Even now, this paper merely scratches the surface. I have not even come close to reading all there is to read on the subject. A new biography of Watson, bringing out the previously hidden facts of his life and work, is badly needed. Though sorely tempted to do so, I do not plan to undertake that demanding task. In the unlikely event a graduate student, say, shows special interest in producing a dissertation on Watson's work, I shall encourage that person to undertake that important work. If no collaborator is forthcoming, I may yet yield to the temptation.

Mexican Journal of Behavior Analysis
vol. 19, monographic issue, 1993, 67-90

The role of repetition in transforming actions into habits: the contribution of John Watson and contemporary research to a persistent theme[1]

El papel de la repetición en la transformación de las acciones en hábitos: la contribución de John Watson y la investigación contemporánea a un tema persistente

Robert A. Boakes
Department of Psychology
University of Sydney

Abstract

It is argued that John B. Watson offered in 1914 an experimental program based on animal research to study one feature of William James' concept on automatic habit: the increasing control of individual components in a response sequence by kinesthetic feedback. Some other aspects of James' concept were

1 Acknowledgments
This paper is dedicated to the memory of Donald Broadbent who died in April, 1993. His book, *Behavior* (1961), was one of the first sources for my interest in the topics discussed here. Another was Richard Herrnstein, my doctoral supervisor, who provided an introduction to the 1967 edition of J.B. Watson's *Behavior: An introduction to comparative psychology*. On reading Herrnstein (1967) again for the first time in very many years I realized the extent to which he had kindled my interest in the early history of behaviorism.

Turning to much more recent help, advice and support for the research providing the background to this paper, I very much appreciate the opportunity to work for 12 weeks in 1992 in the 4th floor animal laboratories at the Department of Psychology, University of Cambridge which was provided by Nick Mackintosh and Tony Dickinson, and even more the highly stimulating environment which they, together with Bernard Balleine and other members of the Department, have created. Financial support for this study leave project was provided by the University of Sydney, and experimental work carried out at this University was partially supported by the Australian Research Council.

Helpful comments on a draft were generously provided by Bernard Balleine, Tony Dickinson, Dick Herrnstein, Tim Miles and Bob Rescorla. Finally I wish to acknowledge the constant advice and support that Fred Westbrook has given me since I came to Sydney in 1989, and also that from many other members of the Australian Learning Group, at one of whose meetings a very early version of this paper was first presented.

left out, specially goal-directed action. A re-evaluation of this feature is discussed according to some contemporary experimental research on reinforcer devaluation.

Key words: William James, John B. Watson, automatic habit, goal-directed action, reinforcer devaluation

Resumen

Se sostiene que John B. Watson ofreció en 1914 un programa experimental basado en la investigación animal para estudiar una característica del concepto de William James sobre el hábito automático: el control creciente de los componentes individuales en una secuencia de respuesta mediante la retroalimentación kinestésica. Algunos otros aspectos del concepto de James fueron eliminados, especialmente la acción dirigida a meta. Se discute una revaloración de esta característica de acuerdo a la investigación experimental contemporánea sobre la devaluación del reforzador.

Palabras clave: William James, John B. Watson, hábito automático, acción dirigida a meta, devaluación del reforzador

1. Habit and instinct in 19th Century theories of evolution

Throughout the 19th century the role of habit in the development of species was a central issue for evolutionary theorists. At the start of the century Lamarck (1809) proposed that species learn new forms of behavior in new environments, that these new behaviors give rise to both bodily and mental changes, and that the latter to some degree, are passed on to their descendants (Richards, 1987). During the many years that separated the genesis of natural selection as a theory of evolution from its eventual publication, Darwin wrestled with what he saw as central objections to his theory. Foremost among these were the origins of instinctual behavior and its relationship to earned behavior. It was only when he felt that he had reached solutions to such problems that he began to write, and then precipitously publish - because of the startling arrival of Wallace's (1858) paper - the full exposition of his theory in *The Origin of Species by Means of Natural Selection* in 1859 (Desmond & Moore, 1991).

The major impact of Darwin's book was to make evolutionary theory respectable. In a remarkably short time what had been previously regarded as

a dangerous, radical, unsound —even blasphemous— account of life on earth became a commonplace way of thinking within the Western intellectual tradition. The mechanism by which Darwin proposed the evolution of species to have occurred —the natural selection of those individuals most successful in producing viable offspring— was not accepted as readily. It has been proposed, for example, that Darwin's most effective champion in promoting evolutionary theory, Huxley, never fully understood the theory (e.g. Gross, 1993). In the *Origin of Species* Darwin discussed the evolution of instinctive behavior, arguing why this must have occurred *mainly* by natural selection and not by a Lamarckian process of evolution. His prime example was the complex and highly specific innate behavior patterns by neuter individuals in various species of social instincts.

Twelve years later Darwin responded to two challenges that appeared likely to overwhelm his theory. One came from physicists who produced ever shorter estimates for the age of the earth and thus shrank dramatically the time available for evolution to occur from the thousands of millions of years Darwin needed for his theory (Boakes, 1984). The second challenge was from critics concerned with the evolution of the human mind. Once again Wallace, his co-discoverer of natural selection, provided the immediate stimulus for publication (Boakes, 1984; Desmond & Moore 1991; Richards, 1987). Darwin's response to these challenges took the form of his first book which was explicitly directed towards psychological issues, *The Descent of Man and Sexual Selection*, of 1871.

In this book Lamarckian inheritance was given new prominence in explaining how often repeated actions by an individual might become instinctual in his or her offspring and thus lead to changes in inherited brain structures, and hence of mental faculties, over only a few generations. His footnotes make it clear that Darwin was very much influenced by several contemporary theorists, many of whom were also close acquaintances, notably Spencer and Lewes. Spencer had published on evolution prior to 1859. In fact, the slogan "survival of the fittest", was his invention and antedated publication of Darwin's theory. Nevertheless, despite the connotations of this slogan Spencer remained a staunch Lamarckian, rejecting natural selection as an important factor in evolution throughout his long career. His importance to psychology lay in his passionate belief in the importance of evolution as a framework for understanding psychological and social phenomena. The two editions of his *Principles of Psychology*, of 1855 and 1872, were probably the most widely read books on the subject in the English-speaking world during the second half of the 19th century, despite his turgid and often impenetrable style of writing. Much more readable were the books of his friend, Lewes, who, like Spencer, firmly believed that the key to the understanding of human mental faculties would come from understanding the processes by which intelligent actions - that is, purposive actions directed towards consciously perceived goals —were turned into automatic habits as a result of repetition, which in turn might become instincts —or "lapsed intelligence"— in later generations (Lewes, 1860).

