PSYCHOLOGY MISCELLANY

No.132 - June 2020

Kevin Brewer

2. Details of the author are included so that the level of expertise of the writer can be assessed. This compares to documents which are not named and it is not possible to tell if the writer has any knowledge about their subject.

Kevin Brewer BSocSc, MSc

An independent academic psychologist, based in England, who has written extensively on different areas of psychology with an emphasis on the critical stance towards traditional ideas.
     A complete listing of his writings at http://psychologywritings.synthasite.com/.

CONTENTS

1. NOT CONSCIOUS

1.1. INTRODUCTION

There different levels of consciousness can be distinguished (table 1.1), but consciousness and awareness are far from simple on/offs.

- Awake/alert

- Light/moderate sedation (eg: still responsive to physical stimulus)

- General anaesthesia (unresponsive to outside stimuli)

(Source: Anderson 2017)

Table 1.1 - Levels of consciousness (based on electrical activity in the brain).

1.2. COVERT CONSCIOUSNESS

It has become clear in recent years that some individuals in a vegetative state (table 1.2) are conscious [1]. They may have "covert consciousness", where their awareness comes and goes, but they cannot move their body. This is different to "locked-in syndrome", where paralysed individuals are fully conscious (appendix 1A) (Thomson 2019a) [2] [3].

---

[1] There is an estimated quarter of a million people in the USA in a vegetative state or a minimally conscious one (Koch 2010).

[2] Koch (2019) outlined five properties of consciousness - intrinsic (private experience), structured (contains different elements), informative (each conscious experience differs from each other),

The use of brain scan technology is helping [4]. Owen et al (2006) asked a woman in a vegetative state to imagine different actions while in a scanner [5]. There was a clear difference in the brain activity when imagining the two actions, and she was able to follow the instructions of which to imagine [6].

Monti et al (2010) studied 23 patients diagnosed with vegetative state. While being scanned, they were asked simple yes/no questions, and they "replied" "yes" by imagining playing tennis or "no" by walking around their home mentally. Four individuals provided "convincing responses" (Owen 2014).

- Brain death - all brain functions ceased.

- Coma - complete loss of consciousness with no sleep-wake cycles.

- Vegetative state - sleep-wake cycles present.

- Minimally conscious state - small signs of awareness (eg: reaching for an object when given command).

- Locked-in syndrome - "fully conscious" but cannot move or communicate.

(Source: Owen 2014)

Table 1.2 - Different Levels of Awareness in Disorders of Consciousness.

A number of different methods have been tried to "wake" such individuals, including (Thomson 2019a):

i) Drugs - eg: zolpidem (sleeping pill). Despite its sedative effect, it also stimulates certain areas of the brain. Limited success in a small placebo-controlled trial (4 of 84 patients benefited) (Thomson 2019a).

ii) Stimulating the thalamus - The "mesocircuit hypothesis" suggests that trauma to the brain disrupts

---

integrated (into a whole picture), and definite (conscious experience cannot be reduced into parts without losing something) (Anderson 2019).

[3] There are two main views on how the physical brain generates consciousness - by the whole brain (holist) or specific neural circuits responsible for specific functions (locationist) (Koch 2017).

[4] Absalom et al (2006) found that speech perception areas of the brain remained active in anaesthetised healthy volunteers in a brain scanner. This opened the door to the possibility that individuals with disorders of consciousness could perceive information spoken to them.

[5] For example, imagining playing tennis produces activity in the pre-motor cortex, while mentally walking around one's house shows activity in the parietal lobe (Owen 2014).

[6] Owen et al (2006) had established that imagining different activities while in a brain scanner produced "a robust and reliable pattern of brain activity that is similar to actually performing the task" (Owen 2014 p43).

the thalamus and its ability to relay signals to the cortex. Stimulating the thalamus with an implanted electrode helped one man in a minimally conscious state (Schiff et al 2007) (appendix 1B).

Stimulating the thalamus with low-intensity ultrasound has been tried as a non-invasive alternative (Monti et al 2016).

iii) Stimulating other brain areas - eg: using non-invasive transcranial direct current stimulation (tDCS) on forebrain areas (appendix 1C).

These methods and others have some success sometimes, but they raise ethical issues. One in particular is the effect on the family. For example, John Whyte described an individual who briefly recovered consciousness after a dose of zolpidem, but this could not be repeated (ie: he lapsed back into the unconscious state). Whyte said: "It was enormously emotional, as you can imagine... The family went from having given up hope, to learning that their loved one had the ability to be conscious, to discovering that they just couldn't realise that ability" (quoted in Thomson 2019a).

1.3. AUTOMATIC DECISIONS

Sigmund Freud placed great emphasis on the unconscious mind as the cause for much behaviour. Modern cognitive psychology takes a different view of processes outside the conscious mind. For example, automatic thought processes are fast, impulsive, and outside conscious awareness, while controlled processes are deliberate, slower conscious decisions (eg: Kahneman 2011).
These automatic processes include snap judgments about strangers, "gut feelings", implicit processing, and unconscious imitation (appendix 1D).
For instance, studies "suggest that an unconsciously perceived stimulus may suffice to cause someone to actually pursue a goal without any awareness of how it originated - no conscious deliberation or free will required" (Bargh 2014 p27).
Pessiglione et al (2007) asked participants to push a lever as fast as possible for a reward. Before each trial, the amount of the reward was presented (picture of a coin either £1 or 1p) such that it was perceived consciously (100 ms) or subliminally (17 or 50 ms) (ie: too fast to be consciously seen). Higher rewards led to faster pushes, as expected, but both for information

communicated consciously and subliminally (Bargh 2014) [7].

There are a number of abilities that do not necessarily require full conscious attention, including:

i) During sleep - eg: the ability to process information as falling asleep and in light sleep, but not in deep sleep (Makin 2016a).

ii) Solving problems - eg: not consciously thinking about a problem can lead to the answer suddenly appearing (the "aha" moment) (Williams 2016).

iii) Social signals - eg: judgments after seeing a face for only a tenth of a second (Makin 2016b).

iv) Proprioception - "Thanks to unconscious processing, most of us instinctively know where our limbs are and what they are doing. This ability... results from a constant conversation between the body and brain. This adds up to an unerring sense of a unified, physical 'me'" (Ananthaswamy 2016 p32).

1.4. INATTENTIONAL BLINDNESS

Inattentional blindness is where focusing on one object or event means that unexpected objects are missed. The best known study (Simons and Chabris 1999) involved participants focusing on counting the number of passes in a video of a basketball game who missed a person in a gorilla suit (unexpected object) appear on the screen for nine seconds.

Similarly, a woman holding an umbrella walked across the screen in Becklen and Cervone's (1983) experiment. The length of time of her appearance was varied (5.5 or 2 seconds) as participants counted the basketball passes. "More exposure to the unexpected object apparently increased the probability that it would be noticed" (Wood and Simons 2019 p2) (ie: 34 vs 7% of participants). However, other studies have not found this (Wood and Simons 2019).

Wood and Simons (2019) were interested in when the noticing of the unexpected object happened - ie: soon after onset. The length of exposure in their experiments did not matter. Participants, recruited via Amazon Mechanical Turk, watched specific objects on a computer screen and an unexpected object was introduced for varying lengths of time (table 1.3).

---

[7] "Humans tend to adapt the degree of effort they expend according to the magnitude of reward they expect. Such a process has been proposed as an operant concept of motivation" (Pessiglione et al 2007 p904).

Wood and Simons (2019) summed up: "The window for noticing an unexpected object appears to be brief relative to the amount of time it is visible on-screen. Even though subjects have more opportunity to detect the unexpected object the longer it remains on-screen, the vast majority of noticing events occur in the first 1.5 s or not at all. This pattern, replicated in all three experiments, indicates that unexpected objects are not noticed as a result of a gradual accumulation of signal across the entire exposure duration, but more as a result of a rapid process concentrated early in the unexpected object's lifespan" (p15).

	Experiment 1	Experiment 2	Experiment 3
Number of participants with usable data (number discarded)	283 (243)	756 (517)	488 (516)
Unexpected object *	Mid-grey cross	Mid-grey cross	Random colour object
Length of exposure to unexpected object and how many noticed it	2.67 s: 38.5% 5 s: 44%	1.5 s: 41% 2.67 s: 43.4% 5 s: 49.4%	1.5 s: 61.5% 5 s: 64.9%

(* The task was to count the number of times white or black shapes bounced off the edges of a display area)

Table 1.3 - Brief details of three experiments by Wood and Simons (2019).

1.5. PHYSIOLOGY

Brain-scanning experiments involving different cognitive tasks tend to have control periods where the participant is asked to empty their mind. It became clear that the "idling brain" was very active physiologically (Smith 2012).

This has been described as the brain's "default mode" (Raichle et al 2001). It helps the brain to stay organised, and maintain a sense of continuity. "'Connections between neurons turn over in minutes, hours, days and weeks', says Raichle. 'The structure of the brain will be different tomorrow but we will still remember who we are'" (Smith 2012 p358).

Changes in the brain through learning are not just changes in neurons and synapses (grey matter), but also in myelin sheaths that insulate the axon (white matter), thereby allowing electrical signals to pass faster through the brain (Burrell 2015). For example, Scholz et

al (2009) found increased myelin in the brains of volunteers who had learned how to juggle over six weeks (compared to controls). One of the researchers said: "We saw a change not only in the grey matter but also in the underlying white matter pathways, suggesting that these pathways strengthen in some way as a result of experience" (quoted in Burrell 2015).

Mice bred with a fault in their oligodendrocytes (which form myelin) never learn a maze however many times they practice it (de Faria et al 2014).

Traditionally, the cerebellum, at the back of the brain, was viewed of limited importance (ie: motor control) compared to the cortex, but recent work has shown that "all the major cortical regions have loops of connections running to and from the cerebellum" (Williams 2018 p36).

1.6. GENERAL ANAESTHESIA

Patients after general anaesthesia (GA) can experience post-operative delirium, which involves confusion, memory loss, and hallucinations (Storrs 2014).

It is difficult to establish which of the drugs used as GA is the cause of the post-operative delirium, and also because of hospital stressors like poor sleep. However, post-operative delirium is more common in older patients (over seventy years old) and those with pre-existing cognitive deficits (eg: dementia) (Storrs 2014).

The amount of GA is also important. For example, Sieber et al (2010) compared older hip surgery patients given light and heavy doses of propofol to induce GA. Significantly more of the latter group experienced post-operative delirium.

There are also concerns about longer term cognitive effects from GA. For example, one study (Chan et al 2013) found recall problems three months later in a heavily anaesthetised group (Storrs 2014).

1.7. NOW

"Now" is an interesting concept psychologically. "We tend to think of it as this current instant, a moment with no duration. But if now were timeless, we wouldn't experience a succession of Nows as time passing. Neither would we be able to perceive things like motion. We couldn't operate in the world if the present had no duration. So how long is it" (Spinney 2015 p28)?

One answer (the "psychological present" [8]) is 2-3 seconds. Fairhall et al (2014) summed up: "The brain integrates incoming sensory information not only over space and sensory modality but also over time. Due to the diverse nature of this information, temporal integration mechanisms may vary across different timescales. The integration of environmental events into a unitary percept may occur within a few hundreds of milliseconds. However, the integration of more complex information that unfolds over time may utilise neural mechanisms that operate across longer time scales. While varied mechanisms may operate over periods as long as minutes, evidence has accumulated to suggest that temporal integration windows (TIWs) of 2-3 seconds may be a fundamental component of human cognition" (p1).

Fairhall et al (2014) reported two experiments on TIWs involving forty-three participants who were presented with short video clips in time-shuffled order (eg: total length 12.8 seconds and 200 ms time shuffled - ie: frames). Participants were able to follow time-shuffles within the 2-3 second TIW, but not beyond that time period. Fairhall et al (2014) concluded that "a function of this 2-3 second window may be to provide a stable and coherent representation of events in a complex, ever-changing world" (p5).

