The Evo-Eco Approach to Behaviour Change

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Abstract

We introduce a new approach to behaviour change called ‘Evo-Eco’ because of its intellectual roots in evolutionary biology and ecological psychology. This approach is based on the inference that brains evolved to provide adaptive behavioural responses to rapidly changing or complex environmental conditions. From this foundation, we develop a model with three basic components: the *environment*, which presents some challenge or opportunity to the individual, the *brain*, which produces potential responses to that challenge, and the *body*, which engages in interactions with the environment (i.e., produces *behaviour*) that changes that environment. The behaviours of interest to behaviour change professionals typically occur in particular settings, which can be seen as a context within which these basic components interact. We report how the approach has been used to develop public health programs, as well as to make novel predictions about behavioural causes (i.e., placement of new target behaviours within a routine) which have proved to impact on the ability to change a behaviour. The Evo-Eco approach thus deserves to be used by public health workers and others to change behaviour.

1. Introduction

Behaviour change is a ‘hot topic’ in many fields with policy makers, marketers, educationalists, health promoters, business managers, sports psychologists, city planners and web designers all seeking to influence our behaviour. Behaviour change is often seen as 'hard'. However, humans are changing their behavior all of the time. We have adopted life in megalopolises, fly from continent to continent, cope with multiple shifts in our jobs and participate in virtual social networks. Nowadays, children spend half their daily lives in school; currency – whether in coin or now online – provides the means for trade, and the internet has changed many behaviours in communication, exchange and entertainment. In 1985, no one could telephone others when away from home; twenty-five years later, mobile phones are ubiquitous. People now take regular baths, give birth in hospitals, drive cars, wear glasses or hearing aids, and use dishwashers. In fact, the rate of behavior change may be becoming *faster* with time: technology adoption curves are steeper than in the past; mobile phones have become endemic in only a few years, for example, whereas regular showering took many years to become popular (http://www.karlhartig.com/chart/techhouse.pdf).

Human psychology thus seems to be designed to produce changes in behavior to match changes in the environment. Indeed, one reason why we have such large brains may be because humans have had to cope with particularly violent and shifting selection pressures as a result of environmental fluctuations, particularly over the last 10,000 years. [1, 2] [3]

Behaviour is the quintessential adaptation of all animals. It can be defined as functional interaction between an animal and its environment, serving to keep bodies alive and reproducing through rapid, flexible self-propelled bodily movement. [4-7] Animals have had to succeed under conditions that require flexible behavioural responses, as their environments tend to fluctuate rapidly [8-10] They therefore evolved nervous systems and, later, brains, that serve to detect and classify situations, to direct complex movements and to store information for later use. [7, 11, 12]. Animals thus evolved nervous systems so as to be able to provide flexible behavior in stochastic environments.

If the human brain evolved to produce behaviour in response to changes in the environment, then efforts to change behaviour would do well to begin by understanding the evolutionary history of behaviour and the brains that direct it, as well as the environments in which those brains evolved. Here we introduce a new approach to behaviour change that is founded in this understanding of behaviour as a flexible, and mostly adaptive, response to changing environments and discuss some of its practical implications for public health.

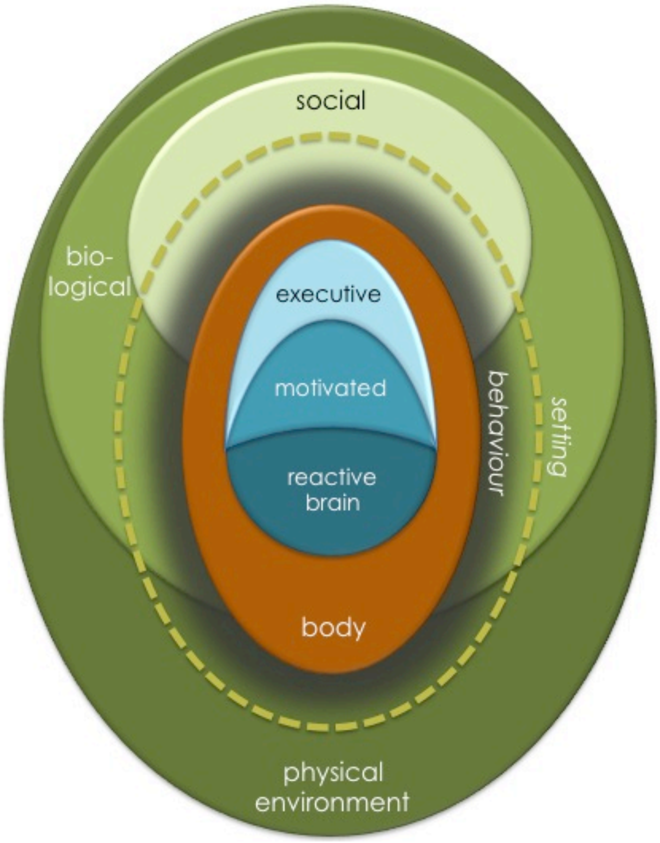
2. The Evo-Eco Approach

We have dubbed the new approach to behaviour change the 'Evo-Eco approach' for its dual origins in the evolutionary biology of behaviour and also in the ecological psychology of the 1950s (as we explain below). The approach can best be explained with reference to a simple model. Figure 1 schematises the basic components of behaviour. It has three fundamental elements:

- the *environment*, which presents some challenge or opportunity to the individual
- the *brain*, which produces potential responses to that challenge, and
- the *body*, which produces *behaviour* that changes that environment.

