and Effect

Much of the experimental work on consistency has been carried out in the context of search tasks. In the typical visual search paradigm (Schneider & Shiffrin, 1997), on each trial subjects are presented with one to four target characters to memorize, with the number of characters denoted by M, the memory set size. Subjects then search one or more visual displays for the target(s), with each display comprising one to four characters: the number of characters is the frame size F. The MxF product is the comparison load and the experimental paradigm allows one to define pure visual search tasks (M = 1 and F = 4), pure memory search tasks (M = 4, F = 1) and hybrid visual memory search tasks. In this experimental situation, consistency can be manipulated at the psychological level. Target and distractors are drawn from different sets of items in consistently mapped conditions (CM) but from the same item set in variably mapped conditions (VM). In other words, from one trial to another, target and distractors can interchange their roles as target and distractors in varied mapping conditions. Conversely, in consistent mapping conditions, they never interchange their roles. Note that this variation represents a variation of cognitive consistency, which is clearly distinguished from the variation in the consistency of responses given by subjects. To anticipate the argument developed below, note that an experiment can mix or not mix blocks of CM and VM processing conditions. In CM conditions, given sufficient practice, M and F have only small effects on performance whereas performance deteriorates as M and F increase in VM conditions. Schneider and Shiffrin (1997) suggest that with a consistent mapping (i.e., when the target and distractors never interchanged their roles) targets are detected automatically, without voluntary control of processing. These tasks became the essential paradigm for automatic versus controlled processing theory (Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977). As long as consistency was operationalized in an empirical situation, there was a strong tendency to consider it as an experimental factor whose influence on cognitive load was well established. The role of consistency at the psychological level led authors to make an important distinction between capacity limited processes and processes that are not limited. This section will show that this position is no longer justified in relation to more recent developments (e.g. Duncan, 1986; Myers & Fisk, 1987; Strayer & Kramer, 1994a, 1994b).

The initial rationale was as follows: (1) consistency promotes the development of automaticity. Two other propositions were included that constitute an equation relating tasks to processes: (2) consistent mapping leads to an automatic process; (3) non-consistent mapping does not permit automatization. As a result of this equation relating consistency to processes (consistent mapping leading to automatic processes versus non-consistent mapping leading to controlled processes), there was clearly no reason for manipulating consistency in a within-subject design; automaticity is a property of consistent mapped tasks. Indeed, an impressive number of experiments were run by contrasting performance for subjects in a consistent mapping condition with other subjects under non-consistent mapping conditions; the typical paradigm compares extended practice of subjects being assigned to either consistent mapping or to non-consistent mapping (e.g. Schneider & Fisk, 1982). Then, why do more recent investigations of automaticity systematically employ a within-subject manipulation (Strayer & Kramer, 1994a, 1994b)? We can distinguish two periods in the development of automaticity research (Terrier, 1996): at first, the use of VM versus CM paradigms provided a static view of consistency, by "consistently" putting subjects either in data-driven processing conditions or in conceptually-driven conditions. As a result, rather than showing processes to have distinct properties, the use of VM and CM paradigms created dissociation between data-driven conditions and conceptually driven conditions. The second period came when investigators tried to examine systematically the generality of automatic/controlled processing training principles in rich, complex tasks (e.g., Myers & Fisk, 1987; Fisk & Gallini, 1989). This second period shows that consistency is a question of levels. The rationale equating task conditions (CM, VM) with processes (Automatic, Controlled) has evolved, as shown by several difficulties encountered. For the sake of clarity let us develop only two of them in this section.

First, the conceptual distinction between limited capacity and automaticity is based on the misleading role of the unitization process. This problem was clearly emphasized in Grossbergs' analysis (Grossberg, 1984), but we can integrate into what constitutes the first general difficulty, several independent analyses which lead to a very similar conclusion (Duncan, 1986; Fisher, 1992; Logan, 1988b). Within Grossberg's framework (Grossberg, 1984), controlled processing is used before an item or task is unitized, whereas automatic processing is used after unitization has occurred. In other words, the analysis developed by Grossberg is that an entire body of literature has looked at "before" and "after" unitization conditions.

