Evolutionary Psychologically Predicted Biases in the Manifestation of Cognitive Dissonance

An Exploration

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Peter Clemerson

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ABSTRACT

It was hypothesised that over evolutionary time, selection pressures have generated a cerebral modularity which detects survival and reproduction related contradictions preferentially over others. It was also hypothesised that contradiction-detecting mechanisms are rendered less effective if contradictions are implicit rather than explicit, or refer to the future rather than the immediate present.

Explicit and implicit contradictions pertaining to the above conditions were embedded in narratives to test these hypotheses. Participants read the narratives via a computer screen, pressing the keyboard space bar to progress through the narratives line by line. A programme recorded reading times (RTs) of each narrative line. An extended RT for a line contradicting an earlier one was interpreted as indicating the generation of cognitive dissonance consequent to detecting the contradiction. A questionnaire was used to ascertain participants' subjective reactions.

Analysis of the RTs provided some evidence that the hypothesised modularity exists for reproduction-related contradictions. The results, particularly those relating to survival, suggest that detection of subject matter related modularity is hindered by heterogeneous phrasing and/or the generation of mortality-related emotions. As predicted, implicit contradictions were less frequently noticed. The phrasing employed did not yield any timeframe-related difference in noticeability.

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INTRODUCTION

Human minds absorb propositional statements from a wide range of sources covering an equally wide range of subjects over long time periods. Festinger (1957) proposed that any pair of retained propositions can be placed in one of three categories: consonant, dissonant or irrelevant. Consonant pairs are logically and/or factually consistent with each other while dissonant pairs are those that are mutually contradictory and cause psychological discomfort. Irrelevant pairs are those that have nothing to do with each other. The psychological discomfort or dissonance caused by the retention of mutually contradictory pairs of propositions is the motivation for some form of resolution. Such resolution takes many forms which Festinger (1957) explores in detail. In this thesis, I propose to explore variation in the degree to which the conscious mind becomes aware of contradictions present explicitly or implicitly in pairs of propositions and therefore the degree to which someone experiences the resulting dissonance.

In principle, any newly retained proposition could be compared with all previously retained propositions currently stored consciously and unconsciously in memory and assessed whether it was consistent, contradictory or irrelevant with respect to all others. Carried out sequentially, even with limited search and comparison facilities, such comparisons are possible in principle but, as more propositions are retained, ever longer periods of time would be required. Clearly the mind does not work like that.

When a new proposition is absorbed, some form of comparison with current knowledge can take place. It often does but need not. Knowing that Bob was in hospital from last Monday until last Thursday and then hearing that Bob was out in his garden during the intervening Wednesday, a person may or may not pose the question "How could he have been?" or something similar. It is also the case that on separate occasions, a person may learn first one fact and later another contradictory fact, and never compare them. Thus, Dinosaurs lived tens of millions of years ago and the Earth was created approximately

6000 years ago are two propositions which someone may learn on different occasions but never compare.

When someone does make immediate comparisons for consistency, it means that some form of relevance check has taken place. As the mind does not contain serial searching and comparison facilities in the form of a sequentially processing computer with a Von Neumann architecture, some form of assessment must take place with the new information being compared in detail with only that other information that is relevant to the new, relevant here meaning either consistent or contradictory.

Given that comparisons between two propositions may or may not take place, evolutionary considerations suggest that the making or not making of comparisons should not take place on a random basis. Some comparisons would be of greater relevance than others to survival and reproductive success. Evolutionary Psychology (EP) therefore predicts that mechanisms should have developed to ensure that those comparisons of greater relevance to survival and reproductive success do take place while those of less relevance need not. The benefits to survival and reproductive success to be obtained from the resolution of contradictions relevant to these subjects is hypothesized as the selection pressure for the capacity for the phenomenological experience of discomfort known as dissonance. Such discomfort is hypothesised as the proximate trigger for the search for resolution.

The same logic applies to both explicit and implicit contradictions.

Contradictions of relevance to survival are those which have as their subject matters the life of the person, bodily injury, food, shelter, security and perhaps reputation (Milinski, Semmann, & Krambeck, 2002). Contradictions of relevance to reproductive success would have as their subject matter fertility, fidelity and sexual attractiveness.

If the suggestion that the noticeability of contradictions is subject matter dependent is found to be true, it generates a very large new field of research. In this initial exploration, only a few early steps into this area are taken.

The next section examines the modularity of the brain and suggests that the non-homogeneity of cerebral processing implicit in subject matter biases should be encompassed within the modular view of the brain. It also examines the details of cognitive dissonance and likens it to all other phenomenological experiences which force well-being promoting activity upon the experiencer. Recent discoveries of lactose tolerance in the adults of cattle herding societies have shown that human evolution, at least for physiological abilities, can take place quite quickly, requiring periods of time of only a few thousand years' duration for local distribution. However, it is hypothesised that a much longer time has been required for the evolution of a distinct and universal type of phenomenological experience such as cognitive dissonance. The development of language would have enabled humanity to hold ever finer distinctions of meaning in mind and therefore have enabled cognitive dissonance (CD) to be experienced ever more frequently. In the next section therefore, the timing of the evolution of language is also explored and the view developed that CD and language may well have co-evolved.

THEORETICAL BACKGROUND

Discoveries of the Non-homogeneity of the Brain

The nineteenth century discoveries of Broca and Wernicke that the areas in the left hemispheres, now named after them, are active during speech are generally accepted at the first to establish that there is some degree of functional localisation in the brain. By 1881 Munk had established that visual activity was concentrated in the occipital lobe. The histological work of Brodmann and Cajal in the early 20th century identified a wide variety of differentially distributed cell types, (Kalat, 1998), and thereby provided a basis for suggestions that other psychological phenomena might be due to activity in distinct areas of the brain.

As early as 1972, Tulving identified a separation of semantic and episodic memory and in 1985, he proposed different neurological substrates underlying this fractionation and suggested different evolutionary pressures as responsible. (Tulving, 1985)

Tools such as single and double dissociations have been used as evidence of functional localisation progressively during the 20th century, (Kalat 1998, Snyder & Nussbaum, 1998). A single dissociation occurs when a variable has a large effect when one category of test is conducted but little or no effect when another different category of test is applied, (Matlin, 1998). For example, Warrington and Weiskranz (1970) conducted memory tests with patients suffering from amnesia due either to Korsakoff's syndrome or to surgical removal of the temporal lobes, and found that explicit memory was poor compared to controls but results of implicit memory tests were very similar, suggesting that different neurological structures were active during the two types of tests.

Malone, Morris, Kay and Levin (1982) report a case of double dissociation in which two patients sustained cerebral damage resulting in prosopagnosia, an impaired ability to recognise faces. Following partial recovery, one patient

failed to recover his ability to match unfamiliar faces although he recovered his ability to recognise familiar ones, while the other patient remained unable to recognise familiar faces despite an improved ability to match unfamiliar ones.

McCarthy and Warrington (1987) report a double dissociation within the short term memory systems. Three aphasics were given sentence and word repetition tasks. Two cases, classified as span-impaired conduction aphasics, were better at repeating sentences than in repeating three word lists whereas the third case, classified as a span-preserved transcortical sensory aphasic, showed the opposite pattern of difficulty. In addition, the span-impaired patients were able to comprehend three word strings but were unable to repeat them while the span-preserved case was able to repeat but not comprehend them.

Various technologies, CAT, PET, MRI, fMRI etc. developed in the later decades of the 20th century have enabled further specialisations to be identified with particular areas of the brain with ever greater precision. Such neuroanatomical studies have strongly suggested that "regions of specialised function were a major characteristic of the brain" (Uttal, 2001, p.11). However, to the degree that such investigations identify more exact localisation, may they require equivalently greater precision of functional refinement? Even the most recent advances have not yet permitted such refinement to identify how and where individual concepts, decisions, biases, etc may be located. If Edelman and Tononi's (Edelman & Tononi, 2000; Edelman, 2004) re-entrant circuits provide a plausible solution, the circuit realising any particular concept is intertwined and constitutes part of the circuit realising related concepts. It seems plausible that pin-prick functional refinement will never be correlated with pin-prick localisation. The issue of what level of granularity of localisation and function evolution may have produced is of great relevance to this thesis.

Countervailing Movements

Behaviourism

Despite the accumulating evidence in favour of specialised localisation of function during the early and middle decades of the 20th century noted above, Behaviourism represented a contrary intellectual discipline. In reaction against the previous introspective approach of Wundt prevalent prior to his work, John Watson advocated that terms such as consciousness, mental states, mind, content, introspectively verifiable, imagery, and the like should never be used (Watson, 1913). Our behaviour is the consequence of our conditioning. We do not act. We react to stimuli. Watson was heavily influenced by the works of Pavlov who had described Classical Conditioning, drawing upon reflexes and learned associations as explanations of many types of behaviour.

Watson's approach to psychology was supported by Skinner who developed the concepts and techniques of operant conditioning. In Skinner's language, the action following stimulus provision is termed an operant and consists of operating upon the environment (Skinner, 1953).The organism, most frequently a pigeon in Skinner's experiments, is provided with an external stimulus. If when so stimulated, it behaves in a required way, it is provided with a reward, a reinforcer. After suitable numbers of repetitions of this pairing, the organism can be conditioned to operate accordingly in the future. Skinner sought to eliminate all variables influencing behaviour except the particular stimulus under examination. He demonstrated that variations in the timing of reinforcer provision could be used to condition or shape quite complex patterns of behaviour (McLeish, 1981).

Classical and Operant conditioning are consistent with and can be held to support the notion that human behaviour is determined exclusively by external factors. Neither Watson or Skinner actually believed that it was **only** external factors which determined behaviour but this qualification to their views was not widely propagated. However, when feelings or intents were introduced as explanations of human behaviour, Skinner was highly critical because of the speculation that he considered was thereby introduced.

Advocates of Behaviourism ignored the internal activities of the brain when propagating the notion that only influences from the external environment were relevant to behaviour. These more widely publicised aspects of Watson and Skinner's work, and that of their associates, supported those social scientists of the time who claimed that these external environmental influences consisted exclusively of social factors. It was societal mores and practices which exclusively determined and shaped human activity.

Cognitive Psychology

The cognitive 'revolution' in psychology that followed Behaviourism commenced in the mid fifties (Matlin, 1998) as dissatisfaction with Behaviourism's restricted set of concepts - stimulus, response, reinforcement, etc - were unable to explain such "mentalist" functions as language and concept formation, categorisation, problem solving, planning, and reasoning. Generally speaking, cognitive psychologists adopted an information processing approach with the general purpose computer as an underlying model, even if not explicitly admitted as such. For example, the modern theory of memory fractionation was initiated by Atkinson and Shiffrin in 1968 (Matlin, 1998). Their model reflected a hierarchy of information storage devices designed for different time retrieval scales, proposing a 3–level hierarchy of memories: a set of sensory ones - one for each of the five senses - a short-term memory and a long-term one. This schema would have been a very familiar one to all electrical engineers designing computer systems at that time, with their components, integrated circuits, magnetic cores, drums, discs and tapes, all working to different time scales and organised in hierarchies of processing, storage and retrieval.

However, it was not just the architecture of the computer that was adopted. It was also its general purpose abilities. Programs being written by the Artificial Intelligence community, performing a very wide range of functions, permitted an analogy to be drawn between the hardware of the computer and the neurological substrate of psychological processes. Just as no subject matter distinction was required within the general purpose storage and processing

structures of the computer, equivalently no such distinction was required between the various components of the brain. An underlying assumption was that the information processing capacity of the brain was free of content specialised processes. The brain was conceived of as being active in the processing of all types of information equally.

An Evolutionary Psychological Reaction

John Tooby and Leda Cosmides analysed the works of a wide range of anthropologists and sociologists and noted the support given by them to the Behaviourist and Cognitive models of the mind briefly outlined above. Based upon their analysis, they defined what they later termed the Standard Social Sciences Model (SSSM) of the human mind (Tooby & Cosmides, 1992) which allowed little or no room for any influences of individualist heterogeneity. It is summarised below:

1. People are essentially the same in their genetic endowment. Our endowment is overwhelmingly devoted to common universal physiological and psychological processes. Such variation that exists is devoted to relatively superficial biochemical differences. These differences are detectable, both in the genotype and in the phenotype. However, most of the variation that exists is inter-individual and within population and not between races or populations. Therefore, such variation does not explain why human groups differ dramatically from each other in thought, values and behaviour.

2. Because infants are everywhere the same apart from superficial differences and adults are everywhere far more different in their behaviour and mental organisation, it follows that there can not be a human nature, an evolved structure of the mind, that is responsible for the very different mental organisations of the adults, and their associated cultural artefacts.

3. Because infants do not have the mental organisation and competencies that adults have, except a competency to learn, infants must acquire these from a source outside themselves.

4. Because the infant arrives unequipped with culture, it looks outward for its source.

5. The source is the social world of the infant's local group. Its total mental organisation can be categorised according to source: there is the innate, biologically determined, behaviour which is observed in the infant, and there is the cultural or learned or acquired or environmentally transmitted, obtained from its social milieu.

6. The causal flow is one way: The cultural and social elements that mould the individual precede the individual and are external to him/her. The mind of the developing adult did not create them; they created the mind. The individual is acted upon and the socio-cultural world is the actor or agent.

7. As what organises and shapes human life is culture, what is interesting and worth studying is the cultural, the extra-somatic or extra-genetic.

8. The generator of complex organisation in human life is a set of emergent processes whose determinants are realised at group level, not at an individual level. The socio-cultural level is a distinct, autonomous and self caused realm.

9. Anything called human nature does not therefore play any notable part as a generator of significant organisation of human life. Human nature is reduced to a capacity for culture.

The implications of this portrait of the brain/mind, belief systems and associated behaviour, are that:

- they are not shaped by genetic factors
- ancestral environments, physical or cultural, have played no part in the shaping of someone alive at any moment
- current cultural pressures are absorbed in an unbiased manner

- the mind is a blank slate.

These implications in turn imply that the brain was or performed as if it was undifferentiated in its parts, i.e., its composition or architecture played no part in influencing or biasing the behaviour that it produced. It could reasonably be thought of as homogeneous or monolithic, even if it was known not to be.

The Modularity Hypothesis

The Fodor View

Seemingly aware of the contradiction between the assumptions underlying Behaviourism, the Cognitive movement and the emerging SSSM on the one hand and the increasing evidence for a non-homogeneous brain on the other, the philosopher Fodor (1983) in a very influential monograph, propagated the concept of the modularity of mind.

He defined a horizontal faculty as " a functionally distinguishable cognitive system whose operations cross content domains' (p.13). Such a system "may employ other faculties such as memory, imagination, attention, perception and so forth" (p.11). He contrasts such horizontal faculties with what he terms vertical ones, and draws upon some of the ideas of Gall (whose ideas were adopted by the phrenologists, thereby later ruining his reputation), namely that psychological mechanisms have domain specificity. Thus one psychological ability is distinguished from another "by reference to its subject matter" (p.16). Gall claimed that the psychological mechanisms that subserve one capacity are different from those that subserve another. Perceptions and memory should be considered as attributes common to psychological mechanisms but "they can have no proper [cross domain] centres in the brain" (Fodor 1983, p.16, quotation from Hollander, 1920, p. 270). As portrayed by Fodor (1983), Gall proposed the existence of conceptually separate psychological modules having particular subject matter domains, and the neural substrates underpinning them, to be responsible for all facets of mental processing. Fodor thus characterises Gall's vertical mechanisms as domain specific, genetically determined, associated with distinct neural structures and computationally

autonomous. Computation in this context means transforming inputs into outputs, possibly but not necessarily using information previously available to the mechanism to do so. They do not share and therefore do not compete for sharable resources such as memory, attention, intelligence, judgment or any other faculty that could in principle be shared or employed commonly across content domains.

Fodor (1983) contrasts these two theoretical standpoints with Associationism. Drawing from the associationist literature, he proposes that an association is a type of primitive operation ('a' is associated with 'b' and therefore 'b' can be substituted for 'a') by which means, computational or transformative operations can take place. Drawing upon computational logic, he notes that computations of arbitrary complexity can be built up by assemblages of such primitive operations. However, he questions whether psychological faculties, however conceived, could be assembled in this way, rather than being in some sense atomic.

Given the above as preliminaries, he discussed the following questions about the nature of a possible modular construction of the mind. (pp. 36-77)

1. Is [the module] domain specific or do its operations cross content domains?
2. Is the computational system innately specified or is its structure formed by some sort of learning process?
3. Is the computational system 'assembled' (in the sense of having been put together from some stock of more elementary sub-processes) or does its virtual architecture map relatively directly onto its neural implementation?
4. Is it hardwired (in the sense of being associated with specific, localized and elaborately structured neural systems) or is it implemented by relatively equipotential neural mechanisms?
5. Is it computationally autonomous or does it share horizontal resources (of memory, attention or whatever) with other cognitive systems?

When he used the term modular, he meant "to some interesting extent" (p. 37). He was explicit in his reluctance to define precisely the terms that he used to describe it. Despite his reluctance to be exact, he answered his five questions as if modular cognitive systems are unequivocally domain specific, innately specified, hardwired autonomous and not assembled.

Although he does not rule out that the brain could have mixed models, that is, some faculties could have modular characteristics as he defines them but also some horizontal features, he discusses the various components of the mind/brain according to his strict definitions. He identifies four types of components:

1. Transducers, (the active elements of the eyes, ears, nose etc.) render input media, light, air vibrations, etc. into signals to be further processed by the input devices. In other words, transducers merely transform the varying photon patterns and wavelengths entering the eye, the varying air pressures falling upon the ear drum, etc. into neuron borne signals to be further processed by the input systems. He regards transducers as relatively uninteresting devices and hardly discusses them.

2. Motor control output systems which he does not discuss.

3. Input devices exist to "pair transduced representation with formulas in the domain of central processors" (p. 70). In other words, they process the characteristics of the transducer outputs into perceptual entities. He regarded the psychological faculty that processes spoken language as an input device.

4. Central processes which are more flexible in their inputs and functions.

A division between input devices and central processes is provided by his statement that an input device's output is "phenomenologically salient" (p. 89). A listener/viewer has heard a sentence or seen an object, but does not necessarily know what the former means or what the latter indicates.

Arguments about what a speaker said are not possible with respect to the output of an input module. Arguments about what a speaker meant are the domain of central processes. Similarly with objects seen. One can note the shape, size, movement, etc. of an object and identify it but not know without consulting memory, a central process function, precisely what it connotes or signifies.

The following considerations indicate that input systems are modular according the definition given above.

1. There is no flexibility in the application of their processing abilities. One can not but apply a perceptual recognition system in, for example, recognising a cow although a range of remembered prototypes might be applied to determine its cowness as opposed to its houseness.

2. One can not but apply the very complicated rules of syntactic and semantic interpretation of language to a sound input stream if the spoken language is one already understood by the listener. As English speaker can not hear a spoken English sentence as a stream of sounds in the way he/she can hear a Swahili one.

3. There are a large number of bottom up processing steps that take place between the transduced input signals and the recognised/understood contents of consciousness. These intermediate steps are not accessible to consciousness.

4. Input systems operated very quickly, on the order of 250ms or less. Fodor (1983) hints at the role of natural selection in the origin of these systems by suggesting that "it is no accident that these very fast psychological processes are mandatory" (p. 62).

5. Input systems operate independently of ones knowledge of the world, that is, semantic and episodic memory. For examples, one can understand sentences such as " I keep a giraffe in my pocket" only if quotidian

> knowledge of the world is excluded from the processing of the input signal. An input device is perceptually reliable only if it processes only what is presented to it by the transducers, without the intrusion of representations of wants, needs or expectations held elsewhere in the brain. The dependency of reliability upon this exclusivity of input information also suggests the role of natural selection in the formation of these input devices.

The distinction between domain specificity and information encapsulation is important. The former refers to "the restricted range of questions to which a device provides answers" (Fodor, 1983, p.103), while information encapsulation refers to the "range of information the device consults in deciding which answers to provide" (p.103), both definitions implying narrowness. In principle, a psychological device could have either characteristic but not the other. However, information encapsulation is a defining characteristic of a module, and like a reflex, it trades access to information for speed.

Fodor (1983) summarises the input systems as constituting "a family of modules; domain specific computational systems characterised by informational encapsulation, high speed, restricted access, neural specificity and the rest" (p.101). He accepts that modules so defined and identified bear considerable resemblance to Gall's vertical faculties.

Fodor was fully aware of the existence of sufficient cerebral localisation in 1983 to support his concept of modularity for the processing of sense data and language. Despite equivalent awareness of the localisation and domain specificity of the aphasias, he does not quite admit any degree of modularity of these. Nevertheless, his criteria 1), 4) and 5) appear relevant.

Fodor (1983) allows for the possibility that there could be pathologies of memory or attention that are not domain specific, which would manifest themselves across multiple domains. This would evidence, contra Gall, the existence of horizontal faculties. However, he does not give any examples.

Central processes are contrasted with modular ones most powerfully in that the former are characterised by cognitive penetrability. This term refers to access to all an organism's knowledge and is therefore the antonym of encapsulation. A central process' functions could have some degree of domain specificity. It need not be general purpose.

Central processes look at what the input systems deliver and what is in memory and, operating largely unconsciously, use all this information to "compute analyses" (p.103) or determine the "best hypothesis about what the world is like" (p.104). Fodor (1983) also refers to this process as the fixation of belief and regards it as isotropic and Quineian. He defines the former term as meaning that a central process may draw upon all sources of available information without any of them being pre-judged irrelevant to the problem in hand. Quineian, after the philosopher Willard Van Orman Quine, refers to the relevance of the entire belief system and its values, not just individual pieces of information, to the analysis or hypothesis fixed.

