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INTRODUCTION

Beyond Dissociations

Reassembling the mind-brain after all?

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> "Comme des bancs de poissons de même espèce, des vols d'oiseaux qui se déplacent d'un même mouvement, des groupements dont les membres ont les mêmes tendances... Leur appliquer un « tu », un « je »... non, nous ne le pouvions plus... il fallait un « nous », un « vous ». Seuls les porte-parole que nous envoyons au dehors continuent à se servir de ces « je », de ces « moi »."
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> " Just like shoals of fish of the same species, flocks of birds moving together or groups of like-minded people... Apply to them a "tu" or a "je"... no, we couldn't do it any more... a "nous", a "vous" was required. Only the spokes-persons we send outside still use these "je", these "moi". "
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> *Nathalie Sarraute (Tu ne t'aimes pas (you don't like yourself), 1989).*

Several important types of dissociation described in science have come to a time to be questioned. For example the contemporary interpretation of the genetics versus epigenesis debate is that there is a complete inter-dependency of the two terms classically opposed. Also, the distinction between matter and space is always becoming fuzzier to physicists. In our field, the debate around the Cartesian dissociation between mind and brain becomes asymptotically closer to the egg and chick question, that is, like Zen koans, producing more silence than wise answers (Suzuki 1971). In many instances, the outcome of the dissociation issue is that the dissociated items constitute the two sides (if not the several) of a single object. In this introduction, we attempt to analyse why so much emphasis has been put on dissociation rather than on integration of the mind-brain components. This debate will justify why the basic question asked throughout the present volume is to know how do diverse systems in the brain co-operate to produce a unified experience and behaviour.

Analysing

"Analysis" is a magic word in science. The breaking up of anything complex into its various simple elements has been the rigorous strategy to oppose to magical and spiritual interpretation of the world. To depart from empiricist or qualitative observation, the usual tool of science and knowledge is decomposition. Alchemy was supposed to produce new substances through the synthesis of ordinary particles, whereas science decomposes compound substances into their primary elements. The determination of the elements or components of anything complex has applied to many different fields including chemistry, mathematics, physics, biology, philosophy and psychology. Separating living from non-living creatures, severing the vegetal and the animal realms, isolating molecules or atoms, distinguishing between genetic and epigenetic, or separating the mind and the body have been proved to promote important steps forward in the understanding of life. The endeavour of what the human is constituted of is indeed very much indebted to the study of dichotomies. As will be further discussed below, the current realm of this dichotomic approach is probably neuropsychology.

Dissociating

Just as "analysis" is a magic word in science in general, "dissociation" is the key word of neuropsychology. The separation of compound psychological functions into their primary elements has proved to be an important source of knowledge and theories about the organisation of the human mind. In this particular discipline, dissociation is viewed as the demonstration that separate systems or separate structures are responsible for two given variables. The study of single cases has provided new directions and improved our understanding of the relationship between the brain and the mental structures and the interpretation of some cases "has proved nothing less than revolutionary" (Code 1996). For most of the important classic cases described in the literature the focus of interest has been the dissociation of function (cf. Code et al. 1996). For example visual agnosia has been regarded as a dissociation of higher (disruption of the cognitive aspects of vision) and lower (intact primary aspects) visual functions (e.g. Teuber 1955).

