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Torturing the brain

On the folk psychology and folk neurobiology motivating 'enhanced and coercive interrogation techniques'

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On 16 April 2009, the US Department of Justice released legal memos detailing coercive interrogation techniques used with terrorism suspects during the Bush administration (http://www.aclu.org/safefree/general/olc_memos.html). The release of these documents has fuelled international controversy over the use of so-called 'enhanced interrogation techniques' (including torture) to extract information from terrorist suspects, despite strong ethical and legal objections. The use of such techniques appears motivated by a folk psychology that is demonstrably incorrect. Solid scientific evidence of how repeated and extreme stress and pain affect memory and executive functions (such as planning or forming intentions) suggests that these techniques are unlikely to do anything other than the opposite of that intended by coercive or 'enhanced' interrogation.

The released memos do not present in any detail the underlying neuropsychobiological model motivating the pro-torture or pro-coercion position; nor do they discuss or reference the contemporary and relevant cognitive neuroscientific literature; in addition, they only mention the Diagnostic and Statistical Manual of the American Psychiatric Association in the context of psychiatric risk associated with torture. Although the memos mention consultations with psychologists and health professionals, the advice of these professionals has not been released and therefore cannot be assessed.

From reading the memos, the underlying neuropsychobiological model appears to be the following: a person possesses information (by definition, this information is in their long-term memory, that is, the enduring personal register of experience, events and facts that lasts at least for minutes and can extend to decades); they intentionally withhold this information under questioning; applying certain non-verbal techniques (Box 1) over prolonged periods of time (press and other reports indicate up to six months or more) will facilitate the release of this information from long-term memory by the captive. The memos do not fully articulate the mechanisms by which coercion makes captives reveal such information. Nevertheless, they appear to be based on the idea that repeatedly inducing shock, stress, anxiety, disorientation and lack of control is more effective than are standard interrogatory techniques in making suspects reveal information. Information retrieved from memory in this way is assumed to be reliable and veridical, as suspects will be motivated to end the interrogation by revealing this information from long-term memory. No supporting data for this model are provided; in fact, the model is unsupported by scientific evidence.

Contemporary neuroscientific models of human memory and executive function are very different. The structural and functional integrity of the hippocampus and the prefrontal cortices, as well as regular sleep, are essential for normal memory function. The hippocampus and the prefrontal cortices are extensively inter-linked and each co-regulates the other. Recalling previously learned information activates a variety of brain areas, especially the prefrontal cortex and the hippocampus. Moreover, activity in the prefrontal cortex is particularly associated with intentionally controlling access to, and retrieval of, memories. When these brain areas function improperly, both memory and executive functions (intention, planning and regulation of behaviour) can be impaired.

Stress causes heightened excitability or arousal in the brain and body, a perception that present or future events will be unpleasant combined with a lack of controllability over these events [1]. Experiencing stress causes release of stress hormones [2] (cortisol and catecholamines, such as noradrenaline; Figure 1). Stress hormones provoke and control the 'fight or flight' response (the immediate and rapid preparation by the body and brain for action in response to threat) that, if overly prolonged, can result in compromised cognitive neurobiological function (and even tissue loss) in these brain regions. Both the hippocampus and the prefrontal cortex are particularly rich in receptors activated by stress hormones. Cortisol binds preferentially to glucocorticoid receptors in hippocampus and prefrontal cortex, increasing Ca^{2+} access and, thus, neuronal excitability [2,3], which compromises normal physiological functioning of neurons if it is sustained over substantial time periods. Catecholamines modulate many sites in the brain (including the hippocampus and prefrontal cortex) and have many effects, including provoking glucose release, and increasing blood pressure and heart rate. These responses are beneficial over the short term, but cause long-term damage to the brain and body if this state of 'hyperarousal' is maintained over the long term. Furthermore, the amygdala [4] (involved in the processing of fear- and threat-related stimuli) can become enlarged, creating a negative feedback loop that amplifies the effects of subsequent stressful events. Finally, prolonged and sustained sleep deprivation, in part because it

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Box 1. Non-verbal CIA techniques formerly used with terrorist suspects