Fodor (1983) claims some neurological plausibility for such a view of central processors despite making qualifications. In modules, [sub]system A may take information only from [sub]system B so neurological wiring may be expected to both reflect and force this. In central processes, there may be much more promiscuous interconnection, in the limit, every process connected to every other and all input systems directly or indirectly. However, in such Quineian isotropic systems, he suggests that the interconnections may be unstable and in operation only instantaneously, that is, in any one configuration for short periods of time as required by the function being computed and the process processing it. In such a case Fodor (1983) notes that "computational isotropy comports naturally with neural isotropy in much the same way that informational encapsulation comports naturally with the [specifically restricted] elaboration of neural hardwiring." (p.118). In support of this view of central processes and the interconnections between them, he draws attention to the concept of the equipotentiality of neural structure, a concept developed

by Lashley who maintained that functional loss was related to quantity of neural loss, (Loeb & Poggio, 2002).

In summarising his views he is quite specific. There exists form/function correspondence for the modular processes but for central processes, approximately universal connectivity exists. He asserts that "there are no content-specific central processes for the performance of which specific neural structures have been identified" (p.119). The implication that central processes could not be localised and domain specific is emphasised by a similar statement, "Central problem-solving is subserved by equipotential neural mechanisms" (p.119). In contrast to his input modules, he triumphally declares that there is no brain centre for *modus ponens*. In this he may have been mistaken although such a statement was possibly defensible in 1983.

His definition of central processes does not mean that they could not be localised or domain specialised to some extent despite his denial that they actually are. Also, while they may be isotropic and Quineian in principle or otherwise non-modular, he does not discuss whether all pathways to potentially relevant information have to be equally facilitative for the process to qualify for non-modularity. He discusses this subject in binary fashion; pathways exist or they do not. In reality there is no reason why interconnections between central processes or memory locations should be equally conductive. There is much scope for variation in conductance, given the wide variety of cell, axon and synapse types, neurotransmitters, neuromodulators and hormones that mediate the interconnections. Once such variation and some degree of locational distribution of memory types are contemplated, the likelihood of universal equality of conductance is plausibly much reduced. In such a case, it becomes questionable whether Fodor's central processes can be regarded as non-modular as he claims. Any bias in the presentation of different information types to a process renders it more modular.

The Evolutionary Psychology Module

At a joint meeting of the Royal Society of London and the British Academy in London, 1995, titled "The Evolution of Social Behaviour Patterns in Primates and Man" Leda Cosmides started a lecture by holding up a Swiss army knife as a model of the mind, (Mithen, 1996). Since that time, the Swiss Army knife as a metaphor for the mind has been indissolubly linked to her and her husband John Tooby. Less metaphorically, they regard the mind as "a diverse collection of evolved mechanisms, many of which are functionally specialist, domain specific, content-imbued and content-imparting" (Cosmides & Tooby, 1992, p.221). "Our ability to perform most of the environmentally engaged richly contingent activities that we do depends on the guiding presence of a large number of highly specialised psychological mechanisms" (Tooby & Cosmides 1992, p.39). Even more specifically the mind is a "confederation of hundreds of thousands of functionally dedicated computers" (Tooby & Cosmides, 1995, pp. xiii, quoted in Samuels, 1998).

Tooby and Cosmides, (1992, and Cosmides & Tooby, 1997) propose the following simple principles that underlie their view of the brain and the mind.

1. The brain is a physical system. It functions as a computer. Its circuits are designed to generate behaviour that is appropriate to the environmental circumstances in which natural selection shaped them.

2. Our neural circuits were designed by natural selection to solve problems that our ancestors faced during our species' evolutionary history.

3. Consciousness is just the tip of the iceberg; most of what goes on in your mind is hidden from you. As a result, your conscious experience can mislead you into thinking that our circuitry is simpler that it really is. Most problems that you experience as easy to solve are very difficult to solve - they require very complicated neural circuitry

4. Different neural circuits are specialised for solving different adaptive problems. There are a very large number of such circuits.

5. Our modern skulls house a stone age mind.

The psychological mechanisms referred to above are sometimes referred to as modules. The use of the word 'module' has been attacked by some psychologists because of its connotations of a single bit of the brain. In none of their early writings did Tooby and Cosmides provide descriptions of or make specific predictions as to how their mechanisms or modules and the interconnections between them are realised by particular neural configurations despite their conviction that they are so realised and that such realisations are adaptations.

In support of the Tooby and Cosmides view, Buss, Haselton, Shackelford, Bleske and Wakefield (1998) proposed the following definition of an adaptation.

1. An adaptation is an inherited and reliably developing characteristic that came into existence as a feature of a species through natural selection because it helped to directly or indirectly facilitate reproduction during the period of its evolution. Buss et al. (1998) propose that solving an adaptive problem is the function of the adaptation.

2. Each adaptation has its own Environment of Evolutionary Adaptedness (EEA) which refers to the cumulative selection process that constructed it, piece by piece until it came to characterise the species. The EEA will differ for each adaptation and is usually described as the statistical aggregate of selection pressures over a particular period of time which were responsible for its emergence.

A pictorial representation of different views of the mind.

The different views of the mind as described in the previous sections is captured in the illustrative sketches below. (Brase, 2003).

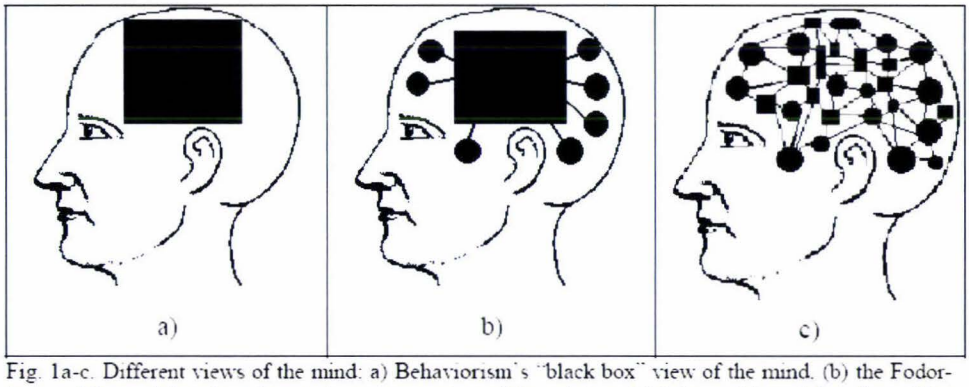


Fig. 1a-c. Different views of the mind: a) Behaviorism's "black box" view of the mind. (b) the Fodorian modular peripherals and central processor view of the mind. and (c) the multi-modular view of the mind.

Figure 1. *Different Views of the Brain*

More Recent Progress in Discoveries of Non-homogeneity from PET, MRI and fMRI, and Event Related MRI

The developments in brain imaging techniques during the last two decades have allowed numerous researchers to place specific forms of psychological processing in identified parts of the brain, sometimes with claims to refined granularity. Some of these claims have attracted criticism. A selection of these claims and criticisms is provided below.

Snowden (2002) showed that semantic memory impairment is associated with temporal neocortical damage and episodic impairment is associated with medial temporal lobe damage. However, there remain links between the two types of memory in that items in semantic memory are retained and accessed better if they are associated with past episodes in the lives of patients than items in semantic memory that have no such link with past episodes.

Brain imaging of patients with semantic dementia shows atrophy in the inferior temporal gyri and temporal poles. In these patients, the superior temporal gyri, Wernicke's area and medial temporal structures are normally spared. Although both hemispheres are involved, evidence is mounting that naming and word comprehension are more impaired by left hemisphere damage while face recognition deficits are associated with right hemisphere damage.

Stone, Cosmides, Tooby, Kroll and Knight (2002) explored the ability of a patient with previously located lesions to reason about social exchange. They found that the patient, with bilateral damage to the limbic system, performed significantly worse in social contract reasoning when compared with controls in the form of normals and differently brain-damaged participants.

Uttal's Criticisms of Recent Research into the Non-homogeneous Nature of the Brain

Uttal (2001), after Fodor, accepts the localisation of "the sensory input channels and their respective receiving areas and the motor regions and outputs of the brain" (p. 208). However, notwithstanding the very large body of evidence supporting greater localisation, he disputes the more specific and perhaps extreme conclusions in support of a looser concept of modularity that have been drawn from recent research by drawing attention to the following aspects of the work.

1. Many researchers find evidence of cerebral activity in widely different parts of the brain for what are reported to be the same or similar functions, fail to replicate the findings of earlier researchers and fail to comment upon the differences.
2. While one researcher concludes that one particular area is active during a specific function, e.g., face recognition, other researchers sometime later discover activity in the same area during another different but related or more general activity, e.g., general familiarity with the stimulus, invalidating the first researcher's very specific conclusions.
3. The signal subtraction technique employed in the PET and fMRI technologies requires signals associated with unavoidable of-no-interest activities to be captured and subsequently subtracted from signals captured when both these and the activities of interest are taking place. The levels at which these former are captured and subsequently used for subtraction are arbitrarily decided upon by the researcher. The subtraction techniques can therefore, at best, capture only those areas in which activity is highest. While this may support localisation, it may also fail to identify other areas

which were active during the target functional activity and the degree to which they were so.

4. The research frequently shows that activity for the single target task takes place in widely distributed networks with substantial feedback taking place among them, such systems being referred to as re-entrant processes. This suggests that finer granularities of both localisation and function lie beneath the observations, with the implication that such finer "grains" of function and neural substrate may be components of a wide range of potentially very different larger scale activities.
5. There sometimes appear to be conflicts between the results of PET and fMRI based studies, each suggesting different areas of localised activity for the same task.
6. Meta-analytic studies are rare and most produce negative results of one form or another.

Uttal (2001) discusses Fodor's (1983) first question and raises the difficulties inherent in defining and refining the boundaries of modules and domains, that is, the difficulties of defining the operations of particular modules and the contents of domains. It is clear that until the former have been defined in functional terms and the latter in any of locational, epistemological or cytoarchitectural terms, it is impossible to provide a precise answer. Carroll (1993) lists the putative functional contents of 53 'modules', as defined by various researchers, many them being compound in nature. In one sense, it would appear that the functional boundaries of a module are arbitrary – a given module is functionally bounded by its definition. If a given module is functionally compound, it is therefore effectively "assembled" by its definition although probably not from the type of computational primitives that Fodor had in mind when rejecting assembly. As to whether this functional architecture "map[s] relatively directly onto its neural implementation", this is an empirical issues as is discussed below.

Response to Uttal

As if aware of the force of Uttal's (2001) criticisms, Ishai, Schmidt and Boesiger (2005) report their own work on face recognition and review it in the

context of much other previous work. They note that there has, for example, been repeated reporting of activation of the lateral fusiform gyrus in face perception (four references given) but accept that this cortical region responds to other categories of familiar objects, e.g., houses, chairs and stools, (four different references) as well as when experts recognise objects in their area of expertise, and also when objects are the units of attentional selection, visual imagery or emotional attention (separate references). In addition, they recognise that facial perception sometimes evokes activation in the prefrontal cortex and the rewards circuitry of the amygdala and nucleus accumbens. Exploiting a core and extended recognition system defined anatomically by Haxby, Hoffman and Gobbind (2000) which comprehends a range of functions related to facial perception, they explored the activations consequent to the presentation of simple black and white drawings of unfamiliar faces and grey scale photographs of unfamiliar, famous and emotional faces. Their results, contra-Uttal, effectively replicated and reinforced many previous studies. Descriptions of the differences between the stimuli used in their study and those of some other studies are provided as explanations for the slightly different results of these other studies, for example, the requirement to make face-name associations, a function that was absent from their own study. Their results are summarised in the table 1 below.

Table 1.
Location of Particular Functional Activity in the Brain

System Type	Region	Function
Core	Inferior Occipital Gyrus	General Face Perception
Core	Fusiform Gyrus	
Core	Superior Temporal Sulcus	Processing of socially relevant information, eg, direction of gaze
Extended	Amygdala	Processing of facial expression
Extended	Hippocampus	
Extended	Inferior Frontal Gyrus	
Extended	Orbito-Frontal Cortex	

Neural responses were stronger in response to famous and emotional faces relative to unfamiliar faces. Stronger activity was noted in the right hemisphere when facial stimuli are presented relative to other common objects.

While the situation for face recognition seems to have stabilised with the evidence for localisation of fairly specific functions having become substantial and convincing, the same can not yet be said for localisation of storage and retrieval of concrete and abstract words and concepts.

Tranel and Damasio (2002), citing lesion-based and electrophysiological work of both themselves and of others, have found that localisation in the temporal lobe takes two forms. There is a general/specific gradient of memories on a posterior/anterior axis, with unique material situated more anteriorly. Names of people, for example, are stored in the left temporal pole, BA 38, while more general concepts are stored posteriorly, in BA 36 and 37. A second form of localisation is lateral. The left temporal lobe specialises in verbal/semantic memories and the right in some spatio-visual ones and episodic autobiographical ones.

Binder, et al. (2003) report that many previous studies intended to identify areas of the brain involved in semantic processing of words have required subjects to undertake a wide variety of tasks, such as word categorization and making judgements as to semantic relatedness, relative to control tasks not requiring semantic processing, such as letter case matching, phoneme detection, syllable counting, rhyme judgement or comparison with non-words. They suggest that these two categories of tasks may differ in ways other than semantic processing, thus introducing confounds into the comparisons of results of fMRI studies. In their study, aimed to ascertain differences in processing of words relative to non-words, they identified greater activation for words in the left hemispherical angular gyrus, dorsal prefrontal cortex, posterior cingulate gyrus and middle temporal and posterior inferior temporal gyri.

Binder, Westbury, McKiernan, Possing and Medler (2005) provide support for Binder et al. (2003) and partial confirmation of Tranel and Damasio (2002). They note a debate between two competing theories of lexical storage and retrieval and cite numerous papers supporting each system. The first theory, known as the dual code model proposes that "two distinct systems for processing word meanings" (p. 905) exist, a left lateralized one for abstract terms and a bilateral one for concrete terms, the right hemisphere providing support for image based storage and processing of concrete terms. The second theory, known as the context availability theory, posits a single system for both categories of words, associating each word with a network of relevant prior knowledge referred to as the context. Supporters of this model admit the advantages in processing concrete words (greater ease and faster response times), claimed by adherents of the dual code model, by attributing them to differences in the amount and quality of stored context.

Binder et al. (2005) required subjects to distinguish between words and very word-like non-words constructed so as not to include highly irregular spelling patterns, by pressing one of two buttons, with the words, of closely matched usage, being selected from concrete and abstract categories. By this means, they claim to have reduced the various confounds noted above that may have complicated the findings of prior studies. By noting differences in response times and fMRI images, they identified strong activation for abstract words solely in the left hemisphere, specifically in the inferior frontal gyrus, the premotor cortex and the dorsal temporal pole, partially at odds with the Tranel and Damasio (2002) finding. Concrete words showed bilateral activation in the angular gyrus, posterior cingulate gyrus and precuneus (part of the parietal lobe) also failing to support Tranel and Damasio (2002). They claim that their results "provide strong evidence that processing abstract concepts in left-lateralized and processing of concrete concepts is bilateral, consistent with the general predictions of the dual code theory" (p. 909). Their results are illustrated below.

Figure 1. fMRI results for the contrasts of (A) concrete–nonword, and (B) abstract–nonword. Red-yellow colors indicate positive *t* values, blue colors indicate negative *t* values. Activation is shown on inflated representations of the cortical surface. Images on the left represent the left hemisphere, images on the right represent the right hemisphere. All maps are thresholded at a corrected mapwise $p < .05$. (See Appendices 2 and 3 for a complete listing of stereotaxic peaks of activation.)

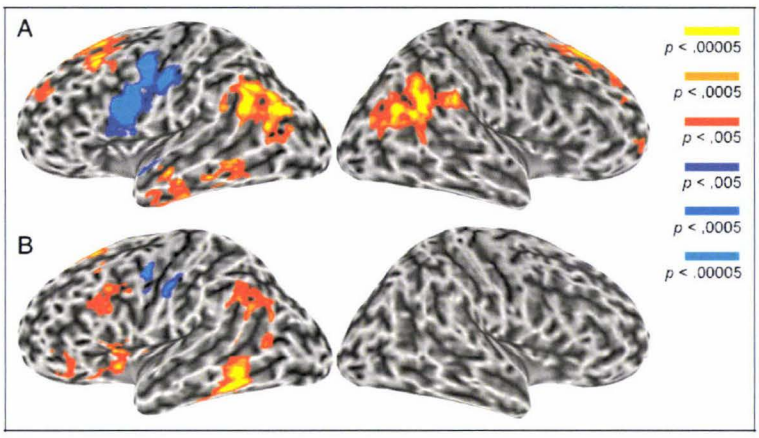


Figure 2. Non-word brain activation contrasts from Binder et al. (2005, p.907)

Figure 2. fMRI results for the concrete–abstract contrast. L = left, R = right. Both lateral (top) and medial (bottom) surfaces are shown. Other formatting as in Figure 1. (See Table 3 for a complete listing of stereotaxic peaks of activation.)

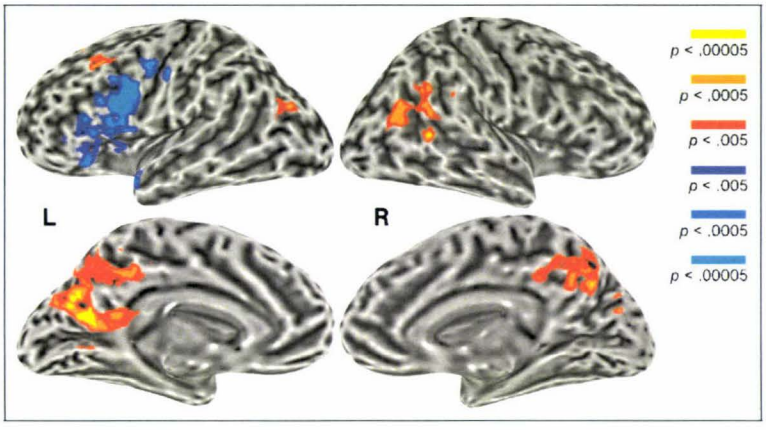


Figure 3. Concrete/Abstract brain activation contrasts from Binder et al. (2005, p.907)

Using fMRI, Zahn, et al. (2007) investigated the localisation of the storage of abstract social concepts relative to more general animal concepts by asking subjects to compare the semantic closeness of pairs of words taken from each categories, such as 'honour' with 'bravery' and 'nutritious' with 'useful'. They found that activation in the superior anterior temporal cortex ensued during comparisons of the former category and not the latter. They note that their results are consistent with the findings of six other papers, dating from 2000 to 2006, that the anterior temporal lobes are important for representing abstract conceptual knowledge. They also note the subdivision for different semantic domains, (tool, animal and faces), were demonstrated in modality specific posterior temporal regions, consistent with the findings of three other papers dated to the late 1990s.

The Non-homogeneous Nature of the Neural Correlates of Conscious Experiences

In reviewing research into the neural correlates of consciousness (NCCs), Kanwisher (2000) claims they are "almost commonplace findings" (p. 89) and summarises a large body of work to justify this statement, including her own work on binocular rivalry. In such experiments, two different stimuli or images are presented to the two eyes. When a subject views these displays, competition takes place within the brain. Rather than seeing a blend of these images or one overlaid by the other, subjects are conscious of first one and then the other, rather in the way that one is aware of first one perspective/shape and then the other when viewing a Necker cube or Rubins's faces/vase. From earlier work with fMRI techniques it had been established that the fusiform face area (FFA) of the brain responds at least twice as strongly to face images as it does to anything else (see above). The parahippocampal place area (PPA) responds to images of places, including houses, but only weakly to non-place images and not at all to face images. In her work Kanwisher (2000) presented participants with images of faces to one eye and houses in the other. They responded by pressing buttons when their conscious perception switched from one image type to the other. Simultaneous fMRI readings of brain activity were made. In the two areas of the brain of relevance, a rise in activity was observed when the subjects indicated that their conscious perception switched to the preferred image type for that area and a fall in activity was observed when the preferred image of that area dropped out of consciousness. However, the stimuli presented to the eyes throughout the switching remained the same.

Kamitani and Tong (2005) explored the localisation of edge detection in an 800 voxel volume of V1 – V 4 area of the visual cortex. After calibrating their equipment, they were able to use fMRI signals to reliably predict on individual trials which of eight stimulus orientations each subject was seeing. Even more impressively, they presented their subjects with a plaid pattern, and asked their subjects to concentrate their attention on just one of the sets of the lines

constituting the plaid, 45° and 135° to the vertical. The authors were able to decode the fMRI signals reflecting the selective attention and predict, with in excess of 80% reliability, which of the two orientations were receiving the subjects' attention. Throughout the latter experiment, there was no change to the stimulus presented to the subjects.

Fodor (1983) remarked that the output of an input module's processing was "phenomenologically salient", that is, it was consciously experienced. From this, the two examples above and many other modern research programmes, it is concluded that not only are there particular (combinations of) areas of the brain that are active for particular types of processing but also that consciousness is modular in the sense that the neural activity producing it is localised according to its subject matter.

My Definition of Modularity

Fodor's (1983) treatment of his input systems puts their case for modularity, according to his definition, very strongly and permits those parts of the brain dedicated to them to be dropped from further consideration. However, it is clear from the assembled evidence of recent research that Fodor's claims to the equipotentiality of the remainder, the central processes, is mistaken if this is to be interpreted in its most obvious sense. There clearly is further cognitive specialisation in the remaining parts of the neo-cortex, viz,

- It is not all required to process all types of cognitions.
- For some cognitions, some parts appear to play no part whatsoever
- There appears to be at least some degree of encapsulation.
- Some of his modularity criteria apply, e.g., 1), 2) and 4) to a greater or lesser extent in each case of specialisation.

I propose that modularity be regarded as a portmanteau term to refer to the ability of a single identifiable localised fragment or interconnected set of fragments of brain tissue to specialise in particular types of cognition, no matter how widely or narrowly defined. One can thus refer to something as a

module if it performs a function as wide in scope as Fodor's language processor or as narrow as merely biasing some particular processing more in one direction than in another. This latter notion is reinforced by Krill, Platek, Goetz and Shackelford (2007) who suggest "Psychological mechanisms can also be expressed as *cognitive biases* (italics added) that cause people to more rapidly attend to some pieces of information relative to others" (p. 234).