However the positive and negative behavioural consequences of a given restricted lesion may be partially explained by the reorganisation of surrounding intact brain tissue. Consequently the specificity of the effect of a given single lesion is often questionable. Masterpieces of such demonstrations are thus provided by a "double-dissociation", for which a lesion of structure X will specifically disrupt function A while sparing function B, and a lesion of structure Y will specifically affect function B while function A would remain intact. Teuber (1955) termed this experimental tool 'double dissociation', and used it for both for animal and human studies, arguing that it indicates some specificity of function, e.g. between anterior and posterior brain lesions. Later on Shallice (1979: 260) even stated that "strong neuropsychological evidence for the existence of neurologically distinct functional systems depends on double dissociation of function". Surprisingly, the glossary and the index of Neuropsychology textbooks do not refer to 'dissociation', but only to 'double dissociation' (e.g. Ellis and Young 1988; Kolb and Whishaw 1990; Heilman and Valenstein 1993). Kolb and Whishaw described it as 'an experimental technique whereby two areas of the neocortex are functionally dissociated by two behavioural tests, each test being affected by a lesion to one zone and not the other'. Heilman and Valenstein (1993) present it as an elegant demonstration that the effects being observed cannot be ascribed to non-specific causes, and do not restrict its use to studies of the neocortex. Ellis and Young (1988) provide an interesting discussion on "dissociations and associations". They also describe double dissociations as being more reliable indicators of the separation between two cognitive processes, but they also argue that the search for dissociation should not be regarded "as some sort of Royal road to understanding the structure of the mind" (p. 5). Following Teuber (1955) they point out that: "Having unearthed a double dissociation there is a lot of work to be done in determining just what cognitive processes mediate aspects of tasks 1 and 2 independently". Interestingly, they depart from other authors when they also raise the issue of determining "what processes, if any, the two tasks share in common", raising the question of situating the patients deficit "in the total cognitive system".

Examples of double-dissociation can be found in many different fields of neuropsychology and have been in most cases exported into cognitivist models as separate "boxes" for two isolated functions. Double dissociations have been reported between e.g. conscious perception and sensorimotor transformation (Milner 1995; 1998), between facial expression analysis and facial speech analysis performed during lip-reading (Campbell et al. 1986), between knowing "what" and knowing "where" for vision (Wilson et al. 1997), between motor and semantic implicit memory systems (Heindel et al. 1989), between personal and extra-personal hemispatial neglect (Bisiach et al. 1986), between word finding and syntactic skills (Ellis and Young 1988: 139), or between automatic and propositional speech (review in Ellis and Young 1988: 251). Several of these dissociations can be matched to the general distinction between implicit and explicit processes which constitutes the main theme of this book. Then studies on intact human subjects also attempted to make the case for dissociation, for example between spatial and temporal information processing (Halbig et al. 1998) or between face recognition and facial expression analysis (e.g. Bruce and Young 1986). In addition, neuroimaging studies now provide instances of double dissociation between two functions (e.g. between imagining and actually perceiving colour (Howard et al. 1998) although these recent approaches to human brain functions allow to point to more complex network organisation than just double-dissociation (e.g. Faillenot et al. 1996; Sprengelmeyer et al. 1998). The description of a double dissociation is a necessary condition for cognitive psychologists to identify elementary modules involved in a given function. Although the notion of a modular organisation of cognition can be traced back to the 19th-century phrenology, the modularity of mind is a dominant paradigm in cognitive psychology and neuropsychology (e.g. Fodor 1983).

It may be noticed that the search for double-dissociation is very reminiscent of a dualist attitude. The duality between spirit and matter is in no way compatible, say, with the three natural realms (mineral, vegetal, animal), nor to the four elements (earth, water, fire, air), nor to the 5 or 7 notes of a musical scale, nor to the 7 colours of a rainbow. Nor does it only to unity. The emphasis put on duality has to be connected to the Cartesian heritage, which has been applied to most fields of contemporary science. Other cultures, such as oriental cultures more sensible to the Buddhist tradition, do not naturally follow this thinking habit, and may rather bind together "dissociable substances" (such as death vs. life or body vs. environment) (Motokawa 1989).