In terms of the brain, there seems to be two broad types of timing mechanism of Now - implicit and explicit. The latter is the conscious judgment of duration, while the implicit mechanism is "how the brain defines a psychological moment and so structures our conscious experience" (Spinney 2015 p28). This combines "the fact that we exist permanently in the present yet experience time flowing from the past towards the future" (Spinney 2015 p29).

Wittmann (2011) described a hierarchy of Nows which are combined to give the property of flow. This process involves the "functional moment" (ie: the threshold at which the brain can distinguish separate events - eg: 2 milliseconds apart for sound and 10 milliseconds apart for vision) (Spinney 2015). But this is at a sub-conscious level.
Kosem et al (2014) saw neural oscillations in the auditory cortex as the mechanism for the encoding of even timing. Neural oscillations can be recorded with magnetoencephalography (MEG), which measures minute

---

[8] "It has been suggested that perception and action can be understood as evolving in temporal epochs or sequential processing units. Successive events are fused into units forming a unitary experience or 'psychological present'" (Wittmann 2011 p1).

activity in the brain [9].

It is not clear, however, "how a group of sub-conscious functional moments are combined to create the conscious experienced moment" (Spinney 2015 p30).

Wittmann's (2011) hierarchy includes "mental presence", which lasts around thirty seconds (to give a sense of continuity), and involves working memory (figure 1.1).

Sense of continuity (30 seconds)

Impression that time is passing

Experienced moment (2-3 seconds)

Combine to create conscious now

Functional moment (milliseconds)
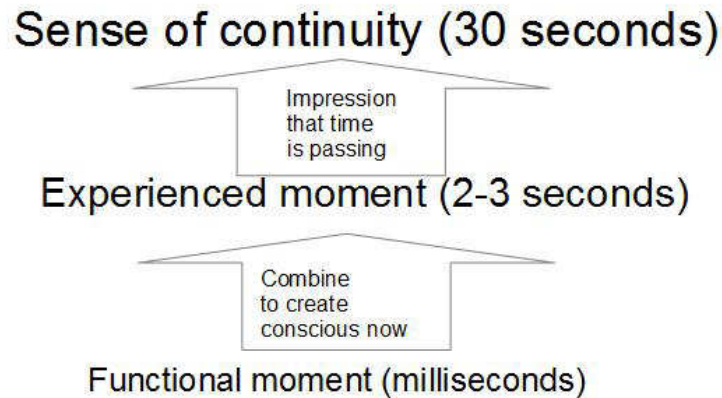
(After Spinney 2015)

Figure 1.1 - Hierarchy of the experience of Now.

In summary:

i) "functional moment" - "a basic temporal building block of perception in the range of milliseconds that defines simultaneity and succession. Below a certain threshold temporal order is not perceived, individual events are processed as co-temporal" (Wittmann 2011 p1). The threshold is about 30 ms (Wittmann 2011).

ii) "experienced moment" - a few seconds. "Whereas the duration of the functional moment is not perceived, an experienced moment relates to the experience of an extended now. According to this conception, the experienced moment has duration" (Wittmann 2011 p4).

iii) "mental presence" - "continuity of experience" over multiple seconds linked to working memory (Wittmann 2011).

---

[9] "The 'internal clock' is a prominent model of time perception which is classically composed of a pacemaker (ticking mechanism), an accumulator (of ticks) and a counter" (Kosem et al 2014 p279).

1.8. THE UNUSUAL

Metamorphopsia is "a distorted perception of the outside world", where objects are perceived as larger (macropsia) or smaller (micropsia) than they actually are (Van Den Berg et al 2019).

Van Den Berg et al (2019) reported a case of micropsia after an individual suffered a stroke in the right posterior brain region. The patient ("DN") was a 64 year-old man in the Netherlands. After the stroke, "DN" "described seeing everything at seventy percent of the actual size. This included both objects and persons. When looking in the mirror, he also perceived himself at seventy percent of his actual size. His estimation of seventy percent was based on prior, pre-stroke knowledge about the original, true sizes of objects. Therefore, his micropsia was especially noticeable when perceiving familiar objects, of which the actual sizes were known. It particularly affected objects in relation to himself. For example, he constantly thought that his clothes would not fit him anymore, because they were perceived as too small. In clothing stores, he would choose clothes in size XL instead of M (his actual size) when the size label was not apparent" (Van Den Berg et al 2019 p203).

The researchers conducted three experiments with DN:

Experiment 1: "delayed grasping" - Cubes of different sizes were presented individually, and DN inspected them for five seconds before being asked to close his eyes and grasp the cube. "In this task, DN consistently opened his hand too wide, spreading his entire hand, even when the sides of the cube were only a few centimetres. When we queried him about this, DN told us that he was compensating for the fact the he was unsure about the exact size of the cubes" (Van Den Berg et al 2019 p206).

Experiment 2: "across visual field comparisons" - Two cubes were presented of equal or different size, and DN had to say if they were the same or which was larger. He made eleven errors in 28 trials, more so related to the left eye.

Experiment 3: "size estimation" - DN was asked to estimate the size of a cube 1.5 metres away. His estimates were on average 90% of the actual size, and 70% smaller than eleven healthy controls (who tended to overestimate the size).

Van Den Berg et al (2019) concluded that "the unilateral occipito-parietal infarction in our patient has caused contra-lesional visual sensory impairments, for which an unconscious, higher-order process tries to compensate at the price of creating a 'shrunken' world"

(p208).

1.8.1. Amygdala Damage

The amygdala is the part of the brain involved in threat detection, and the expression of fear and anxiety. This knowledge comes from lesion, and optigenetics studies with animals, and neuroiaging studies with humans (Khalsa et al 2016).

Human case studies of amygdala-damaged patients are also useful. For example, individuals with Urban-Wiethe Disease (UWD), a very rare genetic condition which produces amygdala damage through calcification (eg: female identical twins; Khalsa et al 2016). Such individuals have impaired fear processing (eg: Becker et al 2012).

However, Khalsa et al (2016) were able to produce a fear reaction by inhaling carbon dioxide (which creates the feeling of not being able to breath), and suggested that "additional neural circuits beyond the amygdala must be involved in the observed fear and anxiety responses" (p3563).

1.8.2. Suspended Animation

"Suspended animation" is common in science-fiction, but an experimental technique called "emergency preservation and resuscitation" (EPR) is the real version (Thomson 2019b) [10].

It involves rapidly cooling a traumatised patient (eg: with gunshot wounds and cardiac arrest [11]) to around 10-15 °C [12] by replacing their blood with ice-cold saline [13]. An operation team is given two hours to work on the person and then they are warmed up.

Usually cells need a constant supply of oxygen, but lowering the temperature stops all chemical reactions and almost no oxygen is needed (Thomson 2019b).

1.9. APPENDIX 1A - INTEGRATED INFORMATION THEORY

A mathematical model of consciousness has been proposed in the form of integrated information theory (IIT) (eg: Tononi 2008). Consciousness arises from the

---

[10] A trial is ongoing at the University of Maryland Medical Centre led by Samuel Tisherman (Thomson 2019b).
[11] Patients with a 5% chance of survival with normal techniques (Thomson 2019b).
[12] Compared to the normal body temperature of 37 °C.
[13] This technique is different to an induced coma which slows the metabolism only (and some oxygen is still needed) (Thomson 2019b).

movement of information around systems. Group of neurons in the brain, say, can be viewed as "islands" or sub-systems, and the flow between them is important. But for consciousness to exist, the flow must be complex and thus sub-systems are interdependent (Brooks 2020).

The integration of information in a system gives a value called "phi", and the higher the phi, the more consciousness a system will have. A sub-system will also have consciousness ("micro-consciousness"), but only the largest phi displays will register as conscious experience. The upshot is that parts of the human brain can be damaged and not effect conscious experience. For example, the cerebellum has a lower phi score (low connectivity between neurons), and damage to this area does not stop conscious experience as compared to the cortex (higher phi score) (Brooks 2020).

There are criticisms of IIT including the calculation of phi, and the suggestion that consciousness is a byproduct of information flow ignores the why and how consciousness arose (Brooks 2020).

1.10. APPENDIX 1B - INVASIVE TECHNIQUES

In 2007 a man in a minimally conscious state was woken by deep brain stimulation (DBS) of the thalamus (Schiff et al 2007). "However, attempts to treat other people in a similar way have failed. The problem lies with the crudeness of deep brain stimulation. The technique involves inserting electrodes deep into the brain and using them to stimulate the tissue around them. But there is no good way to ensure the electrodes stimulate exactly the right area, which means it is hard to control" (Thomason 2015 p10).

DBS of the claustrum (near the hippocampus) caused a women with epilepsy to lose consciousness (Koubeissi et al 2014). She immediately recovered with no memory of the event (Thomson 2014). Anil Seth urged cautious with such a case study as "the woman was missing part of her hippocampus, which was removed to treat her epilepsy, so she doesn't represent a 'normal' brain" (quoted in Thomson 2014).

DBS of the intra-laminar nucleus in the thalamus has worked for some individuals in a minimally conscious state (eg: five individuals; Yamamoto and Katayama 2005).

Working with mice, Liu et al (2015) found that stimulation of an area of the brain called the zona incerta (which connects the cortex and the thalamus) had dramatic effects. Higher frequency stimulation (40-100 hertz) caused an unconscious mouse to wake, and lower frequency stimulation (10 hertz) did the opposite (Thomson 2015).

1.11. APPENDIX 1C - TECHNOLOGICAL DEVELOPMENTS

Many technological changing are occurring which help in understanding the brain, and in the possibility of treatment.

For example, the future of treatment could be electrical, as in tDCS, rather than pharmaceutical. Benefits in trials have been reported for migraine, post-stroke recovery, and depression (Bikson and Toshev 2014).

Optogenetics involves the injection of light-sensitive genes (from algae [14]) into cells, which can then be switched on and off by light. This does require the skull to be open to light, so non-human studies are the main use currently (Boyden 2014).

1.12. APPENDIX 1D - AUTOMATIC PROCESSES

Individuals are more likely to laugh when others laugh, and more likely to perceive a joke as funnier because others laugh.

Cai et al (2019) recorded a professional comedian reading "bad jokes" [15], which were rated for funniness on a scale of 1-7 (baseline measure). Then the participants, who were 24 adults with autism and 48 "neurotypicals", heard the jokes in one of two conditions. Either paired with short spontaneous laughs or short posed laughs ("canned laughter"). The participants rated each joke on the seven-point scale.

Overall, among the "neurotypicals", all jokes were rated significantly funnier when paired with laughter compared to the baseline. All participants rated the jokes as funnier when paired with spontaneous laughter than with posed laughter. "These data indicate that implicit processing of laughter can influence the perceived funniness of a fairly dire joke, and that more spontaneous laughter has the strongest effects" (Cai et al 2019 pR678).

1.13. REFERENCES

Absalom, A et al (2006) An fMRI study of the influence of propofol sedation on neural correlates of speech perception and comprehension British Journal of Anaesthesia 97, 3, p438P

Ananthaswamy, A (2016) Keep track of the body in space New Scientist

---

[14] Opsin proteins produced by some algae and other microbes are sensitive to light. "When illuminated, these protein channels regulate the flow of electrically charged ions across membranes, which allows the cells to extract energy from their environments" (Deisseroth 2010 p31). The upshot is their use in optogenetics.

[15] What do you call a bear with no socks on? Bare feet. What is the best day to cook? Fry-Day.