Formal logic such as syllogisms, multiple regression, inferential rules of propositional calculus (Ermer, Guerin, Cosmides, Tooby, & Miller, 2006) do allow domain general content free processing to take place without bias but such processing is highly artificial, laborious and very time consuming relative to the types of cognitions of Fodor and Tooby and Cosmides had in mind. Such abstract cognitions are likely to employ a wide range of distinct modules as defined above. If in practice, two similarly formatted pieces of information are not processed in a content free manner but, rather, their processing is biased according to the different natures of their content, then I propose that the mechanisms causing the bias can and should be regarded as a module.

If it can be shown that any module as defined above promotes natural or sexual selection's objectives of promoting gene replicating into the next generation and meets Williams' (1966) other criteria of precision, economy, efficiency, complexity, specialisation, reliability and functionality as well, then the word is also being used in the same way as Cosmides and Tooby do.

Modules conforming to the above definition are not isotropic as they do not necessarily take equal cognisance of all information available. They are Quinean as they do reflect the values of the entire belief system. Some of these values can be regarded as evolutionarily epistemological, that is, they are realised not in the form of stored information but as modes of cerebral operation genetically determined. The module(s) of relevance to this thesis prioritise(s) the identification of short term life and reproduction threatening contradictions over long term abstract ones.

It is reasonable to suggest that such Quineian modules may be found in the contradiction detection mechanisms which give rise to cognitive dissonance.

A Review of Cognitive Dissonance (CD)

Festinger's (1957) proposal that pairs of cognitions can be regarded as consonant, dissonant or irrelevant, with dissonant pairs causing psychological discomfort leading to alleviation activity is shown schematically in Fig 1. below.

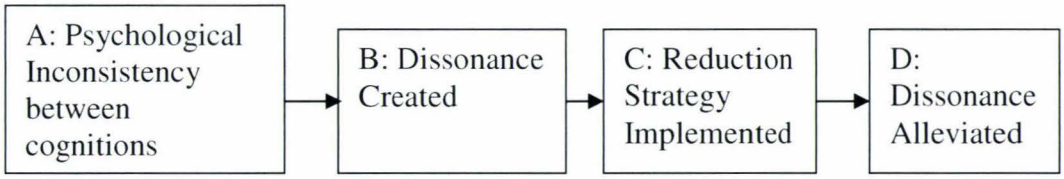


Figure 4: Schematic Diagram of Festinger's Theory of Cognitive Dissonance adapted from Devine, Tauer, Barron, Elliott and Vance, 1999, p. 298.

The terms appearing in the boxes in Fig 1 are discussed below.

Psychological Inconsistency

Illustrative examples of "psychological inconsistency" are provided below, the first four being based upon Festinger (1957). The term "psychological inconsistency" is here used to cover cases where contradiction in the strict logical sense is not present as well as when it is. Aronson (1969) suggests that CD also encompasses situations when one cognition violates an expectancy.

1). A logical inconsistency

In the simplest canonical form, two explicit propositions contradict one another directly as in; *X is A* and *X is not A* or *X is B* (where $B = \neg A$.)

Two propositions may be less directly contradictory and require rephrasing to be transformed into the canonical form illustrated above. For example, the pair

The book's cover is the colour of an unripe orange and *The book's cover is the colour of the summer sky* require some cognitive effort to convert it to *The book's cover is green* and *The book's cover is blue*.

A requirement to rephrase suggests that the contradiction may be less obvious and consequently less likely to be noticed. It appears that no units or measures exist for assessing the degree of rephrasing required for reduction or conversion to the canonical form. This is turn implies that at present it is not possible to state with confidence which of two sets of contradictory statements require the more cognitive work when their contradictory nature is being assessed. Something in the nature of a Hamming or Levenshtein Distance[1] is needed. One could hypothesise that the likelihood of detecting a contradiction between two contradictory statements is related to such a distance or the distance each has from a canonical form.

2). A clash of cultural or behavioural mores, e.g., someone eats their food with their fingers in circumstances where this is not culturally acceptable. The contradiction is expressible in the form of a 'syllogism' or canonical form:

In circumstances Y, nobody does X (the rule)
In circumstances Y, A does X
A contravenes the rule.

It is worth noting that the dissonance/mental discomfort in the example above would arise in an observer's mind as soon as the contravening act is observed. There does not need to be a consciously expressed propositional cognition such as "A is contravening my cultural rules" for the discomfort to be felt. Verbalisation is not necessary.

3) Inconsistency between one cognition and a more encompassing one.

[1] The Hamming Distance between two character strings of equal length is the defined as the number of character substitutions that have to be made to one string to convert it to the other. The Levenshtein distance between two character strings of unequal length is the number of changes as defined above, and/or character insertions and/or deletions that are needed to convert one string to the other.

For example, a voter might normally vote for a particular party but in a particular election, s/he might choose to vote for a candidate of a rival party because of the high quality of this candidate in comparison with that of the candidate of his/her 'normal' party.

4). Current experience conflicts with past experience

Current experience may suggest that proposition A is true, whereas past experience suggests that the proposition A is not true.

A real life example consists of the following.

Current Experience: People are giving champagne to strangers in the streets.

Past Experience: People never give champagne to strangers in the streets.

[The explanation for this personal example: the Current Experience took place in Italy immediately after the Italian Soccer team won the 1984 World Cup. The Past Experience had been my experience until that occasion].

5) Implication

5.1). Implication involving two explicit propositions

When two propositions are made explicit but the implication of one contradicts the other.

Thus proposition A asserts X is true

Proposition B implies that X is not true

Proposition A: I read War and Peace in three days

Proposition B: I read very slowly

5.2) Implication involving only one explicit proposition

In this case proposition B is not explicitly stated but is known already to the person receiving proposition A. The receiver therefore has to mentally activate proposition B in some sense in order for it to be contrasted with proposition A.

Example

Proposition A: David says he can see baby John playing in the garden.

Proposition B: I have just seen baby John asleep in bed.

5.3). Implication requiring the creation of a logical deduction

Some propositions already known or explicitly stated permit a deduction to be made giving rise to another proposition. This latter proposition contradicts a further one, either explicitly stated or already known.

Example

Assume the following propositions are already known and do not need to be made explicit

1. All mammals breathe.

2. Humans are mammals.

3. Socrates is human.

On hearing the proposition 4."Socrates did not breathe", it is to be expected that dissonance will be experienced by the hearer as the fourth proposition will conflict with the proposition "Socrates breathed" which is implied by or deducible from the first three propositions.

It is to be noted that in all the examples above, the opposition within the cognitions does not invoke a conventional emotion, e.g., guilt, hate, etc. I shall refer to the discomfort experienced in the absence of simultaneously felt conventional emotions as propositional dissonance.

Aronson (1969) notes that despite an apparent logical opposition of two cognitive elements, they may not give rise to dissonance. He provides the example of a married couple, one of whom is very clever and the other is rather dull. He regards opinions accurately reflecting these attributes of the two people as an opposition and notes that it might be expected to give rise to dissonance. However, it need not. In such circumstances, he posits that there are underlying cognitions that prevent the dissonance arising, in this case, the (underlying) knowledge that people base their choice of marriage partner upon a very wide range of criteria, intelligence being only one. He suggests therefore that Festinger's comment that dissonance arises if "considering these two [elements] alone, the obverse of one element follows from the other" (Festinger, 1957, pp. 260-61) needs the qualification that dissonance will arise only if there do not exist such underlying cognitions.

In a discussion of Festinger's definition of dissonance "X follows from the obverse of Y" relationship, Brehm and Cohen (1962) propose that many of the variables in such cognitions are continuous rather than discrete, thereby weakening the application of Festinger's definition. They propose instead the amended definition of dissonance; "X follows from any variation from Y in the direction of being obverse" (p.16).

Brehm and Cohen's (1962) definition allows a graded phenomenological experience to follow a single contradiction with the intensity of that experience being related to the degree to which two propositions contradict each other, provided the relevant variables are continuous.

Dissonance Created

Festinger (1957) suggests that dissonance has both psychological and physiological dimensions. The psychological element has been described as "elevated feelings of discomfort, i.e., feeling uncomfortable, uneasy, bothered" (Devine, Tauer, Barron, Elliott, & Vance, 1999, p. 309). In addition, properties akin to a state of mental arousal have been proposed and investigated together with physiological facets, i.e., Non-specific Skin Conductance responses (NS-SCR) and more general Galvanic Skin Responses (GSR). Its subjective phenomenological features have been investigated through self-reports of affective state, which are discussed later.

Dissonance Reduction Strategies

According to Festinger (1957), the magnitude of dissonance between one (set of) cognition(s) and another depends on the number and importance of the cognitions that are consonant and dissonant with the other. He formalized the magnitude in terms of the ratio of consonant and dissonant cognitions, viz, the magnitude of the dissonance is the number of dissonant cognitions divided by the sum of the consonant and dissonant ones. This ratio suggests means by which the dissonance could be reduced; by recruiting more consonant cognitions so that the denominator in the ratio becomes larger or reducing or

invalidating the dissonant ones so that the numerator becomes smaller at a greater rate than the denominator does.

In practice, dissonance has been found to be reduced by the following seven means:

1. Changing a prior cognition, e.g., an attitude or belief, such that it becomes less in opposition to the newly presented or generated one. Most CD research, briefly described later, has taken the form of measuring such changes in belief or attitude and ascertaining the circumstances in which they take place.
2. Reducing the importance of the issue or counter attitude behaviour, a process named trivialization by Simon, Greenberg and Brehm (1995).
3. Bolstering ones own prior cognition(s) by generating consonant cognitions via ones own decisions or actions subsequent to dissonance having been experienced (Sherman & Gorkin, 1980).
4. Self-affirmation by obtaining consonant cognitions of oneself from self or others. (Tauer, Devine, & Elliott, 1998, cited in Devine et al. 1999)
5. Misattribution of the discomfort to some other cause, provided a plausible one exists (Zanna & Cooper, 1974)
6. Denial of responsibility for counter attitudinal behaviour. (Gosling, Denizeau, & Oberlé, 2006).
7. Restructuring cognitions not directly related to a specific attitude-behaviour discrepancy, (Leippe & Eisenstadt, 1999), e.g., some background belief or opinion which lowers the discrepancy.

Simon et al. (1995) note that people use whichever dissonance reduction strategy is the easiest in laboratory conditions, this usually being the first one offered. However, the likelihood of attitude changes, other things being equal, appears to be inversely proportional to the importance of the previously held cognitions (Zuwerink & Devine, 1996). Festinger (1957) suggested that changes of behaviour are the most resistant to change, implying other strategies will be adopted in preference.

Dissonance Alleviation

Devine et al. (1999) note that in most CD research, dissonance alleviation was generally assumed to have taken place when a dissonance strategy had been implemented but this assumption was not widely tested. In order to demonstrate that the implementation of a reduction strategy does indeed lead to dissonance alleviation, Elliot and Devine (1994) devised what they call a Dissonance Thermometer, an instrument to measure the affective states of subjects prior and post the implementation of a reduction strategy. *Discomfort* was measured by instrument items measuring how uncomfortable, uneasy and bothered the subjects felt from self reports using a Likert scale. In order to ascertain if dissonance increased affect in general, items measuring disappointment, annoyance, guilt, self-criticism were included to constitute a *Negself* index and items measuring how good, happy, optimistic and friendly the subjects felt were included to constitute a Positive Index. Using a forced compliance paradigm (see below) the authors induced a state of cognitive dissonance in their subjects and then, with half their subjects, they measured indices of *Discomfort*, Negative Self Assessment (*Negself*) and *Positive* Self Assessment before a dissonance reduction strategy was employed. With the other half, they employed the same measures after the dissonance reduction strategy had been employed. They found, as predicted, that *Discomfort* was higher in the first set of subjects relative to the second and to a control set of subjects. No significant effects were revealed using the *Negself* and *Positive* indices. The authors interpret this result to mean that discomfort is a distinct affective state following dissonance creation and is alleviated by implementation of a dissonance reduction strategy.

CD Research Paradigms

Because Festinger (1957) defined CD very abstractly, subsequent researchers have been able to adopt a very wide interpretation of the term cognition, e.g., behaviours, perceptions, attitudes, beliefs and feelings as well as the consciously held propositions of the type illustrated previously. Consequently, during the decades that followed publication of Festinger's (1957) monograph,

a large number of experiments were conducted to investigate the nature of CD, the limitations of the theory and its relationship to other theories of motivation. A sample of the more widely cited experiments is described below. In addition to the description of the experimental method and findings, some comment is provided which is believed to undermine the conclusions drawn at the time by the experimenters, where relevant.

Free Choice

Once a decision has been made between two options, e.g., purchasing one brand of car in favour of another, dissonance can be generated between the option chosen and the one foregone even if the decision was a rational choice. The positive points of the option foregone and the negative points of the option chosen are in opposition to the decision made. CD theory predicts that action will be taken to reduce the consequent dissonance, typically taking the form of bolstering the option chosen by the gathering of consonant cognitions and cognitions that diminish the force or validity of cognitions favouring the options foregone (Brehm, 1956, cited in Egan, Santos & Bloom, 2007). These predictions were verified by Ehrlich, Guttman, Schonbach and Mills (1957) who ascertained that once purchasers of cars had made their choice and purchased one accordingly, the purchasers were more likely to read advertisements that publicised and promoted the model that they had just purchased than those that publicised and promoted rejected models. In contrast to some other methods of dissonance reduction, such activities do not require interaction with other people.

It is conjectured that in addition to any propositional dissonance that may have arisen due to the opposition of the option chosen and the contrary considerations, there may have existed purchaser anxiety that the purchase decision may be discovered to have been a poor one and that there will be a resultant sense of foolishness, loss and loss of self-esteem. Both the propositional dissonance and the conjectured anxiety are lessened by collecting the predicted cognitions.

Belief Disconfirmation

Dissonance occurs when people are exposed to information which contradicts their beliefs. If beliefs are not changed, dissonance can be reduced either by seeking the support of others who hold the same belief or by converting others to that same belief, thereby obtaining their support, i.e., consonant cognitions. Festinger, Riecken and Schachter (1956) observed precisely the latter when a religious prediction failed to materialise creating cognitive dissonance between the prediction and reality. Adherents embarked upon a new campaign to obtain recruits.

As in the case of Free Choice above, in addition to propositional dissonance arising from the clash of the prediction and reality, it is conjectured that behind the activity predicted and observed lay an emotion, anxiety that one might be perceived as foolish, credulous or dishonest. This anxiety, as well as propositional dissonance, is lessened by obtaining support from others who either already hold the same belief or who can be converted to it.

Effort Justification

Aronson and Mills (1959, cited in Aronson, 1991) reports an experiment conducted in which women were inducted into a sorority group which turned out to be dull and boring. There were two conditions; an intensely and a mildly embarrassing initiation ceremony. On discovering the dullness and boring nature of the group, those who underwent the intense initiation assessed the group more favourably than the other, thereby diminishing the cognitive dissonance generated by undergoing their very embarrassing initiation and their disappointment at its quality.

The same confound criticism can be levelled at this paradigm as for the Free Choice one. The subjects could be motivated to change their opinions by a sense of foolishness and embarrassment in addition to or even in substitution for any dissonance arising from propositional oppositions.

Counter Attitudinal Activity or Forced Compliance

In this paradigm, participants are induced to choose to engage in a counter attitudinal behaviour under conditions of high or low choice (Freedman 1963, cited in Sherman & Gorkin, 1980) and consequent attitude is measured. In a widely cited paper, Festinger and Carlsmith (1959) reported an experiment in which subjects were required to carry out a very boring task for one hour to establish a cognition that the task was boring. Three conditions were defined; a control condition in which subjects were paid nothing and one dollar and twenty dollar conditions, in which the subjects were paid the sums mentioned, in return for reporting that the task was very interesting to a confederate of the experimenter. Later, all subjects were interviewed more fully about the task by a second confederate but all subjects were free not to be interviewed. Some subjects disqualified themselves for various reasons at this stage but there remained 20 subjects in each condition. In their final interviews, relative to the reports of the controls, the $20 dollar subjects rated the task as marginally more interesting and the $1 subjects rated it substantially more interesting. This result was in accordance with predictions that the subjects in the $20 condition would have sufficient justification in their $20 payment to describe the task as very interesting to the first confederate without having to change their opinion, while the subjects in the $1 condition did not have this justification and so changed their opinion more as a dissonance reduction strategy.

By paying some participants as much as $20 in 1957, the authors effectively forced their participation. When participants consider themselves forced or given little choice, there is little dissonance and little cause to change opinions. The condition of low choice was frequently formalized in subsequent experiments, with participants often divided between high and low choice conditions, in which the pressures to participate were varied. In virtually all such experiments, greater change of cognitions took place among the high choice groups.

As in the other investigations described above, the Festinger and Carlsmith (1959) experiment may contain an emotion as a confound. In this case, it would be guilt at lying. The movement of the opinion of the subjects in the $1 condition may therefore have been due to an attempt at guilt reduction as much as to the reduction of a purely propositional dissonance.

In another form of forced compliance, participants are asked to write an essay highly contrary to their own attitude towards such issues as drug use. However, in several cases in the literature, the participants were informed that their essays may or would be used to persuade other members of the public, which appears to allow confounds such as guilt to be introduced. As an example of a well designed forced compliance experiment which allowed little opportunity for the introduction of confounding emotions, Cohen (1962) asked Yale students to write counter attitudinal essays about police brutality shortly after a riot on the New Haven campus had been suppressed by the highly criticised actions of the local police. Students were aware that their essays would not be exploited in any way and were free not to participate. They were paid $10, $5, $1 and 50cts. for the essays if they did so. On completion of their essays, all students were interviewed to ascertain their private attitude to the police action. In accordance with the CD theory that the greater the external inducement, the less the cognitive movement, the results were linear; the smaller the financial reward received by the students, the greater their attitude change.

Explorations of the Nature of Cognitive Dissonance

Is Dissonance a State of Arousal?

Zanna and Cooper (1974) noted that previous research had established that subjects able to attribute their arousal to some external cause in ignorance of the true one were able to reduce their state of arousal more than others unable to make such an attribution. That is, misattribution appears to reduce dissonance leading to a reduced need to adopt some other dissonance reducing strategy. They conducted a forced compliance experiment in which their subjects wrote a counter-attitude essay and were given a pill. Three conditions were specified. One group of subjects were informed that the pill would make them feel tense, another that the pill would have no effect and the third that the pill would relax them. A control group were given no information. Each group was divided into high and low choice sub-groups. It was predicted that the "no effect" groups would produce a standard dissonance effect, the "tension-producing" groups would produce a diminished dissonance effect and the "relaxation-producing" groups would experience an enhanced dissonance

effect despite having taken a pill thought to be relaxing, with degrees of opinion change correlated with the degree of choice. The experiment, which included recording the subjects subjective state of arousal, confirmed the predictions. The authors concluded that the results "could only have been obtained if inconsistent cognition produced at least the perception of arousal" (pp. 707-708).

A later study by Pittman (1975) confirmed the arousal-like properties of cognitive dissonance and the mediating effects of attribution using two independent methods of arousal production, cognitive dissonance and fear of electric shock. When counter-attitude dissonance could be attributed to a state of arousal related to fear of electric shock, attitude change was reduced.

The Aversive Nature of Dissonance

Despite much evidence that cognitive dissonance had effects similar to those of other forms of arousal, as predicted by Festinger (1957), no-one during the early years of cognitive dissonance research had provided evidence that cognitive dissonance could be regarded as aversive, as Festinger (1957) had suggested. Zanna, Higgins, and Taves (1976) reasoned that if arousal was aversive and the opportunity to misattribute arousal to various causes was provided, subjects who were able to attribute arousal to an external aversive cause would undergo lessened attitude change than subjects unable to do so. Four high "high choice" conditions were defined related to the taking of a pill prior to writing counter-attitude essays; subjects were informed that they would feel "tense" or "pleasant" or there was "no effect" or were provided with "no information". The authors reasoned that if dissonance was general rather than aversive, then subjects in both the "tense" and the "pleasant" conditions would be able to misattribute their arousal to the pill and both undergo similar and lower attitude change relative to the "no effect" group. If the dissonance was aversive, the "tense" group would be able to misattribute their dissonance to the pill and undergo little attitude change.

These main predictions were confirmed experimentally with the "tense" group manifesting the least attitude change, and the "no effect" and the "pleasant" groups manifesting substantial change, the "pleasant" group doing so the most.

The "no information" group failed to make dissonance-reducing attitude changes. This is interpreted as suggesting that these subjects preferred to make an attribution of their arousal to the pill in the absence of any information about it as this would be cognitively less complex than changing their attitude. The authors interpret their main results as demonstrating that cognitive dissonance is an aversive phenomenological experience.

The nature of the Elliot and Devine (1994) Dissonance Thermometer was discussed earlier. In that study, student participants were required to freely consent to write a counter attitude essay advocating a 10% increase is student fees. Four conditions were defined; Counter Attitude High Choice Affect-Attitude and Counter-Attitude High Choice Attitude-Affect conditions, the sequence of Affect and Attitude reflecting the sequence in which the respective measurements were taken, and Low Choice and Pro-Attitude conditions. As predicted, attitude change in the first two conditions was high relative to that of the subjects in the third condition. The Dissonance Thermometer was expressly designed in this experiment to measure what were hypothesised to be the aversive elements of Dissonance relative to other aversive feelings/emotions and positive feelings and succeeded in doing so.

The Physiological Facets of Dissonance

Fazio and Cooper (1983) questioned the pill-paradigm on the grounds that "subjects believed that they were taking an experimental pill that was still being tested and [had] potential side effects. Concerns about the experimental status of the pill may have provided a strong contextual clue for labelling any general arousal as a negative feeling" (pp.130-31).