The destiny of dissociations

What does science make with a dissociation? As suggested by Teuber (1955), three problems derive from the idea to locate functions in the brain: discovering symptoms of lesion, assigning these symptoms to specific lesions in given areas, analysing the altered performance which underlies the symptom. "All too many studies stop short at discovery and localisation of symptoms, i.e. with the question of "where", and fail to proceed to the analysis of altered functions, i.e. with the question of "what" to localise" (Teuber 1955: 277–78). Thus dissociation observed within an initially presumed single function between two brain areas and/or two symptoms leaves the scientist with two new functions to analyse. At a later stage the initial dissociation becomes obsolete, and looses its interest. Because the aim is to understand how each function is made, no study will be carried out on the mother dissociation after it has been disunited, so that the fate of a dissociation is to disappear. For example no major work is currently being performed on the "old" dissociation described between the anterior and the posterior brain. Nor would it be useful to study a dissociation between sensory and motor functions, between language and vision, or between frontal and occipital areas. The consequence of this is that the analytical thought responsible for producing dissociations will put most emphasis on the last generated dissociation. If one assimilates the several generations of dissociation described in the brain to a genealogical tree, it can be said that the highest focus of attention is directed to the difference between siblings and forgets about the mother dissociation. And in turn the further analysis will give birth to a new generation of functions, which in turn will generate a greater number of functions to analyse.... An outstanding example of this logic has been provided by Felleman and van Essen (1991) in a review article of the connections between the over 30 distinct areas identified within the visual system. Of course the over 300 simple or reciprocal connections described within the visual system do not allow scientists to understand the brain mechanisms underlying vision, nor individuals to find their way to the phenomenological experience of vision. In the same way, the numerous areas involved in the generation of action are extensively interconnected in a way which precludes an overly simplistic description of the visuo-motor organisation as a straightforward dichotomy (Rossetti et al. 2000; see Pisella and Rossetti, this volume: Figure 1).

How far is science going to divide the brain into always-smaller functional units? Luckily enough, there seems to be a natural limitation to the perpetual division of the cerebral matter, so that the dissociating process should not go beyond the level of neurones or of molecules. A growing number of studies suggest that the coding of relevant information is not performed at the level of individual neurones but rather at the level of cell groups. This neuronal population coding is for example better correlated to the direction in space of the movements performed by an animal from which neuronal activity is being recorded, than any individual neurone (ex: Georgopoulos 1995; Sakurai 1996; Kristan 1997). These indications may suggest that the elementary unit of information processing is not out of reach to the current methods used to approach the brain.

Contrasting with the logic of cutting off from association every distinct piece of the mind-brain, one may hope that it has been sufficiently parcellated to initiate a tentative reconstruction. This attitude will provide us with another way of going beyond dissociations. As it has mostly been useful to analyse the different elements of the brain, it becomes even more important to put the puzzle pieces together again. Indeed the interest in dividing the brain in always-smaller parts is not to make the puzzle always more complicated but to understand the global organisation of the nervous system.

To sum up: It can be argued that the destiny of dissociations is to disappear. There are two ways for dissociation to be consumed: they may be deserted or unmade. Firstly, because a dissociation may have heuristic value only when it is not highly predictable, the derivative functions resulting from a dissociation will take its place in the interest of brain researchers and these functions will be further analysed and dissected, giving birth to potential new dissociations. Following this process the former dissociations are just left behind by science, which carries on its parcellation. The second possible destiny of dissociated functions is simply to be re-associated. As mentioned above, making the case for a dissociation is relevant only when two functions are previously considered as a whole. If two functions have been considered as a whole prior to be dissociated, this implies that the resulting dissociated functions must share several characteristics or interact in several ways. Then focusing on the dissociation will emphasise their difference rather than their common features and interrelations.

The basic idea of this book is that, although dissociation has proved to be a very useful heuristic tool for understanding mind-brain functions, studying the way so-called dissociated modules are interacting to contribute to the whole mind-brain function would provide us with even more insight into how consciousness appears. Interestingly the history of re-association may follow that of dissociation. For example the initial distinction made between the anterior and the posterior brain (e.g. Teuber 1955) has first given rise to the study of dissociation within the posterior brain (i.e. dorsal vs. ventral streams of visual processing, Ungerleider and Mishkin 1982). Later only could the study be initiated of how the parietal and temporal cortex work in conjunction to the frontal areas (e.g. Sakata et Taira 1994; Rossetti et al. 2000). The dissociation between the dorsal and the ventral streams itself has been sufficiently explored to allow the study of further dissociation within the dorsal stream (e.g. Milner 1997) or within the ventral stream (e.g. Buckley et al. 1997), and now the study of the interactions between the dorsal and the ventral stream can be developed (e.g. Rossetti 1998).