Darwin's heir, Romanes, remained steadfastly loyal to the compromise of Darwin's later years. He maintained their dual theory of the origin of instincts (e.g. Romanes, 1882). It was only in the last decade of the 19th Century that the distinction became clear between habit and instinct which the 20th century has held ever since. The German biologist, Weissman's, experimental critique of Lamarckian inheritance, plus the alternative theory of biological inheritance he offered based on gene theory, made both the "lapsed intelligence" account of Spencer and Lewes and the compromise of Darwin and Romanes eventually untenable. A few theorists in the early 20th Century who clung to Lamarck were soon regarded as towards, if not beyond, the fringe of mainstream biology and psychology (eg. Oldroyd, 1980). Within comparative psychology the impact of Weissman's work was most clearly appreciated by Romanes' own successor, Morgan. In his book of 1896, *Habit and Instinct,* he provided an account of instinct, which went back to Wallace and early Darwin, and one of habit, in which the processes by which habitual behaviors develop in an individual are akin to what we now know as classical and instrumental conditioning.

2. William James on Automatic Habits

The American psychologist and philosopher William James served as a bridge from mainly British and French psychological theories developed within an evolutionary framework to American psychology of the early 20th Century. His most important work was his book, *The Principles of Psychology,* of 1890. One of the most famous chapters in this book is his chapter on "Habit". The opening sentence signals the evolutionary context from which he began. "When we look at living creatures from an outward point of view, one of the first things that strikes us is that they are bundles of habits". Nonetheless his treatment of the topic marked a significant change of emphasis: From the role of habit in mental evolution to its role in everyday life. In doing so, he relied less on the ideas of evolutionists like Spencer and more on the British theorist, Carpenter, whose book on *Mental Physiology* (1874) is cited extensively throughout the chapter.

The central theme of the early part of the chapter is that repetition makes actions automatic. What did James mean by "automatic"? Four inter-related, but logically independent, properties can be picked out of his discursive argument. These are not dissimilar to more recent treatments of the distinction between strategic and automatic cognitive processes (eg Hasher & Zacks, 1979; Klatsky, 1984; Schneider & Shiffrin 1977). The first effect of repetition is that it transforms what is initially an invariant chain of discrete actions into a single unit. As will be discussed in the next section, it was an issue which was of much concern to Watson. The way in which a pianist starts with individual notes and later produces runs was the popular Victorian example which James used. The same example persisted well into the 20th Century, as in Lashley's (1951) paper on the integration of behavior. "Chunking" is the *term used later* this century. The second property is what might today be called "increased availability of attention to other tasks". The expert pianist can play a difficult piece, and continue a conversation at the same time. Another example James provided was from the most renowned stuntman and scapologist of the late 19th Century, Houdini, who reported that he trained himself to be able to juggle four balls and simultaneously read a book. The third feature of automatic habits is that we have little conscious awareness of their performance. "Few men", wrote James, "can tell offhand which sock, shoe or trouser leg they put on first". In discussing examples such as knitting, he proposed that "the antecedents of each movement of the chain are accompanied by ... *sensations* to which we are *usually inattentive* but which immediately call our attention if they go *wrong*" (James, 1890; p.115).

The final feature is one that I will discuss further in the final section. This is that an automatic habit acquires the quality of a reflex, in the sense that it is both elicited by immediate stimuli and may be motivationally inappropriate, that is, inconsistent with an individual's current goal. Once again James quoted at length from Carpenter (1874), who had claimed it to be "the universally admitted fact that any sequence of *mental action* which has been frequently repeated tends to perpetuate itself; so that we find ourselves automatically prompted to *think, feel,* or *do* what we have been before accustomed to think, feel, or do, under like circumstances, without any consciously formed *purpose,* or anticipation of results" (italics as in James, 1890, p 112). In support of such a "universally admitted fact" James provided various anecdotes. "Very absent-minded persons in going to their bedroom to dress for dinner have been known to take off one garment after another and finally get into bed, merely because that was the habitual issue of the first few movements when performed at a later hour". He also reproduced a story from Huxley to illustrate what might, in today's vocabulary, be termed interference by a competing overtrained response with a goal-directed action: I"... a practical joker, who on seeing a discharged veteran (soldier) carrying home his dinner, suddenly called out: "Attention!" whereupon the man instantly brought his hands down, and lost his mutton and potatoes in the gutter. The drill had been thorough, and its effects had become embodied in the man's nervous structure" (James, 1890; p.120).

Just how a well drilled habit becomes embodied in an individual's nervous system was a complete mystery, James was careful to concede. All that he could do was offer some similes of which most were based on the action of running water. It should be remembered that James was writing before the cellular structure of the nervous system had been discovered. The electrical basis of neural activity had only become widely accepted in his youth. In his metaphors of streams carving ever deeper channels through fissures in rocks or of blocked drains —civilized plumbing was a Victorian technological achievement that had also only become widespread in Western cities during his youth— there were distinct echoes of the nervous system made of interconnected tubes through which flowed a mysterious vis *nervosa* that went back to Descartes and beyond. As an aside, it is interesting to note how yesterday's metaphors, whether they be based on plumbing or on rule-governed artificial intelligence systems, known at one level to be inappropriate, nevertheless persist in their influence at another level in shaping today's ideas. James used a non-hydraulic simile, the slow setting of a piece of plaster, to emphasise a belief he held very firmly. This was that the nervous system loses plasticity with age, so that new habits are acquired with increasing difficulty as an individual grows older.

Whereas James had little else but similes to offer on the neural basis, or "physics" as he called it, of habit formation, he had a great deal to say about the *function* and ethical importance of habits in everyday life. The last part of his chapter on "Habit" is more like a lay sermon than an excerpt from the handbook of psychology his *"Principles"* purported to be. This part begins with the oft-quoted sentences: "Habit is thus the enormous fly-wheel of society, its most precious conservative agent. It alone is what keeps us all within the bounds of ordinance, and saves the children of fortune from the envious uprising of the poor. It alone prevents the hardest and most repulsive walks of life from being deserted by those brought up to tread therein" (James, 1890; p. 121). He goes on to emphasise the importance of developing good habits early

in life since, according to James as he repeated his plaster analogy, for most of us by the age of thirty our habits —our speech, gestures, way of dressing— are set for life. The *very* positive aspect of frequently repeated habits of an appropriate kind is that they allow us to perform all the thousands of bits of everyday behavior in a completely automatic and yet —in a familiar environment— perfectly adaptive, manner, and thus release the mind to do more interesting things.