- *Attention grasp*: '. . .grasping the individual with both hands...on each side of the collar opening, in a controlled and quick motion. In the same motion. . .the individual is drawn toward the interrogator.'
- *Facial hold*: '...to hold the head immobile. One open palm is placed on either side of the individual's face.'
- *Facial slap*: '. . .the interrogator slaps the individual's face with fingers slightly spread. The hand makes contact with the area directly between the tip of the individual's chin and the bottom of the corresponding earlobe. . .to induce shock, surprise, and/or humiliation.'
- *Walling*: '...The individual is placed with his heels touching the wall. The interrogator pulls the individual forward and then quickly and firmly pushes the individual into the wall. It is the individual's shoulder blades that hit the wall. . .the head and neck are supported with a rolled hood or towel. . .to help prevent whiplash...the false wall is. . .constructed to create a loud sound when the individual hits it. . .[to induce]. . .further shock and surprise...'
- *Wall standing*: '...is used to induce muscle fatigue. The individual stands four to five feet from a wall, with his feet spread approximately to shoulder width...His fingers support all of his body weight. The individual is not permitted to move or reposition his hands or feet.'
- *Stress positions*: '... sitting on the floor with legs extended straight out in front of him with his arms raised above his head'; 'kneeling on the floor while leaning back at a 45-degree angle'.
- *Cramped confinement*: placing the individual in a small box in darkness for up to two hours or in a larger box for up to 18 hours.
- *Sleep deprivation*: 'is to reduce the individual's ability to think on his feet and, through the discomfort associated with lack of sleep [to a maximum of 11 days], to motivate him to co-operate'.
- *Insect placed in a confinement box*: 'You (the CIA interrogator) would like to place Zubaydah [suspected Al-Qaeda terrorist] in a cramped confinement box with an insect. . .he appears to have a fear of insects.'
- *Waterboarding*: ''. . .the individual is bound securely on an inclined bench...The individual's feet are generally elevated. A cloth is placed over the forehead and eyes. Water is. . .applied to the cloth in a controlled manner. . .air now is slightly restricted for 20 to 40 seconds due to. . .the cloth. . .increas[ing]. . .carbon dioxide level[s] in the individual's blood. This increase in the carbon dioxide level stimulates increased efforts to breathe. This effort plus the cloth produces the perception of 'suffocation and incipient panic,' i.e. the perception of drowning...'' (Documents available at: http://www.aclu.org/safefree/general/olc_memos.html)

Substantially more extreme techniques involving extensive physical and mental abuse have been used by totalitarian regimes (e.g. Ref. [14]).

results in a substantial increase in cortisol levels, has a deleterious effect on memory.

There is a large literature on the effects of extreme stress on motivation, mood and memory, using both animals and humans. To summarise a complex literature briefly: chronic, prolonged and extreme stress: (i) inhibits long-term potentiation (LTP; the biological process believed to underlie memory formation in the brain) and facilitates long-term depression (the inverse of LTP) [1]; (ii) causes hippocampal atrophy and, hence, impairs learning in humans and animals [1–3,5,6]; and (iii) is implicated in many neuropsychiatric disorders (especially anxiety, depression and post- traumatic stress disorder) [5]. Notably, repeated chronic exposure to uncontrollable pain (e.g. electric shocks) causes many effects similar to those found under severe but non-painful stress.

A common argument in favour of torture is that it will reliably elicit veridical information from the captive's long-term memory, as asserted by many media commentators in the context of the 'ticking-time bomb' scenario or in the case of a major imminent threat in which lives could be saved. A pragmatic anti-torture argument is that it will not; that torture is as likely to elicit false as it is true information and that separating the one from the other will be difficult. It is likely to be difficult or perhaps impossible to determine during interrogation whether the information that a suspect reveals is true: information presented by the captor to elicit responses during interrogation might inadvertently become part of the suspect's memory, especially because suspects are under extreme stress and are required to tell and retell the same events that might have happened over a period of years. Other factors exacerbate this problem. Confabulation (the pathological production of false memories) is a common consequence of frontal lobe disorders [7] and, as already noted, prolonged and extreme stress has a deleterious effect on frontal lobe function [3]. Thus, distinguishing between confabulations and what is true in the verbal statements of tortured suspects will be difficult.

Extreme stress studies in Special Operations Soldiers [8] have found impaired visuo-spatial capacity and recall of previously-learned information in stressed soldiers (who undergo stress, including food and sleep deprivation, during training modelled on the experiences of American prisoners-of-war). Brain imaging in people previously subjected to severe torture suggests that abnormal patterns of activation are present in the frontal and temporal lobes [9], leading to deficits in verbal memory for the recall of traumatic events [10,11]. A recent meta-analysis [12] of the relationship between pharmacologically induced cortisol elevations (in the upper physiological range) concluded that such elevations impair memory retrieval in humans, as do psychosocial stress-induced cortisol elevations. By contrast, mildly stressful events generally facilitate recall. The experience of capture, transport and subsequent challenging questioning would seem to be more than enough to make suspects reveal information.