Implicit and explicit processing

One of the most important steps in reconstructing the unity of the decomposed mind-brain will probably be to understand the relationship between implicit and explicit processes. It is interesting to notice that the seminal work of von Helmoltz or Freud not only emphasised the distinction between conscious and unconscious but also already clearly addressed the issue of the interaction between these two instances of the mental life. Unfortunately for about one century there has been more and more attraction towards the power of unconscious processes as opposed to the conscious mental life and the report of dissociation between the conscious and the unconscious has become more fashionable than it really deserves. For these reasons, we already understand some of the processes underlying for example the interaction between perception and memory or motivation, the intermingling of movement control with several sensory modalities and several cognitive processes, but very little is known about the interaction between implicit and explicit processing. One of the most obvious and important reasons to study these interactions is that the distinction between explicit and implicit processing can apply to all fields of human cognition, ranging from sensory and sensori-motor processing to memory and language (e.g. Kihlstrom 1987). Table 1 shows a non-exhaustive list of several particular fields where the dissociation has been described under various terminologies.

Table 1. Related dissociations?

PERCEPTION		
subcortical vision	cortical vision	Cajal 1909, ...
tectal vision (Where?)	cortical vision (What?)	Schneider 1969
ambient vision	focal vision	Threvarthen 1968
tactile localisation	tactile identification	Paillard 1983
spatial	object	Ungerleider & Mishkin 1982
MEMORY		
procedural	declarative	Cohen & Squire 1980
implicit	explicit	Shacter 1987
sensorimotor	conceptual	Perrig & Hofer 1989
RESPONSE		
action	experiential	Goodale 1983
motor	cognitive	Bridgeman 1981, 1991, 2000, this volume
sensori-motor	cognitive or representational	Paillard 1987, 1991
implicit	explicit	Weiskrantz 1974
action (How?)	perception (What?)	Goodale & Milner 1992, Milner & Goodale 1995
pragmatic	semantic	Jeannerod & Rossetti 1993; Jeannerod 1994
direct parameter specification	conscious representation	Neumann & Klotz 1994
How?	Where?	Rossetti, Rode, Boisson 1994
automatic	voluntary	e.g. Hommel 2000, this volume....
ACTION CORRELATES?		
reflex eye movement	voluntary eye movement	Post & Leibowitz 1985
elicited extension	guided placing	Hein & Held 1967
ballistic movement	terminal guidance	Paillard 1971
feedback	feedforward	Rossetti & Koga 1992
reaching channel	grasping channel	Jeannerod 1981
kinetic visual cues	static visual cues	Paillard & Amblard 1985
automatic	conscious	Goodale, Pélisson, Prablanc 1986
egocentric reference frame	exocentric reference frame	Bridgeman 1991, ...
personal space	extrapersonal space	....

One other reason for the limited number of investigations about implicit-explicit interaction derives from the fact that the dissociation described between implicit and explicit processing is probably one of the highest-level dissociations studied in the field of cognitive science. In addition, the distinction between these two forms can be very difficult to demonstrate, because it seems possible to perform many sophisticated operations in either way. For these two reasons, the need to understand how these dissociable components may interact and co-operate expresses itself more vividly than for other dissociations.

One argument for dissociating implicit and explicit processing is that these two processes are of different nature. A strong argument for this position is that only one of the two process is left in some patients showing blindsight (Jackson, Place) or numbsense (Pisella and Rossetti). In normal subjects a conflict can be produced between the two levels of processing. The contribution of Bhalla and Proffitt, of Bridgeman, and of Pisella and Rossetti clearly show that the implicit processing performed by the action system gives rise to an internal representation of a visual stimulus that qualitatively and quantitatively differs from explicitable representation on several parameters. In addition, Jackson suggests that a patient with blindsight may access some visual information only in an implicit way, whereas another type of information could give rise to visual awareness. Place's model proposes that different neurological structures are responsible for the implicit and explicit processing observed in blindsight. Imanaka and Abernethy provide an interesting series of experiments showing that attended and unattended proprioceptive information may participate in action control in a different way, the implicit contribution having a counter-intuitively stronger weight than the explicit one. The result shown by Hommel (Fig. 5) accordingly demonstrates that the effect of a visual illusion (related to the Roelofs effect described by Bridgeman), can be modulated according to where subjects focus their attention, and thus according to implicit vs. explicit processing of the visual feature responsible for the illusion. In the same vein, Forgas and Ciarrochi show that mood management can depend upon the access of internal states to consciousness.

