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I.P. Pavlov and the Freedom Reflex

We started off with a very simple experiment. The dog was placed in a stand. It stood quietly enough at first, but as time went on it became excited and struggled to get out of the stand, scratching at the floor, gnawing the supports, and so on. For a long time we remained puzzled over the unusual behaviour of this animal, until it occurred to us at last that it might be the expression of a special *freedom reflex*, and that the dog simply could not remain quiet when it was constrained in the stand. *I.P. Pavlov* (1927, Vol. I, Ch. XXVIII)

If 'A' is drowning on one side of a pier and 'B' is equally drowning on the other, and you have one lifebelt, to which of the two would you like to throw it? Which would I save, Pavloff or Shaw? What is the good of Shaw? And what is the good of Pavloff? Pavloff is a star which lights the world, shining above a vista hitherto unexplored. Why should I hesitate with my lifebelt for one moment? *H.G. Wells*

Pavlov is the biggest fool I know; any policeman could tell you that much about a dog. *George Bernard Shaw*

PICTURE OF PAVLOV TO BE SUPPLIED

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Abstract: *Why was Ivan Pavlevich Pavlov so widely celebrated in the decades after 1900? As his story of the 'freedom reflex' illustrates, Pavlov often overstated his observations. By calling all innate behaviour a* ***reflex*** *and all learned behaviour a* ***conditional reflex****, he meant to eliminate consciousness and volition from science. Pavlov's universal reflex explanation became the prototype for behaviourism.*

Other scientists did not accept the universal reflex explanation. It was not Pavlov's experiments but his utopian promises that led to his meteoric public rise. Pavlov's dream attracted new, rising elites, particularly social reformers like H.G. Wells and the Fabians in Britain. In the Soviet Union he gave credence to efforts to fashion a New Soviet Man. And in the United States, John B. Watson and B.F. Skinner rose to public fame in his footsteps, using extremely limited evidence to make utopian promises of human perfectibility.

Pavlov's vision lent credibility to the behaviourist attack on consciousness. While radical behaviourists were always a small minority, they successfully enforced a scientific boycott of the 'mentalistic' concepts of everyday psychology. After Karl Lashley pointed out in 1930 that Pavlov's ideas contradicted the known brain evidence, B.F. Skinner changed the term 'reflex' to 'stimulus–response relationship'. For another fifty years Skinner convinced the world that consciousness and volition could be ignored.

Pavlov's method is still useful, but none of his utopian promises have been fulfilled. Today, no scientist believes that reflex arcs are basic units of learning. The evidence suggests that Pavlovian association itself requires consciousness.

I.P. Pavlov was a man of great personal integrity. Yet he led the way to an era of taboo against consciousness and voluntary control. Pavlov was a founding hero of the behaviouristic myth of the origins of psychology, which erased the first great age of consciousness science. Most alarming was the immense popularity of Pavlov's dream, which stripped away the most essential elements of human nature.

I: Introduction

One of the great puzzles in scientific history is the international acclaim that greeted I.P. Pavlov's reports about conditional reflexes,[1] just after 1900. Everything can be questioned about this discovery — whether it was a discovery at all;

[1] Many sources point out that 'conditioned reflex' is a translation error (e.g., Miller, 1962). Pavlov's Russian term translates as 'conditional reflex' because he thought animals learned a conditional 'if-then' relationship between a signal like a bell and a biological stimulus like food. It has been translated correctly into French and German but unfortunately not English. This has led to much misunderstanding. The word 'conditioning' encourages the false idea that Pavlovian learning is automatic, simple and mechanical. In fact, it involves very complex brain adaptation, and seems to require consciousness of the conditional association (Hugdahl, 1998; Lovibond & Shanks, 2002). (See section II.4). It is implausible to think that Pavlov was forced to use the term 'reflex' because he had no other words available. Pavlov could have used the standard term 'association' with its long history from Aristotle to Locke. He had many other possibilities. Pavlov used 'reflex' because it gave an air of physiological reality to his untested inferences, and because it allowed him to purge the suspect notion of goals. That was probably a harmful choice, witness the fact that many psychologists are still unable to talk coherently about goals, the key idea in any conception of motivation. The taboo power of the reflex idea is still great, regardless of evidence.

whether reflex arcs are basic units of brain activity, as Pavlov believed; whether learned reflexes can explain more complex learning; and whether they can be learned without consciousness. In all these respects the evidence shows that Pavlov was simply wrong.

What cannot be denied is the messianic enthusiasm that inspired Pavlov (1849–1936) and his potent following among Western opinion leaders. H.G. Wells' choice to throw his lifebelt to Pavlov rather than his friend Shaw is only one example. Prominent philosophers like Bertrand Russell took his claims seriously, and he inspired Western behaviourism through Watson and Skinner.

Paul de Kruif called him 'The Liberator of Mankind . . . the Pasteur of the human brain and heart . . . Russian Saint of Science . . . this grey-bearded old Light of the North has discovered the way not to change human nature but to alter the human heart through the human brain'.[2] L.A. Andreyev celebrated him as 'The Great Teacher and Master of Science' (Andreyev, 1937), and Gantt wrote that 'Pavlov's (method) will permanently elevate him among the Great Scientists.' (Gantt, 1927, p. 30). Pavlov seemed to provide the scientific key for a new, socialist utopia. It was the great secret of his popularity.

Pavlov's celebrity changed history. Words like 'Pavlovian' and 'conditioning' are now embedded in our language, resonant with mechanistic connotations. Yet every human being who wakes up in the morning knows something about consciousness. Everyone trying to do a difficult thing knows voluntary effort. These fundamental, everyday experiences were erased from academic psychology. In many places they are still taboo.

Today we can directly observe the brain activity underlying consciousness and voluntary effort (Baars, 2002; Spence & Frith, 1999). But we cannot claim originality. From the beginning of written thought, about the sixth century BCE, philosophers and sages talked about conscious experience with clarity — in Greece and India and surely in numerous other places. Over the centuries many thinkers contributed to a growing body of understanding. Aristotle, for example, suggested that visual images were 'faint copies' of visual sensations, an idea we now know to be reflected in brain activity (e.g., Kreiman *et al*., 2000). Conscious experiences of music, colour, abstraction, language, meditation, emotion and social relationships were explored for centuries.

The Golden Age of consciousness science: 1780–1910

The first age of consciousness science spans the nineteenth century, beginning with basic discoveries in psychophysics, vision and hearing, colour perception, hypnosis and suggestion, dissociative disorders, brain damage, conversion disorders, the selectivity of attention, the 'narrowness of consciousness', mental imagery, and many other fundamental phenomena; all have been rediscovered in the last several decades. Its pioneers include Fechner, Helmholtz, Charcot, Janet, Wundt, James and Freud, a unique array of first-class minds.