1st October, 32-33

Anderson, A (2017) The risk of going under Scientific American Mind March/April, 61-65

Anderson, A (2019) What is it like to be conscious? New Scientist 2nd November, 28-29

Bargh, J.A (2014) Our unconscious mind Scientific American January, 20-27

Becker, B et al (2012) Fear processing and social networking in the absence of a functional amygdala Biological Psychiatry 72, 70-77

Becklen, R & Cervone, D (1983) Selective looking and the noticing of unexpected events Memory and Cognition 11, 601-608

Bikson, M & Toshev, P (2014) Your electric pharmacy Scientific American Mind November/December, 56-61

Boyden, E.S (2014) Let there be light Scientific American Mind November/December, 62-69

Brooks, M (2020) Here. There. Everywhere? New Scientist 2nd May, 40-44

Burrell, T (2015) Meet your other brain New Scientist 21st February, 30-33

Cai, Q et al (2019) Modulation of humour ratings of bad jokes by other people's laughter Current Biology 29, R677-R678

Chan, M.T.V et al (2013) BIS-guided anaesthesia decreases post-operative delirium and cognitive deficits Journal of Neurosurgical Anesthesiology 25, 1, 33-42

de Faria, J.P et al (2014) New Olig1null mice confirm a non-essential role for Olig1 in oligodendrocyte development BMC Neuroscience 15, 1, 12

Deisseroth, K (2010) Controlling the brain with light Scientific American November, 29-35

Fairhall, S et al (2014) Temporal integration windows for naturalistic visual sequences PLoS ONE 9, 7, e102248 (Freely available at https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0102248)

Kahneman, D (2011) Thinking, Fast and Slow Basingstoke: Macmillan

Khalsa, S.S et al (2016) Panic anxiety in humans with bilateral amygdala lesions: Pharmacological induction via cardiorespiratory interoceptive pathways The Journal of Neuroscience 36, 12, 3559-3366

Koch, C (2010) Revisiting consciousness Scientific American Mind January/February, 20-21

Koch, C (2017) The footprints of consciousness Scientific American Mind March/April, 52-59

Koch, C (2019) The Feeling of Life Itself: Why Consciousness is Widespread but can't be Computed Cambridge, MA: MIT Press

Kosem, A et al (2014) Encoding of event timing in the phase of neural oscillations NeuroImage 92, 274-284

Koubeissi, M.Z et al (2014) Electrical stimulation of a small brain area reversibly disrupts consciousness Epilepsy and Behaviour 37, 32-35

Liu, J et al (2015) Frequency-selective control of cortical and sub-cortical networks by central thalamus eLife 4, e09215

Makin, S (2016a) Think while you sleep New Scientist 1st October, p30

Makin, S (2016b) Decode social signals *New Scientist* 1st October, 32-33

Monti, M.M et al (2010) Wilful modulation of brain activity in disorders of consciousness *New England Journal of Medicine* 362, 7, 579-589

Monti, M.M et al (2016) Non-invasive ultrasonic thalamic stimulation in disorders of consciousness after severe brain injury: A first-in-man report *Brain Stimulation* 9, 6, 940-941

Owen, A.M (2014) Is anybody there *Scientific American* May, 41-45

Owen, A.M et al (2006) Detecting awareness in vegetative state *Science* 313, p1402

Pessiglione, M et al (2007) How the brain translates money into force: A neuroimaging study of subliminal motivation *Science* 316, 904-906

Raichle, M.E et al (2001) A default mode of brain function *Proceedings of the National Academy of Sciences, USA* 98, 2, 676-682

Schiff, N.D et al (2007) Behavioural improvements with thalamic stimulation after severe traumatic brain injury *Nature* 448, 600-603

Scholz, J et al (2009) Training induces changes in white-matter architecture *Nature Neuroscience* 12, 11, 1370-1371

Sieber, F.E et al (2010) Sedation depth during spinal anaesthesia and the development of post-operative delirium in elderly patients undergoing hip fracture repair *Mayo Clinic Proceedings* 85, 1, 18-26

Simons, D.J & Chabris, C.F (1999) Gorillas in our midst: Sustained inattentional blindness for dynamic events *Perception* 28, 1059-1074

Smith, K (2012) Idle minds *Nature* 489, 356-358

Spinney, L (2015) Once upon a time *New Scientist* 10th January, 28-31

Storrs, C (2014) Hidden dangers of going under *Scientific American* April, 21-22

Thomson, H (2014) Consciousness - we hit its sweet spot *New Scientist* 5 July, 10-11

Thomson, H (2015) How to turn a brain on and off at will *New Scientist* 19/26th December, p10

Thomson, H (2019a) Hidden consciousness *New Scientist* 29th June, 38-42

Thomson, H (2019b) Suspended animation *New Scientist* 30th November, 8-9

Tononi, G (2008) Consciousness as integrated information: A provisional manifesto *Biological Bulletin* 215, 3, 216-242

Van Den Berg, N.S et al (2019) A shrunken world - micropsia after a right occipito-parietal ischemic stroke *Neurocase* 25, 5, 202-208

Williams, C (2016) Make decisions *New Scientist* 1st October, p32

Williams, C (2018) The secret of you *New Scientist* 7th July, 36-39

Wittmann, M (2011) Moments in time *Frontiers in Integrative Neuroscience* 5, article 66

Wood, K & Simons, D.J (2019) Now or never: Noticing occurs early in sustained inattentional blindness *Royal Society Open Science* 6, 191333

Yamamoto, Y & Katayama, Y (2005) Deep brain stimulation therapy for the vegetative state *Neuropsychological Rehabilitation* 15, 3-4, 406-413

2. COLLECTIVE EFFICACY

2.1. STUDIES OF DISASTERS

Bandura (1986) described a concept called "collective efficacy" (CE), which he defined as "judgments about group capabilities to make decisions, to enlist supporters and resources, to devise and carry out appropriate strategies, and to withstand failures and reprisals" (quoted in Benight 2004). Zaccaro et al (1995) provided this definition: "a sense of collective competence shared among individuals when allocating, co-ordinating, and integrating their resources in a successful concerted response to specific situational demands" (quoted in Benight 2004). Put simply, CE is "communal coping" (Benight 2004) [16].

Benight (2004) studied CE in Buffalo Creek, Colorado, USA, where forest fires devastated the small community in May 1996 followed in July by flooding.
Fifty residents were surveyed between three to eight weeks later (Time 1), and then around one year further on (Time 2). A control sample from an unaffected community fifteen miles away were recruited. The questionnaires used (table 2.1) included a specially designed twelve-item measure of CE (table 2.2) (appendix 2A).
The variables of lost resources, perception of social support, and level of distress at Time 1 predicted CE perceptions at Time 2. "Lost resources demonstrated a positive relationship suggesting the greater the resource depletion, the greater the psychological distress. Social support demonstrated a negative relationship demonstrating the greater the perceived availability of social support, the lower the psychological distress" (Benight 2004 pp409-410) [17].
Altogether, individuals with high resource loss reported significantly less psychological distress at Time 2 for high perceived CE and social support as compared to low perceived CE and social support. There

---

[16] "Collective efficacy can be both an individual-level perception and a community-level capacity. At the community level, the willingness of community members to intervene for the common good depends on mutual trust and solidarity among neighbours" (Ursano et al 2014 p1).
[17] The importance of relationships is described in the concept of social capital (appendix 2B).

- Loss of Resources (LOR) Scale - 40-item assessment of the degree of loss, scored as "no loss" (0) to "extreme amount of loss" (4) (eg: tangible factors like furniture and clothing; non-tangible factors like health and a sense of daily routine; Hobfoll 1989).

- Interpersonal Support Evaluation List (ISEL) (Cohen et al 1985) - Forty items about social support rated as true or false (eg: "someone to talk to about problems"; "people with whom to associate").

- Impact of Event Scale (IES) (Horowitz et al 1993) - Fifteen items assessing the symptoms of post-traumatic stress in the past week, from "not at all" (1) to "often" (4) (eg: intrusive thoughts about the traumatic event; emotional numbing; avoidance behaviours towards reminders of the event).

Table 2.1 - Three measures used by Benight (2004).

Rate each item about the community from 1 ("not well at all") to 7 "very well"):

- Ability to quickly co-ordinate community wide action.
- Ability of community to recognise the need for outside support.
- Ability to adequately solve conflicts within the community.
- Ability for me to work effectively with others in the community.

(Source: Benight 2004 appendix A p419)

Table 2.2 - Example of items to measure collective efficacy.

was no difference for low resource loss.

Benight (2004) ended: "due to the destructive and destabilising aspects of disasters, individual and collective coping abilities are often stretched to capacity. Community members must work in a concerted and co-ordinated effort to move toward recovery, persevering when environments are non-responsive, managing limited resources in the most efficient and effective manner, and identifying and assisting those most in need. Interventions that enhance collective efficacy perceptions combined with enhanced resource availability may provide important ingredients for successful individual and community-wide adaptation" (p416).

Other studies have shown that CE is beneficial for the individual (eg: lower levels of depressive symptoms; Vaeth et al 2010), and for the neighbourhood (eg: less crime; Sampson et al 1997).

2.1.1. Florida Hurricanes

Ursano et al (2014) studied public health/disaster workers [18] after four hurricanes ("Charley", "Frances", "Ivan" and "Jeanne")and one tropical storm ("Bonnie") hit Florida in seven weeks in 2004. Members of the Florida Department of Health (FDOH) experienced "both personal hurricane-related injuries and high levels of community storm damage within communities" (Ursano et al 2014 p2). Nine months after the events, 2249 FDOH workers completed questionnaires that included post-traumatic stress disorder (PTSD) symptoms [19], and CE. The latter was measured by a ten-item scale developed by Sampson et al (1997), which covered two domains:

i) Informal social control - How likely would their neighbours intervene if: "a) children were skipping school and hanging out on a street corner; b) children were spray painting graffiti on a local building; c) children were showing disrespect to an adult; d) a fire broke out in front of their house; and e) if a fire station closest to their home was threatened with budget cuts" (Ursano et al 2014 p2).

ii) Social cohesion/trust - In the home neighbourhood: "a) people are willing to help their neighbours; b) it is a close-knit neighbourhood; c) people can be trusted; d) people generally get along with each other; and e) people share the same values" (Ursano et al 2014 p2).

Each item was scored on a five-point Likert scale, and so higher scores indicated greater CE.
Other variables included individual hurricane injury/damage (six events - eg: loss of electric power; injury or harm to self), and community hurricane damage (level of assistance received scored as 0 or 1) [20] [21].
Around three-fifths of respondents were classed as having experienced high levels of personal and community damage, and just under 5% of the sample met the criteria for diagnosis of PTSD.
Higher individual perceptions of CE and community-based CE were both associated with lower PTSD symptoms/severity (figure 2.1). So, "disaster workers who

---

[18] Public health workers include those who provide medical care, as well as "traditional state public health positions" like epidemiologists and laboratory technicians (Fullerton et al 2015).

[19] This was measured by the seventeen-item PTSD checklist (PCL-17) (Weathers and Ford 1996).

[20] There are methodological issues with the measures of individual and collective injury/damage experienced (eg: other categories not included).

[21] This was done based on 825 Florida zip codes. Ursano et al (2014) explained: "Zip codes are being used as a proxy for neighbourhood. While this is for the most part a reasonable choice, it is plausible that in some cases zip codes will cross neighbourhoods" (p7).

lived in neighbourhoods with higher community-level collective efficacy had a lower likelihood of probable PTSD, even after adjusting for individual socio-demographic variables, community socio-economic characteristic variables, individual injury/damage, and community storm damage" (Ursano et al 2014 p6).