Losch and Cacioppo (1990) consequently used a novel misattribution device for their subjects; prism goggles which invert the field of vision. Previous research had established that these goggles did not create pleasant or unpleasant feeling relative to the feelings of subjects that were not exposed to such a stimulus. Losch and Cacioppo (1990) assessed and chose their subjects for their contrary view that electric shocks should be used on students more frequently for psychological research than was currently the case, their attitude on a 1 – 9 scale having been ascertained in a survey two weeks prior to the

experiment. Subjects in both high and low choice conditions were informed that removing the goggles after wearing them for three minutes could result in a feeling of pleasant excitement (positive cue condition) or unpleasant tension (negative cue condition). Subjects' physiological responses were recorded. Once they had removed the goggles, cognitive dissonance was generated by requiring subjects to compose in their heads for a further three minutes a set of arguments in favour of greater use of electric shocks in psychological research. They were then required to write their arguments for a further three minutes, during which time physiological recordings were not made owing to the physiological complications of the act of writing, after which physiological recordings were continued during a relaxation period of three minutes. At the end of this, subjects were presented with a dependent variable survey in which was included a question about their attitude to electric shock based research, measured once again on a 1 – 9 point scale. Changes in attitude due to participation in the experiment were determined by comparisons with the declarations made a fortnight earlier. In accordance with previous physiological research, subjects in both high choice conditions registered higher non specific skin conductance responses (NS-SCR) than those in the low choice conditions during the post-decision period and subjects in the high choice/positive–cue condition registered higher attitude change than those in any other condition. The authors interpreted their results to mean that people in dissonant states change their attitudes to reduce unpleasantness rather than arousal per se.

Breadth of Dissonance

The previously described CD experiments did not provide opportunities to ascertain whether CD could affect perceptual assessments of the external world in the same way that other mental and physiological states have been found to do (Aarts, Dijksterhous & De Vries, 2001). Balcetis and Dunning (2007) hypothesised that a state of cognitive dissonance might affect visual assessments of the external environment. In their Study 1, they tested this by creating emotional states of embarrassment in high and low choice conditions by dressing students in South Pacific clothing and inviting or requiring them to assess dimensions of a public place in which they also walked in full view of

bystanders. Those in the high choice condition consistently assessed the distance they traversed as less than those in the low choice condition and the controls who made their assessment without having to don embarrassing clothing. In their Study 2, the authors presented their participants with a difficult physical task; propelling themselves up a hill with their hands while kneeling on a skate board. Using drawings and protractors, all participants had to assess the steepness of the slope. The high choice condition participants consistently rated the slope as less steep than those in the low choice condition and the controls, the latter being required only to assess the steepness of the slope without having to undertake the difficult physical task. The authors conclude that "when experiencing dissonance, perceivers may take advantage of an opportunity to 'push' around perceptual experiences to return to a preferred baseline of cognitive consonance" (p. 921), a conclusion that might be paraphrased as CD changes assessment or perception of the external environment.

'Age' of Dissonance

In a study which, like the one reported in this thesis, explored the evolutionary origins of CD, Egan, Santos and Bloom (2007) modified the free choice paradigm in which individuals rate the attractiveness of a variety of items and then reassess their attractiveness after having made a choice between them. The authors provided different coloured M & M sweets and assessed the relative attractiveness of the different colours by the time each of six capuchin monkeys took to exit their home cage to a testing chamber to retrieve the sweet when the separating door was opened. Nine different colours were tested and each colour was assessed across 20 trials per monkey. By this means, the authors were able to identify statistically triads of three equally favoured colours. Choice and No-choice conditions were defined. In the former, the monkeys had to make a first choice between two differently coloured sweets within a triad when offered both simultaneously and were then offered a second choice between the rejected one and the third. In the no-choice condition, the monkeys were first given just one coloured sweet without any choice being offered but were then offered a choice between the

two remaining ones. These tests were conducted with all three triads of coloured sweets.

The results provided evidence that the monkeys behaved similarly to humans. In the Choice condition, they chose against the rejected colour when it was re-presented in the choice with the third colour but manifested no such bias in the No-Choice condition. The authors conclude that their experiment "suggests that the mechanisms underlying CD reduction ... may have originated ....evolutionarily earlier that previously thought" (p. 978). It is significant for this thesis that the monkeys made choices between items of food, i.e., items of relevance to their survival.

In the same paper, Egan et al. (2007) report on a similar experiment conducted with children aged 4 but in this case, they used different coloured stickers rather than sweets. Similar results to the monkey experiments were obtained. The authors conclude that the mechanisms underlying adult CD reduction may originate developmentally earlier than previously thought. It is important for this thesis to point out that material objects, rather than abstractions, were employed in the child experiments, although they had no obvious survival value.

Criticisms and Reformulations of CD and Rebuttals

Self Perception

The behaviourist Bem (1967) suggested an alternative to phenomenologically experienced motivational dissonance as the cause of attitude change. He proposed a self-perception non-motivational process as the cause of attitude change in which subjects inferred their attitude from their behaviour. He interpreted the subjects in the high choice condition of Festinger and Carlsmith's (1959) experiment to be using their behaviour to judge their attitude, whereas subjects in low choice condition do not use their behaviour to judge their attitude as the external circumstances effectively control them.

One consequence of Bem's (1967) proposal was the use of the counter attitude misattribution paradigm described above. In the Zanna and Cooper (1974) experiment, there was no need to reduce dissonance if it could be misattributed to a pill, an aversive consequence being thought to follow from swallowing it. In Bem's self perception theory, the ability to attribute the experience of dissonance to a pill should have no effect on motivation to change attitudes. No difference between the attitude changes of subjects in different conditions should have been detectable. However, as it was, Bem's reformulation lost support.

Aversive Consequences – the New Look Theory of CD.

Cooper and Worchel (1970) repeated the Festinger and Carlsmith (1959) experiment but included a condition in which subjects were informed prior to being assessed for attitude change that describing the dull task as interesting had had no effect upon the experimenter's confederate. That is, the subjects' lying was reported back to them as having had no aversive consequences. In this condition, the authors found no significant change in attitude.

Cooper and Fazio (1984) proposed that the dissonance that motivated attitude changes arose not so much from the propositional opposition of cognitions in the induced compliance paradigm but from feeling responsible for the aversive consequences of having harmed other participants by inducing them either to believe something false or otherwise causing harmful consequences.

Harmon-Jones (1999) notes that the aversive consequences reformulation depends for its persuasive power upon a null effect, the absence of significant attitude change when there were no aversive consequences of counter-attitude behaviour. He posits many alternative explanations for the lack of attitude change. First, in several no aversive consequences experiments, the issues were unlikely to engender particularly strongly held views in the participants, leading to ambivalence in the minds of the participants. Secondly, later research established an inverse relationship between the length of counter-attitude essays and the degree of attitude change. Writing long counter-attitude essays appears to diminish feelings of dissonance during this period as subjects produce cognitions consonant with their behaviour. One recent finding is that writing a counter-attitudinal essay produces less attitude change

in the direction of the essay than simply making a commitment to write the essay (PsycCritiques, 1997). Thirdly, the subjects may have concentrated upon the known or hypothesised reactions of their audience rather than on the requirement to promote counter-attitude behaviour, resulting in less dissonance and therefore less attitude change. Fourthly, there may have been some dissonance but as the only means of detecting it was by measuring attitude change, it may have been small. A different instrument such as the dissonance thermometer may have detected dissonance more effectively.

In order to demonstrate that aversive consequences are not necessary for dissonance, and in acordance with Cooper and Fazio's (1984) statement that "making a statement contrary to one's attitude while in solitude does not have the potential for bringing about an aversive event" (p. 232), Harmon-Jones, Brehm, Greenberg, Simon, and Nelson (1996) conducted experiments to create dissonance in circumstances in which aversive consequences could not be generated. Under the guise of a recall experiment, they created high and low choice conditions in which participants in private cubicles had to write a statement that they enjoyed the taste of a beverage which existed in two forms, one containing a proper amount of sugar and the other containing two teaspoons of white vinegar. The beverage types were randomly provided to participants, the experimenter being unaware of which participant drank which type. In order that there should be no perception of aversive consequences, prior to writing their statement, the participants were told by the experimenter that to preserve anonymity, he did not actually need the paper on which their statements were to be written and that on completion they should be thrown away in the provided waste paper basket. They then answered a questionnaire to ascertain how much they (dis)liked the beverage. The previously written statements were then retrieved from the baskets to ascertain whether participants had written the requested statement. The results showed that unpleasant-tasting high-choice participants reported more positive attitudes towards the drink than did unpleasant-tasting low-choice participants. The experiment was repeated with counter attitudinal statements required about a boring passage of text and the same results obtained. In a third experiment, the second one was repeated with NS-SCR being measured during three minutes after writing a counter-attitude statement but before assessment of attitude.

High choice subjects evidenced more NS-SCRs than low choice participants. The authors concluded that aversive consequences are not necessary to induce dissonance.

To avoid alternative interpretations that might focus on the negative stimulus used in the previous experiments, Harmon-Jones (1999) described a later experiment in which participants were required to write a counter attitude statement about a pleasant experience. Participants were placed in high and low choice conditions and wrote a statement that they did not like eating a pleasant tasting chocolate sweet, a Herschy Kiss. When a post statement attitude assessment was made, high choice participants reported that they disliked it more than did low choice participants, confirming the normal dissonance induced attitude change in the high choice condition.

Aronson's Self Esteem Variant of Cognitive Dissonance Theory.

Aronson's (1969, 1991) own research into CD theory led him to suggest that purely propositional oppositions were insufficient as causes of the unpleasant experiences induced in the various paradigms in which CD was explored. He noticed that in virtually all paradigms, participants were subjected to experiences that involved some behaviours that violated their self-concepts, assuming such self-concepts were the typical ones of belief in oneself as fairly honest and considerate of others. He proposed that in High choice conditions, it was the state of aversive arousal following the violation of their self-concept that motivated the change in attitudes. Although Aronson chooses to base his theory on the violation of self-concept, phenomenologically aversive emotions are a common experimental psychological factor, upon which his case may rest rather than violation of the self-concept per se. It is hypothesised that any experimental paradigm which could invoke an aversive emotion without threatening the self-concept would obtain the same result as one that did. Experiments such as the Yale experiment of Cohen (1962) suggest that dissonance can be generated in circumstances when the self-concept is not assaulted.

The Emotional Confound

The danger that the act of cognitive alignment might be the result of something other than propositional opposition was known to researchers as far back as 1972. Pallak and Pittman (1972) wrote "[t]hus, obtained task performance effects must be uniquely due to dissonance arousal, that is, to the presence of two dissonant cognitions, rather than to the inadvertent arousal of some other motivational or tension state" (p. 351) and suggested that cognitive alignments being reported by several researchers at that time were precisely due to arousal states other than cognitive dissonance. They designed an experiment to demonstrate that propositional dissonance alone would have an effect upon an unrelated task, similar to the effect of other drive states on such a task and claimed to have demonstrated this. However, their design is open to criticism. All subjects were first required to carry out a very boring pronunciation task and subsequently requested to repeat it to generate a state of dissonance between the cognitions that the task was boring and that they had consented to repeat it. (High and Low choice conditions were also generated at this stage). Participants were then placed in further subdivisions by being informed either that the results of their participation in the experiment would be useful or would be useless, the former statement being intended to provide cognitions consonant with continued participation and therefore to reduce their dissonance. Participants then took a Stroop test, high dissonance having been previously ascertained to generate high error rates. While the consonant cognitions provided in the "useful" condition may well have had the desired effect, those participants in the "useless" condition could well have been aroused to anger, in which case, any difference in Stroop test error rates between these conditions would have anger confounding the results. The authors do not mention this possibility.

Notwithstanding the weaknesses of the Pallak and Pittman (1972) experiment, when Elliott and Devine (1994) used their Dissonance Thermometer, there were items which measured "right now" (p. 387) the participants' state of disappointment with and annoyance at themselves, and how guilty and how self-critical they felt. They reported that there were no significant effects of dissonance generation on this Negself index. The dissonance created in these experiments appears to lack emotional confounds.

Relative Importance of the Categories of Cognitions Giving Rise to Dissonance

No experimental paradigm appears to have been developed which assesses or identifies a relationship between the subject matter causing dissonance and the intensity of the experience, upon which a standardization of ranking of importance could be based. "Empirical attempts to explicate the role of attitude importance are scant" (Devine et al., 1999, p. 312). Devine, Froning and Elliott, (1995, cited in Devine et al., 1999) conducted an experiment to test the view that when attitudes were of high importance to subjects, relative to those that frequently featured in the CD literature, attitude change would be less than when attitudes were of less importance. In an experiment similar to Devine and Elliott's (1994, cited in Devine et al., 1999) they found that in high choice, high importance conditions, participants showed high discomfort when measured before attitude but did not manifest attitude change.

Devine et al. (1999) report a product recycling counter-attitudinal study to explore the effects of high importance versus low importance of issues. They divided their high choice participant sample in two, one half considering environment related issues to be of high importance and the other half having the opposite view. Each of these groups were again divided into two subgroups, one having attitude change measured prior to measurements of affect and the other having the sequence reversed. For high importance groups, attitude change was not a viable dissonance reduction strategy. Irrespective of the sequence in which attitude and affect were measured, the high choice high importance subgroups registered little attitude change and high affect relative to all other subgroups, confirming a role for subject importance as an independent variable.

In discussing the felt magnitude of dissonance, Festinger (1957) asserts that "if two elements are dissonant with one another, the magnitude of the dissonance will be a function of the importance of the elements " (p. 16). This assertion is fundamental to the subject matter of this thesis. Festinger (1957) suggests that dissonance may be expressed to varying degrees which he labelled, not at all,

lightly or powerfully. However, he is silent as to how various categories of subject matter might determine the importance of the conflicting cognitive elements in normal life and therefore the intensity of dissonance. It is a major hypothesis of this work that the importance of cognitive elements is determined by the categories, discussed later, in which they fall. It follows that the degree of dissonance experienced is predicted, on average, by how the elements can be categorised.

Natural selection has led to the evolution of the capacity for aversive experiences and associated them with activities which threaten our well-being precisely in order to ensure we desist from them. In a brief discussion of motivation, Festinger (1957) suggests that at any one moment, current and near term actions are in effect being compared with clusters of cognitive elements, some consonant and some dissonant with the current and contemplated near term actions. One consequence of this is that we live in a state of constant dissonance of varying strength. The magnitude of dissonance felt at any one moment determines whether we continue the current activity or change it. If current levels of dissonance are large, we will change from activity perceived as harmful to our welfare.

If different categories of cognitive elements have different degrees of relevance to our welfare and reproductive success, as would be the case if the fundamental assumptions of EP are valid, it is predicted that cognitions in the categories pertaining to short term survival, material welfare or reproductive success should be more important to us and therefore more powerful in their contribution to dissonance or consonance than some others of little relevance to these subjects. Such predictions are testable.

Similarities of Emotions and Cognitive Dissonance

It was noted in the discussion of CD research paradigms that some form of aversive emotion could have been the driver of actions and changes to cognitions rather than propositional opposition. Lazarus (1991, Ch. 3) in his motivational principle of emotions suggests the following:

- Motivation can be regarded as the mobilisation of mental and behavioural effort either to achieve a goal or to prevent its thwarting;
- The motivation is reactive to demands, constraints and resources present or potentially so;
- The motivation incorporates a cognitive element in that to be reactive, the environment must be perceived, assessed against background knowledge and evaluated for implications for personal well-being.

The sequence of steps within emotional processing are:

1. Cognitive assessment of the actual or potential environment.
2. Assessment and evaluation of the implications for personal well-being and consequent goal setting.
3. Generation of the motivation or compelling urge to action.
4. The mobilisation of the mental and behavioural effort to attain the goal.

The effort can be regarded as a transaction; it is finite and results in something being achieved.

The time scales of the above are usually short; as short as a few hundred milliseconds in the case of fear and fleeing, but are longer is other cases. The emotional experience is usually dissipated by action. Plutchick (2003, pp.109-110) formalised the above notions by suggested that all emotional experiences are as characterised by a sequence of activities defined in the table below:

Table 2.
Plutchik's (2003) definitions of emotion related activities

Characteristic	Definition
A stimulus	Sense data
A cognition	A recognising and/or evaluative cognitive reaction to the stimulus, expressible in words although no such conscious cognition might be experienced, which initiates the emotional experience
An emotion	A subjective enduring mental state, aversive or pleasurable, that moves the experiencer to action

Consequent behaviour	The action that takes place following the start of the emotional experience
An effect	The results of the action, of benefit to the actor
A function	To produce the benefit which, proximally or distally, aids survival or reproduction.

The question thus arises, can cognitive dissonance be regarded as similar to but different from a conventional emotion in that experiencing it stimulates actions of both a mental and physical nature?

The mental action might consist of changing the opinion/view/attitude towards that which conflicted with the original one and/or the physical actions might be aimed at:

- determining which of the competing cognitions most nearly reflects reality or
- employment of some other dissonance reduction strategy.

Cognitive dissonance could then work in a manner similar to conventional emotions. Given that CD has been demonstrated to be experienced in isolation, separately and differently from the aversive emotions mentioned earlier, it seems highly plausible that the evolutionary forces that have been responsible for the phenomenology of emotions have been similarly responsible for that of dissonance, even if it is experienced more weakly.

Consistent with this notion, Harmon-Jones (1999) suggests that dissonance motivates cognitive and behavioural adjustment on the assumption that "cognitions (broadly defined) generally serve action tendencies" (p. 93). Those cognitions of greatest usefulness are those that are relevant to actions that achieve specific goals. If information inconsistent with actions and associated goals is encountered, the dissonance-causing information could prevent continued action and attainment of the goals. Commitment to these goals is undermined. Harmon-Jones (1999) suggests that CD research has established a proximal motivation to reduce the negative discomfort induced by cognitive discrepancy in order to bring about effective action, which could be regarded

as a more distal motivation. As Harmon-Jones does not approach CD from an evolutionary psychological point of view, he does not mention a yet more distal or ultimate motivation, one of gene propagation via survival and reproductive success. Simon et al. (1995) suggest that inconsistencies central to basic needs such as survival would arouse particularly high levels of dissonance, although they did not test this conjecture.

A Role for Consciousness

Sherman and Gorkin (1980) note that in many cases, discrepancies between a person's attitude and behaviour (and by implication, other contrary cognitions) go unnoticed and "the inconsistency isn't bothersome" (p. 390). This everyday phenomenon implies a role for consciousness, suggesting that consciousness is not an epiphenomenon. If dissonance is a motivating experience of a type essentially similar to emotions, it will be experienced only if the contrasting cognitions are noticed, that is, are raised to consciousness in the form of the experienced bothersomeness. Only then will a dissonance reducing strategy be employed. If it is the case that there is a bias in the types of opposing cognitions pairs that are noticed, that is, raised to consciousness, as proposed in this work, the role of consciousness in enhancing the likelihood of survival is made plain. Unlike experiences of emotions, which are widely accepted to influence behaviour at subconscious levels of intensity, dissonance appears to be experienced if and only if opposing cognitions are raised by an unconscious mechanism to consciousness.

Summary of Cognitive Dissonance.

CD is an aversive phenomenological experience of discomfort, with physiological consequences, generated by propositional opposition, which may trigger and be intensified by accompanying aversive emotions or lead to further cognitions which generate aversive emotions. Many decades of experiments appear to have established that for cognitive dissonance to occur, it is not necessary that there be negative or aversive consequences to someone else nor that one's self esteem be assaulted.

The totality of the aversive experience motivates changes in subsequent cognitions and behaviours in order to diminish the intensity of the aversive experience, i.e., to alleviate it. In this, it is psychologically similar to other aversive experiences such as pain or hunger.

CD is adaptive when used to motivate changes in cognitions and behaviours which are consistent with reality and maladaptive when used to motivate actions that favour the retention of cognitions in opposition to reality.

As the discomfort of dissonance is, like all other nameable phenomenological experiences, a unique quale, it is highly probable that the capacity for it is the product of natural selection. It is hypothesised therefore that natural selection has created a relative scale or ranking of subject matters, namely those relating to immediate or short term survival and reproductive success having greater importance and therefore greater mental salience than issues of no immediate relevance to these, such as matters pertaining to the abstract or the long term future.

Given that comparisons between two propositions may or may not take place, Evolutionary Psychology (EP) suggests that the making or not making of comparisons should not take place on a random basis. In accordance with the previous comments, some comparisons would be of greater relevance than others to survival and reproductive success. EP therefore predicts that mechanisms should have developed to ensure that those comparisons of greater relevance to survival and reproductive success do take place while those of less relevance need not.

The same logic that applies to explicit contradictions can be applied to implications. When we acquire and retain a proposition, there may be many implications that follow when it is compared with any of a large number of others that are already retained. These implications form another set of propositions which can then be compared with previously retained propositions to form yet another set of implied propositions and so forth ad infinitum. Clearly, we do not do this, at least, not in ordinary life. Evolutionary

consideration suggests that some implications are more likely to be identified by an unconscious mechanism and raised to conscious propositions than others, specifically those concerned with short term survival and/or reproductive matters.

The need to obtain the resolution of both explicit and implicit survival/reproductive relevant contradictions is hypothesized as the selection pressure that initially produced the capacity for the phenomenological experience of dissonance. In accordance with the definition of a module provided earlier, a module to bias consideration of contradictions in accordance with such EP predictions is hypothesised to exist.

The variation in the extent to which the conscious mind becomes aware of contradictions explicitly present or implicit in pairs of propositions and their consequent dissonance is explored in this thesis as an index of the existence of this biasing module. In order to avoid a weakening of any phenomenological experience in accordance with Brehm and Cohen's (1962) amended concept of dissonance, it is necessary either to use qualitative opposites in contradictions or to use words that are at opposite poles of a semantic continuum.

The emergence of language would have generated circumstances in which CD would have been experienced much more frequently and have done so in circumstances when resolution could have aided survival and/or reproductive success.