When one considers the visual search literature and the generalization of automatic/controlled theory to complex tasks, it is seen to be fraught with difficulties. Consider, for example, the difference between search for CM versus VM training stimuli in traditional laboratory visual-search tasks: in a VM search, response time is an increasing function of the number of comparisons to be made, whereas in CM search, the search time is relatively independent of the number of comparisons (for a review, Schneider & Shiffrin, 1977). However, when they tried to generalize this effect to industrial task training, investigators have noticed a major difference from laboratory conditions (Myers & Fisk, 1987): the VM learning curve was sustained and positive, indicating the presence of learning across the groups of VM blocks. Because this result contradicts the three points in the initial rationale (see above) how could it be explained? A number of important consistent components were present in the design, including the invariant size and shape of the character patterns, the relatively limited number of target locations, etc. The answer was that "It is difficult, in fact, to find any complex tasks (indeed any real-word tasks) that are devoid of consistencies. Therefore, improvement would be expected even in tasks dominated by inconsistent components." (Myers and Fisk, 1987, p. 263). Subsequent studies have shown that subjects can use consistency at other levels than the level embedded in the experimental situation (the single stimuli level): such as a group of stimuli, or context (Fisk, Oransky & Skedsvold, 1988; Fisk & Rogers, 1988, 1991a, 1991b). Because this single dissociation as a function of a number of items in the visual/memory set is seen as a major line of evidence that automatic processing is effortless, it is also considered carefully in Logan's theory of automatization (Logan, 1988b). Initially, reaction time is an increasing function of these numbers, but after considerable practice, the slope approaches zero (Schneider & Shiffrin, 1977). However, can the initial linear increase be interpreted as evidence that the unpracticed task requires effort? Can the zero slope at the end of practice be interpreted as evidence that search has become effortless or capacity free? The instance theory of automatization assumes that initially performance depends on a search algorithm in which subjects try to find the probe item in the memory set or the memory item in the display. After practice, subjects retrieve the appropriate response directly from memory, without searching, when given a probe or multi-display as a retrieval cue. The proposed explanation is that factors that affect the algorithm, such as display size or memory set size, do not necessarily affect memory retrieval (Logan, 1988b, p. 513). Logan also discusses a second major line of evidence that automaticity is effortful, dual-task studies, and the provided explanation is the same as in search tasks: factors that influence the algorithm do not necessarily affect memory retrieval.

A simple example provided by Duncan (1986) illustrates the importance of unitization. The arithmetic problem "2+1=" is generally mapped on to the solution "3"; but the components of this problem (2, +, 1, and =) are not by themselves consistently mapped on to any solution (Duncan, 1986, p. 281). Increasing the unit size in describing stimulus events, so that important aspects of context are included, increases the consistency of stimulus-response mapping. Fisher (1992) also provides clear examples of the role unitization has in automatization, in experimental studies of arithmetic skills development. Because unitization is known as 'chunking', let us discuss a well-known example showing that unitization removes the distinction between capacity limited processes and processes that are not limited: the skills developed by the subject studied by Chase and Ericsson (1981). How could we interpret the long list of digits remembered by the subject? We are clearly wrong if we interpret it in terms of an enhanced capacity of his working memory. It is better to say that the subject has encoded as a single unit a long list of digits, on the basis of skills. Indeed, the results provided by Chase and Ericsson (1981) clearly indicated the application of encoding strategies that allowed the subject to treat a long list of digits as single units, thus boostering his subsequent memory performance. The apparent limitation of working memory, as far as there is a limitation, is a consequence of the states of knowledge applied by subjects. This well-known example is not unique, and one may conclude that the limited capacity which delineates the notion of working memory is severely flawed by other results showing long-term working memory. Since, within an area representing the study of the very temporary management of information, long term memory effects are shown (Ericsson & Kintsh, 1995), the notion of working memory itself might be reconsidered.

Is automatization a way around a limited capacity? The instance theory of automatization (Logan, 1988b) provides a clear departure from this modal view of automaticity in that it does not assume that processing capacity or cognitive resources are limited and that automatization is a way around these limitations. Rather than assuming any capacity limitations, the instance theory assumes that novice performance is limited by a lack of knowledge rather than by scarcity of processing capacity or resources (Logan, 1998b, p. 513). Although cross references do not exist between the different analyses, they all support the same general conclusion regarding the possibility for the distinction between processes that are capacity limited or which are not limited, that it is an artifact resulting from the experimental procedure: "Before" and "after" unitization have been compared. This idea is expressed in Grossberg's analysis (1984), but Duncan (1986) and Logan (1988b) developed the same analysis independently. Interestingly, Logan makes a further step toward what we see as being the important point of this section: different processes were compared with the same criteria, although these processes may be differentially sensitive to the manipulated variable, thus showing a dissociation. Our conviction on the potential for implicit memory research (the consistency account of dissociation) to explain adjacent phenomenon is thus grounded on several analyses. We shall now see, even in the more subtle discussion of the diagnosis of automaticity, that the general argument of this paper is quite identifiable.