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[2] Quoted by Gantt, 1927, p. 20.

Two remarkable achievements illustrate this pioneering age. One is the Psychophysical Law, an enormously general law stating that equal increases in sensory input energy are experienced as smaller and smaller increments of subjective intensity; or, the other way around, that equal steps in subjective intensity require geometric increases in physical energy. An everyday example is a light bulb that can be switched in equal steps from 0 to 40 watts, then 40 to 80 and finally to 120 watts of light energy. Turning the light switch one click is experienced as a major increase in brightness; the second click adds an equal amount of physical energy but is consciously experienced as only a small increase in brightness; and the third increment is hardly perceived at all. Discovered by Gustav Fechner and others about 1820, the Psychophysical Law applies to all the senses and even submodalities like heat, pain, muscular effort, and sweetness. It also applies to abstract judgements like money, effort and criminality. It appears to be a fully general law, a remarkable achievement for a young science of consciousness.

The Psychophysical Law has been sustained consistently for two centuries. It has an extraordinary range of application: It is the basis for the decibel scale of subjective loudness used in music recording and audio equipment. It explains why the first bite of chocolate cake tastes so good, the second less so, and third much less; that what causes a fashion sensation this year is gone the next; and why as we get older, days and weeks that once seemed to last forever begin to flash by faster and faster. It may explain why millionaires need to earn more money the richer they become, and why addicts may need higher drug doses over time. In all these examples equal increments in objective quantities appear smaller and smaller against a growing basis of comparison; and comparison is the essence of the Psychophysical Law. It is a classic piece of scientific discovery, an elegant, precise, general and fully predictable feature of conscious sensation.

Another dramatic topic that gripped the 1800s was what we might call the Dissociation Cluster — the linked occurrence at certain times in history of conversion hysteria, childhood trauma and its after-effects, sexual vicissitudes and suggestibility. Why these four Horsemen of the Apocalypse seem to rise together at certain times and places is not clear, though fast, dramatic changes in social roles seem to be a factor. All four elements of the Dissociation Cluster transform conscious experience. In conversion disorder bodily feelings are changed, leading to hypochondriacal hypersensitivity in some parts of the body and anaesthesia in others; trauma often leads to a dazed sense of unreality, a feeling of distance from ordinary experience, and other forms of dissociation; sexuality always colours our conscious experiences of others and self; and hypnotic suggestion can lead to minor hallucinations, changed perceptual experiences, tunnel vision, radical changes in the body senses, amnesia, blocking of pain, and the like. All four phenomena transform our subjective experience.

An outbreak of the Dissociation Cluster is not a happy event. After decades in the shadows it came back in the 1980s and early 1990s, witness an epidemic of child-abuse reports, along with roiling debates about sexual and family conflicts; a great upswing of reported dissociative disorders like multiple personality; mass panics caused by vaguely defined physical symptoms often attributed to media

horror stories with little scientific evidence; and not least, an increase in reports of dissociation and suggestibility in traumatized individuals.

Outbreaks of the Dissociation Cluster may signal severe societal stress. Its symptoms were first described by Hippocrates in the war-torn Greek city-states of the sixth century BC. In modern times the same cluster emerged just before the French Revolution, when the Viennese physician Anton Mesmer began treating patients with a suggestion therapy rationalized by the notion of animal magnetism. Mesmer made great numbers of aristocratic converts in Vienna and Paris, many of them women, until he was discredited by the French Royal Commission on Animal Magnetism of 1785 (with Benjamin Franklin serving as a prominent member). The Royal Commission concluded that the dramatic cures Mesmer claimed for Animal Magnetism were due to the patients' fervent desires, aided by their imagination and shaped by suggestions from the mesmerist. In a secret Addendum, the Commissioners warned Louis XVI of a pervasive taint of sexuality in the procedure, as Mesmer conducted his sweeping magnetic rituals over the convulsing bodies of his often female clients.

In France the discovery of suggestibility started a century of increasingly excellent research on hypnosis, dissociation and sexual trauma, culminating in the discoveries of Jean Charcot, Pierre Janet, Bernheim and Liébault. Sigmund Freud travelled to Paris in the 1880s to study with Jean Charcot and others. On his second trip he was amazed to see in Bernheim's laboratory a subject who carried out a suggestion post-hypnotically, of which he was not aware at the time. This common hypnotic phenomenon struck Freud with the force of revelation. It was the most visible evidence he had ever seen for the power of unconscious motives, and one he would often cite in later years.

William James also experimented with hypnosis and was well acquainted with others in the Harvard community who explored the Dissociation Cluster. The psychiatrist Morton Prince published the first detailed history of a multiple personality patient, a Miss Beauchamp, a clear and humane story quite consistent with our current evidence. Not surprisingly, James' *Principles* has excellent descriptions of hypnosis and dissociative phenomena, multiple personality, fugue, depersonalization, and psychogenic amnesia, all confirmed by current evidence.

The Psychophysical Law and the scientific study of the Dissociation Cluster are high achievements of the Golden Age of consciousness science. Its findings are on display in the 1,400 pages of James' *Principles*. In spite of inevitable controversies, this extraordinary era gathered momentum to about 1910, when it abruptly died. Later historians created a new 'myth of origins' of their science, which declared the nineteenth century to be confused and prescientific. It was not. The Golden Age was simply erased by behaviourism.

The coup against consciousness

Pavlov was the first well-known scientist to insist that all reference to conscious experience be expunged from science. Thus, a painful electrical shock was called a 'destructive stimulus'. Tasting, smelling and eating was the 'food reflex', fear a

'defensive reflex', and submissiveness the 'slavery reflex'. The personal perspective of the subject was systematically erased.

By 1950 even the word 'consciousness' had disappeared from the textbooks (e.g., Woodworth & Schlossberg, 1954). Today the taboo may be lifting. Terms like 'conscious' and 'subjective' are again in the scientific headlines (e.g., Logothetis & Schall, 1989; Kreiman *et al*., 2002; Edelman & Tononi, 2001). In rediscovering consciousness and volition, contemporary science is substantially in agreement with the long history of ideas, and opposed to the purge of the twentieth century. As we return to consciousness it will be important to understand the era of taboo, and perhaps to rethink the history that was told to justify it.

1. The power of radical behaviourism

Most scientists after 1910 did not deny consciousness outright; it was a small but extraordinarily influential group of radical behaviourists and their philosophical cousins who did so. B.F. Skinner indeed defined radical behaviourism as a philosophy that denies subjectivity.