Ursano et al (2014) explained: "Communities with higher collective efficacy may promote experiences of safety, calming, optimism, and social support. In such communities, members are more likely to have lower exposure to chronic adversities, work together to make resources available for rebuilding, and provide mutual support and assistance. In addition, there may be greater use of health care that can prevent or mitigate disorders such as PTSD. Each of these may enhance recovery from acute stress and lead to lower rates of PTSD" (p6).
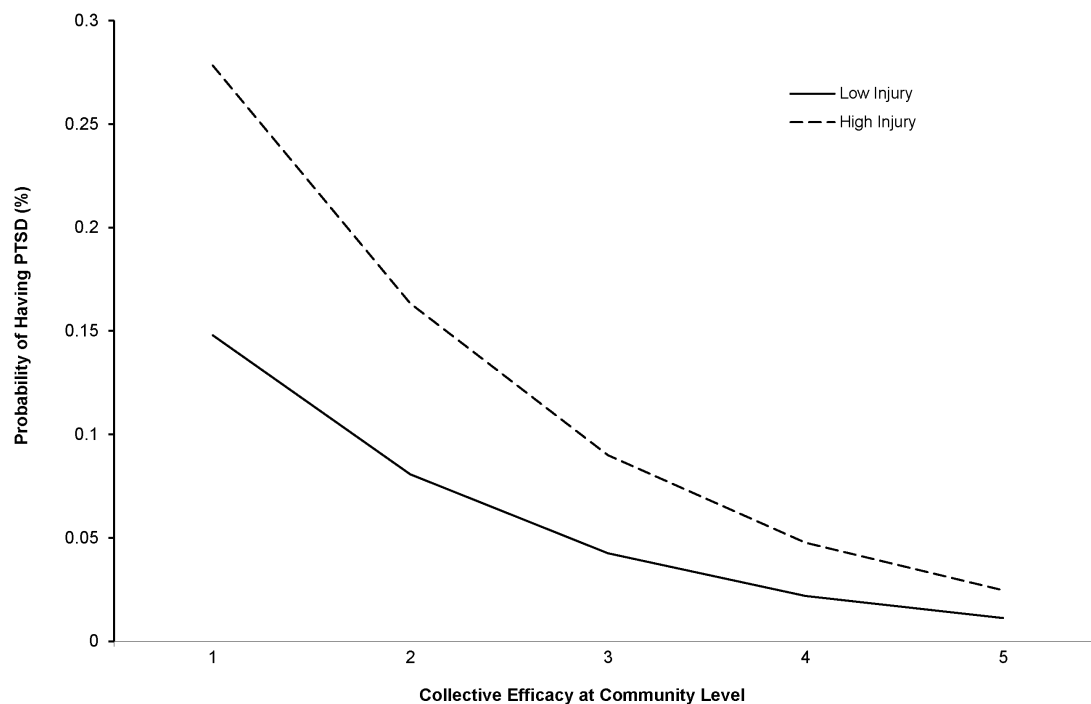
Figure 2.1 - Probability of PTSD based on community-level CE and level of injury/damage.

Fullerton et al (2015) analysed the same data for the relationship between depression and CE. Depressive symptom severity was scored 0 to 27 for the previous two weeks (ie: nine symptoms each scored 0 ("not at all") to 3 ("nearly every day")) (Patient Health Questionnaire Depression Scale 9 (PHQ-9); Kroenke and Spitzer 2002).

The mean score overall was 3.4. Nine per cent of the sample was categorised as moderate to severe depressive symptom level (ie: scores ≥10) and 18% as mild depressive

symptom level (scores from 5 to <10).

Adjusting for socio-demographic variables and socio-economic status, and individual injury and collective storm damage experienced, higher individual-level and community-level CE scores were associated with lower depression scores.

Because of "the cross-sectional nature of this study, assumptions about causal direction are challenging. If perceived collective efficacy is causally related to depression it may be that higher perceived collective efficacy is protective for depression, and lower collective efficacy leads to higher depression. Alternatively, it may be that depression makes one perceive collective efficacy in a more negative light..." (Fullerton et al 2015 p8).

There were no pre-disaster measures of depression. Fullerton et al (2015) admitted that the study "examined general depression that was not necessarily related to trauma and possibly had an onset that preceded exposure to the hurricanes" (p8).

The questionnaire was completed as an electronic version. McKibben et al (2010) commented: "The electronic questionnaire method allowed for the collection of a large number of questionnaires in a cost-effective fashion; however, it would be useful to investigate the possibility of non-response bias [...] Specifically, administrators and professionals with greater computer access may be represented more in these data than are individuals providing logistical and other forms of support" (pS61). Also there would be missing cases of individuals who left the FDOH shortly after the hurricanes (ie: before the questionnaire) (McKibben et al 2010).

2.1.2. Other Findings

Fullerton et al (2013) analysed the questionnaire data for the relationship between PTSD and depression, and increased alcohol and/or tobacco use.

Around 11% of the sample was classed as having at least one of these problems. Ninety-seven FDOH employees in the sample had "probable PTSD", and one-third of these who drunk reported increased alcohol consumption after the hurricanes, and half of these who smoked increased their use.

Eighty-one employees had "probable depression", and one-third of drinkers here increased consumption and over half of smokers increased their use post-hurricanes (figure 2.2).

High level of hurricane exposure (based on personal injury and damage) was associated with a threefold increase in alcohol consumption and smoking. This was

exacerbated by high work demands (eg: working 12-hour or longer shifts; seven days or more without a day off).

Alcohol use was assessed by this question: "Since the hurricanes did you change your drinking habits for any 2-week period of time or more?", with these response options: "I do not drink alcohol" (1), "the amount I drank remained the same" (2), "I drank more than usual" (3), "I drank less than usual" (4), and "I had stopped drinking but started again" (5). Tobacco use (cigarettes, pipe, cigars, chewing tobacco) was measured by a similar question and response options. There was no independent verification of the information given.
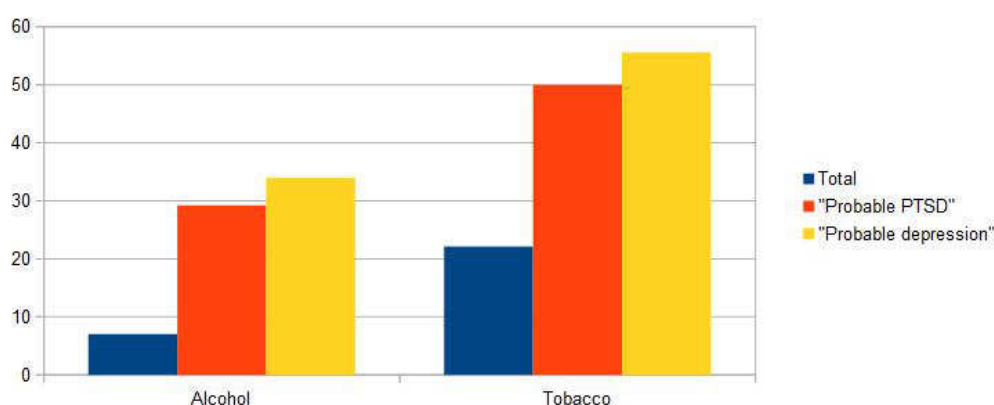

Figure 2.2 - Percentage of sample reporting a post-hurricanes increase in alcohol and tobacco use by those who drank and/or smoked.

McKibben et al (2010) had reported: "Nine months after the 2004 hurricanes, impaired work performance, 'bad' mental health days, 'bad' physical health days, limited day-to-day function, sleep disturbance, and hurricane-related arousal were prominent" (pS57). Nearly half of the respondents had self-reported sleep problems in the previous two weeks, and this was related to greater hurricane-caused injury. Sleep problems were, in turn, associated with impaired work performance, and poor mental health.

2.2. APPENDIX 2A - QUESTIONNAIRE DESIGN

There are five general types of question asked in surveys (De Vaus 2014) (table 2.3):

i) Behaviour - Questions about what people do.

ii) Beliefs - Questions based on true/false

- Simple language without jargon or technical terms.

- Not overlong and complex.

- Not double-barrelled.

- Not leading or loaded.

- Not worded as a negative [22].

- Appropriate to knowledge of respondent.

- Questions have same meaning to all respondents [23].

- "Prestige bias" - prestige of person in question can influence answer (eg: do you with the President...?).

- Not ambiguous.

- Neither too precise nor too vague [24].

- Clear frame of reference (eg: in last month) [25].

- Not offensive.

- "Dead-giveaway" questions that include words like all, always, and everybody, for example, and few people will disagree [26].

(Source: De Vaus 2014)

Table 2.3 - Question wording dos and don'ts.

responses.

---

[22] For example, Cohen et al (1996) found that the same questions about a hospital experience phrased negatively or positively produced different responses (ie: "asking patients if they agreed with a negative description of their hospital experience produced a greater level of reported dissatisfaction than asking them if they agreed with a positive description" (Bowling 2014 p298).

[23] "As respondents hear or read a survey question, they construct a 'pragmatic meaning' that incorporates their interpretation of the gist of the question, why it is being asked, and what constitutes an acceptable answer" (Schaeffer and Presser 2003 p67).

[24] Framing effects (ie: how the question is asked) - eg: "half-empty or half-full" effect (Bowling 2014).

[25] "The choice of reference period is usually determined by the periodicity of the target events, how memorable or patterned the events are likely to be, and the analytic goals of the survey. Thus, investigators may ask about religious practices over the previous year to obtain information about respondents who attend services only on their religion's (annual) holy days. By contrast, questions about purchases of candy bars usually use a much shorter reference period. Although more recent events are generally remembered better than more distant events, the influence of the length of the reference period is probably smaller for frequent and highly patterned events, presumably because respondents use information about patterning to construct their answers" (Schaeffer and Presser 2003 p71).

[26] "Posing questions as statements to be agreed or disagreed with is among the most common formats found in attitude surveys, yet at the same time, it is the most controversial method of asking questions. On the one hand, agree-disagree items are simple to construct and easy to answer. On the other hand, they encourage acquiescence, the tendency to agree irrespective of item content" (Schaeffer and Presser 2003 p80).

iii) Knowledge - Questions about the accuracy of beliefs.

iv) Attitudes - Questions about what is seen as desirable. Attitudes will be measured in terms of direction (agree/disagree), and extremity and intensity (strongly agree/strongly disagree).

v) Attributes - Information about the respondent, like age.

Putting in the cognitive effort to answer a question (ie: thinking about it) is called "optimising" as opposed to "satisficing" (Kosnick 1999) (ie: giving okay answers rather than optimal answers"; De Vaus 2014 p96). Satisficing occurs if the task is complex (eg: difficult words in questions), and if the respondents do not have the necessary ability or motivation, say (De Vaus 2014).

The mode of administration of questions can involve an interviewer, as in face-to-face or telephone interviews, or not (ie: postal or Internet/web-based surveys) (table 2.4).

	Face-to-face interview	Telephone	Postal	Internet
Response rate	Higher (up to 20% greater than postal; Cartwright 1988)	Higher		
Representative sample		Gain access via phone, but misses unlisted numbers	Gain access to sample	Only certain individuals (ie: computer users/owners and with access to Internet); no complete list of users
Issues	Flexible vs social desirability answers; interviewer-interviewee interaction variables	Flexible vs social desirability answers	Problem with boring questions; not sure who completes it	Good for complex questions; not sure who completes it

(Source: Bowling 2014; De Vaus 2014)

Table 2.4 - Key issues with different modes of questionnaire administration [27] [28] [29].

---

[27] Cartwright (1988) found that length of questionnaire influenced response rate - 90% with one-page length compared to 73% with three pages (Bowling 2014).

[28] "Postal and other self-completion methods are only suitable when the issues and questions are straightforward and simple, when the population is 100 per cent literate, and speaks a common

2.3. APPENDIX 2B - SOCIAL CAPITAL

Social capital "refers to features of social relationships that facilitate co-operation for mutual benefit. Features of social capital such as feelings of interpersonal trust and norms of reciprocity have been termed cognitive components and are distinguished in the literature from civic engagement which is considered a structural component" (de Souza and Grunday 2007 pp1397-1398).

