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Section 4

2

Health







Chapter 16

Motivational mismatch: evolved motives as the source of—and solution to—global public health problems

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6 Introduction: evolutionary public health

7 While public health in most countries of the world is better now than it has ever been, a huge
8 burden of preventable disease still remains. Solutions exist: we know that people at risk of HIV
9 infection should use condoms, children in malaria-rife countries should sleep under bednets, we
10 should wash our hands with soap, and that we should exercise more and eat a better diet. However,
11 our behaviour does not seem to match our knowledge. While we mostly *know* what is good for us,
12 the problem is that we do not seem to want to *do* it. This disjuncture between what is desirable
13 and what is health-promoting is the source of many of today's most pressing public health
14 problems.

15 From an evolutionary perspective this provides something of a puzzle. Humans have exqui-
16 sitely complex brains that evolved to drive adaptive behaviour—behaviour that aided the survival
17 and reproduction of our ancestors. These brains should be making us behave in ways that are
18 healthy, not unhealthy. Of course, for the most part, they do. Our fear centres keep us away from
19 predators and cliff edges, our disgust system keeps us away from parasite-ridden food and bodily
20 wastes, our hunger motive keeps us seeking the nutrients we need, and our nurture system drives
21 us to protect and care for our children. However, there are still many ways in which we harm our
22 own health.

23 Evolutionary theory has much to contribute to public health and medicine. It helps us to
24 understand the arms race between pathogens and hosts (e.g. HIV, malaria), the trade-offs between
25 health and other fitness benefits (e.g. birth trauma versus infant cranial size), the functioning of
26 our defence systems (e.g. fever and nausea), and the reasons for the diseases of aging, for example
27 (Nesse and Williams 1995). Research in such areas is increasingly bearing fruit (Nesse et al. 2010).
28 The proponents of Darwinian medicine have also pointed to the fact that there are major differ-
29 ences between our modern environments and those in which we evolved, which lead to what have
30 been termed the 'diseases of civilization'—for example, modern diets causing obesity and exces-
31 sive cleanliness causing allergies (Eaton et al. 1988; Nesse and Berridge 1997). This is called the
32 'mismatch' hypothesis, because it emphasizes that physiological and psychological characteristics
33 which were adaptive in ancestral environments may be less favourable to survival and reproduc-
34 tion in current settings (Nesse 2004; Gluckman and Hanson 2006).

35 In this chapter we focus on the psychological mismatch between the environments in which we
36 evolved and in which we now live. We show that most current public health problems can be
37 explained by maladaptive behaviour in the context of massive environmental changes, most hav-
38 ing occurred since the Industrial Revolution 150 years ago. We show how almost all of our major



1 public health problems are associated with motivated behaviour, usually because we over- or
2 under- use evolutionarily novel technologies. Hence, while we can trace suboptimal health to a
3 lack of fit between our evolved motives and our current environment, understanding of these
4 motivational drivers can help us to modify behaviour, environments, and technologies such that
5 they generate healthier outcomes. We give an example of how ancient motives can be harnessed
6 for the benefit of public health in the case of handwashing with soap—a novel health protective
7 technology for which take-up is suboptimal. In short, we argue that, even if our ancestral motiva-
8 tions help to create public health problems, they can also help to solve them, once we understand
9 how they work.

10 **Public health: what's the problem?**

11 Public health is better today than it ever has been. Infant mortality has been falling in nearly every
12 country in the world¹ and there is no end in sight to improvements in longevity (Oeppen and
13 Vaupel 2002). Yet we still die of avoidable causes. Today's big public health problems come in two
14 varieties. First, a large proportion of the world still lives below the poverty line of one dollar per
15 day and in circumstances of low public investment in healthy environments. Lacking in resources
16 with which to grow or purchase food, with poor access to water and sanitation, and with no
17 option but to burn solid fuels, people are prey to the deficiencies and diseases of poverty. In devel-
18 oping and resource-poor settings, infectious diseases are the major cause of premature mortality
19 (65% of Africans die from infection compared to 35% of South Asians and 5% of those in Europe
20 and the US.² Second, in contrast, people living in countries that have undergone the demographic
21 transition (and increasingly, some population segments in developing countries) suffer primarily
22 from diseases of affluence. People live longer and die of chronic, rather than infectious, causes,
23 including cardiovascular disease, cancer, and diabetes (World Health Organization 2009).

24 Ezzati et al. (2002) comprehensively assessed the factors that could be modified to improve
25 public health in high-, medium-, and low-mortality countries. Figure 16.1 shows their top 20
26 causes of loss of disability-adjusted life years (DALYs) globally. Top of the list came childhood
27 and maternal underweight (associated with 9.5% of total DALYs lost), high blood pressure
28 (4.4%), and alcohol (4.0%). However, as Figure 16.1 shows, there were major differences by
29 region. For example, in developed regions the most important contributors to the burden of dis-
30 ease were tobacco (12.2%), high blood pressure (10.9%), alcohol (9.2%), high cholesterol (7.6%),
31 and overweight (7.4%). In the high-mortality countries, which include sub-Saharan Africa and
32 South East Asia, the leading causes of burden of disease included childhood and maternal under-
33 nutrition (14.9%), micronutrient deficiencies (3.1% for iron deficiency, 3.0% for vitamin A
34 deficiency, and 3.2% for zinc deficiency), unsafe sex (10.2%), poor water, sanitation, and hygiene
35 (5.5%), and indoor smoke from solid fuels (3.6%). However, high blood pressure, tobacco, and
36 cholesterol were also in the 'top ten' in these countries.

37 In Table 16.1 we have collated Ezzati et al.'s (2002) top 20 global risk factors and the diseases
38 they cause. To this, we have added columns on the factors which lead to such diseases, and in
39 particular the novel technologies and behaviours underlying these factors.