The second general argument lies in conflicting results concerning the properties for automaticity (Bargh, 1992; Camus, 1988; Hasher and Zachs, 1979; Logan, 1988b; Perruchet, 1988; Posner, & Snyder, 1975; Schneider, Dumais & Shiffrin, 1984). Researchers use different list of properties, disagree on the necessity and sufficiency of the properties they list, and some studies question the agreement between properties. Posner and Snyder (1975), Schneider, Dumais & Shiffrin (1984), Hasher and Zachs (1979), respectively list three, five, and twelve properties. Hasher and Zachs (1979) argue that all their twelve properties must be present in a truly automatic process, but others are less restrictive; given that the component properties of automaticity do not co-occur as a package they can be investigated separately (Bargh, 1992). In addition, some studies have questioned the agreement between properties. For example, an obligatory process may not be effortful. Bargh (1992) has argued that:

> to more accurately specify the conditions under which an automatic effect will occur in the natural environment, greater attention needs to be given to aspects of the experimental paradigm (e.g. subjects' task goal,

> questionnaire administrations, previous tasks) that might be necessary to produce the effect. (p.181).

There have been two major lines of evidence for effortless automatic processing: search studies (just discussed) and dual-task experiments. Why are dual-task experiments a major line of evidence for effortless automatic processing? Because they show that practiced subjects suffer less interference from a concurrent task than do unpracticed subjects (see Logan, 1988b). The usual interpretation is that the practiced task requires fewer resources than the unpracticed task. Although this may be the case, the instance theory of automatization would rather suggest that the reduction in dual-task interference occurs because of the shift from the algorithm to memory retrieval: because there are different processes as a function of practice, the task that interferes with the algorithm may not necessarily interfere with memory retrieval. The reduction of interference may occur only because experimenters choose concurrent tasks that interfere with the initial algorithm. In other words, the reduction in interference may be an artifact of the experimenter's choice of procedures rather than a general reduction in resource demands.

How can the properties of automaticity be modeled? In an all-or-none fashion? In terms of degree of automaticity, as most often suggested (e.g., Bargh, 1992; Camus, 1988)? In terms of the Transfer-Appropriate-Processing rationale? Attempts towards a more ecological investigation of properties of automaticity (lack of awareness, non-susceptibility to interference, lack of cognitive control) showed the relative nature of automaticity rather than favouring the all-or-none view. Camus (1988) and Bargh (1992), among other authors, have extensively discussed this fact on the basis of conflicting results in the diagnosis of automaticity. The notion of automaticity degree for properties often considered in an all-or-none fashion is not different from the view advocated by important studies (e.g., Schneider & Shiffrin, 1977; Hasher & Zachs, 1979). The important point is rather to carefully consider that the discussion on the criteria for automaticity (see American Psychologist, special issue on automaticity, 1992, Vol. 2) contains conflicting results which reflect the important role consistency of operations has in the automaticity phenomenon. A careful analysis of these conflicting results has led some authors to formulate an interesting suggestion: namely, that the properties of automaticity are operative as far as the property is appropriate to the task performed (Perruchet, 1988). This suggestion is now elaborated on the basis of the gold standard of automaticity research, the Stroop interference phenomenon (Stroop, 1935).

Let us now take the gold standard reference on automaticity, the Stroop color-word interference effect. A short discussion will show the possibility for a Transfer-Appropriate Processing logic to easily handle the phenomenon. In the Stroop color word paradigm, subjects do not intend and cannot control the interference caused by the meaning of the stimulus word; there is an "automatic" processing of the word's meaning. Is sufficient attention paid to the experimental paradigm in the modeling of automaticity properties, especially to the subjects' goal (Bargh, 1992)? Note that in this paradigm, subjects are instructed to name the color in which a word is printed, and that the task is found to be more difficult (interference) if the word itself is a color name, but of a different color. In addition, it should be remembered that the phenomenon will presumably not appear if the word is not a color name (or if the word is not printed in a color which differs with the meaning of the word). Consequently, we see the Stroop color word interference phenomenon as an instance of the compatibility of operation principle: it is the compatibility of processing operations (color naming and accessing a meaning which is also a color) that produces the Stroop color-word interference effect. When considering only the production of this interference effect, it could be argued that one needs to add the assumption that operations similar to the ones consistent with one's goals tend to go off by themselves, and that this is just the aspect of automaticity that the Stroop effect has previously been said to show. However, if attention is paid to the conditions in which the phenomenon occurs and does not occur, both the production and the absence of the effect, the similarity of mental operation can be seen to determine the phenomenon. In addition, there exist different variations of the Stroop paradigm in which the idea of 'operations consistent with one's goals' is more difficult to use: for example, the arithmetic Stroop interference phenomenon.