Evolution Of Language

For natural and sexual selection to have created a subject matter bias in the generation of CD, it is necessary to posit a lengthy period of development of the capacity for CD, contemporary with the development language. Evidence is presented below that the cognitive underpinning of language developed over a long period, many hundreds of thousands of years. In the review of CD, it was established that dissonance is experienced when a person's cognition in the form of a statement, attitude, opinion or action (all capable of being

described in words) clashes with another such cognition. The ensuing conflict alleviation is often effected via speech. There is therefore frequently a dependency of the resolution of CD upon the cognitive abilities underlying language. Assuming the latter developed slowly, it follows that the former would also have done so. However, CD has a further dependency. The development of a capacity for CD would have required a selection pressure; the mere existence of language would not itself have been enough. It is the major hypothesis of this thesis that that selection pressure was the contribution to survival and reproductive success that exploiting CD was able to make: those that felt CD in a situation where conflicting options affecting survival and reproductive success existed and whose CD sensitivity to the conflict was higher than average were more likely than others to seek a resolution that was advantageous to their survival and/or reproductive success. In addition to aiding the gradual evolution of CD, this process would also bias its expression towards circumstances of relevance to survival and reproductive success. Those whose expression of CD was not biased to survival and reproductive success would make lower contributions to the genome of later generations than those who were so biased.

Such biased resolution over many generations would slowly cause the accumulation and fixing in the human genome of the relevant genes. This process could commence as soon as linguistic abilities began to develop but hardly before, and could and probably would take place contemporaneously with the development of language. In principle, the more sophisticated the state of language at any one time, the more frequent the opportunities for CD to lead to adaptive beneficial decision making. At the very least, it can be expected that the rate of development of the capacity for CD would initially have been very slow, but likely accelerated as language facilities developed.

The point for this thesis is that CD is largely dependent upon the refinement of cognition implicit in language for its ability to contribute to survival and reproductive success. However, language's contribution to survival and reproductive success is dependent upon those feelings which motivate speakers' to use it for this purpose. CD is one such feeling and its development

would likely accelerate the use of language as an aid to survival and successful reproduction. It is proposed that this mutual dependency would have led to a contemporaneous evolution and strengthening of both.

It follows from the above reasoning that the more ancient the beginnings of language development, the more time there has been for the development of the capacity for CD and any biases in its expression.

The dating of the evolution of the human language capacity is still a matter of contention. Noble and Davidson (1996) argue that linguistic behaviour emerged no earlier than 100,000 BP while Pinker (1995) suggests that "the first traces of language could have appeared as early as Australopithecus Afarensis" (p.352) about 4MY BP. Evidence is accumulating that language probably predates, at least in primitive form, the evolution of H. Sapiens. and is presented under five headings below.

Anatomical/physiological Evidence

Bickerton (1990) suggests that inhibition of vocalisation probably developed during the Afarensis period (4-3MY BP) as australopithecines moved into the savannah. Alarm barks and involuntary food barks would have been likely to have endangered survival. A capacity for voluntary silence necessarily means simultaneously developing a capacity for voluntary control and use of vocalisations. By the time of Homo Habilis, (approximately 2.2 –1.6 MY BP) this voluntary control is likely to have evolved fairly fully, except in the moments of acute emotional stimulation. By this time, full bi-pedalism had been developed, i.e., it developed during the Afarensis period, changing the orientation of the laryngeal tract from somewhat horizontal to more vertical and simultaneously allowing the tract to descend down the neck. When in the former position, swallowing and breathing can occur simultaneously. This does not occur in a fully grown human, although it does in babies. Also, the basal cranium, the "hole" in the bottom of the skull through which the peripheral/bodily part of the central nervous in the spinal column connects with the brain, migrated from the back of the skull to the bottom of the skull as the skull rotated forwards to ensure that the eyes continued to look forward as

body posture became more upright. These two changes have had the effect of enlarging the laryngeal cavity permitting a large variety of sounds to be emitted. Richmond and Jungers (2008) even suggest that this development commenced as long ago as 6MY BP.

It would appear likely that by Erectine times, sufficient enlargement had taken place to support proto language although this was not necessarily phonemic speech. As when children are just beginning to speak, continually modulated but distinguishable noises are created, but not from phonemes, more like the sounds of tonal languages. Such sounds could have been sufficiently distinct to designate a small vocabulary of lexical items, forming different proto languages as H. Erectus populated the old world. Even chimpanzees have a vocabulary of distinct noises which appear to be interpretable by both other chimpanzees and humans. A recent discovery indicates that even some monkeys extract meaning from combinations of calls (Arnold & Zuberbühler, 2008).

Lieberman, Laitman, Reidenberg, and Ganon (1992) suggest that the Supralaryngeal Vocal Tract (SVT) of Homo Sapiens, which is responsible for the production of human vocalisations of speech, is probably an index of the neural mechanisms and cognitive abilities necessary for speech also. They note that archaeological data suggests Homo Neanderthalensis, a cousin species contemporary with archaic Homo Sapiens (see below) "likely employed some form of language" (p. 464) and also that H. Neanderthalensis probably did not have an SVT identical to that of H. Sapiens. They conclude from this only that the speech of H. Neanderthalensis was not as efficient as that of modern humans although this has been contested (Aiello, 1998, cited in Jackendoff, 1999).

Kay, Cartmill, and Malow, (1998) propose that the size of the hypoglossal canal which transmits the nerve that supplies the muscles of the tongue may provide an indication of the motor co-ordination of the tongue, a greater nerve supply reflecting the evolution of speech and language. They measured the sizes of the canal in chimpanzees, Australopithecines and H. Habilis and find

them comparable. They conclude that these latter species were without language. However, the size of the canals of H. Neanderthalensis and early H. Sapiens, measured at Skhul in Israel, and in Kabwe (Africa) and Swanscombe (UK) dating to middle Pleistocene times (125,000 BP to 75,000 BP), are comparable to modern H. Sapiens. Because of the hypoglossal canal size of Neanderthal and human skulls dating to the middle Pleistocene are similar, they conclude that human vocal abilities may have been essentially modern by a date earlier than 300,000 BP.

Lee and Wolpoff (2003) graphed the gradual increase in encephalisation of early hominid species to modern H. Sapiens during the Pleistocene (see below) and concluded that their results are "incompatible with an interpretation of punctuated equilibrium during this period" (p.186).

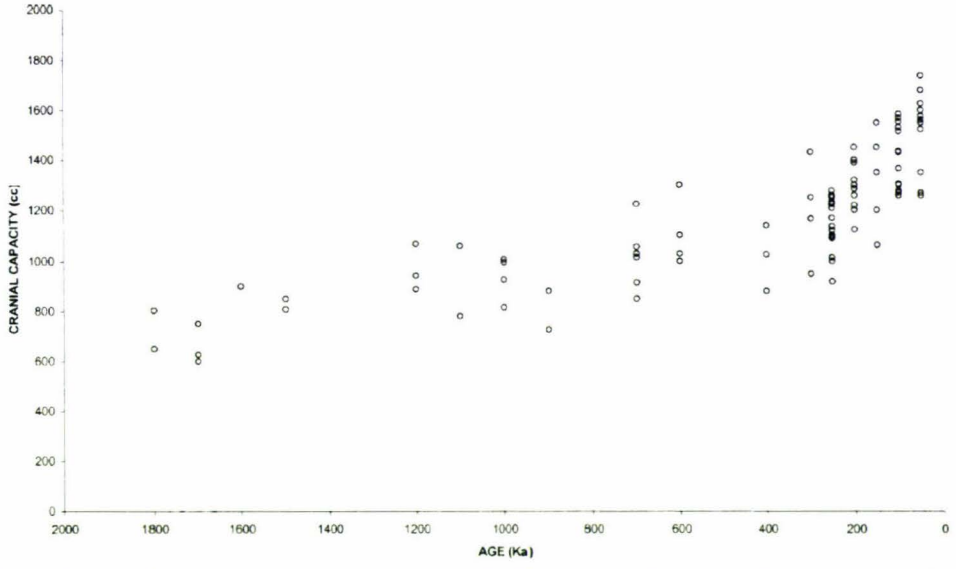


FIGURE 2. Cranial capacity (in cc) as a function of time for 94 specimens of Pleistocene *Homo*. The dates of the specimens between 1800 Ka and 300 Ka are rounded to the nearest 100 Ka, and to the nearest 50 Ka for specimens between 300 Ka and 50 Ka. The distribution has the visual appearance of curvilinearity.

Figure 5. Cranial Capacities of specimens of the Genus Homo

Early Homo Erectus in Africa (from about 1.7 to 1 million BP) averaged 900 cc in brain size, but later H. Erectus specimens from .5 My BP average 1100-1200 cc, which falls within the range of the brain size of modern humans. The earliest or archaic forms of H. Sapiens date to 300,000-400,000 BP and average over 1200 cc. The Neanderthal skull had a brain size of 1500 cc, which is larger than the brains of most modern humans. The average H.

Sapiens Sapiens is around 1400 cc. (details from Washington State University, 2008).

Genetic Evidence

Lai, Fisher, Hurst, Vargha-Khadem, and Monaco (2001) studied the 'KE' family in the UK in which several members across three generations have verbal dyspraxia characterized by deficits in several facets of language processing, such as the ability to break up words into their constituent phonemes, and grammatical skills including production and comprehension of word inflections and syntactical structure. They identified in the affected members of the family differences in the FOXP2 gene which were not present in the unaffected members. They also examined an unrelated person who had similar deficiencies and found similar damage to the same gene. They concluded that the FOXP2 gene is involved in the development process that culminates in speech and language. Enard, et al. (2002) sequenced the FOXP2 related protein of humans, the chimpanzee, gorilla, rhesus monkey and mouse, finding that the human protein contains two amino acid differences from the chimpanzee, gorilla and rhesus monkey version and that these three species' version differs by only one further amino acid from that of the mouse. They note the stability of the FOXP2 gene and associated protein across evolutionary time and suggest that a selective sweep, a process that eliminates less advantageous alleles, has occurred in the human version and dated it to between 120,000 and 200,000 BP. Examining the FOXP2 related protein sequence, Krause, et al. (2007) found that the two Homo Sapiens differences from the non-human apes were shared with Neanderthals. These changes are present in the human haplotype, (a particular length of a chromosome) that had been subject to the selective sweep. As the common ancestor of H. Sapiens and H. Neanderthalensis is dated to not later than 400,000 BP, the authors push back the date of the selective sweep to earlier than 400,000BP.

Verne, Spiteri, Nicod, Grozer, Taylor, Davies, Geschwind and Fisher (2007) have recently demonstrated that the human FOXP2 gene is a transcription factor which influences the expression of other genes modulating synaptic plasticity, neurotransmission, neurodevelopment and axon guidance.

The discovery by Lai et al. that the modern human form of FOXP2 is necessary for language, Krause et al.'s discovery that the same form was present in Neanderthals, and Verne et al.'s discovery that it controls neuronal developmental processes provides suggestive evidence that the selective pressure forcing the sweep may have been the early development of language.

Neurological Evidence

Aboitiz and V (1997) discuss a wide range of cortico-cortical connections that are relevant to short term memory, which plays an essential role in speech (Baddeley, 2002), connections linking various divisions of Wernicke and Broca's areas to each other and to some parts of the prefrontal and some infero-parietal regions that are active during speech. They suggest that such a large set of interconnections would evolve only gradually and propose therefore a Darwinian gradual evolution of speech abilities as opposed to "the Chomskian concept of a discrete language organ that has arisen by a single macro-mutation." (p.394). Unfortunately, the authors do not date the time interval of this gradual evolution but the complexities of the cerebral connections they discuss suggests a period of several hundred thousand years, culminating in a language ability essentially identical to the modern one achieved at least one and possibly several hundred thousand years ago.

Rilling, et al. (2008) used diffusion-tensor imaging to track white matter in mammalian brains. They found that the cortical terminations of the arcute fascilus (AF), which connects the temporal lobes to areas of the frontal lobes, are progressively more complex in macaque monkeys, chimpanzees and humans. Damage to it causes speech aphasias in humans. Macaques have a voice area connected to the AF that is especially sensitive to conspecific vocalisation, although located at a different position on this fibre complex, relative to human voice processing. They suggest that the prominent temporal lobe projection on the human AF has aided the development of language in humans. Petkov, et al. (2008), using fMRI, located a voice processing region in the anterior temporal plane for macaque monkeys with a signal sensitivity

that enables the identification of conspecific individuals, a function performed by the same regions in humans. Ghazanfar (2008) concludes from this that this region has been strongly but gradually modified during human evolution and rejects any macro mutation for speech or the proposal that it is spandrel arising from increased brain size. He concludes that "the neural circuitry in humans evolved gradually from primitive precursors, which parallels findings from ethology which indicate a gradual emergence of vocal sophistication in the primate lineage" (p.484). The neurological evidence supports the view that a primitive language ability was evolving by and during Erectine times.

Paleo-archaeological Evidence

Karkanas, et al. (2007) report a consensus among paleoanthropologists supporting repeated use of fire in the Middle Palaeolithic period (200.000 – 300,000BP) in the Qesem Cave in Israel. However, their own explorations of the Lower Palaeolithic (400,000 – 500,000 BP) strata push back the use of fire to not later than 400,000 BP. "Hearths formed hubs around which other activities were carried out in the cave" (p. 208) such activities including the use of blades manifesting use-wear damage in conjunction with numerous cut marks on bones, the latter evidencing prey butchering, defleshing and marrow extraction. The authors see no distinction between behavioural patterns observed in Middle Palaeolithic populations elsewhere in the Levant and those reported in their paper. The particular activities discovered strongly suggest that language had developed sufficiently by 400,000 BP for complex and dangerous activities to have been successfully coordinated within social groups.

Alperson-Afil (2008) proposes that frequent and controlled use of fire by hominids can be firmly dated to approximately 780,000 BP. She reports on the locations of burned and unburned flint microartifacts at the Gesher Benot Ya'aqov site in Israel. A statistical analysis of their spatial distribution from eight Acheulian archaeological horizons indicates that they occur in dense concentrations rather than being evenly distributed. She concludes that the fire making skills of the Acheulian hominids (H. Erectus) enabled them to create

fire at will in diverse environmental settings. Making the same interpretive assumptions as above, namely that fire hearths evidence complex social activities, Alperson-Afil's discoveries indicate a likelihood that language was developing in Erectine times.

Some authors, e.g.. Ambrose (2002) and Mithen (1996), raise the possibility that the sophistication of H. Erectus' stone tool manufacturing methods and usage are indicative of substantial language development. The issue is contentious as manipulation of objects can be taught as easily through imitation as via language. The difficulty of describing subtle hand movements, e.g., tying knots, without simultaneous demonstration is well known. Children learn to tie shoe laces largely through copying an adult rather than by listening. Tool making and usage, in isolation from evidence indicating the social circumstances in which they were used, provides only weak evidence for the development of language.

Linguistic Evidence

Bickerton (1990, 1995) compared chimpanzee linguistic abilities with those of infants and the content of pidgins and proposed that languages were preceded by proto-languages which had the following characteristics:

1. Short utterances of a few "words".
2. All words were lexical items, i.e., all have referents.
3. The sequence of lexical items would be determined by what was uppermost in mind, the first item being the most important, probably emotionally laden.
4. An absence of grammatical items (if, then, also, although, until, -ed, -ing, en, -s, etc.) and grammar
5. No null elements (references to the non-existent)
6. No pronouns or equivalent
7. No multi-argument verbs
8. No recursion, i.e., no subordinate clauses
9. No cases or inflections or prepositions

10. No movements
11. Pointing, gesturing and prosodic voice modulation

Proto-languages would have been followed by the gradual inclusion of full linguistic facilities in a sequence such as:

1. Particle/sound indicating negation of information believed or shown not to be correct.
2. Wh- questions to ask a wide range of question that pidgin may do merely with tonal inflection. Pidgins can add this function by adopting a Wh-word, usually the who equivalent, and then adding something as illustrated in the table below.

Table 3.
Forms of Wh-words in pidgins

English	Pidgin equivalent in English
Who	Who-man
What	Who-thing
Where	Who-place

3. Pronouns, referring either to assumed person or person already mentioned, permitting avoidance of lengthy repetition.
4. Auxiliaries: can, must, should, would.
5. Expressions of time, present in Pidgin so may have been present in proto-language
6. First or further creation of particles for location (in, on , by, etc.) and direction (to, from, towards, away, etc.)
7. Quantifiers; a , many, much, little, none, few, all, every, etc
8. Multi argument verbs, universal across languages with thematic roles., eg "He gave the stick to the boy" has three arguments in all languages; Agent, Patient, Recipient.

For Bickerton (1990, 1995) the progressive encephalisation during the Pleistocene provided the increasing processing ability needed for the

multiplying linguistic structures such as those listed above. This observation supports his proposal that proto-languages were present in Erectine times and developed gradually into full languages as encephalisation reached today's value.

Bickerton's protolanguage ideas receive support from Jackendoff (1999) and Tallerman (2005) who both see a gradual evolution of syntax emerging from combinations of lexical items.

Conclusion

Several lines of argument converge on the conclusion that early or proto-language was developing in Erectine times. A gradual process of cognitive development during the next several hundred thousand years via Archaic H. Sapiens 300,000 BP (Aitchison, 2000) culminated in full language abilities by approximately 150,000 years BP, the time when H. Sapiens was reaching its current state of development (Klein, 2002). Prior to the exodus of H. Sapiens from Africa or west Asia, approximately 60,000 years BP, there was a period of around a hundred thousand years during which H. Sapiens was resident only in these locations. Modern genetic studies suggest that during this period the gene exchange taking place was sufficient to produce the relatively uniform human genome and range of psychological attributes that exist today, including of course, the capacities for language and cognitive dissonance and any detectable bias in its expression.

Predictions

Assuming the correctness of the hypotheses proposed in this section, it is possible to make a number of prediction about the noticeability of contradictory cognitions.

1. Those concerned with survival related subject matter should be more noticeable than others unrelated to this subject or reproduction.

2. Those concerned with reproduction related subject matter should be more noticeable than others unrelated to this subject or survival.

3. Those that have short term relevance to these subjects should be more noticeable than those having long term relevant.

4. Those explicitly expressed should be more noticeable than those that are implied.

This thesis explores the relative noticeability of these types of contradictions. In order to obtain a large effect, the non-survival and non-reproduction subject matter was chosen to be abstract.

METHOD

Participants

Three independent sets of participants were recruited, the first for an assessment of proposed stimulus material, a second for the reading time trials and a third for a further post-hoc assessment of the stimulus material actually used in the reading time trials.

The first set consisted of 62 participants, a mixture of students and university staff, both academic and non-academic, recruited as a panel of convenience.

For the second set of participants, an effort was made to improve the ecological validity of the results and conclusions by obtaining a slightly more representative section of society. The minimum number of participants to be recruited in accordance with the 2 X 2 X 3 (=12 cells) design (see below), for a reasonable level of power (around 80%) and for a small to medium effect size, was determined to be 80, 40 for the short term experiment and 40 for the long term one. In the event it proved possible to recruit 94 participants.

A mixture of methods was employed to recruit them. The management of two Wellington shopping malls permitted the researcher to approach customers in their food courts. A third refused permission. During a period from approximately noon to 2.00 pm, sole diners at the end of their meal were requested to participate. About 50 % percent agreed, most refusals coming from men. Four participants were obtained in this way on eight occasions. Attendance at a Psychology Department social meeting at the Wellington campus and an email circulated to Wellington based graduate students by the organising staff member resulted in about a dozen participants volunteering. Another staff member invited the author to address approximately 120 first year psychology students at a lecture as a result of which a further 14 participants were obtained . The remainder were obtained via the researcher's personal contacts.

The food court most frequently used is located in the Wellington CBD where employees can be assumed to be relatively well educated. Most of the other participants had tertiary educational qualifications or were in the process of acquiring them. Although some effort was made to extend participant recruitment across a wider section of society than was the case for the first panel, participants were nevertheless mostly positioned in the top half of the intelligence distribution.

The third set consisted of a panel of convenience of 68 participants recruited in a manner identical to the first one.

Experimental Design

To test the hypotheses proposed previously, it was decided to employ a design similar to that used by Huitema, Dopkins, Klin, and Myers (1993). They used a computer program to present one line of a narrative at a time on the screen whenever participants pressed the keyboard space bar. This process continued until the end of the trial text. Every time the space bar was pressed, the computer program recorded the computer clock time. By means of subtraction it calculated how long each line had been displayed to the participant. Their experiment established that when participants noticed an inconsistency between the expectations generated by one line and the meaning of a later one, participants tended to delay pressing the space bar when reading the later one.

The design of this experiment has a 2 (time scales: present and future) by 2 (directness: direct and implicative) by 3 (subject matter: life/death, reproduction and abstract) design. To require all types of contradiction to be assessed by participants would require 12 narratives to be presented to them. It was decided to intersperse non-contradictory narrative between the contradictory ones in order to minimise the possibility that participants would notice a pattern of contradictions after reading the first few. However, doing this in the most obvious way would result in participants having to read 24 narratives, requiring approximately half an hour of their time. It was judged that very few people would be prepared to participate if this was requested of

them. It was therefore reluctantly decided that a between subjects design would have to be adopted and that one of the factors would have to be split across two groups of participants. As the most important factors being tested are subject matter and directness, it was decided that the time scale would have to be split across subjects, one group reading narratives set in the present and the other reading narratives with some emphasis on the future.

Apparatus

A specially programmed laptop computer was used to display the narratives to participants as described below in the *Procedure* section. It stored all participants' Read Times for each line as each participant pressed the Space bar. These timings were subsequently transferred to a Personal Computer loaded with the SPSS, version 15, statistical analysis package, via a memory stick.