3. John Watson on "habit formation and habit integration"

I have dealt at length on James, as his ideas on habit pervaded Watson's entire research career. Watson's first experiments with rats, undertaken for his doctoral degree, can be seen as a test of the Jamesian view that habits are acquired more slowly with increasing age. In his last serious book, *The psychological care of infant and child* (1928), Watson's major theme is the same as James': the importance of installing good habits into a child at the earliest possible age.

James' *Principles* inspired a whole generation of young psychologists at the turn of the century. The debt was not always acknowledged. He not only served as a bridge from British and French evolutionary psychology, but also as one of the more readable guides to the experimental psychology that had developed in late 19th century German universities. These young men with their new American PhDs wanted psychology to be a science and wanted hard —that is, experimental— data. It is notable that James' chapter on habit makes not a single reference to any experimental *result, nor to any* other kind of systematic observation. For the spunky new generation, James was too much the philosopher, an allegiance he never abandoned. James' student, Thorndike, had poured scorn on the anecdotalist tradition and yet took a set of informal observations by Romanes —animals opening door latches— as the basis for the experimental procedure he labelled the "puzzle box", which Watson later called the "latch box" (Boakes, 1984). In general, their peers seem similarly to have viewed James as hopelessly non-scientific and yet directed their experiments towards the issues he had defined. For Watson this was partly a matter of making psychology more precise. Thus, in place of James' sweeping assertion that habits were more easily acquired when young, Watson's thesis experiments of 1902 appeared to indicate that, "whereas the young white rat forms motor habits, maze, Box 1, etc., much more rapidly than the adults", but when the latch box was used "the young animals form the habit of manipulation much less rapidly than do the adults" (Watson, 1914; p. 235).

In his "behaviorist manifesto" Watson turned from his attacks on the introspective tradition to a more constructive argument about the direction psychology needed to take. "I believe we can write a psychology, define it as Pillsbury does (as "the science of behavior"), and never go back upon our definition ... It can be done in terms of stimulus and response, habit formation, habit integration, and the like" (Watson, 1913; pp. 166-167). The manifesto was based on the first in a series of lectures he gave that northern summer at Columbia University. A book based on the whole series was published the following year, *Behavior: an introduction to comparative psychology* (Watson, 1914). The first chapter reproduced almost unchanged his 1913 paper. Two later chapters make it clearer how psychology might become based on "habit formation" and "habit integration". While the 1913 paper came to be seen as a milestone in the development of behaviorism only several years later, the 1914 book became immediately *the* handbook for the next generation of learning theorists and comparative psychologists.

Briefly in Chapter Two and more fully in Chapter Six, Watson makes it clear that the study of learning, which he equated with "habit formation", is to have a central place in the new psychology. The aim is to establish the "laws of plasticity". It is clear that a highly empirical approach is intended for this research program, one that would establish, for example, the effects of age, sex, species, abnormal brain function and so forth. The chapter reviews the limited experimental evidence on such factors that was available in 1914. Typically Watson gives considerable attention to his own research. What is particularly interesting here is the research Watson carried out, partly in collaboration with his then student, Carr, on maze learning in the white rat. This makes clear what he meant by habits becoming automatic as a result of repetition.

A habit he defined as a "complex system of reflexes which function in a serial order when the organism is confronted by certain stimuli" (Watson, 1914; p. 184). What he sought to find out from this series of experiments was the nature of the stimuli eliciting the reflexes which had melded into a maze habit. In an instantly notorious study (see Buckley, 1989; p. 53), he found that visual cues were unimportant, in that little disruption of maze performance was obtained when rats trained in the light were tested in the dark. Furthermore rats made blind by surgery learned the maze as rapidly as sighted rats. Similarly, surgical removal in different groups of animals of the senses of smell, hearing and touch (by clipping their whiskers) had little effect on the rate with

which a rat learned to negotiate a Hampton Court maze. On the basis of elimination Watson concluded, provisionally, that the major source of stimuli controlling individual reflexive components of the habit was the kinesthetic sense (Watson, 1907). Later critics pointed out that at least some of these results were also consistent with the possibility that rats learned about whatever cues were available to them or that they were responding to a configuration of cues from a variety of sensory modalities.

Nonetheless, for Watson these results strengthened the view that automaticity of *habits* meant that each link in a sequence of movements was elicited by kinesthetic feedback from the previous movement. Since, as discussed above, this was exactly what James had suggested to be the first property of an automatic habit, it seems highly likely that this was the main origin of Watson's views on the matter. It was strengthened further by the result of his experiments with Carr (Carr & Watson, 1908). These used a specially designed maze in which the distance to the first turn could be either short or long. They found that a rat well trained on the short version would, when the maze was lengthened for a test, still try to turn at the point in the runway where the next arm had been. It is hard not to see this as an example of an entirely motor-encoded sequence, unitized by proprioceptive feedback, as a later terminology might describe it.

Watson left until the next chapter his views on the mechanism by which such habits are produced. It started with a brief review of some contemporary views, including that of his former supervisor, Angell. (As an aside, it is interesting to find that Angell distantly anticipated the productive ideas of Kamin (1968) on the importance of "surprise" in learning). The list ended with Thorndike who had recently published *Animal Intelligence* (1911), in which he had claimed that there are two fundamental principles of Learning, the "law of effect" and the "law of exercise". Watson categorically rejected the law of effect. "It is our aim to combat the idea that pleasure or *pain has* anything to do with habit formation". On the other hand he wholeheartedly agreed with the law of exercise, which for Thorndike indicated that the strength of a connection is proportional to the number of times a response has been made. Watson believed that this law, or the "principle of frequency" as he put it, could on its own provide a complete account of habit formation (Watson, 1914; pp. 262-268). The basic assumption underlying his theory is that the formation of a habit involves the relative weakening of "useless movements", while useful components of the response sequence become stronger as a result of occurring more frequently. As Herrnstein (1967), for example, has argued, Watson's - or rather Carr's (1914) theory which was fully acknowledged by Watson - has a fatal weakness. Its demonstration that the *relative* frequency of alternative responses can account for eventual selection of the "successful" response, without any appeal to the consequences of these responses, depends on the unlikely assumption that all of the alternatives are equiprobable. Thus, it cannot explain how a response with a very low initial probability, but which happens to be the only response consistently followed, say, by food, could ever become a habit. In their different ways the learning theorists who began their work in the 1920s —Tolman (1932) for example— or 1930s —Hull (1941) and Skinner (1938) provide the obvious examples found this attempt to explain the adaptiveness of behavior quite unconvincing and went back to the first of Thorndike's laws, that of "Effect" which Watson had tried to banish from the new psychology.