40 Undernutrition is the leading cause of healthy life years lost across the world. This problem is
41 primarily associated with a nexus of economic deprivation and repeated infection among moth-
42 ers and children, and is improving, largely due to improvements in food availability and
43 reductions in poverty worldwide. However, some major problems remain. Recent decades have

¹ See www.childinfo.org/mortality_imrcountrydata.php

² See www.globalhealth.org/infectious_diseases/

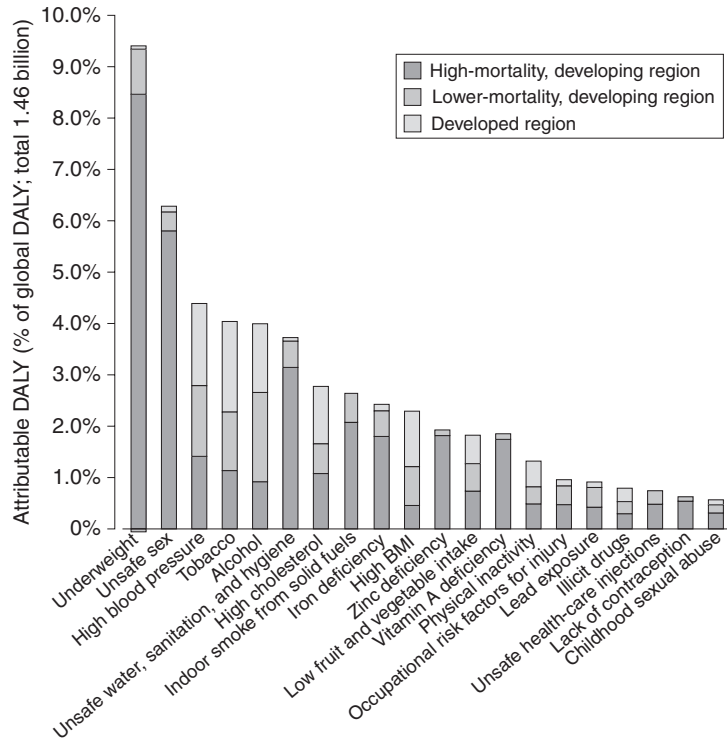


Fig. 16.1 Burden of disease due to leading global risk factors globally and by region (reprinted from Ezzati et al. 2002).

1 seen major shifts away from exclusive breastfeeding and towards mass-produced milks and
 2 weaning foods. These more convenient novel food technologies deprive children of maternal
 3 immunoglobulins, vitamins, and protein, and expose them to environmental pathogens at an
 4 early age (Cousens et al. 1993; Black et al. 2008). Maladaptive behavioural responses to attractive
 5 new technologies (convenience foods) have been encouraged by marketing (Baumslag
 6 and Michels 1995), a recent cultural phenomenon which figures in many current public health
 7 problems.

8 Unsafe sex is the second most important cause of loss of DALYs, largely due to the HIV epi-
 9 demic, which came about because of changes in sexual behaviour in recent decades (Quinn et al.
 10 1986). The virus took advantage of changes in cultural values arising from rural–urban migration,
 11 driven by lifestyle changes and the use of illicit drugs (Udoh et al. 2009). Though a novel technol-
 12 ogy, the condom, is available to prevent the transmission of sexually-transmitted diseases, its use
 13 remains suboptimal, largely because condoms are unrewarding to use, interfering with the pleas-
 14 ure gained from our most basic reproductive motive (Valdiserri et al. 1989).

15 High blood pressure is the third biggest cause of loss of healthy life years. Contributory factors
 16 include diets high in refined salt, as well as inactivity and being overweight (Danaei et al. 2009).
 17 Tobacco and alcohol are the fourth and fifth causes of avoidable disease. While humans (and
 18 some animals) have always enjoyed consuming intoxicating substances, human ingenuity and the
 19 modern mass market have enabled unprecedented numbers to stimulate their reward centres
 20 cheaply and easily using refined products (Di Chiara et al. 1992; Kalivas and Volkow 2005).

Table 16.1 Risk factors for global burden of disease and contributory causes (from Ezzati et al. 2002)

Risk factor for burden of disease	Health Outcomes	Contributory causes	Novel technologies	Novel behaviours	References
1. Underweight	Malnutrition, infection, low birthweight	Economic factors, recurrent infection, industrialization and mass production of food	<i>Convenience foods*</i>	Loss of traditional feeding practices (e.g. bottle feeding, weaning)	[1, 2]
2. Unsafe sex	STDs (HIV), cervical cancer	Rural-urban migration, social breakdown, sex industry, cultural factors	<i>Condoms</i>	Increased same and opposite sex promiscuity	[3, 4]
3. High blood pressure	Cardiovascular disease, stroke	Industrialization and mass production of food, sedentarization of work and leisure	Refined salt, sugar, oils, etc Labour saving and leisure technologies	Over-consumption, sedentary lifestyle	[5]
4. Tobacco	Cancer, heart disease, respiratory disease	Industrialization and mass production of cheap psychoactive drug	Tobacco high in available nicotine (cigarettes)	Smoking	
5. Alcohol	Cancer, heart disease, diabetes, depression, injuries	Industrialization and mass production of cheap psychoactive drug	Refined alcoholic drinks	Regular and binge drinking	
6. Water, Sanitation and Hygiene	Diarrhoeal disease, respiratory infection	Insufficient public/private investment in water supply and sanitation	<i>Soap, toilet, water treatment devices</i>	<i>Handwashing, toilet and water filter use</i>	[6]
7. High cholesterol	Cardiovascular disease, stroke	Industrialization and mass production of processed foods, sedentarization of work and leisure	Low density lipoproteins and trans fats	Use of processed foods, sedentary lifestyle	[5]
8. Indoor smoke	Respiratory disease	Cooking with solid fuels, house design	<i>Improved (gas/electric) stoves</i>	Use of solid fuels for cooking	