The model depicts behaviour as a dynamic interaction between bodies and environments, and situates brains, unsurprisingly, within bodies, and bodies within an environment. The model, however has more layers, breaking brains into three components for behaviour production, and environments also into three categories. Later we will break these divisions down even further (see Figure 3), but we will begin by describing the evolution of the components of this simple model.

Figure 1: The Evo-Eco Model



2.1 Brain

The first component of the model is the brain. The brain has a long evolutionary history over which it has acquired adaptations for controlling behaviour. Three levels of control have evolved in human brains, each of which can be isolated neuroscientifically. [13-17] The earliest and simplest form of behavioural control system is the reactive brain. Following this came the motivational system, and to this was added a system for the executive control of behaviour.

2.1.1 The reactive brain

The first type of control mechanism to have evolved came when early invertebrates such as jellyfish and worms appeared about 600 million years ago, and remains characteristic of invertebrates. This was a system for simple reactions to environmental stimuli that represented opportunities or threats. Such brains operate by Pavlovian decision-making, which entails the release of species-specific approach and avoidance reactions in response to unconditioned or conditioned stimuli (i.e., reflexes). [18] So, for example, recognition of a potential food item would inspire approach among these early animal species, and contact with a toxin would inspire recoil. [19, 20]

Reactive brains can learn through classical conditioning, or acquiring associations between stimuli, or between stimuli and behavioural responses. [21, 22] This reactive-level learning is based on the Hebbian rule whereby neurons that 'fire together, wire together', [23] such that associations become stronger through experience. For example, in fear conditioning, an animal acquires avoidance responses to a previously neutral stimulus when it becomes paired with an aversive stimulus, such as a shock or loud noise. Reactive level learning involves attaching a new link to an existing cluster of knowledge (e.g., faeces tastes awful, so the animal will recognize faeces next time as something to avoid). Such learning is also predictive in the sense that faeces will now be expected to taste bad whenever it comes into view, even without the experience – a learned aversion. [16] A special form of Pavlovian learning is 'evolutionarily prepared' learning mechanisms such as the Garcia effect, a mechanism that trains the body to avoid poisonous substances after only a single exposure, due to its significance for survival. [24] These acquired (rather than innate) automatisms are commonly called 'habits'. [25, 26]

For the purposes of changing behavior, innate automatisms are relatively inflexible, but can be triggered by the right cue (for example, a lactation response to the sound of a crying baby). Habits, on the other hand, can be trained; modifying them is an important task, since many of the daily behaviours that are important to public health, like tooth brushing, hygiene and food consumption, are acquired automatisms [27].

2.1.2 The motivated brain

Above the reactive brain in the Evo-Eco schema is depicted a second brain system, the motivational system. This first appeared around 200 million years ago with mammals, whose characteristic adaptation is motivational control for goal achievement. [28-31]

Motives are psychological adaptations for achieving particular kinds of goals. These goals are associated with carrying out elementary evolutionary tasks such as finding food or a mate. Which motives a species can be expected to exhibit are determined by the niche in which the species lives, which in turn defines the evolutionary problems it must solve to flourish and reproduce. [32] All animals must find food, many must find a mate (if they depend on sexual reproduction), some must climb the social ladder of status (in species with social hierarchies). The means by which each of these niche-based tasks is achieved depend on the species' evolutionary history (e.g., some species solve the food problem by scavenging, others by being predators). Evolutionary reasoning about how species including humans meet their particular needs and the available evidence suggests that humans have a total of 15 dissociable motives. These we have described and labeled as lust, comfort, fear, disgust, hunger, nurture, love, attract, affiliation, status, curiosity, hoard, create, play and justice. [33] Understanding the motives behind healthy and unhealthy behaviour provides a prime strategy to change behaviour. For example, disgust and status play a role in the decision to acquire a toilet [34] and nurture drives the responsive stimulation needed for a child to achieve its developmental potential [35]. For health promoters it is important to note that humans have not evolved a specific 'health' motive, as the conditions for good health are too general to have evolved a specific motivational system. Maintaining health is rather a life-long task underpinned by meeting the needs driven by the other motives.

The motivational system learns through what is known as 'operant conditioning' in the animal learning literature, or reinforcement learning (i.e., 'learning by doing') in psychology. [36] Mammals receive an internal reward for goal achievement (or not) through the midbrain dopaminergic system. The key feature of this system is the ability to derive an *expectation* of reward, such that the reward actually received for any action can be compared to this expectation to determine if the action is in fact leading toward the desired end-state. [37] Thus progress toward goal achievement can be checked at various intervals, and alternative routes chosen if obstacles are encountered.