Stimuli

As one aim of this research was to determine whether there is a bias according to subject matter in humanity's ability to detect contradictions via the generation of cognitive dissonance, it was essential that the contradictions used in the different subjects' texts be of approximately equal contradictoriness of phrasing. It was an early discovery in this research that sentence pairs can easily be generated which contradict each other to various degrees. Because inequality of salience or degree of contradiction, (contradictoriness hereinafter), across the three subject areas would operate as a confound and invalidate any conclusions drawn from the data, it was decided to test the proposed pairs for equality of contradictoriness via some preliminary data gathering.

Candidate pairs of statements for the three subject areas of survival, reproduction and an abstract matter were placed in a survey distributed to a selection of well-educated participants. They were asked to assess the degree to which the candidate pairs of sentences contradicted each other on a Likert

scale, where 7 meant that a pair was completely contradictory and 1 indicated that there was no contradiction. Version 1 of the survey is included as Appendix A

Participants made constructive criticisms of the phrasing and version 2 is included as Appendix B. This correction process continued for several more iterations. However, by the time version 8 was being used, it was clear that a new form of discrimination was taking place. At least some of the participants would carefully assess any slight difference in the phraseology and mark any pair that was only slightly less contradictory, in their opinion, in the 1- 3 range, that is, of low contradictoriness. They were using the entire range of marks available, 1-7, to assess relative contradictoriness, rather than marking each one on anything like an absolute basis, despite instructions to mark them absolutely. It was therefore decided to alter the nature of the assessment by embedding the three subject pairs into a set of six, the new ones containing sentence pairs designed not to be contradictory. Any comparisons that were made between the six would therefore have a baseline of three pairs containing no contradictions against which to assess the contradictoriness of the three pairs of interest. In such an assessment, it was hoped that the three pairs of interest would be judged mostly in the 5-7 range and that all three would be so judged by roughly the same number of participants.

Appendix C shows the final version presented to 62 participants, a mixture of students and university staff, both academic and non-academic. Sentence pairs 2, 4, and 6 contain the contradictions and pairs 1, 3, and 4 are non-contradictory. Inspection of the returned forms strongly suggests that several participants marked the pairs in a reverse manner, namely, they marked the highly contradictory pairs in the 1-4 range and the non-contradictory pairs in the 5-7 range. Their markings were nevertheless included in the results shown as table 1 in the Results Section below.

Each narrative consisted of 11 lines. The neutral narratives not containing any contradiction consisted either of short stories or descriptions of a subject judged to be of some interest to participants. For contradiction containing

narratives, the two contradictory statements were inserted as lines 3 and 10, having therefore 6 lines of text between them. The intermediate lines were germane to the general subject area of the text but were designed to be neutral to the contradictions in lines 3 or 10.

Prior to commencing the read time trials, the contradictory statements intended for inclusion in the narratives were reassessed for relevance to the subjects, survival, reproduction and abstract being tested. The survival pair that had been tested in the first survey of contradictory pairs was judged to be insufficiently related to life and death as its contradiction related to whether the narrator had or had not any food. This pair was therefore replaced with another pair designed to be both contradictory and more immediately related to survival/life/death. The version included within the narratives as finally used appears in Appendix D.

In order to minimise possible confounds caused by physical variation in the appearance of the lines when presented on the screen of a laptop, each line of text was designed to include between 11 and 13 syllables and in so far as was possible, to subtend approximately equal angles upon readers' eyes when displayed on the computer screen.

The sequence in which the narratives were to be read was identified as a possible confound. To minimise any possible reading sequence effect, it was decided to present the narratives to participants via separate scripts in one of two sequences, A or B. Both sequences started with a non-contradictory narrative but the contradictory narratives were presented in different orders. Four scripts were therefore used, sequences A and B for each of the two time scales, present and future.

Procedure

Main Experiment

On consenting to participate, each participant was first requested to read the Ethics related Information Sheet (see Appendix E) giving an overview of the

procedure to be employed and listing the rights of participants. This study had been assessed as Low Risk. Participants were then asked to toss a coin to determine whether a present or future script would be employed; heads determined use of the 'present' script and tails the 'future' one. Prior to commencing the narrative reading, sex and an age assessment (above or below age 30) were recorded for each participant.

For the first 45 participants, one of the present or future scripts was used with the narratives in sequence A and for the remainder of the participants, narrative sequence B was used for each time scale. All scripts commenced with a six line practice narrative so that participants might familiarise themselves with the procedure.

A second method of contradiction detection consisted of a short questionnaire. After reading each narrative, participants were requested to provide short answers to four questions. The questions are included in Appendix D beneath the narratives to which they pertain. For all narratives, three were distracter questions relevant to the general subject matter. If there was an embedded contradiction, the fourth question was carefully designed to elucidate any detection of a contradiction. This question did not ask directly whether the participant had noticed one nor did the word 'contradiction' appear in the question. Rather, it was phrased in such a way as to provide the participant with the opportunity to state that one had been noticed or to enable the answer to be interpreted to indicate whether one had been noticed. Interpretation was not always necessary as participants were sometimes explicit in their statements that they had noticed a contradiction. That cognitive dissonance had been experienced was often indicated in such cases by the participant using the word 'confusing' when answering the relevant questions.

A third informal method of detection of cognitive dissonance consisted of noting changes of facial expressions when a contradictory line was read. Furrowed brows or tilts of the head were often observed. Occasionally, an oral comment was made. These were usually followed by an answer indicating that

the participant had observed a contradiction in the narrative that provoked the action.

Post-hoc Survey

Because the Survival related results (see below) were so contrary to expectations, consideration had to be given to possible explanations. As the Direct Survival pair had been changed from the original food related pair to one more related to life and death for the timing trials, one possibility was that some loss of contradictoriness had occurred as a result of the substitution. It was therefore decided to repeat the Contradictoriness Assessment trial with the Life/Death related sentence pair substituted for the food related pair that had been present in the first Assessment. A table of the findings of this assessment appear in the Results section.

RESULTS

Data Screening

The result of the first assessment of contradictoriness of the pairs of sentences, each designed to be contradictory or not contradictory, is shown in Table 6. A mark of 1 was requested from 62 participants where they judged the pair not to be contradictory and a mark of 7 was requested where the pair were judged to be completely contradictory. The purpose of the assessment was to ascertain whether participants placed the pairs into the same designated categories as motivated their composition, namely contradictory or non-contradictory. Scores in the range of 5 - 7 were decided upon as an indication that participants regarded a pair as having a high degree of contradictoriness and so scores in the range of 1 - 4 necessarily indicate a lower degree of contradictoriness or none at all.

Table 4.
Results of the first Survey of Contradictory pairs for 62 participants

Pair #		Pair Text	# of people marking in the range 1 to 4	# of people marking in the range 5 to 7	Mean Scores (SD)	Sequence of Contradictori-ness
1	1.	I think housework is tedious and uninteresting.	46	16	3.03 (1.78)	
	2.	I enjoy living in a house kept clean and tidy.				
2	1.	We very much do want to have lots of children.	8	**54**	**6.03 (2.09)**	Greatest (Reproduc-tion)
	2.	We very much don't want to have any children.				
3	1.	I intensely dislike driving all types of cars.	38	24	3.81 (1.57)	
	2.	I prefer driving automatics to manual shift cars.				
4	1.	For all jobs I use the same method every time.	14	**48**	**5.56 (2.24)**	Middle (Abstract)
	2.	For all jobs I change the method every time.				

5	1. I believe newspapers slant the news as their owners dictate. 2. I'm annoyed by newspaper articles that ignore important facts.	53	9	2.75 (1.6)		
6	1. I ate the last of my food over a week ago. 2. Luckily, I still have some of my food left.	15	**47**	**5.24 (2.21)**	Least (Survival)	

Note. Standard Deviations are in parentheses

Despite the apparent confusion of some participants who appeared to mark in a way opposite to that requested, the three pairs of statements designed to be contradictory, 2, 4, and 6 in the table, were so assessed by approximately equal numbers of participants and by consistently more than the non contradictory pairs, pairs 1, 3 and 5.

The difference between the scores awarded to the reproduction pair on the one hand and the similar scores awarded to the survival food related and abstract job related pairs on the other may have been more important than was appreciated at the time that these results were obtained. The reproduction pair are closer to the canonical form of A=B and A=~B than are the other two pairs. See the paragraph titled *Post-hoc Analysis of Replacement Survival Items* below for further discussion.

The Reading Times for line 10 (the target line) of each contradiction containing narrative were interpreted as the main indicator of the generation of cognitive dissonance. The RTs for these lines were assessed via SPSS, version 15, for normal distribution. Q-Q plots and histograms were produced for each class of contradiction type. Upon examination they revealed that the captured data did not exhibit large deviations from normality.

Reading Time Analyses of Contradiction Noticeability

The Descriptive Statistics feature of SPSS, version 15, and supplementary figures calculated via Microsoft Excel, version 2000, yielded the summary figures appearing in Table 5.

Table 5.
Mean and Standard Deviations of RTs for different Subject Types and Categories

	Subject Type and Directness					
	Survival		Reproduction		Abstract	
Time Scale	Direct	Implied	Direct	Implied	Direct	Implied
Present	3138	2587	4402	3140	3912	2700
	(1288)	(676)	(1473)	(1401)	(1696)	(999)
Future	3359	2776	3679	3136	4422	2761
	(1219)	(823)	(1486)	(1340)	(2064)	(855)

Note. *All times are in milliseconds. Standard Deviations are in parentheses*

Contradictions as indexed by length of RTs were more frequently noticed in narratives containing a direct or explicit contradiction than in narratives containing an implied contradiction for all subject types, as predicted, with a mean percentage difference of 34%. In all subject types, standard deviations were lower for Implied Contradiction than for Direct ones. Contrary to expectations, Survival related contradictions were less noticeable than Abstract ones except for the Future Implied category, for which they were very nearly identical.

A further unexpected result was the greater average RT for the future-oriented pairs, although the difference was found not to be statistically significant (see below).

In accordance with predictions, reproduction-related contradictions were more noticeable overall than were abstract ones although the overall most noticeable category was Future Direct Abstract, a surprising result as both the future and abstract nature of this pair was predicted to reduce its noticeability.

Standardised Reading Times

As the mean RTs produced an unanticipated result, Survival-related contradictions being less frequently noticed than Abstract ones, the reading

times in Table 7 were standardised to throw into relief the differences in mean reading times between the different Subject Types

The adopted standardisation process consisted of dividing the RTs of line 10, the contradiction containing line, in each contradiction-containing narrative by the mean of the RTs of the first 9 lines of all narratives, for each participant. Line 11 RTs were omitted from this calculation for the same reason as Huitema et al. (1993) who surmised that there may be a carry-over effect from line 10 to line 11, that is, any cognitive dissonance generated by the contradiction in line 10 may still be present in the minds of participants when reading line 11 and extend the RT for line 11.

The result is the ratio of contradiction RTs to non-contradiction RTs for each narrative for each participant, eliminating differences in overall reading speed for a particular narrative from any consideration of the two categories of RTs. It provides better visibility to the subject related differences in RTs than the absolute times provided in table 5. Table 6 shows the mean of these ratios across all participants for the different categories of Subject Type. Numbers in excess of 1 indicate longer RTs for particular contradictory statements than for non-contradictory ones, i.e., they are more noticeable.

Table 6
Standardised RTs for the different Subject Types.

	Survival	Reproduction	Abstract
Direct	1.18	1.48	1.50
Implicative	0.97	1.12	0.99

The Direct Survival figure of 1.18 contrasts substantially with the 1.48 and 1.50 values obtained for Direct Reproduction and Direct Abstract respectively and also highlights the difference between the Direct and Implicative RTs across all subject types although the difference is lower for Survival than for the other two subject types. Surprisingly, the Implicative Survival and Implicative Abstract contradiction RTs are shown on average to be marginally lower than the non-contradiction RTs.

Comparison with Huitema et al. (1993)

Huitema et al. (1993) calculated the difference between mean reading times for the contradiction containing target lines and the non-contradiction containing target lines to highlight the difference. Similar calculations were conducted for this study to ascertain if their results was replicated. All results are shown in Table 7.

Table 7
Mean Read Times of Non-Contradictory and Contradictory Target Lines

	Reading Times		
	This Study		Huitema et al. (1993)
	Means	SDs	Means
Non-contradictory target lines	2,913	1,059	1,397
Contradictory target lines	3,336	1,449	1,660
		Percentages	
Difference between Means	14.5		18.8

Notes. All times are in milliseconds. Huitema et al.(1993) did not give SDs for their Read Times nor distinguished between time frames. The comparison is made with Experiment 2 of Huitema et al.(1993), the one nearest in method to this study. In their experiment 2, the number of text lines separating inconsistencies varied but averaged 4.7. In this study, 6 lines were used uniformly.

The difference in the number of text lines separating inconsistencies and the difference in mean RTs between the Huitema et al. (1993) study and this one have been used later to suggest an instrument in which could be used to investigate implicative contradictions more finely (see below).

Inferential Statistics

A Between Groups ANOVA analysis was conducted with the SPSS, version 15, package to check whether there was any statistically significant Sequence effect for the Narrative Sequences A and B described in the Method Section. The result, $F < 1$, indicated that there was no such effect. All subsequent Results calculations ignored the sequence in which RTs were obtained.

A further examination failed to detect a statistically significant main effect for the two time frames, Present and Future, with $F < 1$.

A main effect of Subject type was found to be statistically significant: F (2, 92) =16.152, p <.001, $\eta^2 p$ =.149, SP = 1.0.

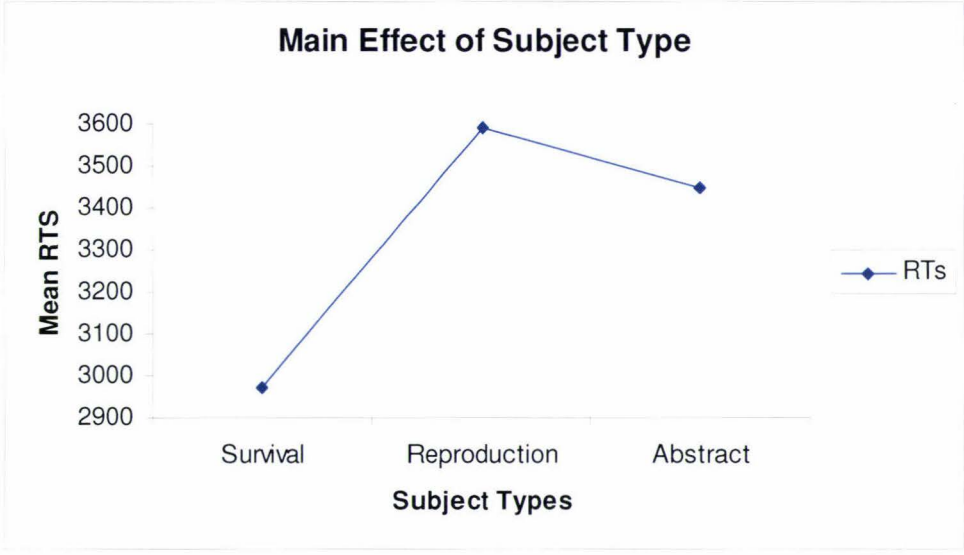


Figure 6. Graph showing the main effect of Subject Type

The graph of the mean RTs of each subject type provided in figure 6 illustrates the expected higher Reproduction RTs relative to the Abstract ones but also shows the unexpected low values of Survival RTs relative to the Abstract RTs.

A main effect of Directness was found to be statistically significant: $F(1,92)$ = 97.624, p < .001, $\eta^2 p$ =.515, SP = 1.0. This is illustrated in figure 7 with Implicative RTs significantly lower than Direct/Explicit ones, as predicted.

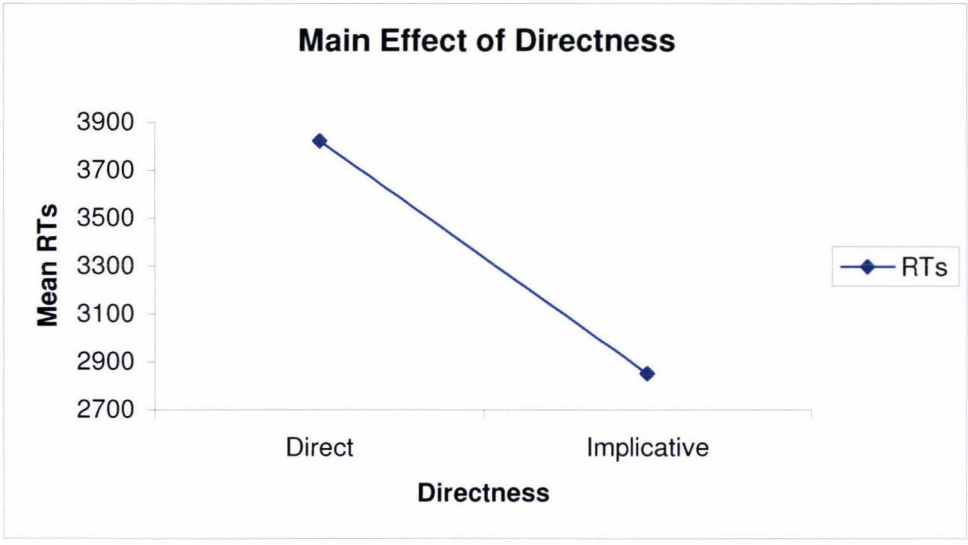
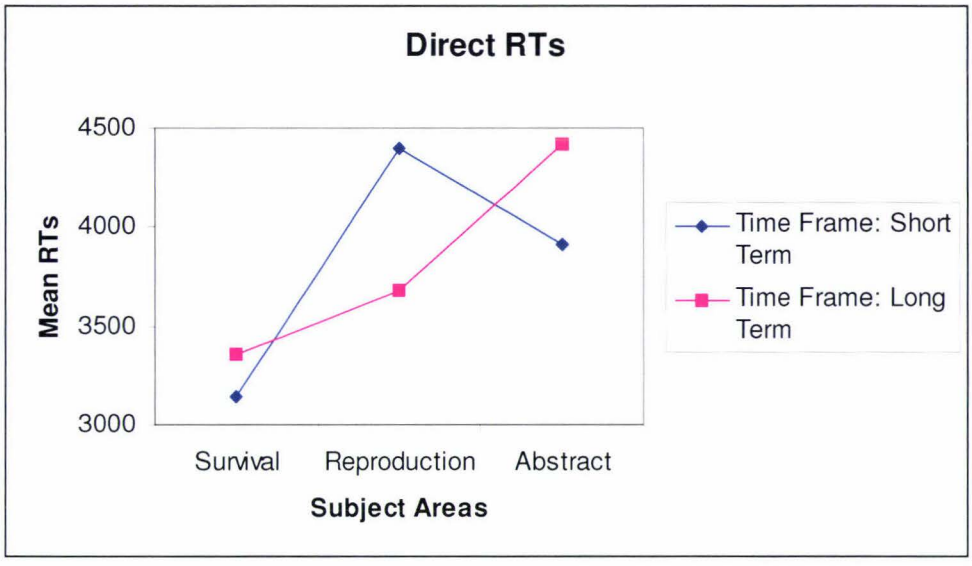


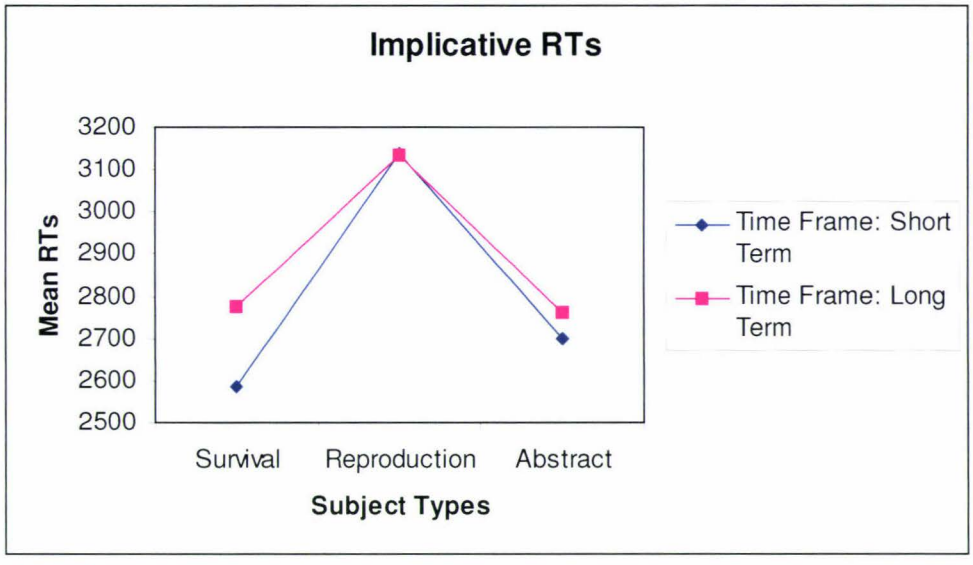
Figure 7. *Graph showing the Main Effect of Directness.*

A Between/Within Groups ANOVA analysis was conducted with the two levels of Time Frame (Present and Future) constituting the Between Groups factors and three levels of Subject type and two levels of Directness constituting the Within Groups factors.

The Mauchly Test for Sphericity indicated that although there was no violation of sphericity for Subject, there was for Subject X Directness. In accordance with recommendations of Pallant (2007), the statistical significance of any interaction was consequently assessed according to the Greenhouse-Geisser line of the SPSS output, which indicated that the three way interaction of Subject Type X Directness X Time Scale was statistically significant: F (1,92) = 3.561, p = .037, η^2p = .037, SP = .611. This interaction is illustrated graphically in figure 8.