9. Iron; 11. Zinc; 13. Vitamin A deficiency	Anaemia, malnutrition, infection	Cereal-based diets, recurrent infection, helminth infection, early weaning	<i>Micronutrient supplements</i>	Consumption of cereals/ weaning foods	[7–9]
10. Overweight	Cardiovascular disease, stroke, diabetes, cancer	Industrialization and mass production of processed foods, sedentarization of work and leisure	Refined salt/sugar/oils, labour-saving and leisure technologies	Over-consumption, sedentary lifestyle	
12. Low fruit and vegetable intake	Cardiovascular disease, stroke, cancer	Industrialization, mass production of processed foods	Refined salt/sugar/oils	Preferential consumption of processed foods	
14. Physical inactivity	Cardiovascular disease, stroke, cancer	Sedentarization of work and leisure	Labour-saving and leisure technologies	Sedentary lifestyle	
15. Occupational injury	Injury	Industrialization	Industrial machinery	Interaction with machinery	
16. Lead exposure	Cardiovascular disease, mental retardation	Industrialization, mass production of automated transportation	Cars, lorries	Driving	
17. Illicit drug use	HIV, overdose, injury, infection	Production and marketing of cheap psychoactive drugs	Refined psychoactive compounds, syringes	Drug consumption/ injection	
18. Unsafe injections	Acute infection	Contaminated injections	<i>Syringes</i>	Syringe reuse	
19. Lack of contraception	Maternal mortality	Cultural factors, lack of access	<i>Contraceptive technologies</i>	<i>Uptake of contraception</i>	
20. Childhood sexual abuse	Depression, alcohol abuse	Cultural factors			

* Items in italics constitute technologies and behaviours that are, beneficial rather than detrimental to health (although they may be both). References: 1, Black et al. (2008); 2, Humphrey (2009); 3, Hamers and Downs 2004; 4, Quinn et al. (1986); 5, Danaei et al. (2009); 6, Bartram and Cairncross (2010); 7, Prentice (2006); Nesse and Williams (2005); Popkin (2003); Ezzati et al. (2003).

1 The communications technologies of the mass market have also allowed marketers to engineer
2 cultural change towards making the use of such technologies socially normative. In the informal
3 economy, the use of illicit psychoactive drugs is now widespread enough to be the seventeenth
4 biggest burden of disease globally, again because they provide synthetic stimulus to the reward
5 system. (Such psychoactive compounds may, however, also have had adaptive advantages, as
6 recreational drugs can lead to promiscuity (Kurzman et al. 2010) and moderate drinking has been
7 shown to be associated with improved longevity (Danaei et al. 2009)).

8 Environmental contagion is the sixth biggest cause of avoidable DALYs lost, due to a lack of
9 clean water, sanitation, and hygiene, which affects mainly the poor in developing countries. These
10 lead to morbidity and mortality from diarrhoea and acute respiratory infections, primarily in
11 childhood. While public failure to invest in infrastructure is part of the problem, the failure of
12 individuals to acquire and use the novel technologies of soap, water filters, and toilets is also an
13 important reason that both children and adults suffer widely from these conditions.

14 Regular exposure to indoor smoke, caused by cooking in poorly ventilated shelters with solid
15 fuels like wood and coal, is eighth on the list. It is associated with avoidable respiratory ailments
16 (Ezzati and Kammen 2001). While electrification is advancing rapidly and propane gas is becoming
17 more widely available, the problem of failure to acquire these new technologies remains
18 widespread in poor rural areas of developing countries.

19 Micronutrient deficiencies in iron, zinc, and vitamins are widespread, primarily in developing
20 countries. They cause anaemia and malnutrition, and are attributable to multiple causes including
21 recent changes in diet and repeated infection (Stoltzfus et al. 1997; Miller et al. 2002; Black
22 2003).

23 Being overweight is the tenth most significant avoidable risk in the world. This is caused by our
24 novel 'obesogenic' environment which mass markets highly stimulating refined, energy-dense
25 foodstuffs, coupled with technologies which facilitate inactive work and leisure patterns (Popkin
26 2003). Obesity is particularly prominent in developed countries, although it is spreading rapidly
27 in developing countries. While these countries are still struggling with underweight and the diseases
28 of poverty, modern problems of obesity, heart disease, and diabetes are also on the rise,
29 threatening to overwhelm already stretched health services (Prentice 2006). A recent OECD
30 (Organization for Economic Cooperation and Development) study finds over 70% of Mexicans,
31 and 50% of South Africans and Brazilians overweight, with rates in China and India increasing
32 by as much as 1% annually (Cecchini et al. 2010).

33 Risk factor number 12, low vegetable and fruit intake, is at least partly due to alternative food-
34 stuffs which are cheaper, more easily available, and more motivating to consume. If apples and
35 cake are equally available, cake tends to be first choice (though preferences can be trained otherwise,
36 with some effort). The 14th factor, lack of exercise, can largely be ascribed to novel technologies
37 that make productive work less energy-consuming and sedentary leisure pursuits more
38 attractive than active ones. Factor 15, occupational hazards, mainly concern injuries at the work-
39 place, many of which concern the use of novel technologies (Leigh et al. 1999) (however, ancestral
40 means of making a living may have been at least as hazardous). Factor number 16, lead exposure,
41 can be ascribed to use of novel transport technologies, especially private cars, which are now
42 cheap and widely available (Fewtrell et al. 2004). Finally, syringes (number 18) are a novel form
43 of, mainly beneficial, technology, whose re-use in resource-poor settings leads to a major burden
44 of infection (Kermode 2004), and novel contraceptive technologies (number 19), if more widely
45 used, could substantially reduce the burden of maternal mortality (Campbell and Graham
46 2006).