The discrepancy between implicit and explicit level of sensory processing that is revealed in experimental conditions does however not spontaneously appear in everyday life. Bhalla and Proffitt show that this discrepancy seems to be solved by a biased internal mapping between the two types of representation. If a given stimulus is interpreted as A by a given system (e.g.

verbal) and as A' by another system (e.g. action), then an internal coherence can be maintained if the two systems are referring to the same external object by A and A' respectively. In most of the experimental evidence presented in this volume the discrepancy between implicit and explicit processing is expressed under particular circumstances where a time pressure is applied (e.g. Bridgeman; Pisella and Rossetti). Such time constraints are also crucial for the integration of automatic stimulus-response processing with intentional control (Hommel), and for allowing a visual prime to affect semantic activation of target words (Bar). They may be responsible for the difference found between laboratory exploration of implicit face recognition in prosopagnosic patients and the every day life deficit (Young and Ellis).

Another distinction between implicit and explicit processes emphasises their respective thresholds. A recent article published by Dienes and Perner (1999) proposes an analysis of explicit knowledge based on a progressive transformation of implicit into explicit products, applying this gradient to different aspects of knowledge that can be represented. The ambition of the theory proposed is to bind philosophical conception of knowledge with relevant psychophysical and neuropsychological data. Dienes & Perner propose that the access of a given knowledge to explicit representation is mainly dependent upon the explicitation of the components of this knowledge. Therefore the question arises whether all implicit information can, at least in principle, become explicit, especially in the framework of the dorsal-ventral dissociation that is largely referred to by the authors of this volume. Action offers the opportunity to express implicit knowledge without involving declarative processes and therefore seems to stand in contrast with the views of Millikan (1984) and Dretske (1998). If "sometimes the unconscious and the conscious representations will contradict each other" Dienes and Perner (1999), as is shown in several chapters of the present book, then is there not the need to further refine the theory of accessibility of implicit knowledge to consciousness in order to allow for a possible discrepancy between implicit and explicit processing? This question should be kept in mind because several contributors to the present volume present instances of such contradiction in the field of action. Interestingly studies on implicit and explicit participation to action control are well represented in this book by several stimulating contributions.

The exploration of implicit and explicit processing in unilateral neglect presented by Ladavas also supports the idea of a continuum between these two processes, based on the difference between the thresholds required for their respective activation. Another argument for the threshold view of the relationship between explicit and implicit processing arises from developmental studies. For example Perner and Clements elegantly show that children appear to be progressively shifting from the complete absence of theory of mind (1) to an implicit, and (2) then only to an explicit theory of mind enabling them to attribute conscious states to others.

Despite the dissociation introduced between implicit and explicit processes, some exchange can be described between dissociated systems or subsystems. Most of the present volume contributions show that integration plays a key role in the functional aspects of the specific functions explored. The contribution of Ladavas et al. convincingly demonstrates that explicit and implicit processing of visual information by patients with hemispatial neglect are extremely difficult to disentangle, because unconsciously perceived information can contaminate the explicit responses produced by the patient. The fact that locating an object is largely performed through unconscious processes whereas identifying it spontaneously gives rise to conscious representation may be responsible for this kind of contamination, as is the case for locating one's own hand prior to initiating an action (Imanaka and Abernethy). In addition, Ladavas et al. propose that consciousness implies that object location and intrinsic object properties have to be integrated, which seems to be a converging hypothesis to explain the alteration of consciousness in hemispatial neglect. There is indeed evidence suggesting that location has an essential, primary status with respect to attentional orienting. Although target location can be known in the absence of feature (colour or orientation) information, the reverse does not seem to be true (e.g. Bloem and van der Heijden 1995; Brouwer and van der Heijden 1996).