> It is possible to be a behaviourist and recognize the existence of conscious events. We may set up a distinction between a public and a private world, the first a communicable one and the latter forever reserved from scientific treatment. But I preferred the position of radical behaviourism, in which the existence of subjective entities is denied (Skinner, 1979).

As John B. Watson wrote in 1925:

> . . . the time has come for psychology to discard all reference to consciousness . . . it is neither a definable nor a usable concept, it is merely another word for the "soul" of more ancient times. . . . No one has ever touched a soul or seen one in a test-tube. Consciousness is just as unprovable, as unapproachable as the old concept of the soul . . . *the Behaviourist must exclude from his scientific vocabulary all subjective terms such as sensation, perception, image, desire, purpose, and even thinking and emotion as they were subjectively defined* (p. 5) [Italics added].

Pavlov, Watson and Skinner were famous for decades, while moderates like Guthrie, Hull and Tolman were never known to a wider public. The radicals put others on the defensive by accusing traditional psychologists of being unscientific. More than a century of extraordinary scientific progress was branded as 'introspectionist' or 'mentalistic' in contrast to 'respectable behaviourism'. Such public name-calling is unusual in science. E.G. Boring wrote that ' . . . all along behaviourism has been seeking an enemy so that it could disprove the charge that it is fighting windmills, for it must fight something; it is a movement' (1929, p. 120).

Watson's scientific purge of 'sensation, perception, image, desire, purpose and even thinking and emotion' was carried out with great thoroughness in Britain and the United States (Baars, 1986). By mid-century, according to George A. Miller, 'The power, the honours, the authority, the textbooks, the money, everything in psychology was owned by the behaviouristic school' (Baars, 1986, p. 203).

Other psychologists believed that the complete rejection of consciousness was too extreme to last (e.g., Boring, 1929; Hilgard, 1948). But time and again the

rejectionist camp rose to greater prominence. In the upshot, a small minority purged psychology of its most central problems for most of the century. By keeping moderates on the defensive they made empirical progress nearly impossible.

2. Pavlov set the pattern

Pavlov did not reject consciousness as completely as Watson and Skinner. But he set the tone. Watson and Skinner emulated Pavlov's public career with remarkable fidelity. Between 1900 and 1990 not a decade went by without one of the three radicals dominating the headlines. Utopian rejection of human consciousness was a fabulous career move.

It is a telling fact that the three celebrated radical behaviourists exercised their greatest impact not in scientific journals but through the public media. The nineteen-year-old B.F. Skinner rejected the subjective life after reading a popular book by Bertrand Russell, who had high praise for John B. Watson; and it was Watson who first promoted Pavlov's universal reflex explanation in the West (Watson, 1916; 1925; Russell, 1921; Skinner, 1976).

In contrast, scientific journals did not publish utopian promises, nor were they as damning about consciousness and volition. Peer-reviewed journals tended to resist unproven claims. Utopian promises and purges were promoted through popular media because they made for spectacular headlines (e.g., Watson, 1925; 1927; 1928; 1929; Watson & MacDougall, 1929; Watson & Rayner, 1928; Skinner, 1934; 1945; 1948; 1961; 1967; 1969; 1971).

Yet after decades of public fame, the radical behaviourists shaped even the journals, and their taboos pervaded the sciences and philosophy. Like the young Skinner, students decided to become revolutionary behaviourists because of the image projected by the radicals. Behaviourism was the hard-rock music of psychology; it had all the attractions of simplicity, a radical and utopian stance, a total rejection of the dead past, and the grandiose promise of founding a world no one had seen before. The only problem was that all those claims required a purge of history. Behaviourism needed to erase the past and create a new myth of origins. Pavlov was a founding hero of the new myth. Pavlov had an established scientific reputation long before he began to study conditional reflexes. He received a Nobel Prize for his surgical experiments on digestive secretions, which were reflexive. But Pavlov often used the term 'reflex' extravagantly and circularly, as shown by his story of the freedom reflex.

There is of course no reflex of freedom, although it is easy to see resistance to coercion in animals and humans. Herding cats is nearly impossible, and it is equally hard to keep male dogs from sniffing females in heat. Wild horses resist taming, and most animals cannot be domesticated at all. Human beings fiercely resist unwanted control. But struggling against coercion is not a reflex — it is nothing like a simple atom of behaviour. Pavlov passionately fought that elementary point. And he constantly overinterpreted the very limited results he saw in the laboratory.

Pavlov went on to propose a 'reflex of religion,' an 'investigatory reflex' as shown by exploration and curiosity, a 'self-defence' reflex, and a 'reflex of purpose'. 'All life, all its improvements and progress, all its culture are effected through the reflex of purpose, are realized only by those who strive to put into life a purpose. '. . . the comforts of life (the aim of practical people), right laws (aspired to by statesmen), knowledge (the goal of educated people), discoveries (the treasures of scientists), virtues (the ideal of righteous people), etc' (1927, Vol. 1, p. 279). Even suicide could be explained: 'the tragedy of the suicide lies in the fact that he has an inhibition, as we physiologists would call it, of the reflex of purpose . . . .' (p. 279).

These explanations are circular, of course. People who pursued goals were said to show the reflex of purpose. If they were suicidal their reflex of purpose must have been inhibited. Thus everything could be explained *post hoc*, though the imputed reflex arc was never observed. It did not exist.

Why Pavlov's circular argument is important

This point is not just relevant for understanding Pavlov. The identical gambit was used by Watson and Skinner. Skinner's unit of behaviour was not the reflex but 'stimulus–response conditioning'. Yet the tactic of *post-hoc* explanation was the same. Pavlov claimed that conditional reflexes occurred in the brain, which he could not observe. Skinner claimed that S–R connections must have occurred in the 'history of the organism', which he could not observe either. Thus neither Pavlov nor Skinner had direct evidence for their universal claims. They simply overgeneralized from limited laboratory results, a plain violation of accepted scientific practice.

3. Sliding definitions

It is crucial to understand that Pavlov used the word 'reflex' with constantly sliding meanings. Physiologically, a reflex is a fixed reaction that is evoked by a specific neuronal arc, like the knee-jerk reflex. Such reflexes are clearly defined because the anatomy and physiology can be seen. But simple reflex arcs are small in number, and many of them can be isolated only when the cerebral cortex is removed (Sherrington, 1906/1947). A second meaning of 'reflex' is anything that can be causally elicited, like salivation at the sight of food. In that case the brain basis was partly inferred, without direct neural evidence. Pavlov's third and most general meaning of 'reflex' was 'everything the brain does', including conscious and purposeful acts. Consciousness and volition depend upon the cerebral cortex, which has a completely different anatomy and physiology from the spinal cord (e.g., Sherrington, 1906/1947; Lashley, 1930; Edelman & Tononi, 2001).