The Carr model of habit formation makes no appeal to any kind of associative mechanism whatsoever: "useless" responses occur relatively infrequently and so are eliminated. In 1914 Pavlovian conditioning did not provide the central conceptual framework for Watson that he embraced a decade later (Watson, 1924). However, he does add to Carr's model the idea of "stimulus substitution" as a secondary principle (Watson, 1914; p. 272). It is not discussed at any length, but the suggestion is that automatization of habit results from kinesthetic stimuli coming to elicit the responses *that had* initially been evoked by external stimuli.

In summary, what Watson offered in 1914 was an experimental program based on animal research and also, as he was beginning to show (e.g. Watson, 1914; pp. 201-202), a methodology applicable to human learning, to study one feature of James' concept on automatic habit: "chunking" or the increasing control of individual components in a response sequence by kinesthetic feedback. He left out entirely the other features James discussed which were noted in the previous section: increased availability of attention to other concurrent tasks; decrease in awareness of one's own behavior; and transformation from goal-directed action to independence from an individual's current motivational state. In terms of the narrow conceptual framework that Watson wished to impose, these issues lay outside a scientific psychology.

4. Reinforcer devaluation in rats: the effect of extended training

It has taken a remarkably long time before conceptual advances and empirical

developments have allowed us to address the other features of habits that James discussed. The one I will treat here is that of analyzing the way in which behavior that initially appears goal-directed may lose this property and of addressing the question of whether repetition is the major factor responsible for such a transformation. For Watson the very term "goal directed" was an example of just the kind of mentalism he fought to expurge from psychology; for him it reeked of pre-Darwinism vitalism. Nevertheless, I wish to argue that we can now obtain entirely objective behavioral data, of the kind he might well have approved, which bear on this issue.

The first major step needed was a clear distinction between learning and performance. Tolman (1932) made this step, but it was a long time before mainstream learning theory followed. The next crucial distinction was between classical and instrumental conditioning. Despite the pioneering work of Miller and Konorski (1928) and Skinner (1937), it took another three decades before widely accepted experimental procedures were adopted for assaying the roles of stimulus-reinforcer and response-reinforcer contingencies with respect to particular instances of learned behavior. One example of what I am alluding to here is the use of omission contingencies by Williams and Williams (1969) to identify the role of stimulus-reinforcer contingencies in autoshaped keypecking by the pigeon. Another is the use of the bi-directional test (Grindley, 1932) to identify the role of response-reinforcer contingencies, as in Weisman and Litner's (1971) demonstration that a fear inhibitor can act as an instrumental reinforcer for wheel-turning. A large number of different research programs contributed to these developments. They included Miller's (1969) heroic attempts to obtain instrumental conditioning of autonomic responding and the analysis of avoidance learning *within* the general framework of two-factor theory (Mowrer, 1956; Rescorla & Solomon, 1967). However, the point at which the two steps were fully taken was probably most clearly marked by Mackintosh's (1974) book, *The Psychology of animal learning*, which brought these various developments together in a way which has remained without equal.

Sixty years on from Watson (1914), then, we reached a stage where commonly used methods could identify instrumental behavior and distinguish it from classically conditioned behavior. The next step was to ask what were the important underlying associative structures. Are these just S-R connections of the kind Thorndike had first suggested, or do they involve associations between responses and their consequences, as Thorndike (1898) and many others since within this tradition, have always denied? Dickinson (1993 in press) has recently argued that two behavioral criteria need to be satisfied before one can begin to consider some behavior to be "goal-directed". The first is that the behavior in question is shown to be under the control of response-reinforcer contingencies and not stimulus-reinforcer contingencies. This is not trivial in that many of the things that animal do seem on casual inspection to be goal-directed, but when analyzed appropriately - notably by assessing the effect of *an omission* contingency - turn out to be controlled largely by Pavlovian (classical) processes. Thus, the rat may be described loosely as pushing open a flap "in order to get access to the dipper containing sugar solutions" or running a maze "to get food". It often turns out that such a description is completely misleading, since such behavior persists even when counter-productive (e.g. Holland, 1979). A better loose description is to say that such responses occur "in anticipation" of whatever has been found before under these circumstances. Furthermore, even where some behavior is found to be highly sensitive to its consequences, Pavlovian associations between contextual events and the instrumental reinforcer can play a major role in controlling the rate of responding (e.g. Pearce & Hall, 1979), as two-factor theories have emphasized (Mackintosh, 1983).

The second of Dickinson's criteria is that the behavior is sensitive to the current value of the reinforcer. The pertinent behavioral test here is the reinforcer revaluation procedure. Typically this involves the following four stages. In Stage 1, a response reinforcer contingency is employed to establish an appreciable rate of responding, ideally under conditions which minimize the possible effects of Pavlovian factors. In Stage 2, the value of the reinforcer is changed in the experimental condition, but maintained for control conditions. In Stage 3, responding is tested in the absence of the reinforcer, i.e. in extinction, in order to evaluate the impact of the reinforcer revaluation in the previous stage. Finally, in Stage 4, the response-reinforcer contingency is reintroduced as a check that the revaluation manipulation has its intended effect when the animal is once more given access to the reinforcer.

Several experiments using this procedure were reported from the mid-1970s onwards where revaluation was achieved by pairing the food or fluid used as the instrumental reinforcer with lithium chloride in order to produce an aversion to the previously highly attractive reinforcer (e.g. Chen & Amsel, 1980; Holman, 1975). The general finding was that such devaluation had no effect on responding in extinction: subjects that had acquired in Stage 2 a profound aversion to the reinforcer nonetheless responded as rapidly in Stage 3 as control subjects for whom it remained as effective an instrumental reinforcer as ever, as demonstrated in Stage 4. Watson might *have found* such results very satisfying and seen them as providing support for his *views on the* automaticity of habits.