In a torture situation, the captor and the captive have different motivations. The captor wants the captive to speak and reveal key information from their long-term memory. The captive wants to escape the extreme stress while not revealing key information. In classical conditioning, circumstances signalling escape from stressful or noxious and/or aversive events are known as conditioned safety signals [13]. Here, the detainee's own words provide the safety signal: 'while I'm talking, I'm not being waterboarded'. The truth of what the detainee says does not provide the safety signal, just the fact that s/he is talking. In other words, speech acts signal periods of safety. Equally, when the captive is talking, the captor's objective has been obtained. Finally, and presumably, subjecting a fellow human being to torture is stressful for all but the most psychopathic. In fact, the historical literature [e.g. 9] is replete with accounts of alcohol or drug abuse by

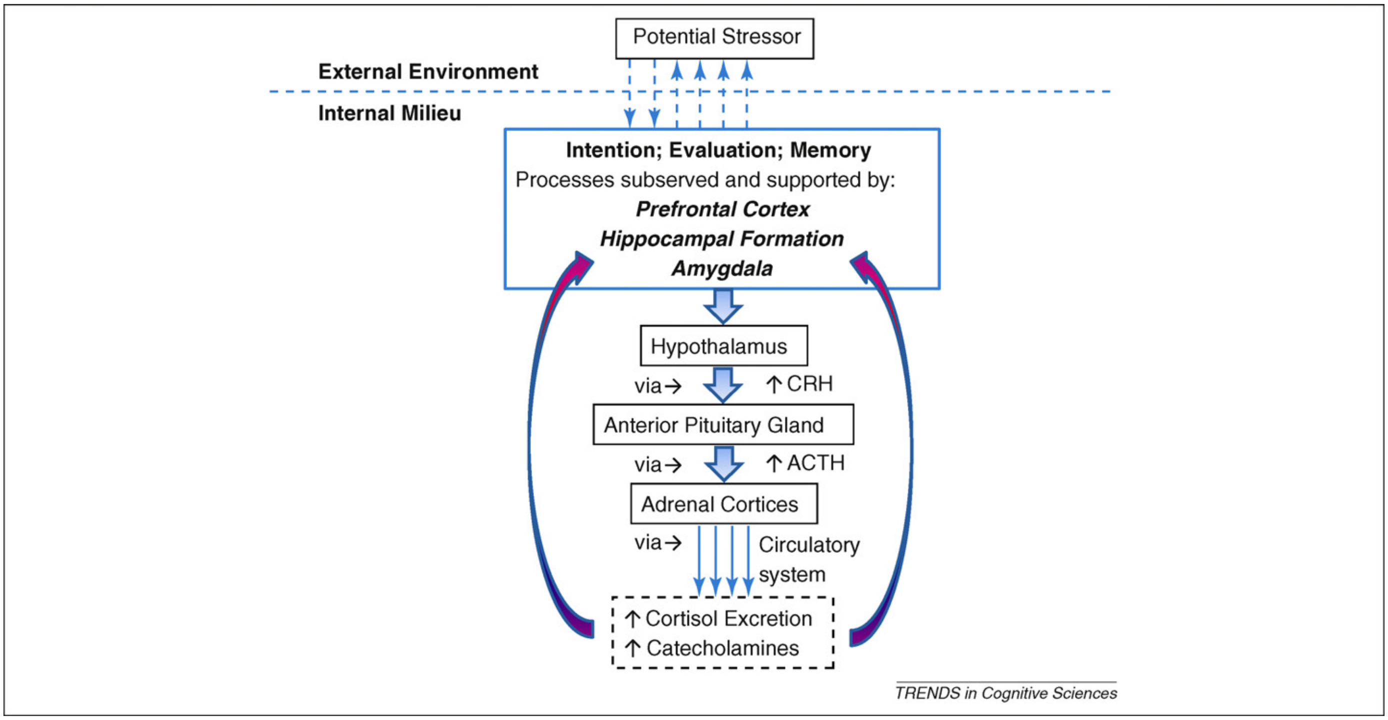

Figure 1. The stress response is controlled by the hypothalamic–pituitary–adrenal (HPA) axis. Behavioural stress (e.g. uncontrollable electric shocks, extended physical restraint or confinement) and/or systemic stress (e.g. anoxia, infection or sustained sleep deprivation) triggers the release of corticotropin-releasing hormone (CRH) from the hypothalamus into the portal circulation to the anterior pituitary, which releases adrenocorticotrophic releasing hormone (ACTH) into the bloodstream, causing substantial and sustained stress hormone (cortisol) release from the adrenal cortices and catecholamines from the adrenal medulla (the adrenal glands are located on the kidneys in the body trunk). The acute and chronic stress response includes 'fight or flight' initiation, mobilization of energy stores, decreases in reflex thresholds and increases respiratory rate, muscle tension and gastric motility [2–6].

torturers. Thus, the fact that the captive is speaking also provides a safety signal to the captor; making the captive talk, rather than the truth of what the captive is revealing, might mark the end of the torture. As long as the captive is talking, the captor can avoid using torture.