Pavlov constantly slides from one meaning to the next, to uphold the illusion that they are all the same. They are not. To say that reflexes are essential to bodily action is much like saying that wheels are essential to automobiles. The statement is true as far as it goes, but it leaves out the engine, the driver, the gears and everything else that makes the wheels move. Pavlov's universal reflex

explanation is much like saying that cars need *nothing but* wheels; or perhaps that *everything* — including the driver — is just another wheel.

As George A. Miller wrote, 'Pavlov would never concede that his physiological interpretation was merely an elaborate figure of speech' (1962). The *Encyclopaedia of Philosophy* speaks of his 'subjective intuitions clothed in pseudophysiological vocabulary' (Edwards, 1967, Vol. VI). Sir Charles Sherrington, one of the foremost physiologists of the time, reportedly remarked that 'His observations are the most brilliant but his deductions leave me cold'.[3] It speaks volumes that Sherrington's classic work on reflex physiology only cites Pavlov once among 314 scientific sources (1906/1947).

Yet it was Pavlov's 'deductions' that made him famous, and which convinced entire disciplines that consciousness must be dropped from science.[4] How did it happen?

II: Pavlov and the Russian Predicament

Pavlov was a man of great personal integrity, and there is no reason to doubt that he believed his own utopian dreams. He took serious personal risks in criticizing the Tsarist regime before the Revolution and Soviet authorities afterwards. He is said to have written to Stalin in 1927, 'On account of what you are doing to the Russian intelligentsia — demoralizing, annihilating, depraving them — I am ashamed to be called a Russian!' (Basgen & Blunden, 1999–2000). A less useful figure would surely have ended up in Siberia for those words.

Born in 1849, he was already in his seventies during the Bolshevik revolution. At times he seemed sunk in Dostoievskian gloom. Pavlov's anguish over the fate of Russia was life-long and real. As a son of a poor priest from the peasant class he was obsessed by the fate of his people. By 1900 the Romanoff imperial dynasty had been in power for four centuries without fundamental political change. Only in 1861 were Russia's peasants legally released from slavery. Hopeful signs of liberalization were reversed after the assassination of Alexander II in 1881, on the very eve of the signing of the first Russian Constitution. As a result, the Constitution never went into effect and the system continued unreformed. The thinking of the peasants and the regime before the Revolution were still governed by the ancient Russian Orthodox Church. These events no doubt marked Pavlov.

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[3] Cited by Gantt, p. 24, from John F. Fulton (1940) *Bull of Inst of Hist and Med*, pp. 332–54.

[4] Some would argue that Watson's behaviourism was only an American phenomenon. That is true to the extent that academic psychology largely switched from Germany to the US shortly after 1900, because Europe had the catastrophe of World War I followed by the Great Depression, and could not support a costly new academic field. Institutional conservatism at European universities also kept chairs of psychology from being established for decades. Thus the professionalization of psychology shifted from Germany to the US at just the time behaviourism took over. Nonetheless, British analytic philosophy was for all intents and purposes equivalent to behaviourism, as Skinner long maintained. This philosophy dominated English-speaking countries for decades. In biology, Pavlov and reductionists like Jacques Loeb had a similar impact. Behaviourism of one kind or another therefore made a clean sweep: philosophy, psychology, and physiology all rejected consciousness, at least in English-speaking countries and the USSR.

Only the intelligentsia in Moscow and St. Petersburg were able to escape the pervasive medieval tyranny, and they were divided by various degrees of radicalism and despair. Under these dreadful conditions Pavlov believed that only science offered hope.

> When the negative features of the Russian character — laziness, lack of enterprise, and even slovenly relations to every work — provoke melancholy moods, I say to myself, No, these are not our real qualities, they are only the damning inheritance of slavery . . . it left the reflex of purpose without any exercise in the fundamental habits of living (1927, Vol. 1, p. 280).

If all human action could be viewed in light of physiological reflexes, he believed, further scientific study would surely lay the foundation for a technology of social progress:

> Only science, exact science about human nature itself, and the most sincere approach to it by the aid of the omnipotent scientific method, will deliver Man from his present gloom, and will purge him from his contemporary shame in the sphere of inter-human relationships (1927, Vol. 1, p. 41).

Significantly, Pavlov's lecture on 'The Reflex of Freedom' was read in May of 1917, a time when the old regime was finally crumbling. Only a month before, in April, V.I. Lenin had arrived in Moscow, ready to seize power.

1. What Pavlov was looking for

Pavlov and his admirers saw his work in terms of the long struggle between science and religion. To many intellectuals science had been the key to Progress ever since the Renaissance, while established religion seemed to support an oppressive status quo. The history of science was seen as a series of groundbreaking discoveries memorialized by names like Galileo, Newton and Darwin. To his admirers, Pavlov was one more hero in the series. He was 'the Pasteur of the human brain and heart' as Paul de Kruif wrote (quoted by Gantt, 1927, p. 20). The trouble is, of course, that science can become just as dogmatic and closed-minded as any religion, especially if it goes far beyond the evidence.

One long philosophical battle concerned vitalism, the idea that living things cannot be reduced to chemicals because they had a spiritual life force, an *élan vital*. Many partisans of science viewed vitalism as the great enemy. According to Miller,

> In Germany, the science of physiology was controlled by four men: Hermann Ludwig von Helmholtz, Emil Du Bois-Reymond, Ernst Brücke, and Carl Ludwig. *These men formed a private club in Berlin whose members were pledged to destroy vitalism. . . . And it was in this intellectual atmosphere that the pioneer psychologists were educated*. Freud was Brücke's student; Pavlov studied under Ludwig; Wundt was Du Bois-Reymond's student and Helmholtz' assistant. With physiology reduced to chemistry and physics, the next step was to reduce psychology to physiology (1962, pp. 193–4, italics added).

In Britain, Thomas Henry Huxley extended this mechanistic approach to consciousness. He wrote:

> Consciousness . . . would appear to be related to the mechanism of the body . . . simply as a [side] product of its working, and to be completely without any power of modifying that working, as the [sound of] a steam whistle which accompanies the work of a locomotive . . . is without influence upon its machinery (quoted in James, 1890/1983, p. 135).