The first clear exception to the generally obtained outcome of the revaluation procedure was reported by Adams and Dickinson (1981). They found that under certain conditions lever-pressing by rats, which had been reinforced by sucrose pellets in Stage 1, could be reduced in the extinction test of Stage 3, as a result of pairing the sucrose pellets with lithium in Stage 2. It should be noted that this reduction, as in all subsequent demonstrations of a reinforcer devaluation effect, was relatively small. Such subjects would respond fairly vigorously during the early part of the Stage 3 extinction test, although somewhat less than the control subjects, even though they would not touch the pellets when they were re-introduced in Stage 4. Nonetheless, what such a reinforcer devaluation effect shows is that lever-pressing by rats for sugar pellets is at least to some degree sensitive to the new value of the instrumental reinforcer. It thus satisfies Dickinson's second criteria for goal-directed behavior. A mass of previous evidence indicates that it also satisfies the first, dependence on the response-reinforcer contingency as opposed to simple Pavlovian contingencies (see Mackintosh, 1974; 1983).

This means that we have at last reached the stage where we are able to ask whether repetition reduces the goal-directedness of an animal's instrumental behavior and turns it into an automatic habit, in James' fourth sense of the word. Adams (1982) addressed this question by comparing a group of rats whose training in Stage 1 was limited to 100 lever-presses each reinforced by a sugar pellet (CRF: continuous reinforcement) with a group trained for 500 continuously reinforced lever-presses. Following the usual Stage 2 treatment of pairing the sugar pellets with lithium, in the extinction test of Stage 3 only the 100 response group showed the reinforcer devaluation effect by responding less rapidly than their controls. Thus, he obtained the first experimental evidence from animal subjects in support of the Jamesian hypothesis. Unfortunately, as Adams (1982) noted, there are alternative explanations for this result. In the first place latent inhibition effects are notoriously powerful in food aversion learning: an animal that has already eaten 500 sugar pellets with no ill effect subsequently develops an aversion to them much more slowly as a result of repeated sugar pellet-lithium pairings than an animal that has previously eaten only 100 sugar pellets. To meet this problem Adams (1982) included a third group which were given a partial reinforcement schedule whereby their 500 lever-presses were followed by sugar pellets on only 100 occasions. No reinforcer devaluation effect was shown by this group either. However, partial reinforcement introduces further complexity into any interpretation, as found by Dickinson, Nicholas and Adams (1983) in an experiment which showed that loss of sensitivity to reinforcer devaluation occurred as a result of training on variable-interval schedules, but not as a result of training on carefully matched variable-ratio schedules (cf. Chen & Amsel, 1980). This led Dickinson (1989) to propose that repetition *per se* does not transform actions into habits. Instead, the crucial factor is whether variations in an individual's behavior become decreasingly correlated with its outcome. Once a moderate rate of responding is established, variable-interval schedules produce such a decreased correlation.

There was another way in which Adams (1982) tried to rule out the possibility that insensitivity to reinforcer devaluation in his 500-CRF group was a result of a reduced aversion to sugar pellets due to the effect of latent inhibition in Stage 2. This was to train all subjects in this stage until individually they reached the same criterion for failing to eat the pellets. In this study devaluation took place with pellets delivered into the Skinner box. Other revaluation experiments have presented the reinforcer in a different environmental context. This raises a further possible problem, since one consequence of establishing over a series of lithium-based conditioning trials an aversion to a previously familiar taste is to establish contextual control over the aversion. Thus, subjects familiarized with saccharin and then repeatedly given access to this fluid in a target environmental context followed by lithium injection, while access to saccharin in a natural context is never followed by lithium, come to avoid saccharin in the target context, but prefer it over water in the neutral context (Boakes, Westbrook, Elliott & Swinbourne, submitted; Puente, Cannon, Best & Carrell, 1988). The possible implication for reinforcer devaluation studies is that an aversion established in a context other than the conditioning chamber may become less likely to transfer to the conditioning chamber with extended training.

An elegant solution to these problems of comparing brief and extended training is provided by the within-subject designs used by Colwill and Rescorla (1985). Instead of giving separate groups of subjects different amounts of training, they trained the same subjects to perform a number of responses, on some of which they were given extended training and on some only brief training. To simplify somewhat, say that in Stage 1 a rat is trained to press a lever for sucrose solution thirteen times as *often as to pull a* chain for the same outcome, and then in Stage 2 the sugar solution is presented noncontingently in the conditioning chamber with the manipulanda absent, and followed by lithium injection until a complete aversion to the reinforcer that had sustained both responses is established. Will this produce a greater decrease in chain-pulling than in lever-pressing, as James (1890) might have predicted? The answer obtained by Colwill and Rescorla (1985) in a series of such experiments was a consistent no; although routinely obtaining a reinforcer devaluation effect, they failed to detect any impact of extended training on the size of the effect. Either the 19th century evolutionists, James and 20th century lay belief were quite wrong or the experimental method used by Colwill and Rescorla (1985) was an inappropriate one for finding the difference between an action and a habit.

5. Resistance to satiation and incentive learning

There are many ways in which the value of a reinforcer may be changed other than by pairing it with lithium chloride. A much simpler, and arguably more fundamental, method is to change an animal's bodily state in a way that is related to a particular reinforcing event. Water is an effective instrumental reinforcer for a thirsty animal, but loses its value if the animal is food deprived instead. In the opposite direction a salt solution may be only weakly effective for animal in a normal state of salt balance, but can become a powerful instrumental reinforcer if a salt craving is induced. The research discussed in this section uses the simple procedure of changing the state of an animal from one of high food deprivation to one of low deprivation in order to devalue the food used in Stage 1 as the instrumental reinforcer. There is a long history of experiments which have trained animals when hungry and then have satiated them with food before testing them in extinction. The universal finding is that considerable responding occurs in the early phase of such an extinction test. Since, when given the food again while still sated, such animals do not eat the food, an entirely purposive, habit-free and rational individual should presumably hardly respond at all in the extinction test. The fact that, instead, a great deal of responding occurs has been called resistance to satiation" (Morgan, 1974). This leaves the question of whether any reduction in responding occurs at all during extinction, relative to control subjects who remain food deprived. Answers to this question have been inconsistent. Recently Balleine (1992) has proposed that the crucial factor is whether the animal has had an opportunity prior to the extinction test to learn, through direct exposure to the food when sated, that it is less attractive in this state than in a state of food deprivation, a process he and Dickinson refer to as incentive learning. Of this, more later. At present the most important point is that, when an animal that has been food deprived during instrumental training and then given ad libitum food prior to the extinction test, under at least some conditions it will respond less in extinction than controls that are tested when deprived.