Social capital is associated with self-rated health. So, improving social capital should improve health. de Souza and Grunday (2007) tried this with an intergenerational programme in a city in Brazil where older adults mixed with adolescents. The adolescents were more likely to report good health after the fourteen-week programme, but older adults showed no difference in health. There were other positive outcomes like strengthened relationships with neighbours among the older adults (de Souza and Grunday 2007).

2.4. REFERENCES

Bandura, A (1986) Social Foundation of Thought and Action Englewood Cliffs, NJ: Prentice-Hall

Benight, C.C (2004) Collective efficacy following a series of natural disasters Anxiety, Stress and Coping 17, 4, 401-420

Bowling, A (2014) Research Methods in Health: Investigating Health and Health Services (4th ed) Buckingham: Open University Press

Cartwright, A (1988) Interviews or postal questionnaires? Comparisons of data about women's experiences with maternity services Milbank Quarterly 66, 172-189

Cohen, G et al (1996) Can different patient satisfaction survey methods yield consistent results? Comparison of three surveys BMJ 313, 841-844

Cohen, S et al (1985) Measuring the functional components of social support. In Sarason, I.G & Sarason, B.R (eds) Social Support: Theory, Research and Applications Boston: Martinus Nijhoff

de Souza, E.M & Grundy, E (2007) Intergenerational interaction, social capital and health: Results from a randomise controlled trial in Brazil Social Science and Medicine 65, 1397-1409

language, and when a sampling frame of addresses (eg: postal or electronic) exists" (Bowling 2014 p288).
[29] It has been well established that different interviewers (young/old; male/female) elicit different amounts of information and responses from interviewees (Bowling 2014).

De Vaus, D.A (2014) Surveys in Social Research (6th ed) London: Routledge

Fullerton, C.S et al (2013) Post-traumatic stress disorder, depression, and alcohol and tobacco use in public health workers after the 2004 Florida hurricanes Disaster Medicine and Public Health Preparedness 7, 89-95

Fullerton, C.S et al (2015) Depressive symptom severity and community collective efficacy following the 2004 Florida hurricanes PLoS ONE 10, 6, e0130863 (Freely available at https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0130863)

Hobfoll, S.E (1989) Conservation of resources: A new attempt at conceptualising stress American Psychologist 44, 513-524

Horowitz, M.J et al (1993) Stress response syndromes and their treatment. In Goldberger, L & Brenitz, S (eds) Handbook of Stress: Theoretical and Clinical Aspects New York: Free Press

Kroenke, K & Spitzer, R.L (2002) The PHQ-9: A new depression diagnostic and severity measure Psychiatric Annals 32, 509-521

Krosnick, J.A (1994) Survey research Annual Review of Psychology 50, 1, 537-567

McKibben, J.B.A et al (2010) Sleep and arousal as risk factors for adverse health and work performance in public health workers involved in the 2004 Florida hurricane season Disaster Medicine and Public Health Preparedness 4, S55-S62

Sampson, R.J et al (1997) Neighbourhoods and violent crime: A multi-level study of collective efficacy Science 277, 918-924

Schaeffer, N.C & Presser, S (2003) The science of asking questions Annual Review of Sociology 29, 65-88

Ursano, R.J et al (2014) Post-traumatic stress disorder and community collective efficacy following the 2004 Florida hurricanes PLoS ONE 9, 2, e88467 (Freely available at https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0088467)

Vaeth, P.A et al (2010) Depression among couples in the United States in the context of intimate partner violence Journal of Interpersonal Violence 25, 776-790

Weathers, F.W & Ford, J (1996) Psychometric review of PTSD Checklist (PCL-C, PCL-S, PCL-M, PCL-PR). In Stamm, B.H (ed) Measurement of Stress, Trauma and Adaptation Lutherville, MD: Sidran Press

Zaccaro, S.J et al (1995) Collective efficacy. In Maddux, J.E (ed) Self-efficacy, Adaptation and Adjustment: Theory, Research and Application New York: Plenum Press

3. FOOD AND DIET MISCELLANEOUS

3.1. FOOD LABELLING

Sugar-sweetened beverages (SSBs) are seen as "uniquely harmful because they contain large amounts of calories, which can be rapidly absorbed and are less satiating, leading to inadequate caloric compensation at other eating occasions and contributing to overall positive energy balance" (Taillie et al 2020 p3). One public policy response has been a tax/levy on SSBs (ie: to increase their prices) (eg: 42 countries and six US cities; Taillie et al 2020) (appendix 3A).

Other strategies include government restriction on marketing of SSBs, sale and promotion in or near schools, and front-of-package (FOP) warning labels (Taillie et al 2020).

Taillie et al (2020) concentrated on the latter as introduced in Chile in 2016 for energy-dense non-essential foods (including SSBs). The Law of Food Labelling and Advertising also introduced restrictions on promotions, particularly to children.

These researchers analysed household purchases of over 2000 urban households between 2015 and 2017 (ie: before and after the Law). Purchases of beverages classed as "high-in" (sugars) by FOP warning labels were compared to "not-high-in" ones (main outcome measure).

Mean volume of high-in beverage purchases declined by over one-fifth in the post-regulation, and this varied with educational level (figure 3.1) [30]. "This translates into roughly 12 fewer calories and 2.7 fewer grams of sugar purchased per capita per day from high-in

---

[30] "Households with higher educational attainment had larger relative reductions in high-in beverage purchases than did households with less education. This may be because higher-educated household had lower baseline purchases of high-in beverage purchases than did low-educated households, creating a larger relative difference..." (Taillie et al 2020 p14).
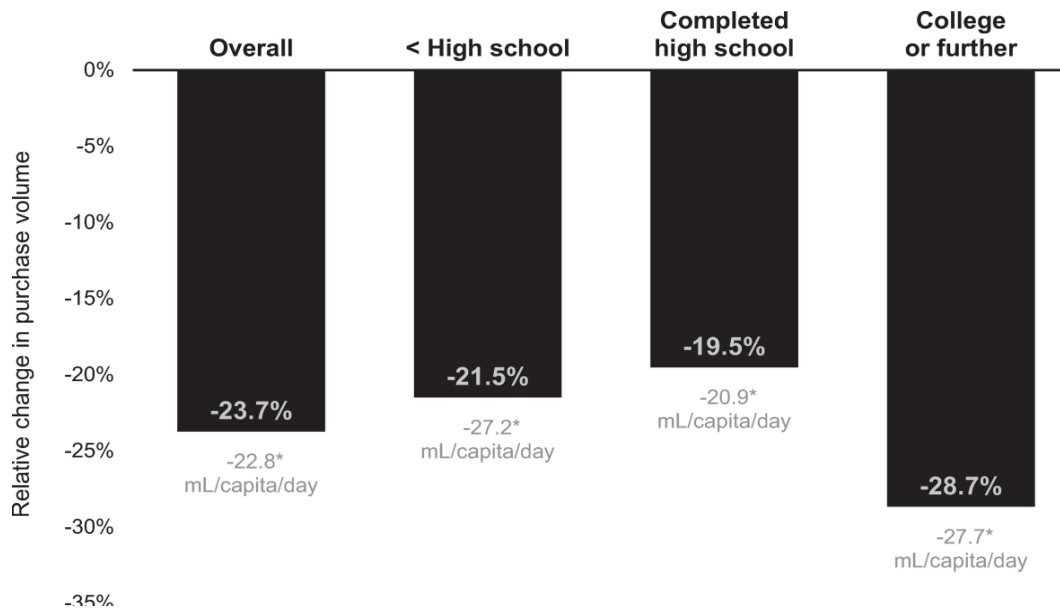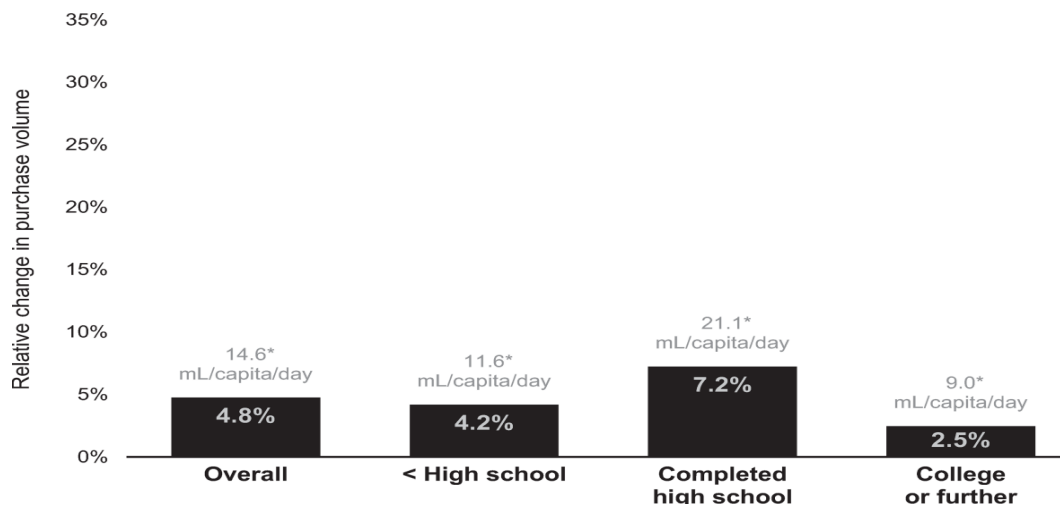
(Source: Taillie et al 2020 figure 1)

Figure 3.1 - Relative (%) and absolute (millilitres (mL) per capita per day) changes in purchases of high-in beverages in the post-regulation period (compared to pre-regulation) based on education.

beverages" (Taillie et al 2020 p14). Purchases of not-high-in beverages increased in the post-regulation period (figure 3.2).

(Source: Taillie et al 2020 figure 2)

Figure 3.2 - Relative (%) and absolute (millilitres (mL) per capita per day) changes in purchases of not-high-in beverages in the post-regulation period (compared to pre-regulation) based on education.

The main limitation of this study, Taillie et al (2020) admitted is that "this is an observational pre-post study and thus unable to assess the causal impact of the law or disentangle the drivers of the observed reductions in high-in beverage purchases. The reductions in purchases of high-in SSBs found in this study likely reflect a combination of changes in consumer behaviour (eg: consumers choosing not to purchase a high-in beverage) and industry behaviour (eg: product reformulations that could shift products from high-in to not-high-in status, or other industry actions such as changes in marketing strategy or pricing changes). For example, after the policy, we observed that there was a large decline in the percent of households who purchased high-in fruit drinks and a sizeable increase in the percent who purchased high-in fruit drinks after the policy. Currently, it is not clear whether this is because consumers were choosing to switch from high-in fruit drinks to not-high-in fruit drinks or whether they purchased the same or similar beverages, but these beverages were reformulated under the nutrient thresholds and thus no longer subject to the regulation (and thus no longer classified as 'high-in')" (pp15-16).

Other key limitations included the pre-regulation period of one year used as the baseline, urban households sampled, and only beverages purchased at stores included (not in restaurants or schools, nor home-made) (Taillie et al 2020).

3.2. EATING DISORDER BEHAVIOUR

Herle et al (2020b) observed: "Although childhood eating behaviours have typically been studied in the context of obesity, their role in the development of eating disorders in adolescence has received little attention. Importantly, in addition to overeating and undereating, food fussiness (the tendency to eat only certain foods and to refuse to try new foods) is common during childhood, and might be a precursor to adolescent dieting, a previously suggested risk factor for anorexia nervosa" (p113).