47 While one could take issue with how Ezzati et al. (2002) carve up what is a highly complex web
48 of interlinked disease causation, and some of the factors that they leave out (e.g. risk factors for



1 malaria, tuberculosis (TB), and depression) their widely-cited league table provides a snapshot of
2 today's main public health problems. From Table 16.1 a striking pattern of technological and
3 behavioural determinants of ill health emerges. The data shows that we endanger our health by
4 consuming too much of some foods, too little of others, exercise too little, abuse psychoactive
5 substances, and take risks with sex and cars.

6 Mismatched motivation

7 From an evolutionary perspective, the incidence and persistence of so much unhealthy behaviour
8 is puzzling. Over evolutionary time, behavioural tendencies that lead to high morbidity and mor-
9 tality should have been selected out of the gene pool (assuming they had no outweighing fitness
10 benefits). Time, however, is exactly the problem. We have effected huge changes in the environ-
11 ments in which we live in just a few generations—particularly over the last 150 years or so—
12 hardly enough time for there to have been any genetic changes to affect our psychological
13 make-up. Technological advances have made possible products such as refined sugars, edible oils
14 and salt, psychoactive substances, labour-saving devices, and fast cars, and made them easily
15 accessible to the populations of mass-market economies in the space of a century. Our motives
16 have led us to create these technologies and a mass market of exchange of innovation and value
17 creation, with ever-increasing efficiency of production and distribution (Ridley 2010). So while
18 accelerating innovation and mass-production in formal and informal economies has brought
19 huge gains in public health (water supply, disposable nappies, better nutrition), it has also had
20 significant negative consequences (obesity, addiction, violent death).

21 The pattern is striking: all of the top ten global causes of loss of DALYs can be ascribed to tech-
22 nological mismatches; either because of the widespread adoption of technologies with harmful
23 effects (refined salt, sugars, oils, psychoactive compounds, sedentary leisure, guns, syringes) or
24 the failure to adopt health-giving technologies (sanitation, soap, pills, bednets, bicycles). Why is
25 this? Humans are equipped with a set of motives that cause us to behave in such a way as to meet
26 our needs in the environments in which we evolved. Our ancestors—mammal, primate, pre-hu-
27 man, or *Homo sapiens*—needed to find food, mates, social partners, and other resources, and
28 evolved brain systems to meet those needs (Aunger and Curtis 2008). However, those motives
29 have also driven accelerating human innovation, leading to the invention and mass production of
30 new technologies which have transformed living environments in all countries. Our motivated
31 behaviour responds to these technologies and not to the ancestral objects and environments
32 which 'designed' our brains.

33 The pattern is even more striking if we look at the top ten causes of burden of disease in devel-
34 oped economies, where nine of ten risk factors can be ascribed to this mismatch (tobacco, high
35 blood pressure, alcohol, cholesterol, overweight, low fruit and vegetable intake, physical inactiv-
36 ity, illicit drugs, unsafe sex). A major feature of modern market economies is mass production.
37 It reduces the cost of making products which are able to stimulate the senses in super-salient
38 fashion (e.g. cigarettes, high-density foods), and hence causes widespread abuse of highly reward-
39 ing products. In this way, new technologies such as refined foodstuffs and stimulants, vehicles,
40 and communication devices, which have been designed to be attractive and motivating to use,
41 become ubiquitous. However, acquiring such technologies to gratify these medium-term desires
42 can have long-term health consequences, such as obesity, cardiovascular disease, addiction, and
43 injury. Since hunger, lust, and comfort are fundamental motives, products that save energy and
44 effort, and meet our appetites, thus providing reward, readily spread. And products that can pro-
45 vide reward directly, via the intake of ethanol, nicotine, or other psychoactive compounds, are
46 especially attractive.





1 For example, people have smoked tobacco for thousands of years. However, there is little sug-
2 gession that lung cancer was a common problem in populations which smoked low-grade tobacco
3 (e.g. among American Indians, Europeans). What turned the habit from a low-grade irritation
4 into a primary carcinogen and hence public health problem was the widespread use of cigarettes
5 after World War II (Boaz 2002). Cigarettes contain finely shredded tobacco leaves wrapped in
6 paper. The increased surface area of tobacco being burned at higher temperature delivers a much
7 larger nicotine hit to the lungs, which is physiologically distinct from slow-burning twists of
8 tobacco. Nicotine releases dopamine in the brain, which makes tobacco smoke a psychoactive
9 drug working on the brain's reward system.

10 What distinguishes psychoactive compounds from other classes of substances is that they
11 provide psychological rewards independent of having achieved an evolutionary goal. Other
12 behaviours, to produce rewards, must rely on positive feedback from the environment—either in
13 terms of consumption of resources, or feedback in the form of recognized signs of success
14 (e.g. a smile on the face of a fellow group member, suggesting a status improvement). With
15 psychoactive substances, reward comes from consumption of the substance itself, which directly
16 stimulates the reward system (Pomerleau 1997; Nesse and Williams 1998). The technology
17 associated with cigarettes mimics the natural reward system, and subverts standard choice
18 mechanisms in the brain.