The tight link that exists between conscious states and the integration of the world complexity is also emphasised by Revonsuo et al. Following Lahav (1993) they argue that unconscious processing has only access to partial information, which is consistent with the experimental data provided in several other chapters (e.g. Bridgeman; Jackson; Pisella and Rossetti). By contrast, conscious processing is necessary to form a meaningful model of the world, which is needed to elaborate, initiate and evaluate integrative, adaptive and flexible behaviour. The question of whether zombies can be found within the human brain can thus be answered positively only in the case of rather simple responses (e.g. pointing to a visual target). Because of their simplicity, these responses can be processed very fast and remain more dependant on the environment than the complex systems responsible for sleep walking (Revonsuo et al.), mood management (Forgas and Ciarrochi) or theory of mind (Perner and Clements). Strong Zombiehood (Revonsuo et al.) seems to be restricted to simple sub-systems whereas the richer both way interaction described in normals between the implicit and explicit processes involved in complex management would leave space only for Weak Zombiehood.

One extremely interesting feature of the dissociation between implicit and explicit processing is that an internal coherence appears to be maintained in the mind-brain, which suggests that under normal circumstances the whole system easily overcomes the divergence between subsystems to produce a unified interpretation of the body and/or the world. This characteristic feature emphasises the gap that has to be filled between the decomposed understanding of the brain provided by cognitive neuroscience and the phenomenological experience of internal states or external perception. It clearly emphasises the need to put together scientific elements so as to build up a more complex whole that would better correlate with subjective experience. The outstanding set of experiments presented by Bhalla and Proffitt further shows that functions related to explicit representation and to action, though dissociated under some circumstances, produce transfer functions from one to the other. Their contribution will suggest that although different internal scales may be used to represent the external world these scales are being put into register in order to preserve this internal coherence. The only limitation to this coherence maintenance system seems to related differences in the temporal constraints attached to the different representations (see also Bridgeman; Pisella and Rossetti). It is interesting to notice that these temporal constraints seem to be distributed along a gradient, which suggests that they are not incompatible with the notion of a continuum between implicit and explicit processing (Hommel; Pisella and Rossetti).

Synthesis

Analysis of the brain has led to an extreme parcellation of the neural matter and of the neuronal processes. However to understand how a brainteaser is built in, one has to be able not only to disassemble but also to recompose its complex 3D structure. In the same way, the major future challenge for consciousness scientists will obviously be to reconstruct the brain after having decomposed it. Let us consider again the famous dissociation between the ventral and the dorsal stream of visual processing. This dissociation can be considered as a first step towards a full decomposition of the visual system into a very sophisticated network of dozens of cortical areas (cf. Felleman and van Essen 1991). On the other hand it may also be regarded as an attempt to make sense of the incredibly complex network of areas and connections forming the visual system. But it remains based on a "dualistic" view of how the brain is organised, which can be challenged in various ways. For example the results described in this book by Bridgeman, by Bhalla and Proffitt, or by Pisella and Rossetti suggest that powerful interactions can take place between the dorsal and the ventral stream of visual processing. These results clearly indicate that dissociating visual functions is not the best way of understanding the complexity of visual processes. After having opposed the two terms of the dissociation between implicit and explicit processing, scientists will then have to follow the Hegelian idea, and initiate the final stage of the triadic progression in which an idea is proposed, then negated, and finally transcended by a new idea that resolves the conflict between the two initial terms. A further step has to be considered to the opposition between two components that are described as a dissociation. In the same vein, Marshall (1996) proposed recently that the future of neuropsychology is made of deconstructing the past. If the past of neuropsychology, as well as other areas of human sciences, is made of dissociations, then future research should be aimed at reconstructing a whole. For example, an alternative view to the dissociation theory would be that vision for action and vision for perception constitute the two extreme terms of a continuum gradient of visual functions (Rossetti, Pisella and Pélisson 2000). For representational level more complex than just visuomotor behaviour the existence of complex interactions between implicit and explicit processing (among others) is even more obvious (e.g. Young; Forgas and Chiarrochi; Révonsuo et al.).