In an arithmetic Stroop task (e.g., Zbrodoff & Logan, 1986), there is a confusion between two arithmetic operations, for example addition and multiplication. Typically, subjects who are instructed to verify simple equations, answer positively (correct) when some false equations are presented (e.g., 7 + 3 = 21). This positive answer occurs because the mapping between the solution ("21") and the problem ("7", "3"), while being incorrect within the additive system, is correct within the multiplicative system. Here, the idea of operations consistent with one's goal cannot explain the origin for such an "associative confusion". The associative confusion is a result of great compatibility between the terms of the problem and the solution in a given system. Indeed, if subjects have the same verification goal, it is rather clear that such a mapping will not occur if terms and solution cannot be correctly mapped onto each other, either in one system or in another system (e.g., 7 + 9 = 21). Again, if attention is devoted to the subjects' goal (verification) and to the conditions in which the property of automaticity either occurs or does not occur (false positive response on false equations only when the equation is correct in another mathematical system), the notion of compatibility of processing operations can handle the Stroop interference phenomenon. More generally, the Stroop interference effect and other classical examples of automaticity have been demonstrated to occur and not to occur given certain processing goals on the part of the subject (Dark, Johnston, Myles-Worsley & Farah, 1985). Consequently, the problem is not only to conceive the properties of automaticity as a "goal-dependent phenomenon" (Bargh, 1992) but also to explain this goal dependency. It is our assumption that the solution for such an explanation of the goal-dependency of automaticity may rely on consistency of mental operations. But this short discussion of the gold standard of automaticity research, the Stroop interference phenomenon, was only developed to suggest this idea.

The basic point in this section is that there has been a confusion between cause and effect when distinguishing processes that are capacity limited and processes that are not limited. Dissociations were not the effect of processes that differed in terms of capacity; rather they were the effect of a "hidden" manipulation of the consistency of operations. Dissociations were produced by putting subjects in conditions that differed initially in their processing requirements during study, while the same tool was used during a test. In the area of search tasks, dissociation as a function of a number of items in the memory/visual set, and dissociation as a function of a secondary task, may simply reflect the different compatibility between study conditions and the test phase. Subjects were artificially maintained in this situation (typically extended practice in consistent versus non-consistent mapping), and because experimental variables showed dissociation after extended practice in the two conditions, different processes were inferred. This interpretation can be modeled by different theories. In terms of the instance theory of automatization (Logan, 1988b), an algorithmic based functioning was compared with a memory based functioning; in terms of the unitization theory (Grossberg, 1984), the experimenter observed the subject before and after unitization occurred. Besides the logical difficulties involved in interpreting dissociation as the mark for different processes or systems, the interpretation of observed dissociations were simply wrong: when subjects are not prevented from processing information at a shallow level, the dissociations studied in search tasks disappear (e.g., Myers & Fisk, 1987). In the terms preferred in this paper, because these terms also contain a research program for testing the proposed interpretation (see Roediger et al., 1989), the distinction between processes that are capacity-limited occurred when processes at study were mostly data-driven, whereas the distinction of processes that are not capacity limited occurred when the processes engaged were more conceptually driven because both processes at study were evaluated with conceptually driven processes at test (or variables affecting primarily conceptually driven processes conducted at study). Recent work on the automatic versus controlled theory by Strayer and Kramer (1994a, 1994b), in which conditions known as "consistent mapping" are referred to as "data driven processing" and conditions known as "non-consistent mapping" are referred to as "conceptual processing", is in line with this conclusion. In other words, the experimenter readily dissociated processes, but not as is usually thought: the dissociation occurred between study and test processing requirements over time. A useful complement of this idea can also be found in current discussions of long-term versus short-term memory effects; some studies provide a similar conclusion. This re-interpretation of the 'automatic' and 'controlled' distinction in terms of consistency of operations does not imply that the relation between test phases and encoding phases has been neglected in past research. Interestingly, in their analysis, Hasher and Zacks (1979, p. 367) noted that most often a retention test was given to the subject in studying differences between the two sorts of processes and, they indicated the relevance of the distinction between recall and recognition in terms of effort. We now know, on the basis of implicit memory research that recall and recognition are essentially conceptually driven tests of memory, whereas other tests (either explicit or implicit) are data driven. The general argument developed in this section simply results from the knowledge gained since the Hasher and Zacks analysis: some memory tests recruit primarily conceptually driven operations, whereas others recruit primarily data-driven operations conducted at test; consequently, dissociations can be interpreted in terms of consistency of operations over time. The importance we see in the domain of implicit memory is probably clearer now.