19 Accelerating innovation has also made a number of health protective technologies widely avail-
20 able. Toilets, water filters, soap, and condoms are novel technologies and probably a good invest-
21 ment, even for the poorest: however, their take-up and use is suboptimal. It can be argued that
22 this is because we have no intrinsic motivation to use them: had they been available ancestrally,
23 the adaptive advantages they conferred might indeed have led to them becoming attractive in the
24 same way that clean water is. The same argument could be made for the failure to comply with
25 treatment for diseases such as leprosy or TB, to submit to influenza vaccination, or to sleep under
26 a bednet. Getting an injection, remembering to take pills, or using a condom involves effort for
27 which there is little immediate reward, and sometimes a disincentive—they can hurt, take time,
28 and interfere with the joys of sex, for example. Such novel technologies were not a part of our
29 ancestral environment, hence we have not undergone selection to find their use rewarding.

30 The market mirrors our motivations—where the demand is mainly for curative products
31 which alleviate the discomfort of sickness, rather than products which prevent it. Hence, effort is
32 invested in innovation for technologies of treatment rather than prevention, and people under-
33 utilize opportunities to vaccinate themselves, or to screen themselves for early signs of disease.
34 The market has also failed to design and deliver technologies that can definitively rid us of many
35 important infectious diseases, such as malaria, TB, and leishmaniasis.

36 The market also modifies our motivated responses. Modern marketing methods often exploit
37 two other motives—status and affiliation. Technologies can be invested with status enhancing
38 abilities, through celebrity endorsement for fast cars, for example (Miller 2009), and can become
39 the norm to copy—when the cool guys in class and the majority seem to binge drink we may
40 employ our 'copy the successful' and 'copy the frequent' tendencies, which also evolved for good
41 evolutionary reasons (Richerson and Boyd 2005).

42 In a nutshell then, the reason that we do not behave optimally, as far as our health is concerned,
43 is that there are alternatives to healthy behaviour that are more rewarding. Oily, salty, and fatty
44 food is more rewarding than the alternatives and our desire to consume them preferentially has
45 led the market to make such foods cheap and easy to access. If a healthy option exists, it often is
46 not intrinsically rewarding and is not widely taken up. Our once-adaptive preference for mini-
47 mizing exertion has led to dramatic shifts away from energy-intensive occupational, leisure,
48 transport, and domestic production activities (Popkin 2003). Our desires for cheap transport and



1 for technologies of self-defence have unlooked for side effects, driving a rise in violent death due
2 to accidents, anger, and depression. The use of alcohol, tobacco, and illicit drugs are on the rise
3 because they are cheap and rewarding to use in the short term, but they damage health in the
4 medium- to long-term. Condoms, bednets, soap, vaccinations, prescribed medicines, and toilets
5 can be unrewarding to acquire and use in the short term, despite their long-term health benefits.

6 **Evolutionary health promotion in practice**

7 What then can be done about motivational mismatch? Are we doomed to face an ever-rising tide
8 of obesity, addiction, and violence? Can we improve the uptake of health-giving technologies?
9 First, we analyse one case study from this perspective—the problem of how to promote safe
10 hygiene—and then reflect on the general applications of such evolutionary thinking to the public
11 health problems that we have been discussing.

12 Much of our own work focuses on the prevention of diarrhoeal disease, the second biggest killer
13 of children in developing countries, accounting for over 1.5 million deaths a year (Boschi-Pinto
14 et al. 2008). Systematic reviews suggest that handwashing with soap (HWWS) is probably the
15 most effective, and cost-effective, means of preventing this problem, cutting rates of diarrhoeal
16 disease by 42–47% (Curtis and Cairncross 2003; Cairncross et al. 2010) and rates of respiratory
17 infection by 23% (Ensink 2004; Rabie and Curtis 2006). One review of interventions to reduce the
18 burden of disease in developing countries put hygiene promotion, including HWWS, as possibly
19 the most cost-effective intervention of all (Jamieson et al. 2006).

20 Yet soap is a relatively novel technology, one that has only been mass-produced for about 150
21 years (Wilson 1954). Purchased regularly by almost all households of the world for the purposes
22 of body and clothes washing, soap is still rarely employed on hands (Curtis et al. 2000) to prevent
23 the faecal–oral transmission of diarrhoea-causing microbes (including *Escherichia coli*, *Salmonella*,
24 *Shigella*, rotavirus, *Campylobacter*, *Vibrio cholera*, etc.). When asked, most people say that they
25 wash hands with soap, however, we found that directly observed HWWS after toilet use stood at
26 only 3% of mothers in Ghana and in rural India (Biran et al. 2009), 13% in rural China, 14% in
27 Peru, 18% in Kyrgyzstan, and 29% in Kenya (Curtis et al. 2009). Handwashing is not so much
28 better in the UK. In one study, we found that only 43% of mothers washed hands with soap after
29 changing a dirty nappy. In a motorway service station, electronic counters revealed that only 32%
30 of male and 64% of female toilet users used soap (Judah et al. 2009a). Of commuters in a sample
31 of UK cities, 28% had bacteria of faecal origin on their hands (Judah et al. 2009b).

32 Over a period of 10 years we have been carrying out formative research studies to try to under-
33 stand handwashing behaviour, so as to improve it. We have data from more than 12 countries in
34 most geographical regions. A focus of the studies was to identify the motives that could be used to
35 drive the use of soap for handwashing. We hypothesized that these would include disgust, fear,
36 nurture, comfort, attraction, and affiliation. (Note that each motive has a technical definition
37 according to its adaptive origins: for example, disgust as the driver of infection avoidance behav-
38 iour (Curtis et al. 2004); fear for harm avoidance from accident and violence; comfort for physi-
39 ological equilibrium-seeking behaviour; nurture for child care behaviour; attraction for
40 mate-seeking and adornment behaviour; status for social influence-seeking behaviour; and affil-
41 iation as the driver of group-adherence seeking.)