Graph 1



Graph 2

Figure 8. Graphs showing RTs for the three levels of Subjects, two of Time Frame and the two of Directness

The striking result in figure 8 illustrated by the graphs is the contrast between the pattern of RTs for each of the subject types. Similar RTs for Survival are observed for both levels of Time Frame for a given level of Directness, although contrary to expectation, Future RTs are slightly greater than Present ones. For Reproduction, the move from Direct to Implicative has the predicted effect of reducing RTs for both levels of Time Frame but does so to a different degree. For Direct, the RTs are much lower for Future than for Present, as predicted, while for the Implicative, they become identical. A third pattern is

observed for the Abstract subject. Unlike Reproduction but like Survival, for both levels of Directness, Future RTs are higher than Present ones, contrary to expectation. In the change from Direct to Implicative, RTs for both levels of Time Frame fall, in accordance with expectation, but the difference between RTs for the two levels of Time Frame changes from a mean of .51 secs for Direct (Figure 8, Graph 1) to a mean of .061 secs for Implicative, (Figure 8, Graph 2).

There was an interaction of Subject X Time Frame, which was found to be statistically significant: $F(1,92) = 4.862$, $p = .009$, $\eta^2p = .05$ $SP = .788$. The interaction is illustrated in figure 9.

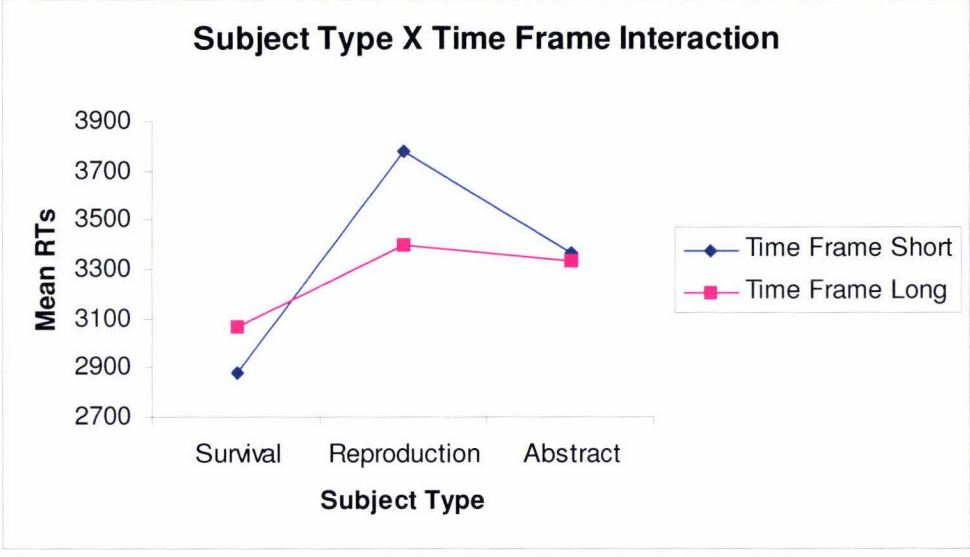


Figure 9. Graph showing the interaction of Subject Type X Time Frame.

For Survival, Long Time Frame RTs are greater than the Short ones, contrary to expectations. The change of Subject Type from Survival to Reproduction was both to increase the RTs (noticeability) and to reverse the relative noticeability for the two levels of Time Frame. The change of subject from Reproduction to Abstract is to reduce the difference in RTs for the two levels of Time Frame, making them almost identical.

There was an interaction between Subject and Directness which was found to be statistically significant: $F(1,92) = 7.610$, $p = .001$, $\eta^2p = .076$, $SP = .917$. The interaction is illustrated in figure 10.

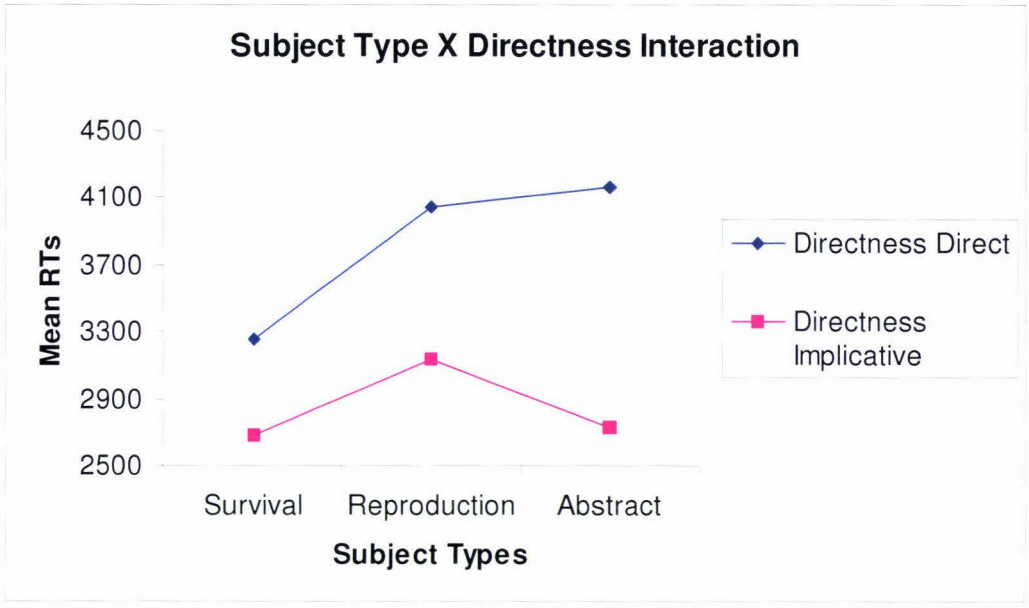


Figure 10. Graph showing interaction of Subject Type X Directness

The RT difference between the two levels of Directness is relatively small for Survival, larger for Reproduction and larger again for Abstract. In addition, the graph shows the Direct RT for Reproduction as lower than the Direct RT for Abstract while for the Implicative equivalents, the Reproduction RT is greater than the Abstract one.

No significant interaction between Directness and Time Frame was detected with $F < 1$.

Two further Between/Within Groups ANOVA analyses were conducted, the Between Groups factors being Age (below and above aged 30) and Sex (male and female), and the Within Group factors being Subject type and Directness as before. No significant effect was found for the two levels of Age: $F < 1$, or for the two levels of Sex: $F\ (1, 92) = 2.17$, $p = .145$, $\eta^2p = .033$, $SP = .306$.

Analysis of Self-Reports of Contradiction Noticeability

An analysis of the 94 questionnaire sheets was made to assess the extent to which recorded answers indicated that a contradiction had been explicitly noticed. For each narrative containing a contradiction, the third question was

phrased to give participants the opportunity to reveal whether the contradiction had been noticed. Table 8 shows the number of answers, interpreted as described in the Methods section, which indicated that contradictions had been noticed, for the various categories of narrative.

Table 8.
Number of contradictions detected as interpreted from answers provided during the question and answer session following each narrative reading.

Subject Type	No. of Contradictions Noticed		
By Directness			
Direct Reproduction	36	Total	87
Direct Abstract	36		
Direct Survival	15		
Implicative Reproduction	20	Total	40
Implicative Abstract	14		
Implicative Survival	6		
By Subject			
Direct Reproduction	36	Total	56
Implicative Reproduction	20		
Direct Abstract	36	Total	50
Implicative Abstract	14		
Direct Survival	15	Total	21
Implicative Survival	6		

This result supported the result obtained by recording RTs, namely that Reproduction related contradictions were the most frequently noticed and Survival related ones were the least. Also, as predicted, the Implicative contradictions were consistently less frequently noticed than the Direct ones in all subject categories.

Post-hoc Analysis of Replacement Survival Items

Because the Survival related results were so contrary to expectations, consideration had to be given to possible explanations. As the Direct Survival pair had been changed from the original food related pair to one more related to life and death for the RT trials, one possibility was that some loss of contradictoriness had occurred as a result of the substitution. It was therefore decided to repeat the Contradictoriness Assessment trial with the Life/Death related sentence pair substituted for the food related pair that had been present in the first Formal Assessment.

The results appear below, showing the new survival related pair being judged less contradictory than the others, despite having been designed and originally considered to be at least as contradictory as the Abstract pair.

Table 9.
Results of the second Survey of Contradictory pairs for 68 Participants

Pair #	Pair Text	# of people marking in the range 1 to 4	# of people marking in the range 5 to 7	*Average Scores* (SD)	Sequence of Contradict-oriness
1	1. I think housework is tedious and uninteresting. 2. I enjoy living in a house kept clean and tidy.	56	12	2.60 (1.71)	
2	1. We very much do want to have lots of children. 2. We very much don't want to have any children.	3	**65**	**6.68** (.836)	Greatest [Reproduc-tion]
3	1. I intensely dislike driving all types of cars. 2. I prefer driving automatics to manual shift cars.	49	19	3.25 (2.03)	

4	1. For all jobs I use the same method every time. 2. For all jobs I change the method every time.	7	**61**	**6.34** (1.24)	Middle [Abstract]
5	1. I believe newspapers slant the news as their owners dictate. 2. I'm annoyed by newspaper articles that ignore important facts.	64	4	2.19 (1.36)	
6	1. Several times I thought I was about to die. 2. I never once believed my life was in danger.	15	**53**	**5.57** (1.86)	Least [Survival]

Note. Standard Deviations are in parentheses ().

DISCUSSION

Main Effects and Interactions

This thesis was designed to explore the cognitive dissonance generated by reading contradictory statements separated by a standardised interval of intervening lines. Several sensitivities were explored; to subject matter, implicitness and timeframe.

The evolutionary importance of survival and reproduction was hypothesised to have led over evolutionary time to a greater sensitivity to contradictory information related to these subject matters relative to abstract ones. It was consequently hypothesised that survival and reproduction related contradictions would generate cognitive dissonance (CD), as indexed by length of RTs, more frequently than abstract ones for each level of Directness and Time Scale. The surprising result that for both levels of Directness, Survival related CD, as indexed by RTs, was generated less frequently than Abstract related CD calls for an explanation. Also, for the Direct Level of Directness, Abstract related contradictions were more frequently noticed than Reproduction related ones although this order was reversed for the Implicative level of Directness, the latter being in accordance with predictions.

The following factors are discussed in turn as possible explanations for the surprising Survival results;

1. an ability to process life/death issues particularly fast using some mechanism that works faster than for other subject matter,
2. the unimportance of survival related matters,
3. the phrasing of the contradictory sentences themselves,
4. emotional factors related to death.

A Particularly Fast Module for Processing Survival Related Contradictions

Le Doux (1998) has researched the anatomy of a fast acting mammalian module for initiating flight from life-threatening circumstances. The mechanism is non-verbal and performs only the very limited function of

initiating the physical activity of flight prior to full assessment of the nature of the danger achieving this in as little as 12 milliseconds in some species. The full assessment takes place both later and more slowly via normal cognitive mechanisms of object recognition. There is no obvious reason why selective pressures should have caused the evolution of a fast acting verbally based mechanism in humans, given that a substantial time could typically elapse between the arrival of the two contradictory pieces of information. In addition, decisions taken on the basis of verbal contradiction are unlikely to yield any advantage by being taken on a very fast time scale, indeed the opposite might be the case. The nature of the stimuli used in this thesis were both verbally based and devoid of urgency in the sense that they related to the recent past or future but not the immediate present. It seems very unlikely that the Survival related results reported in this thesis could evidence the existence of a fast acting survival-related language processing module.

This conclusion is supported by the pattern of answers that emerged from the questionnaire during the narrative reading sessions. Table 10 shows that the subject related pattern of contradiction noticeability obtained from the reading times was repeated when participants were given the opportunity to state whether they had detected a contradiction. Participants were not under any time pressures when answering the relevant questions. As the patterns of answers across subject areas and Directness are the same as for RTs, the most obvious conclusion to draw is that both mechanisms measure only noticeability. To suggest that RTs index both speed of detection and noticeability while the questionnaire answers reveal only the latter would be to abandon parsimony.

The Unimportance of Survival Related Contradictions

The idea that survival related contradictions would be of relative unimportance is inherently implausible and Nairne, Thomson, and Pandeirada (2007) report on work that suggests the opposite. They hypothesised that evolution may have 'tuned' memory to fitness relevant information and investigated this possibility. Their participants were divided into three groups, the experimental group who were required to assess a set of 30 words, e.g., juice, soccer, bear,

for relevance to survival, and two control groups required to assess the same words for relevance to moving home to a foreign country or general pleasantness, the authors claiming that the latter is a standard deep processing control, exploiting the semantic level of the Craik and Lockhart (1972) Levels of Processing model of memory. After a distraction period, the participants undertook a surprise memory recall test of the 30 words. The experimental group performed significantly better in the recall test than either control group. In a second within-groups experiment, they asked participants to assess half the words for relevance to survival and half for moving home. As in experiment 1, participants undertook a distraction activity and were then given a recall test. The scores for the survival assessed words were significantly higher than those for the control condition. Similar experiments were carried out for recognition memory, experiment 3 being similar to experiment 2 and experiment 4 using self-reference (how relevant is each word to you?) as the control condition. Both these latter experiments demonstrated better memorisation of words related to survival than any of the control conditions.

Nairne and Pandeirada (2008) report on this and other experiments that produced equivalent results. They suggest that human memory systems do possess design features tuned to particular selection pressures, survival related events and circumstances being one among several. However, in listing survival related subject areas they mention "food (edible vs inedible), water, shelter, medicinal plants, predators, prey" (p. 241) but do not mention life or death explicitly or their synonyms. The omissions of these two essential aspects of survival may be highly significant. (See Emotional Factors section below.)

The originally proposed Survival contradictions related to food, (table 6) may have fared better than the versions actually used (table 12). The number of people marking the food related contradiction in the 5 –7 range, at 47, was very close to that of the abstract one, at 48, although the food related pair could, in the light of possible sensitivity to phrasing discussed below, be considered considerably less direct than the abstract pair.

It is suggested that Nairne et al. (2007, 2008) have demonstrated a heightened ability to retain in memory matters of survival relevance and, this being so, there is unlikely to have evolved any opposing mechanism which would diminish cognitive processing of specifically survival related contradictions.

Sentence Phrasing

The survival-related results invite very close scrutiny of the phrasing of the contradictory pairs, reproduced for convenience in table 10.

Table 10.
Pairs of Contradictory sentences used in the Narrative Reading experiment, with ratio of mean RT to lowest mean RT (Present Implicative Survival).

	Direct		Implicative	
Subject Type				
	Present/Short Term			
Survival	1. Several times I thought I was about to die	(1.21)	1. He knows the end is not very far away.	(1.00)
	2. I have never once believed my life was in danger		2. His recovery will take quite a long time.	
Reproduction	1. We very much do want to have lots of children.	(1.70)	1. Our family has had infertility problems.	(1.21)
	2. We very much don't want to have any children		2. We're convinced conception will happen this week	
Abstract	1. For all jobs I use the same method every time.	(1.51)	1. He has no idea what he wants to do.	(1.04)
	2. For all jobs I change the method every time.		2. He thinks he knows what to do with his time	
	Future/Long Term			
Survival	1. Several times I'll think I'm about to die	(1.31)	1. Patients know the end will not be far away.	(1.07)
	2. I will never think my life is in danger		2. Their recoveries will take quite a long time.	
Reproduction	1. We will definitely have children some time.	(1.42)	1. Our family has had infertility problems.	(1.21)
	2. We will definitely never have any children.		2. Conception will happen whenever we want.	

Abstract	1. For all jobs I'll use the same method every time 2. For all jobs I'll change the method from last time	(1.71)	1. He's not giving any thought to what he might do. 2. He already knows what he'll do with his time.	(1.07)

Note. Bracketed figures are the ratios of mean RTs to that of Short Term Survival Implicative

The most salient points of the table 10 and graphs in figure 8 demanding an explanation are the following

1. The lower Survival related RTs relative to the other two subject areas for the Direct contradictions for both levels of time frame,
2. The reversal of positions of the Direct Reproduction and Abstract RTs, in the Graph 1 of figure 8 for the two Time Scales.
3. The different shapes of the graphs 1 and 2 in figure 8, showing the Subject X Time scale X Directness interaction.

The possible wording differences are examined below to ascertain if these could, at least partially, explain these unanticipated results.

Survival Related RTs Lower than the Other Two Subject Areas

In the Reproduction contradictions, a close examination reveals the following comparisons of the wording

" …..do want…." versus "….don't want….." (Direct Short term)

"……have children….." versus "…..never have children…." (Direct Long Term)

The Abstract contradiction wording is

"…… I use the same ….." versus "…. I change the …." (Direct Present/Short Term)

"…… I'll use the same ….." versus "….I'll change the …." (Direct Future/Long Term)

These appear nearer the canonical form mentioned earlier (A= B, A= ~B) than the Survival equivalents

"....I thought I was about to die" versus "....never once believed my life was in danger." (Direct Present)
".....I'll think I am about to die" versus "....never think my life is in danger" (Direct Long Term/Future

The greater closeness of the manifest phrasing of the non-survival related contradictions to the canonical form would appear to provide at least a partial explanation of the lower noticeability of survival related contradictions. Indeed this finding suggests a greater sensitivity to the manifest form of a contradiction than was appreciated at the time of their composition.

The Reversal of Positions of the Direct Reproduction and Abstract RTs, in the Graph 1 of figure 8 for the Two Time Scales.

The most noticeable contradictions, viz,
" .....do want...." versus "....don't want....." (Reproduction Direct Short term)
"..... I'll use the same ....." versus "....I'll change the ...." (Abstract Direct Future/Long Term)

appear to have a higher noticeability as indicated by higher RTs of about .5 sec than

".....will definitely have....." versus "..will definitely never have....." (Reproduction Direct Future)
"..... I use the same ....." versus "....I change the ...." (Abstract Direct Short Term/Present)

The differences in phrasing all appear negligible and seem unlikely to be able to account for the differences in RTs, undermining to some degree the suggestion of sensitivity to phrasing made above. A few Direct Future

Abstract RTs appear to be particularly high and so may have had a disproportionate effect. At present no other suggestion seems available to explain the reversal. Further research might show that it is simply a chance anomalous result.

The Different Shapes of the Two Graphs in Figure 8, Showing the Subject X Time Frame X Directness Interaction.

Graph 2 of figure 8 indicates that both the Implicative Reproduction contradiction, viz

"....has had infertility problems" versus "....conception will happen this week" (Short Term)
"....has had infertility problems" versus "....conception will happen whenever we want" (Future)

have the same RTs as each other and approximately .4 sec higher than

"....the end is not very far away" versus ".recovery will take quite a long time" (Survival Short Term)
"....the end will not be far away" versus ".recoveries will take quite a long time" (Surv. Long Term)
"....no idea what he wants to do...." versus "....know what to do...." (Abstract Short Term)
"....not giving any thought ....." versus "....already knows....."(Abstract Long Term)
all of which have approximately the same mean RTs.

None of these six phrasings appear to be nearer a canonical form than any of the others, **providing support for the main hypothesis underlying this thesis**, namely, that there is a subject related sensitivity to contradictions, in particular, reproduction related ones. However, the evidence for this conclusion has been provided only for implied contradictions. The contrast between this result and the result of the Direct contradictions suggests that phrasing differences are more important to the noticeability of contradictions

than differential sensitivity to subject matter. This in turn implies that sensitivity to subject matter will manifest itself only when differences of phrasing have been eliminated. Uncertainty surrounding this issue may be resolved by further research.

The Present and Future Implicative contradictions for each subject type are approximately equal as shown on graph 2 of figure 8. The major difference between the two graphs is the reversal of Present and Future Reproduction and Abstract RTs visible in graph 1 and discussed above which is not seen in graph 2. Given the support for the reproduction sensitivity shown in graph 2 and the apparent anomalous change shown in graph 1, it is suggested that the same anomalous result detected in graph 1 is manifesting itself in the Subject X Time Scale X Directness interaction. In other words, the same anomalous result is still manifesting itself when all three factors are assessed simultaneously because the two levels of the third factor Directness do not compensate for it

Emotional Factors

In support of the implausibility of survival related contradictions being less important than other contradictions is the Terror Management literature, which examines the emotions generated, and the behavioural effects of these, when considerations of mortality are forced upon experimental participants. Pyszczynski, Greenberg and Solomon (1999) propose a dual-process model of defences against mortality salience. They propose that proximal defences can be used to remove conscious death related thoughts from attention either by suppressing such thoughts with distractions or by pushing the problem of death into the distant future. Promising to diet or starting an exercise program, or "focusing their attention on whatever evidence there might be to support long life expectancy" (p. 841) are provided as example proximal defences which have the necessary distractive effect. The second part of their model consists of what they call distal and unconscious defences, the employment of symbolic cultural conceptions of oneself and reality, e.g., positing forms of lengthy or even eternal existence, as ways of dealing with the unconscious knowledge of the inevitability of death. Relevant cultural concepts would

include religious beliefs of life after death or the creation of secular institutions such as foundations or named buildings.

Of relevance to the experiment reported on here are the proximal defence mechanisms. The attention of participants was explicitly drawn to their own deaths in the survival contradiction, one line of the narrative emphasising the possibility of death and the other mentioning it. The method of experimentation also provided a mechanism of distraction, namely, pressing the space bar. Such an elementary action, one with which each participant was fully familiar by this time, provided participants with the means to divert their attention to the content of the next line of the narrative. Experience with previous narratives would have indicated that the content of the narrative lines following the current one mentioned something different. The means to avoid further focused attention ones own death were therefore readily available – press the space bar quickly. It is suggested that this means of avoidance was employed at least to some degree and provides a possible but partial explanation for the relatively short survival related RTs.

Directness

It was hypothesised that the nearer to the canonical form (A=B and A=~B) two contradictory sentences are, the easier it will be for the cognitive mechanism that recognises them to do so. This hypothesis is based upon another, namely, the cognitive mechanism that compares the meaning of two contradictory sentences has to transform the meanings into a representation nearer canonical form in order for the contradiction to be recognised. It follows that the greater the distance of the manifest forms of the two sentences from this canonical form, the more likely is the transformation to fail leading to a lower likelihood of contradiction detection and generation of CD.