4. Summary and Conclusions: What Consistency Might Be

Some investigations have inferred processes without making explicit the important factor responsible for dissociation (e.g., implicit learning). Others have produced dissociations by systematically manipulating consistency (e.g., search tasks) and the role of consistency as an important factor was explicit whereas its psychological value could be recognized more strictly. Because the debate on implicit learning is quite closed at the present time, the reader will probably doubt the practical value of consistency; but the same difficulty arises after reviewing some critical analyses of automatic vs. controlled theory (Duncan, 1986; Perruchet, 1988). However, theoretical and empirical issues raised by a growing line of research conducted in the area of memory and automaticity, implicit memory, clearly reveal the theoretical nature of consistency. These "new" dissociations support an important shift in the comprehension of automaticity. Traditionally, the starting question is "Is consistency the factor leading to several modes of processing?" As a result, the subsequent theoretical question is "Why is consistency important for the development of automatic processing" (e.g., Logan, 1988a). We prefer the following question: Is consistency of operations the way human beings relate their mental experiences? In this case, consistency explains both modes of processing that have been dissociated by past research. Some observations support this second view in various areas, as indicated by this brief and selective review.

On the emphasis placed either on environment or on subjects depends the awareness of the psychological nature of consistency. Environment-based consistency (implicit learning), situation-response based consistency (cognitive load theory, automatic vs. controlled theory), and an interactive-based form of consistency relying on mental operations over time (implicit memory) are three forms of consistency one can see in literature on automaticity, the latter form being a pure relation of mental products gained during the subject-environment interaction. This form of consistency underlies the recent debate in the field of implicit memory, and one may suspect that this account could dominate in explaining recent controversies as well as old established constructs in traditional memory research.

Why does consistency have an important role in cognitive load discussions? Its role has been underestimated. Consistency is not the most important psychological factor. Rather, it is the way human beings relate their mental experiences. The analysis of recent results in the domain of implicit memory provides an explanation of dissociation and this pragmatic view of the way memory works also constitutes an operative tool for investigating the way mental operations are altered by experimental factors or by characteristics of subjects. Once the psychological nature of consistency has been demonstrated, its pragmatic value is also immediately apparent: Let us now consider an implication consistent with contrastive analysis (Baars, 1994) that will not fall into the selective influence assumption.

If consistency of operations over time can explain dissociation between measures of retention -- some memory tasks being more data-driven and some others being more conceptually driven -- then it is no longer necessary to modify the current task realized by the subject in order to study the contribution of processes within a task. One may use a couple of memory tasks (a most perceptive and a most conceptual one) assessed after the task being investigated. Unlike other paradigms, this sort of contrastive analysis does not modify the current activity being investigated (dual task study conditions), and does not fall into the selective assumption influence. As stated earlier (Lockhart & Craik, 1990), an ecological analysis does not demand the abandonment of laboratory paradigms; rather it requires the use of paradigms that fit natural functioning. In our view, there is to date too much knowledge on what a dissociation does really mean to ignore the necessity for reexamining traditional distinctions in putative memory systems (e.g., semantic vs. episodic distinction). If this implication seems wrong to some cognitive psychologists, they will also ignore its methodological consequences and the working reciprocity we have proposed in this brief note. However, a problem will still remain: similar arguments outside the field of implicit memory, in the sense that there are perhaps no separate memory systems, now appear. Not only the rationality of memory must appear now (Anderson, 1989; Glenberg, 1997; Koriat & Goldsmith, 1994, 1996), but also the methodological consequences of the provided explanation should be drawn. And it seems rather clear, at least to us, that consistency of operations offers both an explanation and tools for investigation, and further that current research on implicit memory has an advantage in clarifying the possibility for such a working reciprocity between theory and method.

As soon as the explanatory strength of the consistency framework is acknowledged the discussion about cognitive load becomes much clearer. Also, the effects of consistency on memory performance, i.e., whether at different times similar cognitive operations are involved or not, seem more crucial than other variables such as stimulus complexity or memory capacity. Therefore, applying the consistency framework it seems that the Transfer-Appropriate Processing approach to memory might explain different dissociation phenomena better than such concepts as cognitive load, implicit learning, capacity-limited processing. It is argued here that cognitive dissociations which have attracted a lot of attention can best be explained within a framework of cognitive consistency or compatibility of processing steps at different time intervals. In this respect, consistency is the cornerstone within the Transfer-Appropriate Processing approach and not just one of many processing constituents.

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