Thus, the partisans of scientism rejected any basic difference between living organisms and chemistry; they sometimes considered consciousness an irrelevant by-product of the brain; and they wanted to reduce human voluntary *purpose* to mechanistic causality. Volitional purpose posed a paradox, according to vitalists, because it seemed to reverse physical causality: Instead of an earlier event causing a later one, a future end seemed to cause present actions.

Pavlov's claims therefore had a kind of inevitability to partisans of scientism. It was just what they were looking for. As he wrote:

> Our starting point has been Descartes' idea of the nervous reflex. This is a genuine scientific conception, since it implies necessity . . . a stimulus appears to be connected of necessity with a definite response, as cause with effect (1927, Vol. 1).

Pavlov often marvelled at the 'machine-like' nature of reflexes. But how was he to relate simple reflexes to all brain activities, including the great cerebral hemispheres? Here he had a notable predecessor.

> A bold attempt to apply the idea of the reflex to the activities of the hemispheres was made by the Russian physiologist, I.M. Sechenov . . . he attempted to represent the activities of the cerebral hemispheres as reflex — that is to say, as *determined*. Thoughts he regarded as reflexes in which the effector path was inhibited, while great outbursts of passion he regarded as exaggerated reflexes with a wide irradiation of excitation (p. 156).

Pavlov had great admiration for Sechenov. In 1913 he proposed an ovation:

> Exactly half a century ago, in 1863, was published in Russian the article 'Reflexes of the Brain', which presented in clear, precise, and charming form the fundamental idea which we have worked out at the present time. After the birth of this idea, it grew and ripened, until in our time it has become an immense force for directing the contemporary investigation of the brain. Allow me at this fiftieth anniversary of the 'Reflexes of the Brain' to invite your attention to the author, Ivan M. Sechenov, the pride of Russian thought and the father of Russian physiology! (1927, Vol. I., p. 222).

This is the key to Pavlov's thinking: a lifelong commitment to the idea that all human brain activity was made up of reflexes in simple, causal chains. His experiments were confidently designed to work out this claim in detail.

2. What Pavlov found

Humans and other animals learn many things, but innate reflexes could only explain built-in behaviours like salivation and leg extension. Pavlov therefore needed to show that reflexes could be associated with new stimuli. That is why

the 'conditional reflex' was so important. In the laboratory Pavlov showed how dogs could learn to salivate in anticipation of meat powder, given an arbitrary signal like a bell. Dilute acid in a dog's mouth would also evoke salivation, and after mixing India ink into the acid solution, just the sight of the dark liquid elicited salivation. Thus, salivation could apparently be evoked by an arbitrary sight or sound. Since seeing and hearing required the cerebral hemispheres, this meant that the 'higher centres' of the cerebral cortex were involved in reflex association. For decades, with the help of a large work force, Pavlov worked out all the details of this experimental paradigm.

Any pet owner knows that one need only walk to the pantry at feeding time to evoke eager anticipatory activities in hungry dogs or cats. Yet in nature animals do not look for food in kitchens. Cans of pet food have no biological relationship to hunting, killing and eating. They involve learned expectations. This is the essence of Pavlov's famous experiment, something one can see by watching a poodle lick its chops many seconds before tasting dog chow. In that sense George Bernard Shaw was right — any policeman can tell you that much about a dog.

Today, brain imaging during Pavlovian learning shows massive neuron populations recruited by the task of associating stimuli, nothing remotely like a two-neuron spinal arc (e.g., Hugdahl, 1998). It seems that the simple laws Pavlov claimed to find were the result of a complex brain — perhaps 10 billion neurons in the dog — confronted with the most confining environmental demands. The simplicity Pavlov thought was in the brain resulted from manipulations so reductive that animals could learn only reflex associations. Humans thus confined might behave just as simply.

Pavlov's experimental work was standard incremental science. It was useful over the longer term for mapping out animal sensory capacities, for example. But it is his universal claims beyond the laboratory that are our concern here.

3. An untested generalization

Pavlov never tested reflex learning outside the laboratory. But it is an elementary point of scientific method that experiments can never be generalized without extensive testing under natural conditions. That is why physics has long used astronomical observations to test theory. Biology was largely observational for centuries, as in Darwin's epochal voyage on *HMS Beagle*. Darwin never conducted a single experiment on his voyage; he only observed nature. In the case of reflexes it took half a century for behaviourists to admit that in the real world, reflex association did not work as advertised (e.g., Garcia & Koelling, 1966; Breland & Breland, 1961). The universal claims Pavlov made were simply untested when they were most celebrated. Reflex explanation became a closed belief system as fixed as any theological dogma. Everything could be explained *post hoc*, and no premise could be questioned. Questions about consciousness and volition were simply excluded as unscientific, *ex hypothesi*.

One could state it in a few sentences:

Premise a: All innate behaviour is a reflex, a point-to-point causal connection between a stereotyped stimulus and a built-in response.
Premise b: All learned behaviour involves new connections between arbitrary physical signals and innate reflexes.
Conclusion: All observable activities can be explained from premises a and b.

It only remained for Skinner to add a third:

Premise c: All novel responses must have been selectively reinforced in the past. (Skinner, 1957)

In this view, Pavlovian learning was stimulus–stimulus (S–S) association, and the Skinnerian kind was stimulus–response (S–R) association. This exhausted all forms of learning. Skinner further denied the need for physiological evidence, ensuring that his claims could not be falsified by brain findings. Both Skinner and Pavlov avoided real-world observation, so that no one could test whether their claims held true in nature. Yet they did not hesitate to claim universal truth. They both founded a cottage industry of experimentation, which made incremental findings and finally, after half a century and more, overthrew the fundamental assumptions of the founders.

It is simply not true that all learning involves reflex association. Most learning does not. For example: perceptual learning, pattern learning, serial order learning, short-term memory, language learning, paired associate learning, explicit and implicit learning, episodic and semantic learning, sensorimotor learning, most cognitive, emotional and social development, problem-solving, skill learning, and 'operant conditioning' of voluntary actions. Not even classical memory association can be explained by reflexes. From Aristotle to Locke, memory was viewed as the association of *ideas*, a completely different concept than association of stimuli and responses. As a result, modern textbooks on human learning rarely refer to Pavlovian conditioning.

Pavlov's term 'reflex' settled mind–body arguments by fiat. If one applied it to curiosity, purpose, pain, hunger, religion, the struggle for freedom and the like, one meant that these were no more than physical events. Indeed, it may be that reflex reduction was attractive precisely *because* it abolished mind–body debates. Philosophical arguments were simply put aside.