As greater cognitive effort in the form of such transformation is necessary for implied contradictions than for more direct or explicit ones, it was hypothesised that the former would generate fewer cases of CD than for the latter. This predicted result was obtained, **providing some evidence for the hypothesised mechanism.**

Time Frame

The greater mean RTs for the Future related contradictions was surprising but because no statistically significant effect for the two levels of Time Frame was found, an explanation is not considered formally necessary. Nevertheless, given the result in the direction opposite to that expected, an examination of the texts for the two levels of Time Frame permits two possible conclusions:

1. The original hypothesis proposing some sensitivity to immediacy is false, although the Terror Management literature suggests otherwise in the case of death/survival related matters.
2. The phrasing employed did not adequately contrast the immediate from the remote future.

Further research could elucidate these conclusions.

The Method Adopted for this Experiment

Many of the experiments described in the Review of Cognitive Dissonance section explored dissonance resulting from conflict either between actions and belief/attitudes already held prior to commencement of the experiment e.g., the Cohen (1962) experiment in which Yale students wrote counter attitude essays about the recent action of local police, or between actions and belief/attitudes generated during the experiment, e.g., the Festinger and Carlsmith (1959) experiment in which participants carried out a boring task.

In the experiment reported on in this thesis, the experiment was similar to the latter in that a belief about a given situation was generated during the reading of line 3 of a narrative. This was retained in memory, as was the case in the Festinger and Carlsmith (1959) experiment, and was available to be compared with the later contradictory line, rather than with an action as was the case in the cited examples. The experimental design employed for this thesis is thus seen to be different in some respects from most others that have been used to explore CD. There are a number of justifications for this.

The Huitema et al. (1993) method was adopted precisely to generate dissonance from comparing two ideas expressed directly near to and deliberately some distance from the canonical forms of contradiction explored in the Review of Cognitive Dissonance section.

The reading of texts by participants ensured that no confounding emotions such as guilt were introduced by an action. Because the participants were in one sense observers of a scene, rather than actors in it, only propositional dissonance, as defined in the earlier section, could be generated.

A secondary means of detecting dissonance was introduced, whereas the measurement of CD in the experiments described earlier had only one. Besides the measurement of extended RTs, participants were provided with an opportunity to comment on the contradictory lines. As noted in the Method section, they frequently indicated dissonance by means of various facial expressions and furrowed brows and their remarks such a 'What!', 'Sounds strange' or 'Confusing'. As noted in the results section, the pattern of these observations supported that obtained from the RTs although these observations themselves were not used for formal analysis.

The claim is therefore made that this experimental paradigm gets closer to the original Festinger (1957) concept of the comparison of contradictory ideas or cognitions than paradigms employing actions and previously held attitudes.

An Instrument for Measuring Implicative Contradictoriness

All RTs for the implicative contradictions are shown in Table 5 and figure 7 to be shorter than their Direct equivalents, supporting the prediction that the further from the canonical contradictory form, the less likely is a contradiction to be noticed. There appears not to exist any theoretically based way to predict from the phrasing of an implicative contradiction how easily its contradiction will be noticed, or alternatively phrased, how much cognitive effort is required to notice it. In the absence of a theory based instrument, it may be possible to construct a pragmatic one. The means of detection of cognitive dissonance

used in this experiment was adapted from that used by Huitema et al (1993). Their result as shown in table 9 indicated a mean increase in RTs of 18.8% for contradictions over non-contradictions whereas the equivalent figure for this experiment was 14.5%. The explanation for the greater noticeability of their contradictions probably lies in the lower average number of intermediate lines of text between the contradictory sentence pairs in their narratives at 4.7 compared to a standardised 6 in this experiment.

This difference suggests a practical method of creating an instrument for measuring the degree of cognitive processing required to notice an implied contradiction. The idea is based upon the median lethal dose, LD_{50} (abbreviation for "Lethal Dose, 50%") of a toxic substance or radiation, this being the dose required to kill half the members of a tested population. The proposed adaptation consists of measuring the noticeability of a contradiction and associated cognitive difficulty by ascertaining how many lines of neutral text can be placed between two implicative contradictory sentences such that exactly half or some other standardised proportion of a representative sample population of participants notices the contradiction. One or more methods of assessing whether participants have noticed the contradiction could be used, e.g., RTs and questionnaires as used in this thesis or, more adventurously, fMRI observation.

If the instrument were to be used to assess differences in the noticeability of contradictions according to subject matter, the findings reported here suggest that crafting the phrasing such that subject matter sensitivity was being measured rather than phrasing differences would be challenging but not impossible. However, provided sufficient care was taken, it might be possible to measure the sensitivity to subject related contradictions with a reasonably objective instrument. It is a prediction that should such carefully phrased contradictions be created, those related to survival and reproduction would have a higher score of interpolated neutral sentences than those related to other matters. However, the experiment reported in this thesis implies that the survival related contradictions would have to cover the subjects suggested by Nairne et al. (2008) rather than death or even life explicitly.

Summary of Results

In the Introduction and Predictions section, four predictions were made. Each of these is reviewed below.

Contradictions concerned with survival related subject matter should be more noticeable than others unrelated to this subject or reproduction.

This prediction was not supported either for Direct or Implicative contradictions, possibly because of an emotional confound.

Contradictions concerned with reproduction related subject matter should be more noticeable than others unrelated to this subject or survival.

The prediction was supported for Implicative contradictions but not for Direct ones.

Contradictions that have short term relevance to these subjects should be more noticeable than those having long term relevant.

This prediction was not supported. It is possible that the phrasing used may not have sufficiently contrasted an immediate present with a remote future.

Prediction explicitly expressed should be more noticeable than those that are implied.

This prediction was supported for all categories of subject type and time frame.

Concluding Remarks

In exploring an evolutionary theme, this thesis may be regarded as a first step towards the creation of an instrument which assesses the ability of the human

mind to detect contradictions according to variation in subject matter. It may also be regarded as an exploration of the degree to which the mind is sensitive to variation in phrasing across a directness/implication spectrum. With further research, objective instruments may be created which permit these two variables to be more deeply explored and the interaction between them perhaps fully determined.

APPENDICES

Appendix A - First Versions of Contradictory Pairs

Present/Short Term Time Frame

Pair 1

I am quite confident that we can have children.
I really worry that we may not both be fertile.

Score.....

Pair 2

I never know when the next request will come.
I am always asked to do it early in the week.

Score.....

Pair 3

I ate the last of my food over a week ago.
Fortunately, I still have some of my dried fruit left.

Score.....

Future/Long Term Time Frame

Pair 1

I will be confident that we can have children.
I will worry that we may not both be fertile.

Score.....

Pair 2

I will not know when the next request will come.
I'll always be asked to do it early in the week.

Score.....

Pair 3

I shall be able to find all my food in the forest.
To avoid hunger, I will take dried fruit with me.

Score.....

Appendix B - Second Version of Contradictory Pairs

Present/Short Term Time Frame
Pair 1

I am confident we can have our own babies.
I really worry that we may both be infertile.

Score.....

Pair 2

I never know when the next request will come.
I always receive requests early in the week.

Score.....

Pair 3

I ate the last of my food over a week ago.
Fortunately, I still have some dried fruit left.

Score.....

Future/Long Term Time Frame
Pair 1

I will be sure that we will have our own babies.
I will worry that we may both be infertile.

Score.....

Pair 2

I will not know when the next request will come.
I'll always receive requests early in the week.

Score.....

Pair 3

I shall be able to find all my food in the forest.
Unfortunately, I will have to take all my food with me.

Score.....

Appendix C - Final Version of Contradictory Pairs

Present/Short Term Time Frame

Pair 1

We very much do want to have lots of children.
We very much don't want to have any children.

Score.....

Pair 2

For all jobs I use the same method every time.
For all jobs I change the method every time.

Score.....

Pair 3

I ate the last of my food over a week ago.
Luckily, I still have some of my food left.

Score.....

Future/Long Term Time Frame

Pair 1

We will definitely have children one day.
We will definitely never have any children.

Score.....

Pair 2

For all jobs I'll use the same method every time.
For all jobs I'll change the method every time.

Score.....

Pair 3

I shall forage for all my food in the forest.
I will eat only the food I take with me.

Score.....

Appendix D - Contradictory Narratives and Questions incorporated into a Questionnaire, used for the RT data collection

Rules adhered to for the creation of the texts

1. Each text consists of 11 statements.
2. The 3rd statement is contradicted by the 10th one.
3. Each statements consists of between 11 and 13 syllables, inclusive.
4. Each statement is approximately the same length visually.
5. The non-contradiction statements were made:
6. relevant to the subject area,
7. neutral in meaning to the contradictory pair of lines, i.e., none of them reinforce the meaning of either of the contradictory pair of statements.
8. Each text was subjected to inspection for compliance to the above rules after an interval of several days after final creation/phrasing.
9. Of the four comprehension questions, three were neutral to the contradiction, but the third one was phrased to ascertain whether it had been detected.

Direct Survival	
Short Term	Long Term
1. These notes may record my last coherent words.	1. I hope one day that I'll explore the rain forest.
2. My rain forest exploration has been disastrous.	2. I will keep a diary to record my thoughts.
3. Several times, I thought I was about to die.	3. Several times I'll think I'm about to die.
4. I now know what the word hunger really means.	4. I do not therefore expect to become hungry.
5. I am worried about drinking the river water.	5. Drinking the river water may be a problem.
6. My dysentery is causing a rapid weight loss.	6. Water borne bugs cause dysentery and weight loss.
7. I now have sores and blisters on my legs and arms.	7. Sores and blisters will appear on ones legs and arms.
8. At night, the wild life noises are very frightening.	8. At night, the wild life noises will be frightening.
9. I am anxious about my chances of survival.	9. Sometimes, I may worry about my survival.
10. I never believed my life was in danger.	10. I will never think that my life is in danger.
11. I am convinced that I will never explore again.	11. After that trip, I doubt I will explore again.
Comprehension Questions	*Comprehension Questions*
1. What do think is the most worrying?	1. On such a risky venture, what will worry you most?
2. What do you think is the most damaging your health?	2. What would give you the worst health problems?
3. What did you think of your chances of survivals?	3. What will you think of your chances of survival?
4. What is your attitude to future explorations?	4. Will you explore again after this contemplated trip?

Survival Implicative	
Short Term	Long Term
1. Dad's symptoms first appeared several months ago.	1. Symptoms will appear long before patients report them.
2. His journey to hospital was by ambulance.	2. Journeys to hospital will be by ambulance
3. He knows the end is not very far away.	3. Patients know the end will not be far away.
4. He finds the doctor's manner very gentle.	4. Doctors' manners are usually very gentle.
5. The medical staff are always very kind.	5. The medical staff will always be very kind.
6. The ward is normal with only seven beds.	6. The wards will normally have only seven beds.
7. Father is under close medical supervision.	7. Patients will soon be under medical supervision.
8. Most of the family will visited him tomorrow.	8. Most families will visit patients the next day.
9. He finds hospital food better than expected.	9. Patients find hospital food better than expected.
10. His recovery will take quite a long time.	10. Their recoveries will take quite a long time.
11. He was very quick to complain of boredom.	11. They will be very quick to complain of boredom.
Comprehension Questions	Comprehension Questions
1. What did the family do once the father was in hospital?	1. What will do families do in these circumstances?
2. How many beds were there in the ward?	2. How many beds do you expect to find in the wards?
3. What were the father's views about the future?	3. What are the likely futures of these patients?
4. What did the father complain about?	4. What will patients complain about?

Reproduction Direct	
Short Term	Long Term
1. We are very happy to have got engaged	1. We are looking forward to getting married.
2. We have already bought a very nice house.	2. We will be buying a house some time in the future.
3. We very much do want to have lots of children.	3. We will definitely have children some time.
4. Both of us were born into quite small families.	4. Both of us were born into quite small families.
5. Neither of us have many brothers or sisters.	5. Neither of us have many brothers or sisters.
6. We have quite a busy social life together.	6. We will have quite a busy social life together.
7. We also have a lot of interests in common.	7. We will pursue our common interests together.
8. We each have only a few uncles and aunts.	8. We each have only a few uncles and aunts.
9. However, we do have quite a lot of cousins.	9. However, we do have quite a lot of cousins.
10. We very much don't want to have any children.	10. We will definitely never have any children.
11. We look forward hugely to our married life.	11. We will look forward to a happy life together.
Comprehension Questions	Comprehension Questions
1. What type of accommodation do you have?	1. What will be your attitude to house buying?
2. How would you describe your social life?	2. What sort of social life will you have together?
3. What is your view of yourselves as potential parents?	3. What is your view of yourselves as potential parents?
4. What sort of families did your parent have?	4. What will your own parents hope for? (Changed to 'What sort of families did your parent have?' at TH046 approx)

Reproduction Implicative	
Short Term	Long Term
1. Our neighbour's baby is due early next week. 2. We want to have several children very soon. 3. Our family has had infertility problems. 4. We haven't discussed our plans with anybody. 5. We have had a couple of dogs as pets till now 6. We have no preferences about boys and girls. 7. Other parents seem to have the same attitude. 8. It's not too early to think about children's clothes. 9. However, we haven't decided about names. 10. We 're convinced conception will happen this week. 11. We know that all babies need a lot of care.	1. Our neighbour's baby is due some time next year. 2. We'll have several children but not for a long time. 3. Our family has had infertility problems. 4. We will not discussed our plans with anybody. 5. We will have a couple of dogs as pets till then. 6. We will have no preferences about boys and girls. 7. Other parents seem to have the same attitude. 8. It's too early to think about children's clothes. 9. It's also too early to decide about names. 10. Conception will happen whenever we want. 11. We'll know that all babies need a lot of care
Comprehension Questions 1. When is your neighbour's baby due? 2. What kind of pets do you have? 3. Do you anticipate any difficulties about having children ? 4. What views do you have about the sex of your babies?	Comprehension Questions 1. When is your neighbour's baby due? 2. What kind of pets will you have? 3. Do you anticipate any difficulties about having children ? 4. What views will you have about the sex of your babies?

Abstract Direct	
Short Term	Long Term
1. People frequently ask me to do this job.	1. People will frequently ask me to do this job.
2. People usually don't care which method I use.	2. People will usually not care which method I use.
3. For all jobs I use the same method every time.	3. For all jobs I'll use the same method every time.
4. My interest in the job has declined over time.	4. I will benefit greatly from my many mistakes.
5. I wonder how many more times I will do this job.	5. I will doubtless improve my expertise over time.
6. After so many times, I am now bored with it.	6. Each time I will improve on the previous time.
7. Each time I improve my skills on the last time.	7. There will be few ways I could improve any more.
8. I doubt if I can improve very much more.	8. I will wonder how many more times I will do this job.
9. I have benefited from my many mistakes.	9. After so many times, I will get bored with it.
10. For all jobs I change the method every time.	10. For all jobs I'll change the method from last time.
11. I don't doubt that I could do it in my sleep.	11. I expect I'll be able to do it in my sleep.
Comprehension Questions	Comprehension Questions
1. How familiar are you with this task?	1. How familiar will you become with this task?
2. What do you think of your skill levels?	2. Will you your skill levels improve?
3. How much variation is there in your method?	3. Will there be any variation in the method you use?
4. How interesting do you find the job now?	4. What will you think of your own eventual competence?

Abstract Implicative	
Short Term	Long Term
1. John's retirement is only a few weeks away. 2. Retirement offers time for new opportunities. 3. He has no idea what he wants to do. 4. He regards retirement as a time for reflection. 5. And time to reflect on what he has made of his life. 6. Even now, John wonders about his life's achievements. 7. Most of John's work has generated lifelong stress. 8. Retirement reduces life's many pressures. 9. His daily routine will soon be quite different. 10. He thinks he knows what to do with his time. 11. Life changes so much on this important occasion.	1. John's retirement is still many years away. 2. Retirement will offer time for new opportunities. 3. He's not giving any thought what he might do. 4. Retirement will be a time for reflection. 5. He will reflect on what he has made of his life. 6. John does not yet dwell on his life's achievements. 7. Most of John's work will generate lifelong stress. 8. Retirement will reduce life's many pressures 9. His daily routine will then be quite different. 10. He already knows what he'll do with his time. 11. Life changes so much on this important occasion.
Comprehension Questions 1. How fare away is John's retirement? 2. What does he think of it? 3. How clear is John about how he will use his time? 4. What do we know about John's working life?	Comprehension Questions 1. How fare away is John's retirement? 2. What does he think of it? 3. How clear is John about how he will use his time? 4. What do we know about John's working life?

Neutral Texts used in all scripts

The Family Holiday

1. I think we should have a family holiday
2. I have about three weeks holiday leave owing
3. On the way home I will get some travel brochures
4. We will have to choose between skiing and the sun
5. I am sure that the children would prefer skiing
6. We parents would prefer the sun, sand and surf
7. Family discussions about locations are best.
8. Children always turn discussions into quarrels
9. I should probably just announce the location
10. I will discuss this idea with my partner first.
11. I am glad to have decided on this action

Comprehension questions
1. How much leave to you have owing?
2. What sorts of places are you contemplating visiting?
3. Which type would you prefer to go to?
4. What action will you take to get a decision?

The Wood

1. I enjoy the many kinds of trees in the forest
2. I wonder at the differences between them
3. I did not notice their variation at first
4. I have been learning their names from library books
5. I try to name them as I pass during my walks
6. I am proud to acquire my new knowledge
7. I am also learning about their biology
8. Sometimes I explain their growth patterns to friends
9. They usually find it interesting too
10. They do not like the detail as much as I do
11. I have to remember that when I talk to them

Comprehension Questions
1. What have you been learning form library books?
2. How do you use this knowledge?
3. What do you tell your friends?
4. What difference is there between your interest and theirs?

The Banks

1. Some years ago my bank opened a branch near home.
2. I noticed another bank did the same soon after
3. Both of them were quite busy for a while afterwards
4. Then all the other banks did something similar.

5. The best shopping streets were soon awash with banks.
6. I began to read there were too many bank branches.
7. Some of them then put ATMs facing the pavements.
8. I thought that this would cost them a lot of money
9. The banks always want to increase their profits.
10. Then I noticed they started closing retail branches
11. Now I sometimes can't find a bank when I want one.

Comprehension Questions
1. When did the banks start opening branches locally?
2. What did you notice about the shopping streets?
3. What did you think about the cost of the ATMs?
4. What frustrates you about banks today?

Architecture

1. I recently received a book about architecture.
2. It had designs and pictures of palaces in it.
3. The dimensions of rooms were carefully calculated.
4. The ratios were determined by the ancient Greeks.
5. There were no corridors by the sides of bedrooms.
6. The bedrooms were all interconnected by doors.
7. You had to walk through other people's to your own.
8. They all had four poster beds with curtains.
9. With no corridors, this was how privacy was provided.
10. The word 'corridor' appeared in the sixteenth century.
11. It's from Latin, meaning a place you can run in.

Comprehension Questions
1. Who determined the desirable ratios of room dimensions?
2. How did people reach their bedrooms?
3. How was privacy provided?
4. What does the word 'corridor' mean?

Music

1. People of all types like some kind of music.
2. Much early music came from the human voice.
3. Musical instruments are thousands of years old.
4. Their makers had no sharp metal tools to use.
5. Even holes in bones appear randomly placed.
6. Today's instruments are quite sophisticated.
7. Learning to play an instrument takes patience.
8. A player must devote many hours to learning.
9. Some people practise over an hour each day.
10. That is quite difficult for a young child.
11. It is sufficient for quite rapid progress though.

Comprehension Questions

1. What was the origin of music?
2. What were early instruments made of?
3. What attribute is required to learn to play an instrument?
4. How much time per day is required to play one well?

Trees

1. I enjoy the many kinds of trees in the forest
2. I wonder at the differences between them
3. I did not notice their variation at first
4. I have been learning their names from library books
5. I try to name them as I pass during my walks
6. I am proud to acquire my new knowledge
7. I am also learning about their biology
8. Sometimes I explain their growth patterns to friends
9. They usually find it interesting too
10. They do not like the detail as much as I do
11. I have to remember that when I talk to them.

Comprehension Questions

1. What have you been learning from library books?
2. How do you use this knowledge?
3. What do you tell your friends?
4. What difference is there between your interest and theirs?

Appendix E - Information Sheet provided to participants in the RT trials

Massey University
Department of Psychology

July 2008
Experiment by Peter Clemerson, Wellington 04 938 5923 and 027 368 1550
Extramural MA student at the Department of Psychology, Massey University, Palmerston North
Supervisor: Dr. Stephen Hill.

Participant Information and Instructions

The experiment has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researchers named above are responsible for the ethical conduct of this research.

If you have any concerns about the conduct of this research that you wish to raise with someone other than the researcher, please contact Professor Sylvia Rumball, Assistant to the Vice Chancellor (Ethics and Equity), tel 06 350 5249, email humanethics@massey.ac.nz.

Participants are being recruited by personal invitation. The statistical methods employed require not less than 80 participants for this research. No particular qualifications are required.

Confidentiality and Rights

Your personal results will be kept confidential. The data collected will not be used for any purpose other than this research project and will be discarded on its completion. It will not be possible to link your name to the results. Peter is interested in the percentage of people who answer in certain ways, not in individual responses.

If you decide to participate, you may decline to answer any question and withdraw at any time. If you are uncomfortable with any part of this procedure, please feel free to say so.

Procedure:
This psychological experiment takes about 15 minutes to complete.

Follow the blue instructions on the screen. Push the space bar to move on.

A sequence of one-line sentences will appear in black. Please read each line carefully before moving on. Some of them use the words 'I' and 'we'. Think of these as referring to yourself when you read them. You are that person.

After each sequence, Peter will ask you four very simple questions about the text in black. This is not an IQ or memory test. There are no right or wrong answers. Please answer whatever occurs to you. You may not remember enough to give an answer. If so, just say so.

The first sequence does not count towards the experiment. It is a practice run to show you what to expect.

Following the practice run, there are twelve sections in total.

If you have any questions about this process, please feel free to ask them now or at any other time.
If you leave an email or postal address with Peter, he will send you an outline of the final results in December.

Your kind cooperation is much appreciated. Thank you.

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