We have recently used this method of devaluing an instrumental reinforcer to examine the effect of extended training (Dickinson, Balleine, Watt, Gonzalez & Boakes, submitted). Training was of limited extent in Balleine's (1992) experiments where he obtained decreased responding in extinction as a result of a downshift in motivational state ie. from training under high food deprivation to testing under low deprivation. It consisted of four sessions in which lever-pressing was followed by 30 food pellets in each session, as the mean interval on a random interval (RI) schedule was progressively increased from 2 sec to 30 sec. The question we asked was straightforward: Would extending such training, by giving a further 8 sessions of RI 30-sec training, make leverpressing less sensitive to a downshift in motivation? The answer was yes: a marked, and statistically significant, reduction in responding in extinction was found only in sated subjects, given both prior exposure to the pellets when sated - the incentive learning effect - and the same limited training as in Balleine (1992). Subjects given extended training showed no significant effect of their deprivation state during testing (Dickinson et al, submitted; Expt. 1).

This result was clearly consistent with James' notion of automatic habits. However, further experiments designed to distinguish the effects of response frequency from increased exposure to the reinforcer established only the latter as the important factor. Thus, subjects given only the brief instrumental training, but then a number of sessions in which the levers were absent and non-contingent pellets delivered (RT 30-sec) showed the same insensitivity to the downshift in motivation as subjects given the extended instrumental training (Dickinson et al, submitted; Expt. 2).

Dickinson and Balleine (1993) make much stronger claims than those advanced here for the distinctiveness of goal-directed actions. These are based on incentive learning effects of the kind already described in connection with Balleine's (1992) downshift experiments. In the same set of experiments were ones that involved an upshift in motivational level, i.e. animals were trained when sated and tested when hungry. In this case increased responding in extinction was obtained only in animals that had previously been given an opportunity to learn that food pellets are more attractive in a food-deprived than in a non-deprived state. Such incentive learning effects have also been found in the same Cambridge laboratory using a version of the lithium-based reinforcer devaluation procedure described in the previous section (Balleine & Dickinson, 1991). They had previously been found with yet another reinforcer revaluation method in which rats are trained when food-deprived to make different instrumental responses, lever-pressing and chain-pulling, which are followed by different outcomes, food pellets and high concentration sucrose. Subsequently, when given ad libitum food but deprived of water for the extinction test, the expected higher rate of the response previously associated with sucrose was found only in subjects that had previously drunk sucrose when water-deprived. The incentive learning in this case appeared to take the form of having to learn that it is more attractive to drink sucrose solution when thirsty than to eat a dry food pellet (Dickinson & Dawson, 1988; 1989).

In many of these Cambridge experiments another response has been recorded along with the instrumental response of major interest, such as lever-pressing. This additional response is the animal's pushing against a flap in front of the magazine aperture so as to gain access to the reinforcer. This response is taken to be mainly under the control of Pavlovian contingencies by Dickinson and Balleine (1993), on the basis of the earlier research using the omission test by Holland (1979), which was referred to earlier. The consistent finding has been that such magazine entries are directly affected by changes in motivational state and unaffected by incentive learning procedures, as is typically found with more conventional Pavlovian procedures (see Dickinson & Dawson, 1989). These theorists draw a sharp distinction between the motivational systems underlying on the one hand Pavlovian-based, or classically conditioned behavior, which is directly affected by changes in motivational state, and on the other hand goal-directed actions where a separate process of incentive learning has to take place before motivational changes affect behavior.

In the above set of experiments it proved necessary for incentive learning to occur before reinforcer revaluation effects were obtained. Other studies have not found this to be necessary. For example, Rescorla has obtained a direct effect of lithium-based devaluation using a 2-response within-subjects design that allows a sensitive choice test, both with hypertonic lithium injěctions (Rescorla, 1992; cf. Balleine & Dickinson, 1992) and isotonic injections (Rescorla, 1993). The same procedure has also been employed extensively by Westbrook and his collaborators (personal communication) at the University of New South Wales. They have still not obtained consistent evidence indicating that incentive learning is necessary for a reinforcer devaluation effect to be obtained. Similarly, with respect to resistance to satiation, at the University of Sydney we have used the downshift procedure i.e. shifting from high deprivation during brief instrumental training with food pellets to low deprivation during the extinction test. The result we consistently obtain is that the downshift produces a reduction in responding, whether or not subjects have been previously exposed to the food pellets when sated (Boakes & Clarke, in preparation).

At present it is a complete mystery as to what factors promote the importance of incentive learning. It may well be that when the answer is found, it will shed further light on the role of extended training. For the present, though, what experimental evidence exists provides a clear conclusion. Reinforcer revaluation can affect instrumental behavior in a way that indicates that such behavior is affected by the current value of the reinforcer. Where extended training has reduced sensitivity to current reinforcer value, this appears to result from increased exposure to the reinforcer and not from increased frequency of the response. In the only set of experiments which have used a within-subject design to control for reinforcement frequency (Colwill & Rescorla, 1985) no effect of response frequency has been found, despite considerable efforts to this end.

6. Conclusion

In transmitting convention wisdom from the 19th to the 20th century James proposed that goal-directed, intelligent actions were to be distinguished from "blind" automatic habits and that what transformed the first into the second kind of behavior is frequency of performance. For Watson such a distinction was not scientific. Within his reflex based conceptual framework all behavior was in one sense "automatic": it consists of responses that are directly elicited by stimuli. In 1914 for Watson learning mainly consisted of the elimination of "useless" responses, while by 1924 it was mainly based on his version of Pavlovian conditioning by which previously neutral stimuli *came to elicit* new responses as a result of repeated S-R co-occurrence. The *only way in which he* followed James in the belief that frequency of occurrence makes a habit more automatic came from his conclusion from maze experiments which seemingly demonstrated the increasing role of kinesthetic stimuli from the previous movement in eliciting the next link in the chain.

In agreement with Watson's 1913 insistence that psychology will progress only if based on objective measures of behavior, but rejecting his reflex-based account of learned behavior, recent research on instrumental conditioning indicates that James' distinction between actions and habit can be a valid one, even when applied to the rat in a Skinner box. The key procedure is that of reinforcer revaluation following instrumental conditioning. The important finding from experiments using this procedure is that under some conditions the rate, for example, of lever-pressing by a rat is sensitive to the current value of the reinforcer, and not just to its value when the response was acquired. Furthermore, under some conditions this sensitivity is decreased if the rat is given extensive training on the instrumental task before testing is carried out once the reinforcer has been changed in value. To this extent then, repetition changes partially goal-directed action into an automatic habit.