There is limited research here. Kotler et al (2001), for example, studied 800 children from six to 22 years old, and found that "conflicts and struggles around meals in childhood were associated with higher risk for anorexia nervosa in adolescence and young adulthood, whereas childhood undereating was associated with later bulimia nervosa" (Herle et al 2020b p113). The number of eating disorder cases was small in this study as only diagnosed cases were considered (Herle et al 2020b).

Longitudinal cohorts provide larger samples to study, like the Avon Longitudinal Study of Parents and Children (ALSPAC) in England, which covered nearly 14 000

children born in 1991-2, and their parents. This cohort
has been studied to show a relationship between childhood
growth and eating disorders (Yilmaz et al 2019), and
trajectories of eating behaviour in childhood and weight
(body mass index) at eleven years old (Herle et al
2020a).

Herle et al (2020b) reported further analysis of
ALSPAC data on childhood eating behaviours, and eating
disorders and eating disorder behaviours in adolescence.

The outcome measures at 16 years old were self
reports of binge eating (defined as "eating a large
amount of food at least once a week and having a feeling
of loss of control during that episode"; p114), purging
to lose weight or avoid gaining weight (ie: self-induced
vomiting or laxative use), and fasting (ie: "not eating
at all for at least a day, to lose weight or avoid
gaining weight"; p114) (Herle et al 2020b). "Participants
who indicated that they exercised for weight loss
purposes, felt guilty about missing exercise and found it
hard to meet other obligations, such as schoolwork,
because of their exercise regime were coded as engaging
in excessive exercise" (Herle et al 2020b p114).

Eating behaviours in childhood were parent-reported
at approximately annual points between one to nine years
old, and had been categorised previously by Herle et al
(2020a) (table 3.1), and broadly as:

OVEREATING
- Low - no overeating
- Low transient - some overeating in first 5 years of life only
- Late increasing - overeating increased after five years old
- Early increasing - increasing overeating throughout childhood

UNDEREATING
- Low - no undereating
- Low transient - some before five years old
- Low and decreasing - some before 9 years old
- High transient - increased in first 5 years of life
- High decreasing - declined steeply by 9 years old
- High persistent - throughout childhood

FUSSY EATING
- Low - no fussy eating
- Low transient - some before five years old
- Low and increasing - throughout childhood
- Early and decreasing - in first 2 years of life only
- Rapidly increasing - increased throughout childhood
- High persistent - throughout childhood

Table 3.1 - Trajectories of childhood eating behaviours.

a) Overeating - This was associated with increased

risk of adolescent binge eating and Binge Eating
Disorder, particularly for the "early increasing
overeating" category.

     b) Undereating - "Persistent undereating" was a risk
in adolescent female anorexia nervosa [31].

     c) Fussy eating - There was an association with a
risk for anorexia nervosa in adolescence.

     At least one measure of eating behaviour in
childhood was available for 12 002 children, of which at
least one outcome measure was available for 4760. Eating
disorder behaviours and diagnoses were higher for females
than males (figure 3.3).
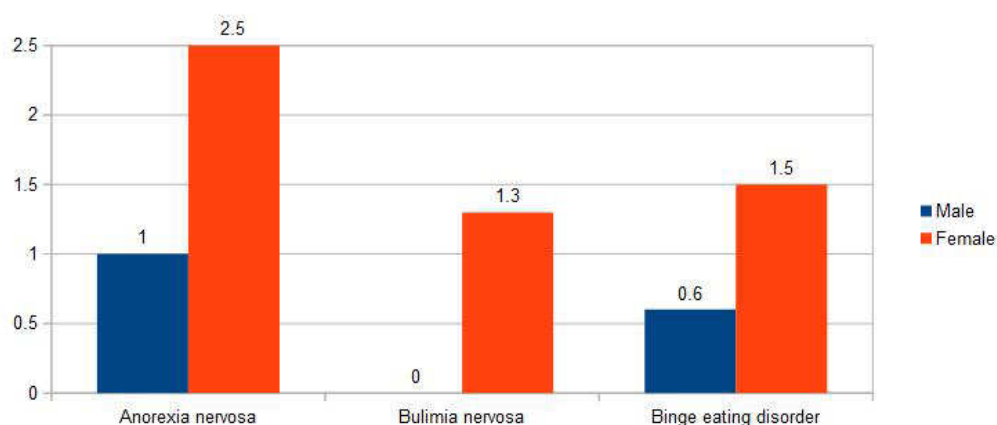
(Data from Herle et al 2020b table 1 p115)

Figure 3.3 - Percentage of adolescents with eating
disorder diagnoses.

     Herle et al (2020b) summed up: "Our results support
the hypothesis that there is continuity between early
life eating behaviours and later eating disorder
behaviours and eating disorders. This notion has
important implications for future preventive strategies.
Findings suggest that identifying children with specific
eating behaviours might be a promising approach for
targeted intervention to prevent progression to
disordered eating and eating disorders in adolescence"
(p118).
     Note that some of the high risk categories were
small (eg: n = 82 for "high persistent undereating"), as
were the outcome measure groups (eg: eleven male Binge

---

[31] Among 69 female anorexia nervosa cases, four were categorised as "high persistent undereating" and
"high persistent fussy eating".

Eating Disorder cases). Herle et al (2020b) also admitted: "As commonly observed in longitudinal cohort studies, participants tend to drop out as time goes on [32]. This loss of follow-up has been associated with socio-economic position of the participants and their families, reducing the generalisability of the findings" (p118).

3.2.1. Incidence

In the UK, over one and half million people suffer from an eating disorder, but "this is likely to be an underestimate as many people do not seek help", and this includes a reported increase in cases between 2000 and 2009 (but "it is not clear if this is due to increased help seeking or due to better diagnosis") (Demmler et al 2020).

Thus, a need for data on the subject. Demmler et al (2020) made use of the Secure Anonymised Information Linkage (SAIL) database covering the Welsh NHS. The focus was the period 1st July 1990 to 30th June 2017.

From general practitioner (GP) data, over 14 000 individuals were diagnosed with an eating disorder, with a peak age of 15-19 years old (and the diagnosis of males being later than female generally). There were another 1200 cases from other health information (eg: in-patient hospital admissions). There was a total of 15 558 cases (after removal of "double counts" by GPs and hospital admissions).

The number of new cases (incidence [33]) rose from 8 per 100 000 people in 1990-1 to 24 (peak) in 2003-4 [34].

"Incidence of diagnosed eating disorders is relatively low in the population but there is a major longer term burden in morbidity and mortality to the individual" (Demmler et al 2020 p105). Compared to matched controls, they were nearly twice as likely to die, and much more likely to experience other psychological problems (eg: alcohol misuse), and to be prescribed a wide range of medications.

Demmler et al (2020) admitted that their study "only reports on diagnosed eating disorders that are both known to the healthcare practitioners and coded into patient records within the study period; as a result we cannot estimate or report on undiagnosed or pre-existing eating disorders, and so incidences are only for clinical presentation and will always be expected to be an underestimate of the true numbers. Furthermore, it is not

---

[32] If individuals drop-out of a study, it may still be possible to analyse their incomplete data. This is known as "intention-to-treat" analysis (Bowers 2008).

[33] The incidence is the number of new cases in a population in a defined time, while the prevalence is the number of cases in a population at one point in time per 1000 or 10 000 population (Bowling 2014).

[34] This compares to 36 per 100 000 in 2009 in England (Demmler et al 2020).

possible to report on the prevalence of eating disorders
in the population as the database does not enable us to
determine recovery from a previously diagnosed eating
disorder" (pp109-110).

3.2.2. Long-Term Outcome

What about the long-term outcome of anorexia nervosa
(AN)? [35] A review by Steinhausen (2009) of studies in the
second half of the 20th century established a mortality
rate of 5%. Overall, sufferers could be divided into
approximate thirds - fully recovered, improved, and no
improvement (Rydberg Dobrescu et al 2020).
In terms of long follow-up periods, Rydberg Dobrescu
et al (2020) noted three studies - 21 years in a German
study (Zipfel et al 2000) (recovery 51%), 22 years in a
US study (Eddy et al 2017) (63% recovery), and 33 years
in a Swedish study (Theander 1985) (76% of patients
recovered by the end of follow-up). The latter study was
different to the other two with a retrospective design,
but it did involve face-to-face interviews (as did Zipfel
et al 2000). Eddy et al (2017) undertook telephone
interviews at follow-up (Rydberg Dobrescu et al 2020).

Rydberg Dobrescu et al (2020) reported the latest
details of the "Gothenberg anorexia nervosa study", which
began in 1985 with 4291 individuals born in 1970 in
Sweden. Fifty-one individuals (all but three were female)
were categorised as the "AN group", and fifty-one matched
controls were selected [36].
Follow-ups were made six years later (mean age 21
years old) (Gillberg et al 1994), ten years after onset
(mean age 26 years old) (Weentz et al 2001), and at 32
years old (mean age) (18 years after onset) (Weentz et al
2009).
Rydberg Dobrescu et al (2020) reported the thirty-
year follow-up (mean age 45 years old). All participants
were traced, and only four of the AN group refused
interviews. All 102 individuals were still alive.
In the AN group, 64% (n = 30) were classed as fully
recovered (defined as six consecutive months symptom-
free). Nine individuals (19%) had a current eating
disorder diagnosis (anorexia for three of them). The
remainder were not classed as fully recovered nor as
having a current diagnosis. There was not complete data
for all the AN group.

---

[35] AN has the highest mortality of all psychiatric disorders, most commonly from medical
complications or suicide (Liu et al 2020).

[36] Matching can occur in two ways - matched case-control (each case individually matched with a
control) and unmatched case-control (or frequency matching) (eg: same proportions of males and
females in cases and controls) (Bowers 2008). This study used the former.

The AN group was significantly more likely to have other psychiatric disorders than the comparison group.

The study was limited by the small sample size, and the relatively short period of time for the definition of recovery.

In terms of the trajectory of the condition over thirty years, weight increased with age, and "[L]ater age at onset among individuals with adolescent-onset anorexia nervosa predicted good outcome, ie: adolescent onset is better than childhood onset..." (Rydberg Dobrescu et al 2020 p101).

3.2.3. Deep Brain Stimulation

Liu et al (2020) reported success with electrodes implanted (deep brain stimulation) in the area of the brain known as the nucleus accumbens of women with anorexia nervosa. It is suggested that this area in the ventrum striatum is linked to learning from experience (and has a "crucial role in the reward circuitry"; Liu et al 2020 p644), and anorexia sufferers have abnormal connections here which produces the fear of gaining weight (Klein 2020).

Twenty-eight treatment-resistant women with a very low body mass index (BMI) had the electrodes implanted [37] [38]. Over the following two years, weight gain occurred as well as reduced depression and anxiety (figure 3.4).
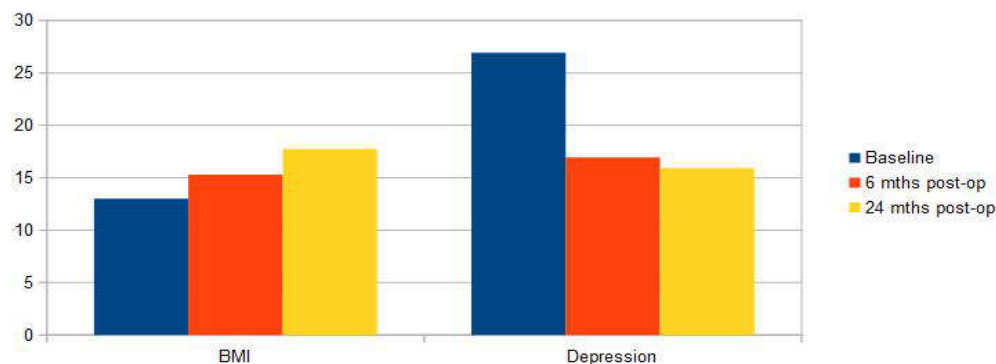
(BMI = body mass index: kg/m²; depressive symptoms measured by Hamilton Depression Scale (HAMD) where a higher score is more depressed)

(Data from Liu et al 2020 table 2 p646)

Figure 3.4 - Mean scores for selected outcome measures.