But there was a cost: One had to purge the entire vocabulary of common sense. All the 'mentalistic' words of natural language were declared to be unscientific. Of the 100,000 words understood by educated speakers of English, some two-thirds are mentalistic; they are the words we use in daily life to describe ourselves and others (Baars, 2003a). These psychological words evolved over centuries, beginning with ancient Greek and Latin: Words like 'idea', 'image', 'concept', 'enthusiasm' and 'emotion'. Behaviourists claimed that all scientifically usable concepts could be translated into external stimuli and responses, an assumption that was not generally rejected until the end of the twentieth century (Baars, 1986).

In fact, as Skinner pointed out, behaviourists merely adopted a philosophy — physicalistic reductionism. Skinner often noted that 'Behaviourism is not the

science of man, it is the philosophy of that science' (1974, p. 3). Yet many behaviourists attributed their convictions to experimental findings — just as Pavlov attributed the 'freedom reflex' to experimental observations. In fact, his putative discoveries were inspired by his long-standing philosophical commitments. Pavlov obviously thought it worthwhile to sacrifice consciousness and volition for a promise of human perfectibility. Not everyone agreed.

I don't want to leave the impression that nothing was accomplished in behavioural studies between 1913 and 1990. Behaviourists learned much of lasting value. But they certainly did not add to our understanding of our own experience, of cognitive functions, purposeful control, or of the self.

4. Did Pavlov disprove consciousness?

Few scientists believe that Pavlov disposed of the question forever. In the last decade consciousness has come to the fore again in biopsychology. New discoveries have been made, new scientific journals and societies founded, books published, and collections of articles produced (e.g., Baars *et al*., 2003). A search for the word 'consciousness' in the biomedical literature shows an increasing curve starting from several dozen in 1965 to over 5,400 in the year 2000 (Baars, 2003b). While this gives only a rough estimate, it is consistent with other evidence. Consciousness is back.

Contrary to popular belief Pavlovian training is not automatic and unconscious. Not only must an animal or person be conscious of the innate stimulus (like food) and of the signal (like a bell); they must also be conscious of the *relationship* between the two. Lovibond and Shanks (2002) conclude that 'The bulk of the evidence is consistent with the position that awareness (of the relationship) is necessary but not sufficient for conditioned performance'. Pavlovian training thus supports the role of consciousness in learning (e.g., Baars, 1988; 2002a).

A clever experiment by Dawson and Furedy (1976) demonstrates this point. They trained an association between a soft tone followed by a surprisingly loud noise. If they are given in a series ('tone–NOISE, tone–NOISE, tone–NOISE . . .'), after a while the tone alone evokes a change in skin conductivity, as sweat pores open to prepare the body to react to the noise. The tone has become a signal that a loud noise is coming: Pavlovian association. Now, without changing the stimuli, Dawson and Furedy changed the way subjects understood the task. They were told that the noise signalled the tone, rather than vice versa. Their task was to judge the loudness of the tone. The new series was perceived as 'NOISE–tone, NOISE–tone, NOISE–tone . . .'. Yet physically nothing had changed. Under these conditions absolutely no Pavlovian learning occurred. Isolated tones no longer evoked sweating. Thus, the subjects' interpretation of the stimuli changed everything. Conscious interpretation seems to be needed for Pavlovian association to occur (Baars, 1988).

5. Did Pavlov disprove volition?

In 1888 William James wrote, 'In *voluntary* action the act is foreseen from the very first. The idea of it always precedes the execution. This is the essence of every voluntary action' (p. 241). The simplest way to find out whether an action is voluntary is to ask someone whether it is their goal, or to ask them to adopt it. People can perform skeletal muscle movements on request, but they cannot decide to move the smooth muscles of the intestines. Almost everyone can silently talk to themselves on purpose, but most people cannot wiggle their ears at will. These contrasts reflect systematic differences in the neurophysiology. But even today, some psychologists refuse to talk about volition as such, still misled by the behaviouristic decades of rejection.[5]

James' definition provides a simple test for voluntary control in humans. In many cases people can tell us about their goals before carrying them out. That is an indispensable fact in fields like neurology and psychiatry. To abandon it would make medical diagnosis impossible. You cannot even ask a patient to open his mouth and say 'Ah' without giving him a conscious goal. Most psychological pathology also is defined by the fact that certain unwanted acts, thoughts or feelings cannot be controlled on purpose. In the real world volitional control is inescapable (Baars, 1988; 1992; 1997; 2002a).

It is easy to demonstrate the need for a concept of volition by the knee-jerk reflex. The reader can drape one leg over the other so that it can swing freely, and then tap sharply just below the knee cap on the patellar tendon. Your leg will swing out involuntarily, with a spring-loaded quality quite different from a voluntary movement. To Pavlov and others, this movement had just the mechanistic quality needed to illustrate the physical nature of human action.

However, now take the demonstration one step further and *try to imitate* the reflex action of your leg, with exactly the same velocity and dynamics. That is, simply try to follow the *goal* given in the previous sentence. It is quite difficult to do exactly; voluntary control of the leg is quite different from the knee-jerk reflex. Normal leg movements are guided by cortex, while an involuntary spinal reflex is momentarily free of cortical control. That is why it feels so different. We can be surprised by our own knee-jerk reflex, but not by our own voluntary actions. As James pointed out, the crucial difference is that we can steer voluntary actions by their endpoints, their goals. Such a comparison between a spinal reflex and its voluntary imitation constitutes a true experiment. It shows the reality of volitional control, because *contra* Pavlov, we must explain not just the local reflex, but also its normal goal-guided voluntary version. Physiologists in 1900 understood this point perfectly well. As Sherrington wrote,

[5] The cortical basis of volition does not apply to all motivational mechanisms. Numerous goal-related regions exist in the brain, including in the phylogenetically earlier brainstem (e.g., the peri-aqueductal grey, the region involved in mother–infant attachment in mammals). These brain regions involve goals that humans may experience as impulsive, not under full voluntary control. They are not cortical. Just as consciousness involves a particular *kind* of knowledge in human beings, volition involves a particular *kind* of goal-directed control. (See Baars, 1988).

> It is clear, in higher animals especially so, that reflexes are under control by higher centres to whose activity consciousness is adjunct. By these higher centres, this or that reflex can be checked, or released, or modified. It is urgently necessary for physiology to know *how* this control — volitional control - is *operative* upon reflexes (1906/1947, pp. 385–6).

Today, brain imaging techniques can show the neuronal activity of volition. Spence and Frith recently wrote that

> A number of brain regions contribute to the performance of consciously chosen, or 'willed', actions. . . . Disease, or dysfunction, of these circuits may be associated with a variety of disorders of volition (1999).