However, despite the conventional wisdom represented by James, current evidence suggests that repetition of the response is not responsible for this change. There is still no experimental evidence to support Thorndike's "Law of Exercise" or Watson's "Principle of Frequency". Instead what matters is the increased familiarity of the reinforcer. Why should this be so? It is tempting to invoke the concept of latent inhibition, the near universal finding that familiar stimuli change value more slowly than novel ones. But this is merely to apply a label, since the mechanisms underlying latent inhibition are not understood (e.g. Bouton, 1993). Lewes' (1860) phrase "lapsed intelligence", the everyday notions of "absent mindedness" and "doing something without thinking" suggest a different idea, namely, a failure to retrieve the current *value* of the reinforcer against the background of its previous values. Thus, the more often in the past a reinforcer has been experienced at one value, the more likely that its most recent value will not be retrieved. Experiencing both values of the reinforcer within the same context may increase the likelihood of such retrieval failure. This in turn suggests an approach to the puzzle of why exposure outside the conditioning chamber to the new reinforcer value, the incentive learning effects discussed by Dickinson and Balleine (1993), sometimes increases sensitivity to the current value. It may make this easier to retrieve when the rat returns to the Skinner box for its extinction test.

References

Adams, C.D. (1982). Variations in the sensitivity of instrumental responding to reinforcer devaluation. *Quarterly Journal of Experimental Psychology*, 34B, 77-98

Adams, C. & Dickinson, A. (1981). Instrumental responding following reinforcer devaluation. *Quarterly Journal of Experimental Psychology, 33b*, 109-122.

Balleine, B. (1992). Instrumental performance following a shift in primary *motivation* depends upon incentive learning. *Journal of Experimental Psychology: Animal Behavior Processes, 18*, 236-250.

Balleine, B. & Dickinson, A. (1991). Instrumental performance following reinforcer devaluation depends upon incentive learning. *Quarterly Journal of Experimental* Psychology, 43B, 279-296.

Balleine, B. & Dickinson, A. (1992) Signalling and incentive processes in instrumental reinforcer devaluation. *Quarterly Journal of Experimental Psychology, 45B*, 285-301.

Boakes, R.A. (1984). *From Darwin to Behaviorism: Psychology and the minds of animals* Cambridge: Cambridge University Press.

Boakes, R.A. & Clarke, J.V. (in preparation). Hooded and albino Wistar rats compared on a range of learning tasks.

Boakes, R.A., Westbrook, R.F., Eliiott, M. & Swinbourne, A.L. (submitted). Context dependency of conditioned aversions to water and saccharin.

Bouton, M.E. (1993). Context, time, and memory retrieval in the interference paradigms of Pavlovian learning. *Psychological Bulletin* (in press).

Buckley, K.W. (1989). *Mechanical man: John Broadus Watson and the beginnings of Behaviorism*. New York: Guilford Press.

Carpenter, W. (1874). *The principles of mental physiology*. New York: D. Appleton.

Carr, H.A. (1914). Principles of selection in animal learning. *Psychological Review, 21*, 157-165.

Carr, H.A. & Watson, J.B. (1908). Orientation in the white rat. *Journal of Comparative Neurology and Psychology, 18*, 27-44.

Chen, J-S. & Amsel, A. (1980). Recall (vs recognition) of taste and immunization against aversive taste anticipations based on illness. *Science, 209*, 831-833

Colwill, R.C. & Rescorla, R.A. (1986). Associative structures in instrumental learning. In G.H. Bower (Ed.), *The psychology of learning and motivation, 20*, 55-104. New York: Academic Press.

Darwin, C. (1859). *On the origin of species*. London: Murray.

Darwin, C (1871). *The descent of man and selection in relation to sex*. London: Murray.

Desmond, A. & Moore, J. (1991). *Darwin*. London: Michael Joseph.

Dickinson, A. (1989). Expectancy theory in animal conditioning. In S.B. Klein & R.R. Mowrer (Eds.) *Contemporary Learning theories: Pavlovian conditioning and the status of traditional learning theories* (pp. 270-308) Hillsdale, N.J: Lawrence Erlbaum Associates.

Dickinson, A (in press). Instrumental conditioning. In N.J. Mackintosh (Ed.), *Animal learning and cognition*. Vol. 9 of the *Handbook of Perception and Condition*. Orlando, Florida: Academic Press.

Dickinson, A. & Balleine, B. (1993). Motivational control of goal-directed action. *Animal Learning and Behavior* (in press).

Dickinson, A., Balleine, B., Watt, A., Gonzalez, F. & Boakes, R.A. (submitted). Motivational control after extended instrumental training.

Dickinson, A & Dawson, G.R. (1988). Motivational control of *instrumental* performance: the role of prior experience of the reinforcer. *Quarterly Journal of Experimental Psychology, 4B*, 113-134.

Dickinson, A & Dawson, G.R. (1989). Incentive learning and the motivational control of instrumental performance. *Quarterly Journal of Experimental Psychology, 41B*, 99-112.

Dickinson, A., Nicholas, D.J. & Adams, C.D. (1983). The effect of instrumental training on susceptibility to reinforcer devaluation. *Quarterly Journal of Experimental Psychology, 35B*, 35-51.

Gross, C.G. (1993a). Hippocampus minor and man's place in nature: a case study in the social construction of neuroanatomy. *Hippocampus, 3*, No. 4, 304-415.

Gross, C.G. (1993b). Huxley vs. Owen: the hippocampus minor and evolution. *Trends in Neuroscience, 16*, No. 12, 493-498.

Grindley, G.C. (1932). The formation of a simple habit in guinea pigs. *British Journal of Psychology, 23, 127*-147.

Hasher, L & Zacks, R.T. (1979). Automatic and effortful processes in memory. *Journal of Experimental Psychology: General, 108*, 356-388.

Herrnstein, R.J. (1967). Introduction to J.B. Watson (1915;1967 reprint) *Behaviorism: an introduction to comparative psychology*.

Holland, P.C. (1979). Differential effects of omission contingencies on various components of Pavlovian appetitive responding in rats. *Journal of Experimental Psychology: Animal Behavior Processes*, 5,178-193.