---

[37] Around one-fifth of sufferers do not respond to treatment - psychological and/or pharmacological (Liu et al 2020).
[38] The women were recruited at Ruijin hospital, Shanghai, China, between 2010 and 2015. The outcome measures of BMI, and mood, anxiety, and obsessive symptoms were collected at baseline, and at six and 24 months post-operation.

Weight improvement was better for women with the restricting type of AN as compared to the binge-purge type (figure 3.5).
        But this study had no control group (Klein 2020).
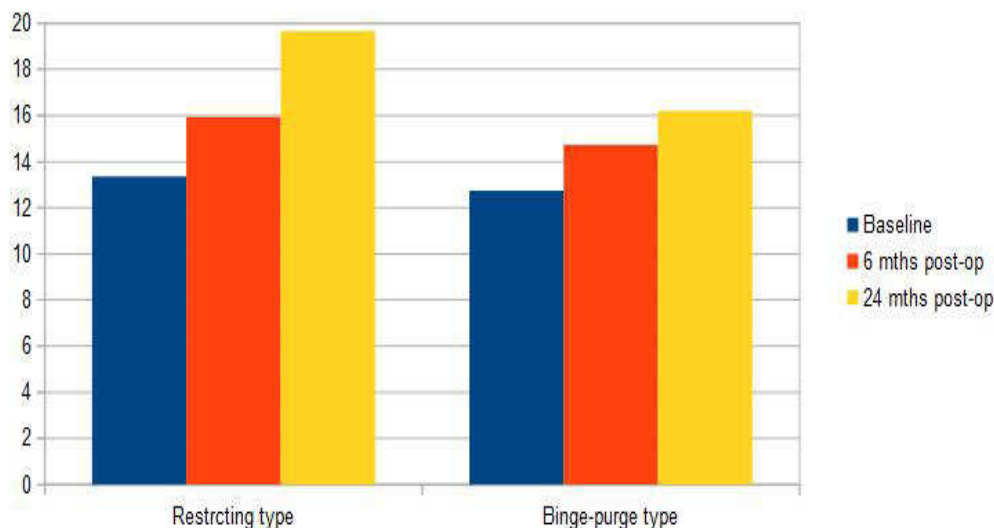
(Data from Liu et al 2020 table 3 p648)

Figure 3.5 - Mean BMI scores for two types of AN.

3.3. MICRONUTRIENTS

        Around two billion people globally are deficient in essential micronutrients, like iron, zinc, and omega-3 fatty acids [39]. A diet including 100 g of fish per day would provide half the recommended daily allowance of iron and zinc for under 5s, for example (Editorial 2019).
        Fishing communities in poorer countries could overcome these deficiencies with their catches (eg: one-fifth of fish caught would meet micronutrient needs of under 5s; Hicks et al 2019). But many of these communities are encouraged to export their catches to richer countries, which creates the local deficiencies as well as risks overfishing (Pauly 2019).

        Deficiency of micro-nutrients has consequences (table 3.2).

---

[39] There may also be up to one million premature deaths per year from such deficiencies (Hicks et al 2019).

Micro-Nutrient	Deficiency
Vitamin A	Night blindness
Vitamin D	Born and tooth fragility
Vitamin B12	Anaemia
Vitamin C	Scurvy
Calcium	Rickets
Iodine	Thyroid problems

(Source: Hubbard and Mechan 1997)

Table 3.2 - Deficiency of selective micro-nutrients.

3.3.1. General Deficiency

Derbyshire (2019) argued that choline should be added to the list of essential nutrients. Choline makes up cell membranes, and is involved in the liver's fat metabolism, for instance. It is found in red meat and eggs (Wilson 2019).

Steven Zeisel (eg: Zeisel and Blusztain 1994) studied volunteers in a controlled environment given high or low choline diets (500 milligrams (mg) vs 50 mg per day) [40]. The low-choline group had more liver enzymes in their blood and fat in their liver (Wilson 2019).

3.4. HIGH SALT DIET

A high-salt diet (HSD) is an independent risk factor for stroke and dementia in humans, as well as cognitive impairment from reduced cerebral blood flow (Faraco et al 2019).

Studies with mice, for example, have tried to establish the mechanism of HSD and cognitive impairment. Faraco et al's (2019) work showed that it is through the accumulation of tau protein in the brain. In the experiments, the HSD was 8-16 times higher than the normal mouse chow (control group). This is the equivalent of 12.5-20 g per day for humans (where the recommended level is 4-5 g per day) (Faraco et al 2019).

The cognitive ability (memory) of the mice was tested in two standardised ways:

- Novel object recognition (NOR) test - A mouse becomes familiar with two plastic coloured objects for a short time, and then 24 hours later one of the objects is

---

[40] The US Institute of Medicine recommends 550 mg per day for men and 425 mg for non-pregnant women (Wilson 2019).

changed. Mice explored novel objects more than familiar ones. If recall was good, the mouse would know one object was changed and spend more time exploring it. No difference in exploration between the familiar and the novel object was taken as recall problems.

- Barnes maze test - A brightly-lit circular platform with 20 circular ("escape") holes. A mouse placed in the middle of the platform will seek to escape. The escape hole is always the same, so each subsequent trial should be quicker to find it (latency to locate) if recall is good. A mouse that shows no improvement has poor recall.

A HSD also affects the immune system. Studies suggest that "the high salt content of a Western diet causes a general pro-inflammatory state and might contribute to the increasing incidence of autoimmunity" (Jobin et al 2020 p1).

Jobin et al (2020) reported a more general compromise of the immune system with a HSD, particularly anti-bacterial defences. Both mice and humans were studied. In the latter case, ten health volunteers in Germany consumed 6 g extra of salt per day for seven days (via tablets).

The specific implication of the study is to reduce salt consumption during bacterial infections (as well as the general advice to reduce salt generally).


3.5. CHOLESTEROL AND HEART DISEASE

Blood cholesterol concentration is linked to cardiovascular disease, specifically that the "blood concentrations of non-HDL [high-density lipoprotein] and LDL [low-density lipoprotein] cholesterol are accepted as causal cardiovascular risk factors and constitute a cornerstone of cardiovascular disease risk prediction in the general population" (Brunner et al 2019 p2174).

Assessing the level of risk requires large-scale data, like the Multi-National Cardiovascular Risk Consortium, which includes data on 524 444 individuals from forty-four population-based cohorts in Europe, Australia, and the USA (Brunner et al 2019).

Brunner et al (2019) analysed data from 1970 to 2013, and from thirty-eight of these cohorts. The outcome measure was the first occurrence of a major cardiovascular event (ie: first non-fatal or fatal coronary heart disease or ischaemic stroke event).

In summary, the study suggested "that increasing concentrations of non-HDL cholesterol predict long-term cardiovascular risk, particularly in cases of modest increase at a young age" [<45 years old] (Brunner et al 2019 p2180) (figure 3.6). More specifically: "A 50%

reduction of non-HDL cholesterol concentrations was associated with reduced risk of a cardiovascular disease event by the age of 75 years, and this risk reduction was greater the earlier cholesterol concentrations were reduced" (Brunner et al 2019 p2173).
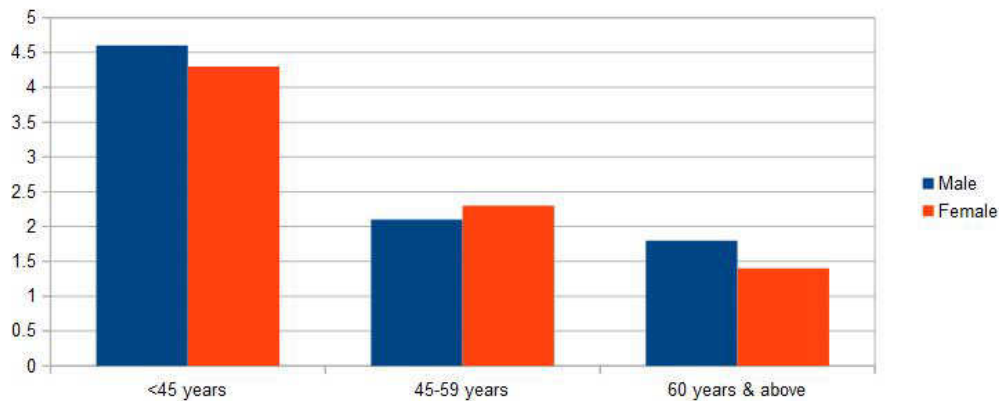
(Data from Brunner et al 2019 figure 3 p2178)

Figure 3.6 - Hazard ratio of cardiovascular disease based on highest non-HDL cholesterol level (≥5.7 mmol/L) (where the lowest category, <2.6 mmol/L = 1.00), age and gender.

3.6. CONSTITUTIONAL THINNESS

Ling et al (2019) began: "Given the ever-growing epidemics of obesity and weight-related health complications such as type 2 diabetes and cardiovascular disease, many studies have focused on understanding metabolic changes associated with overweight and obesity. However, novel insights on metabolic differences in humans might also come from studying people on the extreme opposite side of obesity, a state called constitutional thinness (CT). CT is characterised by a stable low BMI, generally <18 kg/m². Unlike in anorexia nervosa or other eating disorders associated with low weight, the non-pathological state of CT is defined by the lack of psychological features such as food aversion, refusal to eat alternated with binge eating, lower self-esteem, perfectionism, and body dissatisfaction" (p606).
So, it is not so much that such individuals do not eat in the modern world's obesogenic environment as that they eat and do not get fat.
Ling et al (2019), for example, performed an overeating experiment with 30 individuals classed as having CT and thirty healthy normal-weight controls. For a two-week period, all participants consumed 600 kcal

surplus (in the form of a bottle of "Renutryl Booster" [41]) to their usual food intake daily. Food diaries were kept and calculations were made of energy expended.

The persistent low body weight of the CT group was linked to higher mitochondrial activity in the cells in white adipose tissue. Put simply, their bodies were burning more energy in the normal functioning. This is the opposite to obese individuals (Ling et al 2019).

3.7. APPENDIX 3A - SUGAR LEVY

Scarborough et al (2020) studied the UK Soft Drinks Industry Levy (SDIL) introduced in 2018, which changed manufacturers £0.24 per litre on drinks with 8 g sugar per 100 mL (high levy category) and £0.18 for 5-8 g sugar (low levy category). Drinks with less than 5 g sugar, and all fruit juices and milk-based drinks were exempted. Data for the period September 2015 to February 2019 from nine UK supermarkets were analysed. The main outcome measures were:

i) The proportion of available drinks in the high and low levy categories - There was a reduction in the proportion of drinks in the levy categories by February 2019, especially for branded drinks (compared to supermarket own-brands). For example, prior to SDIL, around 60% of branded drinks were above the levy threshold for sugar content, but only around 15% after the SDIL was introduced.

ii) The mean price - There was a limited increase in the price of levy drinks after SDIL (ie: the levy was not passed on to consumers). However, exempt drinks did increase in price in some cases.

iii) The mean product size - Little change in size (ie: manufacturers did not pass the levy on to consumers by reducing the size for the same price - known as "shrinkflation"; Corless 2019).

iv) The number of drink brands available - Little difference in the number of drinks available before and after the SDIL.