42 Most of the research has been qualitative (Curtis et al. 2009), but quantitative studies provide
43 similar findings (Aunger et al. 2009). Key conclusions are surprisingly similar from country to
44 country. Respondents almost always know of the health benefits of HWWS, but this fails to trans-
45 late into practice. Key motives for HWWS were disgust, comfort, nurture, and affiliation. Physical
46 settings, such as lack of easily available water, reduced, but did not prevent soap use.

1 **A key role for disgust**

2 Of all of the potential motives for HWWS, one in particular jumped out from the series of form-
3 ative studies. Women everywhere said they washed their hands when they felt or smelled disgust-
4 ing. They could only falteringly explain this: 'Because they are *yuk*, I can't explain, they are just
5 *yuk*', went a typical interview. The most commonly mentioned contaminants were fish, excreta,
6 and rotten or dead material, often of animal origin. Hands that had been in contact with faeces
7 had to be washed. The fear of being perceived as dirty or disgusting by others was also a powerful
8 motive for hygienic behaviour.

9 A series of studies on disgust helped to confirm our hypothesis that disgust evolved to drive the
10 behaviours that prevent contact with infectious agents. The disgust system in the brain responds
11 to cues indicating sources of infection risk in the environment, and orchestrates appropriate
12 avoidance behaviour (Curtis and Biran 2001; Curtis et al. 2004). The system is tuned by exposure
13 and cultural information; learning what it is best to avoid in local circumstances (Curtis et al.
14 2011).

15 Disgust should therefore be the motive that is most appropriate for the promotion of infection
16 reduction behaviour, such as HWWS. This idea was fed into a commercial creative process to
17 design national marketing campaigns (Curtis et al. 2007). In Ghana, the agency Lintas produced
18 a powerful television commercial³ depicting a mother emerging from a toilet with a purple stain
19 on her hands—this was then transferred to the food that she prepared, and then to the child that
20 ate it. In screenings, mothers found the advert powerful and shocking. After 6 months of a high-
21 intensity nationwide media campaign, reported handwashing rates increased by 13% after using
22 the toilet and by 41% before eating (Scott et al. 2007).

23 We further tested a variety of messages displayed at the entrance to public toilets in the UK,
24 electronically monitoring the impact on soap use. Disgust-based messages such as 'soap it off or
25 eat it later' and 'don't take the loo with you—wash with soap' worked significantly better than
26 control messages (Judah et al. 2009a). Elsewhere, Porzig-Drummond et al. (2009) tested disgust-
27 based handwashing interventions in the lab and in a public toilet, and in both situations found
28 that the disgust motive worked better than hygiene education.

29 **Other motives for handwashing with soap**

30 The above studies suggested that motives other than disgust were also important drivers of
31 hygiene behaviour. Mothers tended to do whatever everyone else in their village was doing; a
32 typical comment was 'handwashing with soap is just not something we do around here'. Affiliation
33 to local social norms of non-use of soap can therefore help to keep use rates low, but if the social
34 norms support soap use, this can increase its uptake. Our public toilet experiment confirmed this
35 effect. HWWS rates were higher at times when there were more people using the toilets and also
36 when the message 'Is the person next to you washing hands with soap?' was displayed at the
37 entrance. A key lesson was that public campaigns should never comment on how low soap use
38 rates are, for fear of driving rates even lower, but should rather try to make HWWS appear com-
39 mon and the norm, because the affiliation motive will then drive it up (Perkins 2004).

40 Other potential motives that could drive increasing use of soap were status and attractiveness;
41 however, as HWWS is not socially very visible, it is hard to use this motive to drive soap use.
42 Mothers also wanted soap for its comfort value: even extremely poor families would often choose
43 to purchase luxury bath soaps because they have a pleasing odour and do not dry the skin out.

³ See it at www.globalhandwashing.org/multimedia



1 Though traditional health education campaigns attempt to enlist fear of disease as a motivating
 2 factor, explaining to mothers the dire consequences of failure to improve their behaviour, our
 3 studies made it clear that this strategy was unlikely to work. Mothers already ‘knew’ of the health
 4 risks of poor hygiene, but regarded possible diarrhoea as a distant threat, one that was unlikely to
 5 be life-threatening, and one that was more often due to causes outside their control. Fear of dis-
 6 ease only became relevant during local disease scares. HWWS rates in Kenya were unexpectedly
 7 high and were plausibly explained as a temporary response to a current cholera epidemic. Data
 8 from our public toilet research in the UK, collected during the recent H1N1 swine flu epidemic,
 9 suggested that HWWS peaks and then falls back to pre-epidemic levels, suggesting that fear
 10 responses in such epidemics may be short-lived.

11 While we have used evolutionary reasoning to seek for motives that might be key in driving the
 12 use of soap, necessary because it is a novel technology for which people have no intrinsic affinity,
 13 we are not the first to discover these drivers of soap use behaviour. The company Procter and
 14 Gamble (P&G) employed disgust in their early advertisements for Zest soap, where they claimed
 15 other soaps left a scummy residue, while Zest left skin truly clean.⁴ The comfort motive has been
 16 employed repeatedly by advertisers. For example, a 1957 advert for Unilever’s Dove soap claimed
 17 that it ‘doesn’t dry your skin’.⁵ Soap has also long been sold using the affiliation motive, suggest-
 18 ing you need soap to be an accepted member of society (‘From your head down to your toe, a
 19 daily bath with Lifebuoy will stop B.O.’⁶ or to be attractive (‘Don’t wait to be told, you need
 20 Palmolive Gold’).⁷ P&G’s advertisements for Camay soap make the attraction motive even more
 21 explicit.⁸ Finally, soap companies also recognized that soap could be sold using the nurture
 22 motive, mother’s desire to care for and groom their children (see, for example, Johnson and
 23 Johnson’s Indian baby milk soap advert.⁹

24 In many countries the conclusions of our formative research on HWWS were fed into a process
 25 based on commercial marketing, where creative professionals were briefed to develop interven-
 26 tions based on the motives that we identified, that could be applied on a mass, a community, or a
 27 family/individual basis, depending on the available channels of communication and budget
 28 (Curtis et al. 2007). Results were encouraging, with substantial measurable improvements in
 29 handwashing rates (Curtis et al. 2001; Scott et al. 2007).