Holman, E.W. (1975). Some conditions for dissociation of consummatory and instrumental behavior in rats. *Learning and Motivation*, 6, 358-366.
Hull, C.L. (1943). *Principles of behavior.* New York: Appleton-Century-Crofts.
James, W. (1890). *The principles of Psychology.* New York: Henry Holt.
Kamin, L.J. (1968). "Attention-like" processes in classical conditioning. In M.R. Jones (Ed.) *Miami symposium on the prediction of behavior: aversive stimulation,* (pp. 9-33). Miami, Florida: University of Miami Press.
Klatsky, R.L. (1984). *Memory and awareness: an information-processing perspective.* New York: W.H. Freeman.
Lamarck, J.B. de. (1809). *Philosophie Zoologique.* Paris: Dentu.
Lashley, K.S. (1951). The problem of serial order in behavior. In L.A. Jeffries (Ed.), *Cerebral mechanism in behavior: the Hixon symposium.* New York: Wiley.
Lewes, G.H. (1860). *The physiology of common life.* London: Blackwood.
Mackintosh, N.J. (1974). *The psychology of animal learning.* London: Academic Press.
Mackintosh, N.J. (1983). *Conditioning and associative learning.* Oxford: Clarendon Press.
Miller, S & Konorski, J. (1928). On a particular form of conditioned reflex. (English translation by B.F. Skinner (1969), *Journal of Experimental Analysis of Behavior, 12,* 187-189.)
Morgan, C.L. (1896). *Habit and instinct.* London: Edward Arnold.
Morgan, M.J. (1974). Resistance to satiation. *Animal Behavior,* 22, 449-466.
Mowrer, O.H. (1956). Two-factor learning theory reconsidered, with special reference to secondary reinforcement and the concept of habit. *Psychological Review, 63,* 114-128.
Oldroyd, D.R. (1980). *Darwinian impacts: an introduction to the Darwinian revolution.* Kensington, NSW, Australia: New South Wales University Press.
Pearce, J.M. & Hall, G. (1979). The influence of context-reinforcer associations on instrumental performance. *Animal Learning and Behavior, 7,* 504-508.
Puente, G.P., Cannon, D.S., Best, M.R. & Carrell, L.E. (1988). Occasion-setting of fluid ingestion by contextual cues. *Learning and Motivation, 19,* 235-239.
Rescorla, R.A. (1992). Depression of an instrumental response by a single devaluation of its outcome. *Quarterly Journal of Experimental Psychology,* 44B, 123-136.

Rescorla, R.A. (1993). A note on the depression of instrumental responding after one trial outcome devaluation. *Quarterly Journal of Experimental Psychology,* in press.
Rescorla, R.A. & Solomon, R.L. (1967). Two-process learning theory: Relationship between Pavlovian conditioning and instrumental learning. *Psychological Review,* 74, 151-182.
Richards, R.J. (1987). *Darwin and the emergence of evolutionary theories of mind and behavior.* Chicago: University of Chicago Press.
Romanes, G. (1882). *Animal intelligence.* London: Kegan, Paul, Trench & Co.
Schneider, W. & Shiffrin, R.M. (1977). Controlled and automatic information processing I: Detection, search and attention. *Psychological Review, 84,* 1-66.
Skinner, B.F. (1937). Two types of conditioned reflex: A reply to Konovski *and Miller. Journal of General Psychology, 16,* 272-279.
Skinner, B.F. (1938). *The behavior of organisms.* New York: Appleton-Century-Crofts.
Spencer, H. (1855). *Principles of psychology.* London: Longman, Brown, Green and Longmans.
Spencer, H. (1872). *The principles of psychology.* 2nd Ed. London: Williams & Norgate.
Thorndike, E.L. (1898). Animal intelligence: an experimental study of the associative processes in animals. *Psychological Monographs, 2,* (4 Whole No. 8).
Thorndike, E.L. (1911). *Animal intelligence: experimental studies.* New York: Macmillan.
Tolman, E.C. (1932). *Purposive behavior in animals and man.* New York: Century.
Wallace, A.R. (1858). On the law which has regulated the introduction of new species. *Journal of the Proceedings of the Linnaean Society, 2,* 45-62.
Watson, J.B. (1903). *Animal education.* Chicago: University of Chicago Press.
Watson, J.B. (1907). Kinaesthetic and organic sensations: their role in the reactions of the white rat to the maze. *Psychological Review: Monograph Supplement, 8,* No. 33.
Watson, J.B. (1913). Psychology as the behaviorist views it. *Psychological Review, 20,* 158-177.
Watson, J.B. (1914). *Behavior: an introduction to comparative psychology.* New York: Henry Holt.
Watson, J.B. (1924). *Behaviorism.* New York: Norton.

Watson, J.B. & Watson, R.R. (1928). *The psychological care of infant and child.* New York: Norton.

Weisman, R.G. & Litner, J.S. (1971). The role of Pavlovian events in avoidance training. In R.A. Boakes & M.S. Halliday (Eds.) Inhibition and learning (pp. 253-270). London: Academic Press.

Williams, D.R. & Williams, H. (1969). Auto-maintenance in the pigeon: Sustained pecking despite contingent non-reinforcement. *Journal of the Experimental Analysis of Behavior, 23,* 506-521.

Mexican Journal of Behavior Analysis
vol. 19, monographic issue, 1993, 91-101

The Illusion of a Voice Inside our Head: Watson's solution

Víctor Manuel Alcaraz Romero
Universidad Nacional Autónoma de México

Abstract

Our culture supposes the existence of two worlds: One of them is the external reality, the other one is the internal world composed by perceptions, feelings and thinking. The internal word is not observable. For this reason, Western traditions consider that our internal life is non-material. Such conception appears when the society attempts to explain the behavior of human beings, characterized by several types of activities. It is possible to observe some responses, but sensorial reactions and thoughts are in a special situation. They are outside of our vision range. Activities in this last condition are represented through a metaphorical expression. For instance, imagination is an activity of our sensorial organs. If someone wants to talk about his imaginations, he describes a kind of miniature picture of his surroundings located in the center of his head. We believe that thinking is in the same place, like a little voice that talks to us about our ideas. Our culture can not conceive that imagination is behavior of seeing and thinking is composed by internal speech and covert acts. The only difference between overt and covert acts is their magnitude and the fact that covert acts appears without a stimulus visible to an external observer. In this paper we analyse the historical development of the construction of internal world. Our conclusion is that internal world is an illusion. It is the product of a society that represents in a metaphorical way the covert bodily reactions. The internal world is composed by different metaphors of our language elaborated with the existent constituents in each historical period.

Keywords: Internal world, metaphors, imagination, thinking.