It is interesting to note that one of the first dissociations heralded between cortical areas dealt with 'association' cortex. More than 100 years ago Flechsig divided the cerebral cortex into three zones: the primary or projection zones on the one hand and the intermediate and terminal zones, together called the *association* cortex (Flechsig 1886, quoted by Gross 1998: 74–75, 183–184). This latter was attributed the function of transforming the sensations into perceptions, and to integrate them together with other sensory modalities. The association cortex has been then considered as the area in charge of 'the process of elaboration and intellectual interpretations...' (Bolton 1900, quoted by Gross 1998). This ironical historical consideration suggests that (1) sensations have to be distinguished from perception, as already argued by the ancient-Greece philosophers following Aristotle (2) perception and elaborated processes require the association of sensation to images and ideas kept in memory, to other sensory modalities, as well as to internal states linked to motivation and emotion. Although the dissociation between the primary and the association areas has been questioned later on (ex: Teuber 1955), these two statements also illustrate the rhetoric of assembling and disassembling the brain. The scientific approach made an extensive use of dissociation, whereas the brain is associating cognitive elements into a person's cognitive life. And the subjective experience is most often that of an individual (*in-dividis*) organism. The putting together of scientifically discovered parts or elements so as to make up a complex mind-brain whole should however not be a simple task. The aim of this book with respect to this project is only to provide the demonstration that combining and unifying the isolated data of science into a cognisable whole is more than just preparing an old alchemist recipe or reheating an old soup to synthesise human consciousness. In no way it constitutes a step backwards in time but rather constitutes the new track that one should follow to make further progresses. The synthesis of implicit and explicit processes is a crucial issue to understanding the organisation and the functions of the mind.

References

Bisiach, E., Perani, D., Vallar, G. & Berti, A. (1986). Unilateral neglect: personal and extrapersonal. *Neuropsychologia,* 24, 471–482.

Bloem, W., van der Heijden, A.H.C. (1995). Complete dependence of color identification upon color localization in a single-item task. *Acta Psychologica* 89, 101–120.

Bridgeman, B. (2000). Interactions between vision for perception and vision for behavior. This volume, 17–40.

Brouwer, R.F.T., van der Heijden, A.H.C. (1996). Identity and position: dependence originates from independence. *Acta Psychologica* 95, 215–237.

Bruce, V. & Young, A. (1986). Understanding face recognition. *British Journal of Psychology,* 77, 305–327.

Buckley, M.J., Gaffan, D., Murray, E.A. (1997). Functional double dissociation between two inferior temporal cortical areas: Perirhinal cortex versus middle temporal gyrus.

Journal of Neurophysioly, 77(2):587–98

Campbell, R., Landis, T. & Regard, M. (1986). Face recognition and lipreading: a neurological dissociation. *Brain,* 109, 509–521.

Code, C. (1996). Classic cases: Ancient and modern milestones in the development of neuropsychological science. In C. Code, C-W. Wallesch, Y. Joanette & A. Roch (Eds.) *Classic cases in neuropsychology.* Hove: Psychology Press, 1–10.

Code, C., Wallesch, C-W, Joanette, Y. & Roch, A. (1996). *Classic cases in neuropsychology.* Hove: Psychology Press, pp 385.

Dienes, Z., Perner, J. (1999). A theory of implicit and explicit knowledge. *Behavioral and Brain Sciences,* 22:5, 735–754.

Dretske, F. (1998). *Explaing behavior: reasons in a world of causes.* MIT Press.

Ellis, A.W. & Young, A.W. (1988). *Human cognitive neuropsychology.* Hove and London: LEA, pp 358.

Faillenot, I., Toni, I., Decety, J., Gregoire, M.C. & Jeannerod, M. (1997). Visual pathways for object-oriented action and object recognition: functional anatomy with PET. *Cerebral Cortex,* 7(1), 77–85

Felleman, D.J. & Van Essen, D.C. (1991). Distributed hierarchical processinng in the primate visual cortex. *Cerebral Cortex,* 1, 1–47.

Fodor, J. (1983). *The modularity of mind.* Cambridge MA, MIT Press.

Georgopoulos, A.P. (1995). Current issues in directional motor control. *Trends in Neurosciences.* 11, 506–10.

Gross, C.G. (1998). *Brain, Vision, Memory. Tales in the History of Neuroscience.* Cambridge, MA, MIT Press.

Halbig, T.D., Mecklinger, A., Schriefers, H, Friederici, A.D. (1998). Double dissociation of processing temporal and spatial information in working memory. *Neuropsychologia.* 36, 305–311.

Halligan, P.W. & Marshall, J.C. (1998). Neglect of awareness. *Consciousness and Cognition.* 7(3), 356–380.