After a century of taboo we have returned to the scientific questions of 1900.

III: Other Physiologists did not Accept Pavlov's Claims

Sir Charles Sherrington, also a Nobel Prize winner in physiology, took a very different tack from Pavlov. Sherrington was a pioneering student of reflex actions. His classic work *The Integrative Action of the Nervous System* (1906/1947) came out only two years after Pavlov's work was first published in the West. It presents numerous experiments on reflexes. Sherrington was critical of Descartes' mechanistic idea that

> Cat, dog, horse, etc. were trigger-puppets which events in the circumambient universe touched off into doing what they do. It lets us feel that Descartes can never have kept an animal pet.

Sherrington and others demonstrated that simple reflexes can be seen mainly when the spinal cord is isolated from the cortex. Under those conditions animals actually become 'trigger puppets'.

> (The cerebral cortex) can be removed under anaesthesia, and on the narcosis passing off the animal is found to be a Cartesian puppet: It can execute certain acts but is devoid of mind. Thoughts, feeling, memory, perceptions, conations (voluntary actions), etc.; of these no evidence is forthcoming.
> Thus, the cat set upright on a 'floor' moving backward under its feet walks, runs or gallops according to the speed given to the floorway. In the dog a feeble electric current on the shoulder brings the hind paw of that side to the place, and performs a rhythmic grooming of the hairy coat there. If a foot treads on a thorn that foot is held up from the ground while the other legs limp away. Milk placed in the mouth is swallowed; acid solution is rejected. The dog shakes its coat dry after immersion in water.

Yet spinal reflexes are impoverished:

> But, when all is said, if we compare such a list (of spinal reflexes) with the range of situations to which the normal dog or cat reacts appropriately, it is extremely poverty stricken. It contains no social reactions, it fails to recognize food as food: It shows no memory, it cannot be trained or learn: it cannot be taught its name. The mindless body reacts with the fatality of a penny-in-the-slot machine (p. xii).

To Sherrington, reflexes showed one level of integration. But they also raised the question of a higher level: What is it that the brain does to guide and organize

spinal activities? In normal animals reflexes are subordinate to the conscious and voluntary control of the cerebral cortex. That is where goal-directed action is organized, where food and danger are recognized, social action is directed, and incoming sensations are unified. A striking example Sherrington explored was the unitary perception of the world when two different images are presented to the two eyes. In recent years this has proved to be one of the most productive methods for studying visual consciousness (e.g., Logothetis & Schall, 1989).

In physiology Sherrington was as prominent as Pavlov, but he did not make utopian claims. He was not famous to the general public. Pavlov's popular followers ignored him.

1. Lashley's evidence against brain reflexes

Karl Lashley began as a student of John B. Watson, the first famous radical behaviourist in psychology. In 1923 Lashley noted with approval how behaviourism was 'spreading like wildfire'. Seven years later, in a classic article, he has changed his mind. While reflex pathways could explain some spinal mechanisms, they failed to account for basic facts about the brain. He wrote,

> The notion of the reflex arc was developed in studies of spinal preparations (animals whose brains were severed from their spinal cords). Under these simple conditions something like a point-for-point correspondence between receptor cells and muscle groups could be demonstrated, as in the case of the scratch reflex.

However,

> in the study of cerebral functions we seem to have reached a point where the reflex theory is no longer profitable. *And if it is not serviceable here, it can scarcely be of greater value for an understanding of the phenomena of behaviour* (Lashley, 1930, p. 12) [italics added)].

The reason is, of course, that normal behaviour always involves the intact brain. Lashley's critique was therefore not just physiological, but psychological as well.

Lashley presented three arguments against a reflex explanation. First, there simply was no evidence for reflex pathways in the cortex: ' . . . there is certainly no direct evidence for the existence of any sharply defined reflex paths whose interruption results in the loss of isolated elementary functions' (p. 10).

Thus, cerebral cortex is fundamentally different from the spinal cord. Second, there was no evidence for stereotyped sensory input. In contrast to isolated reflexes, a large class of sensory stimuli were effectively equivalent.

> We have a situation where a habit is formed by the activation of one set of receptors and executed immediately upon stimulation of an entirely different and unpractised group. The equivalence of stimuli is not due to the excitation of common nervous elements.

Finally, there was no evidence for stereotyped reflexive responses in animals with intact brains. Instead, habits showed motor equivalence: A maze could be run in many different ways.

> Turning to motor activity, we are confronted by an identical problem. If we train an animal in a maze we find little identity of movement in successive trials. He gallops through in one trial, in another shuffles along, sniffing at the cover of the box. *If we injure his cerebellum, he may roll through the maze [(italics added].*

The animal has a vast range of possible ways to reach its goal, even when its motor control has been severely damaged. 'He follows the correct path with every variety of twist and posture, so that we cannot identify a single movement as characteristic of the habit'. The same points applied all the way from birds to humans. 'Activities ranging from the building of characteristic nests by birds to the activities of man show the absence of stereotyped movements in the attainment of a predetermined goal' (pp. 6–7). Thus, any single goal can be achieved in many different ways, across a vast range of species.

In sum, Lashley found no rigid reflex-like sensory or motor functions in the cortex, and no simple reflex pathways. Pavlov's universal reflex hypothesis did not hold up. Yet as we shall see, falsification did not stop the radical program of stimulus–response reduction.

IV: Reflex Explanation in the West

In the decades after 1900 the goal of reducing all behaviour to reflexes became popular in the United States and Britain among social reformers, journalists, philosophers, and radical behaviourists. Many physiologists and psychologists remained sceptical; but their voices were not heard by the public.

It was John Watson who first imported Pavlov into Western behaviourism (Watson, 1916; Hilgard, 1986). Like Pavlov, Watson confidently promised utopian solutions:

> Give me a dozen healthy infants, well-formed and my own specified world to bring them up in and I'll guarantee to take any one at random and train him to become any type of specialist I might select — doctor, lawyer, artist, merchant-chief and yes, even beggar-man and thief, regardless of his talents, penchants, tendencies, abilities, vocations, and race of his ancestors (1930, p. 82).

This had wonderful appeal to American readers. But Watson had no evidence. He had published only one case of conditioned fear in a baby, the case of 'Little Albert' (Watson & Rayner, 1928). It was Pavlov's story all over again.

The reflex hypothesis encountered a crisis when Lashley's 1930 article appeared (above). It was widely read, and his evidence was not disputed. Yet the hypothesis was not abandoned when it was falsified; it merely assumed a new guise. Under the influence of B.F. Skinner, all behaviour was taken to involve 'stimulus–response contingencies' without evidence for a physiological reflex (Skinner, 1931; 1953; 1976; Baars, 1986). Skinner thereby saved the behaviourist movement.