Waterboarding is cited in the legal memoranda as causing elevations in blood carbon dioxide levels (hypercapnia). Data on the effects of hypercapnia or hypoxia (decreased blood oxygen) on brain function are not cited; neither are data on carbon dioxide narcosis (deep stupor or unconsciousness), which might be expected as a result of acute and repeated waterboarding. Brain imaging data suggest that hypercapnia and associated feelings of breathlessness (dyspnoea) cause widespread increases in brain activity, including brain regions associated with stress and anxiety (the amygdala and prefrontal cortex) and pain (the periacquiductal gray) [15]. These data suggest that waterboarding in particular acts as a severe and extreme stressor, with the potential to cause widespread stress-induced changes in the brain, especially when this procedure is repeated frequently and intensively.

The proposed use of phobic stimuli (e.g. insects) underscores the unsophisticated folk psychological model underpinning coercive interrogation. Chronic controlled exposure to phobic stimuli is known as 'flooding therapy' and is among the most effective methods applied under Cognitive-Behaviour Therapy (CBT) to treat phobias. Repeated and non-threatening exposure to a phobic stimulus usually results in individuals no longer being afraid of these stimuli.

In sum, coercive interrogations involving extreme stress are unlikely to facilitate the release of veridical information from long-term memory, given our current cognitive neurobiological knowledge. On the contrary, these techniques cause severe, repeated and prolonged stress, which compromises brain tissue supporting memory and executive function. The fact that the detrimental effects of these techniques on the brain are not visible to the naked eye makes them no less real.

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Letters

Only half right: comment on Regier and Kay

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We accept Regier and Kay's argument that linguistic terms affect color categorization in the right but not the left visual field (LVF) [1]. We also agree that left and right hemispheres might contain qualitatively different color processing systems. We disagree, however, with the suggestion that the right hemisphere contains a set of prelinguistic color categories that influence perception when stimuli are presented in the LVF. Their argument rests on studies [2,3] that seem to show categorical perception of color by prelinguistic infants. The key finding was that infants showed faster eye-movements from a borderline green background to a blue target than to a more central green. Unfortunately, infants in these studies were tested on only two pairs of stimuli. Consequently, the results might have reflected simple color preference [4] by the infants for the blue rather than the green target. Such a conclusion is supported by results from recent studies [5,6] in which infants showed a significant negative bias for looking times to a green hue compared to the average time spent looking at other hues. (Earlier studies of infant categorical perception (CP) either had major methodological flaws or have not been replicated, as discussed in [7], so we do not consider them here.) No explanation in terms of color categories in the right hemisphere is required if infants shift their gaze faster towards blue than to central green on the basis of simple color preference. More varied investigations of infant behavior using a variety of different color categories with participants from different linguistic communities are required before we can conclude that prelinguistic infants demonstrate CP for color that mirrors the effects found in language users.

Humans can make fine perceptual discriminations between approximately two million different shades of color. Our recent findings indicate that discriminations are *no* more sensitive at category boundaries than within categories [8]. We therefore believe there to be a *non-categorical* color processing system (possibly, but not necessarily, restricted to the right hemisphere) that can make extremely fine discriminations between colors and assess whether two colors are identical. We do not believe that this system 'knows' precise information concerning similarities and differences between two shades of color (e.g. that one is brighter or more saturated than another, or that two different shades share the same name). A non-categorical system might work better at making fine perceptual discriminations *because* it is not categorical. CP in language users probably arises from the concurrent operation of the perceptual and categorical systems. When judging, for example, whether two different shades of blue are identical, information from the left-hemisphere categorical system indicating that they share the same name conflicts with information from the perceptual system that they differ. Decisions for items from different color categories are made more quickly not because of increased sensitivity to perceptual change at category boundaries, but because both categorical and perceptual systems indicate that they differ. At slower response times, CP occurs for stimuli in both visual fields [9,10] because information presented to the LVF has had time to access the categorical system in the left hemisphere. CP for color can therefore be readily explained if one processing system is language-based and categorical and the other system is perceptual but not categorical.

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