Scarborough et al (2020) summed up: "The SDIL was associated with a large reduction in the percentage of soft drinks (particularly branded drinks) that are subject to the levy because of large reductions in the sugar levels of these drinks. There was no evidence for

---

[41] A nutritional supplement for undernourished individuals containing 72 g carbohydrates, 30 g protein, and 21 g fat (Ling et al 2019).

similar reductions in control SDIL-exempt drinks, suggesting that the SDIL was the motivating factor for this change. We found that the levy was not directly passed on to the consumer through commensurate increases in the prices of targeted drinks, but manufacturers and retailers appear to have taken the opportunity to undertake wider revision of their entire soft drink market offer" (p12) (eg: increased price for exempt drinks).

The researchers had no data on the impact of SDIL on sugar consumption by individuals.

3.8. REFERENCES

Bowers, D (2008) Medical Statistics From Scratch: An Introduction for Health Professionals (2nd ed) Chichester: John Wiley & Sons

Bowling, A (2014) Research Methods in Health: Investigating Health and Health Services (4th ed) Buckingham: Open University Press

Brunner, F.J et al (2019) Application of non-HDL cholesterol for population based cardiovascular risk stratification: Results from the Multi-National Cardiovascular Risk Consortium Lancet 394, 2173-2183

Corless, J (2019) Shrinkflation: How Many of Our Products are Getting Smaller? Newport: Office for National Statistics

Demmler, J.C et al (2020) Shining the light on eating disorders, incidence, prognosis and profiling of patients in primary and secondary care: National data linkage study British Journal of Psychiatry 216, 105-112

Derbyshire, E (2019) Could we be overlooking a potential choline crisis in the United Kingdom? BMJ Nutrition, Prevention and Health 2, 2 (https://nutrition.bmj.com/content/2/2/86)

Eddy, K.T et al (2017) Recovery from anorexia nervosa and bulimia nervosa at 22-year follow-up Journal of Clinical Psychiatry 78, 148-149

Editorial (2019) Let fishers share Nature 574, p6

Faraco, G et al (2019) Dietary salt promotes cognitive impairment through tau phosphorylation Nature 574, 686-690

Gillberg, C et al (1994) Anorexia nervosa outcome: 6-year controlled longitudinal study of 51 cases including a population cohort Journal of the American Academy of Child and Adolescent Psychiatry 33, 729-739

Herle, M et al (2020a) Eating behaviour trajectories in the first ten years of life and their relationship with BMI MedRXiv (https://www.medrxiv.org/content/10.1101/19003665v2)

Herle, M et al (2020b) A longitudinal study of eating behaviours in childhood and latter eating disorder behaviours and diagnoses British Journal of Psychiatry 216, 113-119

Hicks, CC et al (2019) Harnessing global fisheries to tackle micronutrient deficiencies Nature 574, 95-98

Hubbard, J & Mechan, D (1997) Physiology of Health and Illness: With Related Anatomy Cheltenham: Stanley Thornes

Jobin, K et al (2020) A high-salt diet compromises anti-bacterial neutrophil responses through hormonal perturbation Science Translational Medicine 12, eaay3850

Klein, A (2020) Brain implants may help anorexia New Scientist 2nd May, p12

Kotler, L.A et al (2001) Longitudinal relationships between childhood, adolescent, and adult eating disorders Journal of the American Academy of Child Psychology 40, 12, 1434-1440

Ling, Y et al (2019) Persistent low body weight in humans is associated with higher mitochondrial activity in white adipose tissue American Journal of Clinical Nutrition 110, 605-616

Liu, W et al (2020) Deep brain stimulation of the nucleus accumbens for treatment-refractory anorexia nervosa: A long-term follow-up study Brain Stimulation 13, 643-649

Pauly, D (2019) Micronutrient richness of global fish catches Nature 574, 41-42

Rydberg Dobrescu, S et al (2020) Anorexia nervosa: 30-year outcome British Journal of Psychiatry 216, 97-104

Scarborough, P et al (2020) Impact of the announcement and implementation of the UK Soft Drinks Industry Levy on sugar content, price, product size, and number of available soft drinks in the UK, 2015-19: A controlled interrupted time series analysis PLoS Medicine 17, 2, e1003025 (Freely available at https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1003025)

Steinhausen, H.C (2009) Outcome of eating disorders Child and Adolescent Psychiatric Clinics of North America 18, 225-242

Taillie, L.S et al (2020) An evaluation of Chile's Law of Food Labelling and Advertising on sugar-sweetened beverage purchases from 2015 to 2017: A before-and-after study PLoS Medicine 17, 2, e1003015 (Freely available at https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1003015)

Theander, S (1985) Outcome and prognosis in anorexia nervosa and bulimia: Some results of previous investigations compared with those of a Swedish long-term study Journal of Psychiatric Research 19, 493-508

Weentz, E et al (2001) Ten-year follow-up of adolescent-onset anorexia nervosa: Psychiatric disorders and overall functioning scales Journal of Child Psychology and Psychiatry 42, 613-622

Weentz, E et al (2009) Adolescent-onset anorexia nervosa: 18-year outcome British Journal of Psychiatry 194, 168-174

Wilson, C (2019) The neglected nutrient New Scientist 29th October, 20-21

Yilmaz, Z et al (2019) Developmental pre-morbid body mass index trajectories of adolescents with eating disorders in a longitudinal population cohort Journal of the American Academy of Child and Adolescent Psychiatry 58, 2, 191-199

Zeisel, S.H & Blusztain, J.K (1994) Choline and human nutrition Annual Review of Nutrition 14, 269-296

Zipfel, S et al (2000) Long-term prognosis in anorexia nervosa: Lessons from a 21-year follow-up study Lancet 355, 721-722

4. SPOTTING PERSONALITY TYPE IN THE FACE

The human face gives information about emotions, but it may also tell the observer about the owner's personality. Studies on objective characteristics of the face have found some association with personality traits, like facial symmetry and extraversion, or facial width to height ratio (fWHR) and achievement striving, deception, and risk-taking. "The accuracy of fWHR-based judgements suggests that the human perceptual system may have evolved to be sensitive to static facial features, such as the relative face width" (Kachur et al 2020 p1).

It is possible that certain genes contribute to both face and personality, and that explains the association, as well as hormone levels in the womb and in the early years of life. Alternatively, an individual's self-perception of their face influences their personality development. "Just as the perceived 'cleverness' of an individual may lead to higher educational attainment, prejudice associated with the shape of one's face may lead to the development of maladaptive personality characteristics (ie: the 'Quasimodo complex' [Masters and Greaves 1967]). The associations between appearance and personality over the lifespan have been explored in longitudinal observational studies, providing evidence of 'self-fulfilling prophecy'-type and 'self-defeating prophecy'-type effects [Zebrowitz et al 1998]" (Kachur et al 2020 p2).

One problem is the many possible personality characteristics [42]. This has led to a focus on the Five-Factor Model (FFM) (or "Big Five"), which describes five dimensions of personality as underlying all traits - Extraversion, Agreeableness, Conscientiousness, Openness to Experience, and Neuroticism.

The association between FFM traits and facial features has been studied in various ways, but with inconsistent results (Kachur et al 2020). For example, the use of composite facial images. Individuals known to be high on a particular dimension are photographed and these facial pictures are combined into a "prototype" face which can be compared to a composite of low scorers of the same trait. Participants are then asked to rate the faces for the personality dimension in question (eg: high association for extraversion; Kramer and Ward 2010).

"Studies relying on photographic images of individual faces, either artificially manipulated or realistic, tend to yield more modest effects. It appears

---

[42] "An additional challenge faced by studies seeking to reveal the face-personality links is constituted by the inconsistency of the evaluation of personality traits by human raters" (Kachur et al 2020 p3).

that studies using realistic photographs made in controlled conditions (neutral expression, looking straight at the camera, consistent posture, lighting, and distance to the camera, no glasses, no jewellery, no make-up, etc) produce stronger effects than studies using 'selfies' [Livesley et al 1998] Unfortunately, differences in the methodologies make it hard to hypothesise whether the diversity of these findings is explained by variance in image quality, image background, or the prediction models used" (Kachur et al 2020 p2).

Kachur et al (2020) listed four general problems with the previous research:

i) There are a large number of specific facial features, and some are hard to quantify.

ii) The use of isolated facial features is a weak method because When people identify others, they consider individual facial features (such as a person's eyes, nose, and mouth) in concert as a single entity rather than as independent pieces of information" (Kachur et al 2020 p3).

iii) Studies tend to assume a linear relationship between personality traits and facial features, which may not be the case.

iv) The use of real-life photographs introduces too many uncontrolled variables (eg: background; angle of head; facial hair style). These differences are "based on the subjects' choices, which are potentially influenced by personality; after all, one of the principal reasons why people make and share their photographs is to signal to other what kind of person they are" (Kachur et al 2020 pp2-3).

Kachur et al's (2020) solution was the use of machine learning algorithms, like artificial neural networks (ANNs). Over 25 000 respondents to a Russian language website completed a FFM personality test, and uploaded photographs of their face looking directly at the camera with a neutral facial expression and no make-up. About half of the responses were used in the training and testing of the ANN.
Conscientiousness had the strongest association with facial features, and the weakest was Openness to Experience.
Overall, the mean correlation was 0.24, which the authors accepted as modest, "indeed, facial image-based personality assessment can hardly replace traditional personality measures. However, this effect size indicates that an ANN can make a correct guess about the relative

standing of two randomly chosen individuals on a personality dimension in 58% of cases (as opposed to the 50% expected by chance). The effect sizes we observed are comparable with the meta-analytic estimates of correlations between self-reported and observer ratings of personality traits: the associations range from 0.30 to 0.49 when one's personality is rated by close relatives or colleagues, but only from -0.01 to 0.29 when rated by strangers. Thus, an artificial neural network relying on static facial images outperforms an average human rater who meets the target in person without any prior acquaintance" (Kachur et al 2020 p6).

In relation to the evolutionary explanation of faces and personality traits, Kachur et al (2020) noted that "one would expect the traits most relevant for co-operation (conscientiousness and agreeableness) and social interaction (certain facets of extraversion and neuroticism, such as sociability, dominance, or hostility) to be reflected more readily in the human face. The results are generally in line with this idea..." (p6).

The use of real-life photographs from volunteers, Kachur et al (2020) admitted, "could still carry a variety of subtle cues, such as make-up, angle, light facial expressions, and information related to all the other choices people make when they take and share their own photographs. These additional cues could say something about their personality, and the effects of all these variables are inseparable from those of static facial features, making it hard to draw any fundamental conclusions from the findings. However, studies using real-life photographs may have higher ecological validity compared to laboratory studies; our results are more likely to generalise to real-life situations where users of various services are asked to share self-pictures of their choice" (p6).

Kachur et al (2020) concluded: "We believe that the present study, which did not involve any subjective human raters, constitutes solid evidence that all the Big Five traits are associated with facial cues that can be extracted using machine learning algorithms. However, despite having taken reasonable organisational and technical steps to exclude the potential confounds and focus on static facial features, we are still unable to claim that morphological features of the face explain all the personality-related image variance captured by the ANNs. Rather, we propose to see facial photographs taken by subjects themselves as complex behavioural acts that can be evaluated holistically and that may contain various other subtle personality cues in addition to static facial features" (p6).

REFERENCES

Kachur, A et al (2020) Assessing the Big Five personality traits using real-life static facial images Scientific Reports 10, 8487

Kramer, R.S.S & Ward, R (2010) Internal facial features are signals of personality and health Quarterly Journal of Experimental Psychology 63, 2273-2287

Livesley, W.J et al (1998) Phenotypic and genetic structure of traits delineating personality disorder Archives of General Psychiatry 55, 10, 941-948

Masters, F.W & Greaves, D.C (1967) The Quasimodo effect British Journal of Plastic Surgery 20, 204-210

Zebrowitz, L.A et al (1998) The relationship between appearance and personality across the life span Personality and Social Psychology Bulletin 24, 7, 736-749