Skinner's famous box, invented about 1935, was useful for collecting data about stimuli and responses, but 'operant conditioning' in fact involves nothing other than voluntary, purposeful behaviour. Skinner himself was quite clear about that point when he wrote that 'the operant is the field of purpose'. Operant behaviour *always* involves goals like food, water or avoiding pain. What is

learned is a response that is a subgoal to be carried out before the biological goal can be reached. A hungry pigeon learns to peck at a red light as a means to its real goal of food. But to state this obvious fact, the common sense vocabulary of goals is needed — and it was banned as unscientific. Goals are not physically observable, though they are often easy to infer from watching an animal behave. But inferential concepts were banned from radical behaviourism (Baars, 1986). Thus an external, physical description of the action had to be devised: the vocabulary of operant conditioning. That was perhaps Skinner's most significant accomplishment: a third-person account of common sense.

Skinner rose to public prominence in the 1940s and 50s. For five more decades, his public fame kept the rejectionist program alive. The ban against consciousness stayed strong.

Like Pavlov and Watson, Skinner claimed that his ideas applied to all animals and humans without testing them in natural situations. His universal claims began about 1935, before he had even trained many pigeons. Decades later, when Breland and Breland (1961) finally conducted operant training in 38 different species, they found numerous limits on the method, and intrusions of untrained actions. In nature such 'unconditioned' behaviour is likely to be much greater

In sum, the three most extreme behaviourists dominated public debate between 1920 and 1990. All of them based their claims on utterly inadequate evidence. All appealed to utopian hopes, and all aimed to purge consciousness and volition. Together they shaped the century.

V: Purging Consciousness

Pavlov's most questionable impact came from what he denied, rather than what he asserted. Scientists assert flawed ideas all the time, but they are usually falsified quickly. But in the twentieth century consciousness and volition were purged for most of the century. They became taboo. No working scientist was free to explore them, on pain of being read out of science. Pavlov's denial of the fundamentals could not be falsified, because it was forbidden to test them.

Imagine if physics in 1900 had declared relativity and quantum theory to be unscientific. Twentieth-century physics would be an intellectual desert. Einstein, Planck and Heisenberg would be erased from history. To its credit the physics community was open to ideas that overturned the received wisdom. The new human sciences were not. They dealt with difficult puzzles by rejecting them. The taboo against consciousness became the norm in psychology and even biology, endorsed by analytical philosophy.

The great taboo was not just a loss to science. Neglect of our core humanity has wider costs. No one can empathize with 'trigger-puppets'. Four successive generations of university students were taught mechanistic beliefs about themselves and each other. They went on to adult lives believing that science had proven their personal experiences to be meaningless, and their voluntary efforts in life to be merely the product of reflex association. A more alienating doctrine is hard to imagine.

VI: Where We are Today

Starting in the 1970s, psychology went through a 'cognitive revolution' in which many nineteenth-century ideas were rediscovered and given a stronger empirical and theoretical basis (Baars, 1986). Mental imagery came back, as did memory, meaning, perception, knowledge, thinking, language and the like. But the cognitive revolution did not bring back consciousness and volition. These have only returned with the rise of cognitive neuroscience in the last decade (e.g., Baars, 1988; 2002; Edelman, 1989; Edelman & Tononi, 2001; Spence & Frith, 1999). Scientifically we are much closer to the nineteenth century than to the twentieth.

It is now a hundred years since Pavlov's first report about conditional reflexes. Perhaps 10,000 experiments have been published using his method.[6] Many useful results have been obtained, in emotional association, appetitive learning, and even drug addiction. Pavlovian training is also used to explore simple associative learning in the brain. But none of his utopian promises have come true. The great scientific problems Pavlov claimed to have eliminated, consciousness and volition, are back in the headlines (Spence & Frith, 1999; Baars, 2002). Pavlov's taboo against consciousness and volition became a dominant theme of Anglo-American thought for a century. Much of it is with us still.

VII: Conclusion: Denying Consciousness is Dehumanizing

The twentieth century was torn by some of the most destructive conflicts since the great religious wars of European history. In war — domestic or foreign — people always dehumanize the enemy; we treat others as feelingless objects. While Pavlov had utopian intentions, his ideas set the stage for a dehumanized conception of people. A person without feelings, choice, and identity can only be a negligible cog in a blind and merciless machine. With such a 'scientific' conception it becomes much easier to dehumanize people.

Pavlov's followers saw his work in terms of the long struggle between science and religion. Science was seen as the key to human progress, while established religion seemed to support an oppressive status quo. To his admirers, Pavlov was one more hero in the progress of science.

British analytic philosophy was for all intents and purposes equivalent to behaviourism, as Skinner long maintained. It dominated English-speaking countries for decades. In biology, reductionists such as Jacques Loeb had a similar impact. Behaviourism of one kind or another therefore made a clean sweep: philosophy, psychology, and physiology all rejected consciousness.

Utopian perfectionism can be destructive. A respected team of French Marxist historians recently estimated that utopian regimes from Lenin to Pol Pot were responsible for 100 million domestic deaths in the twentieth century (Courtois *et al*, 1999). That number may be doubled with the death toll from other ideologies,

[6] By 1965 Razran estimated that 6,000 experimental papers had been published about Pavlovian learning. That number has now perhaps doubled.

with their own ideals of coerced perfection. Those massacres were invariably preceded by dehumanization of the victims, denying their conscious point of view.

It is a devastating irony that Pavlov's idealistic reduction of human nature could have such results. But reflex explanation could only become a comic-strip caricature. In my view it led to dreadfully impoverished science, compared to the humanizing riches of the century of William James. Of course there is nothing wrong with studying reflexes; but it is false and misleading to say that it provides a more scientific substitute for the fundamentals of human psychology. We are still struggling to recover from the resulting mistakes.

The most disturbing side of Pavlov's celebrity was the worldwide enthusiasm for a simplistic reduction of mind. Just before World War II, John Maynard Keynes issued an eloquent warning:

> Practical men, who believe themselves to be quite exempt from any intellectual influences, are usually the slaves of some defunct economist. Madmen in authority, who hear voices in the air, are distilling their frenzy from some academic scribbler of a few years back. I am sure that the power of vested interests is vastly exaggerated compared with the gradual encroachment of ideas. But, soon or late, it is ideas, not vested interests, which are dangerous for good or evil (1936, p. 570).

Pavlov's story is a cautionary tale for utopian dreamers to come.

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