30 **The problem of novel technologies**

31 Soap is an example of a novel health-enhancing technology. While hygienic behaviour evolved
 32 before humans did (being manifest throughout the animal kingdom), soap was invented only
 33 recently (by the Babylonians, Egyptians, or in the Middle Ages, depending on which authority
 34 you consult: Curtis 2007; Smith 2007), and has only become commercially available to the major-
 35 ity in the last hundred or so years. There is no intrinsic, evolved motivation to use soap—the
 36 advantage it confers is too recent to be reflected in brains. The problem is, therefore, how to make
 37 rubbing onto the skin a bar of sodium stearate (plus additives), then rinsing it off, a rewarding
 38 and hence motivating activity. Our efforts, and those of commercial marketers, have shown how
 39 soap use can become motivating to help avoid disgust and shame, as an aid to nurturing children,

4 See www.youtube.com/watch?v=_96T_DRNNW8andNR=1

5 See www.youtube.com/watch?v=SMtqXC20D8g

6 See www.youtube.com/watch?v=astrjgUhc2Iandfeature=related

7 See www.youtube.com/watch?v=cfP-wASMikQ

8 E.g. <http://www.youtube.com/watch?v=CLrNXz55k4wandNR=1>

9 See <http://www.youtube.com/watch?v=PZTZIkC46Gk>



1 and as an aid to affiliation via social norms. These efforts create new mental associations between
2 ancient motives and new technologies. We are now engaged in an industrial design process in
3 pursuit of new hand-cleansing technologies that are intrinsically more motivating to use (by
4 making a more convenient or attractive product). Through a combination of an available, appeal-
5 ing product and effective promotion targeted at key motivations, as well as support from soap
6 companies, the hope is that HWWS may become a normative behaviour in society, no longer
7 dependent on the persistent efforts of health promoters.

8 Are there general lessons that can be drawn from this work that can be applied to other new
9 health technologies, such as pills, injections, condoms, bednets, and toilets? We believe so. For
10 example, consumer research showed that toilets might best be marketed, not for their health
11 benefit (as governments and non-governmental organizations do at present), but for new values
12 such as *status*, *comfort*, reduced *fear* of snakes or attacks at night, and through avoidance of
13 *disgusting* faecal matter in open defecation fields (Jenkins and Curtis 2005). Research into the low
14 uptake of insecticide-treated bednets showed that they might be better marketed as an aid to the
15 *comfort* of a good night's sleep rather than for the health benefit they might confer (Guiguemde
16 et al. 1994). Condom marketers have long realized that health messages are not the best way to sell
17 condoms. The Durex company, for example, now aim to sell them as an aid, rather than as a
18 deterrent to sexual attractiveness.¹⁰

19 **Beating mismatch**

20 If it is possible to attach new motivations to products for which we have no intrinsic affinity,
21 might it also be possible to use the same approach to discourage the unhealthy behaviours which
22 are the source of most ill health in developed countries? Potentially. Novel technologies which
23 have unhealthy consequences when consumed excessively (e.g. cigarettes) can also become asso-
24 ciated with new motivational values. The British Heart Foundation advertisement series which
25 associated disgust with cigarettes was thought to have been highly effective.¹¹ It has been sug-
26 gested, however, that realization of the effects of smoking on the health of others was the main
27 reason for its steep decline in recent years. Campaigners and legislators pointed out the injustice
28 of harming others and imposed smoking bans in public areas, relying on the human need to
29 affiliate to drive cessation (Christakis and Fowler 2008; although harmful technologies can, of
30 course, also be made less attractive through public policy, such as by increasing sales tax or
31 restricting access).

32 Take another public health problem: obesity. Most of the food types that dominate present
33 diets were introduced quite recently: dairy products, cereal grains (especially refined grains that
34 lack germ and bran), refined sugars (especially sucrose and fructose), refined vegetable oils (with
35 low ω -3 and high ω -6 fatty acids), alcoholic beverages, refined salt, and ω -6 saturated, fatty, acid-
36 rich, mammalian meats. These foods have displaced the wild plant and animal foods of our pred-
37 ecessors. Research shows that rats' brains react to these sweet, fatty foods in the same way that
38 addicts' brains respond to cocaine. Thus 'conditioned hypereating' (Kessler 2009) works the same
39 way as other 'stimulus response' disorders in which reward is involved, such as substance abuse.
40 Furthermore, it has been suggested that some food companies are developing products that trig-
41 ger compulsive overeating (Power and Schulkin 2009).

42 One solution that has been advocated is a return to ancestral diets (high in fibre, low in salt,
43 carbohydrate, and fat: Milton 2000, 2002). However, such foods are outcompeted in supermarket

¹⁰ See www.youtube.com/watch?v=yyahoTR1Otkandfeature=fvst

¹¹ See www.youtube.com/watch?v=ef3gofQcOKk

1 baskets by highly-motivating, highly-processed, super-stimulating, calorific foodstuffs,
2 supported by sophisticated marketing employing motives such as status. Motivated by the
3 threat of legislation and pressure from consumers, some global food companies are now investing
4 effort in designing products that are both healthy and motivating. Drinks containing
5 artificial sweeteners rather than sugar, and prepared fruit snacks that make fruit easier to con-
6 sume, are early examples of what looks set to become a major trend.¹² Marketers can appeal
7 to nurture and affiliation motives to make feeding healthier food (at least to children) both
8 rewarding and normative.