Heilman, K.M., Valenstein, E. (1993). Introduction. In *Clinical Neuropsychology* (third edition). K.M. Heilman K.M. & E. Valenstein (Eds). New York: Oxford University Press, 3–16.

Heindel, W.C., Salmon, D.P., Shults, C.W., Walicke, P.A. & Butters, N. (1989). Journal of Neurosciences, 9(2), 582–587.

Hommel, B. (2000). The prepared reflex: automaticity and control in stimulus response translation. In: S. Monsell & J. Driver (eds). *Attention and Performance vol, XVIII.* Cambridge, MA, MIT Press, in press.

Howard, R.J., ffytche, D.H., Barnes, J., McKeefry, D., Ha, Y., Woodruff, P.W., Bullmore, E.T., Simmons, A., Williams, S.C., David, A.S. & Brammer, M. (1998). The functional anatomy of imagining and perceiving colour. *Neuroreport* 9, 1019–1023.

Jones, G.V. (1983). On double dissociation of function. *Neuropsychologia,* 21, 397–400.

Kihlstrom, J. F. (1987). The cognitive unconscious. *Science* 237, 1445–1452.

Kolb, B. & Whishaw, I.Q. (1990) *Fundamentals of human neuropsychology* (third edition). New York: Freeman and Co, pp 910.

Kristan, W.B.Jr, Shaw, B.K. (1997). Population coding and behavioral choice. *Current Opinion in Neurobiology,* 6, 826–31.

Marshall, J.C. (1996). The future of neuropsychology — deconstructing the past. In C. Code, C-W. Wallesch, Y. Joanette & A. Roch (Eds.). *Classic cases in neuropsychology.* Hove: Psychology Press, 363–366.

Milikan, R. (1984). *Language, thought, and other biological categories.* MIT Press.

Milner, A.D. (1995). Cerebral correlates of visual awareness. *Neuropsychologia* 33, 1117–1130.

Milner, A.D. (1997). Neglect, extinction, and the cortical streams of visual processing. In: P. Thier, H.O. Karnath (eds). *Parietal lobe contributions to orientation in 3D space.* Springer-Verlag Berlin, 3–22.

Milner, A.D. (1998). Streams and consciousness: visual awareness and the brain. *Trends in Cognitive Sciences*, 2, 1, 25–30.

Motokawa, T. (1989). Sushi science and Hamburger science. *Perspectives in Biology and Medicine*, 32(4), 489–504.

Pisella, L. & Rossetti, Y. (2000). Interaction between conscious Identification and non-conscious sensory-motor processing: Temporal constraints. This volume, 129–152.

Rossetti, Y. (1998). Implicit short-lived motor representations of space in brain damaged and healthy subjects. *Consciousness and Cognition*, 7, 520–558.

Rossetti, Y., Pisella, L. & Pélisson, P. (2000). Eye blindness and hand sight: temporal aspects of visuo-motor processing. *Visual Cognition*, 7, in press.

Sakata, H. & Taira, M. (1994). Parietal control of hand action. *Current Opinion in Neurobiology*, 4, 847–856.

Sakurai, Y. (1996). Population coding by cell assemblies — what it really is in the brain. *Neuroscience Research*, 1, 1–16

Shallice, T. (1979). *Journal of Clinical Neuropsychology*, 1, 183–211.

Sprengelmeyer, R., Rausch, M., Eysel, U.T. & Przuntek, H. (1998). Neural structures associated with recognition of facial expressions of basic emotions. *Proceedings of the Royal Society of London* ,265, 1927–1931.

Suzuki, D.T. (1971). *Essays in Zen Buddhism* (3d ser.) New-York, Weiser.

Teuber, H.L. (1955). Physiological psychology. *Annual Review of Psychology*, 6, 267–296.

Ungerleider, L.G. & Mishkin, M. (1982). In D.J. Ingle, M.A. Goodale and R.J.W. Mansfield (Eds.), *Analysis of Visual Behavior.* MIT Press, 549–586.

Wilson, B.A., Clare, L., Young, A.W. & Hodges, J.R. (1997). Knowing where and knowing what: a double dissociation. *Cortex*, 33, 529–541.