9 Modern marketing is thus a social invention that can be used not only by commercial busi-
10 nesses to promote unhealthy products, but also by companies—and public health programmes—
11 to make their health-promoting messages more effective at changing behaviour on a large scale.
12 Industries can also turn their attention to developing products that meet the unmet needs of the
13 poorest who are currently excluded from the benefits of modern technologies. Cheap (but still
14 attractive) technologies such as water filters and insecticide-impregnated bednets can be designed
15 and successfully marketed to the large consumer base at ‘the bottom of the pyramid’ (Pralhad
16 2005).

17 **Conclusion: evolutionary public health**

18 The idea that a ‘mismatch’ between ancestral conditions and modern lifestyles can lead to health
19 problems is not new (Eaton et al. 1988; Williams and Nesse 1991). However, to date, there has
20 been no systematic analysis of motivational mismatch as it applies to modern health problems,
21 nor of the implications of this analysis for action to improve health.

22 Here we have seen that of the top ten risk factors for loss of DALYs, six (unsafe sex, high blood
23 pressure, tobacco, alcohol, high cholesterol, overweight) are mainly due to mismatch and for the
24 other four (underweight, iron deficiency indoor smoke, lack of water sanitation and hygiene),
25 mismatch plays a part. Of the top 20 risk factors, 13 are directly due to mismatch and mismatch
26 plays a part in the most of the rest. In developed market economies, fully nine out of ten of the
27 main risk factors for loss of health can be attributed to motivational mismatch (tobacco, high
28 blood pressure, alcohol, cholesterol, overweight, low fruit and vegetable intake, physical inactiv-
29 ity, illicit drugs, unsafe sex).

30 From an evolutionary public health perspective, these health problems come in three catego-
31 ries. The first is lack of uptake of health-giving technologies such as sufficient foods, micronutri-
32 ent supplements, sanitation, soap, contraception, condoms, and cooking stoves. Poverty and
33 underdevelopment is part of the reason why health-improving technologies are not more widely
34 used, but another is that many of these technologies are evolutionarily novel and not intrinsically
35 motivating to acquire or use, even if they are available. The second category is the overconsump-
36 tion of highly-motivating novel technologies with direct ill-effects (tobacco, alcohol, psychoactive
37 drugs, and foods high in salt, fat, and carbohydrate). These are intrinsically rewarding (or mimic
38 the brain’s reward system). The third category contains motivating novel technologies with
39 harmful side effects such as labour-saving means of production, leisure, and transport, which
40 reduce physical activity and sometimes cause injury (e.g. by producing environmental toxins, or
41 by introducing infection on re-use in the case of syringes).

42 Societies are increasingly moving away from conditions that resemble the ancestral environ-
43 ments in which our motivational systems evolved, towards those with modern industrial

¹² See, for example www.sustainable-living.unilever.com/the-plan/nutrition/

1 economies and plentiful novel technologies, favouring the diseases of mismatch. Finding solu-
2 tions to these problems is thus becoming more urgent. Poorer countries, particularly, increas-
3 ingly face a double burden: not having yet cured the diseases of poverty, they simultaneously face
4 inexorable rises in the panoply of modern diseases: cardiovascular disease, diabetes, cancer, and
5 substance abuse.

6 So does this diagnosis, based in evolutionary public health, offer us new solutions to these
7 intractable problems? We have suggested that they do. The link between novel technologies and
8 psychological rewards underpins our argument that public health interventions must either curb
9 an evolved motivation exploited by a problematic novel technology, or associate use of a health-
10 beneficial technology with some new reward which increases its level of use. For example, ciga-
11 rette smoking, which provides artificial rewards directly to the brain, can be curbed by linking
12 that practice to disgust or disreputable people. Or use of a condom can be linked to the rewarding
13 notion of being what a 'real man' does. In this way, a mismatch between some evolved motive and
14 a novel technology which currently leads to a public health problem can be 'matched' with a dif-
15 ferent reward to help solve the problem.

16 Our analysis also suggests that health can be improved, not just by focusing on behaviour, but
17 by improving the technologies on offer. For the poorest, more can be done to find cheap and
18 attractive technologies that meet basic needs (protection from insect vectors of disease, improved
19 simple toilets, new hand-cleansing technologies). For the better-off, more can be done to make
20 healthy options more attractive (active sports, healthier food products, alternatives to smoking
21 and drinking). Modern marketing techniques have much to offer public health practitioners
22 (Curtis et al. 2007). Consumers and regulatory authorities will increasingly provide the carrots
23 and sticks that will give a competitive advantage to those manufacturers of consumer products
24 who strive to enhance health.

25 Taking an evolutionarily informed approach to public health thus has a number of benefits. It
26 allows us to see public health in a long-term perspective, showing how patterns of disease and
27 behaviour have changed as we have modified our settings. It highlights how our evolved motives
28 have led us to create a world that is much better at meeting our needs than it ever has been (Ridley
29 2010). This has had major health benefits, but also given us the diseases of mismatch that now are
30 amongst our biggest global health problems. We have argued that understanding the evolved
31 motivational drivers of behaviour gives us a useful perspective, not just into the reasons why we
32 fail to behave healthily, but also into means of promoting safer behaviour. Our lesson for the
33 public health practitioner is this: motives got us into this mess but they can also get us out, if only
34 we systematically understand the ways in which motivational mismatch works.

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