2.1.3 The executive brain

When primates evolved about 65 million years ago, a third level of behavioural control arose. The executive control of behaviour (depicted as the top level of the brain in Figure 1) is based on the ability to run through imagined scenarios of future outcomes. This deliberative level of decision-making entails search and evaluation of action options through a representation of the causal structure of the world. [38] Some of the processing occurring at this level bubbles into consciousness, which is a limited 'theatre' in which memory and other information is pulled together for decision-making. [39] The executive brain employs declarative memory as a specialized mechanism for remembering the specifics of particular experiences, such as the license plate number of the car that just hit someone on the street, or the name of a second cousin. [40, 41] Declarative memory allows humans to develop highly specific scenarios based on detailed information, and weigh up complex chains of potential future actions against one another. So, for example, plans can be made to make an appointment at a screening clinic because the value of the possible long term health benefit is gauged as greater than the value of using the time to meet other needs. Much of current health promotion practice relies on the assumption that health-related behaviour is centrally driven by such rational decision-making and hence focuses on communicating the possible health benefits associated with particular courses of action. Our approach suggests that this will rarely be the most effective route to behaviour change.

This third level of behavioural control also has its own learning system, which employs meta-representation, or the ability to simulate complex situations, often symbolically. [42] At this level learning can happen vicariously, for example through sophisticated forms of social learning (i.e., learning by merely observing the actions of others), such as imitation. [43] Also included here is reflective learning, in which various scenarios are simply imagined (rather than experienced), and new conclusions drawn – what might be simply called 'thinking'. [44] This process can also take place subconsciously through a process known as implicit learning. [45] In effect, these are various forms of 'learning without doing'.

The executive control system also stores representations of the self in declarative memory, giving individuals identities. Identity can play an important role in health behaviour; for example, changing one's identity to that of a non-smoker can assist with smoking cessation. [46, 47] For behaviour change, another important form of declarative memory is social norms: people have ideas (based on experience) about what other people do (descriptive norms), and what other people think they should do (prescriptive norms), which can impact on their own behaviour (through the motives to affiliate or to increase status). Communications that revise perceived norms of binge drinking behaviour downwards, for example, have been shown to lead to reductions in alcohol abuse in student populations [48].

All three behaviour control systems are operating all the time, in parallel. Having multiple decision-making systems allows the brain to make use of controllers with different advantages. The reactive system is best when there is a good expectation of a particular outcome (e.g., the consequences have been well-established through previous trials). The motivated system is best for tracking needs and changing the environment to meet needs over a medium time horizon; the executive system enables the planning of behaviour over the medium to long term, sometimes overriding the other systems. [32]

With each behavioural control system operating in parallel there must be psychological adaptations for selecting among options. There is some evidence that the three control systems are integrated. [14, 49] For example, the control of behavior can be shifted from one system to another through focal brain lesions, suggesting the coexistence of neurally distinct decision making systems. [50, 51]

The three levels of control can also interact in several ways. Of particular interest to the science of behaviour change is habit formation; a specialized mechanism that passes control from higher to lower levels of control through repeated experience. [52-54] Habit change can begin with a conscious decision to acquire a new behaviour, progress to motivated behaviour, and, through continued reinforcement in regular environments, end up as a practiced automatism. Over time, in stable environments repeated behaviour leads to reduced errors, until these are eliminated, at which point the brain releases control to reactive level production (i.e., the response becomes habitual). [55] This is Thorndike's 'law of effect'. [56] In each step, repeated reinforcement leads to reducing the level of control necessary for continued behaviour production, ending up with fast-acting, automatic responses to environmental cues using a purely reactive level of control. [57] Changing habits is a key challenge for behaviour of importance to public health, including daily hygiene, exercise, diet and compliance with medication. Efforts are being made to explore the determinants of habit formation and how daily behaviours such as handwashing or fruit consumption can become learnt automatisms [25, 27] For example, we are using smart home technology to test the prediction that providing a regular reward such as a pleasant perfume in a soap, can lead to handwashing becoming more automatic than it would be without that reward.

The fact that we have three different types of control system can lead to problems. Reactive, affective and reflective systems have evolved to serve different ends and then been forced to work together. For example, an individual may use executive control to plan to avoid long term health problems by not buying tempting food items, so as not to trigger the hunger motive, but then be unable to prevent an automated act of consumption when the plate of biscuits is offered by the well-meaning colleague.

This model of the brain as composed of three types of behavioural control mechanisms with related adaptations in terms of learning, memory and action selection capabilities, is, of course, a major simplification. Each control system has had its own separate and joint evolutionary trajectory [54] and the brain has other control functions, nevertheless, the three levels provide a useful heuristic for directing efforts at behaviour change.

2.2 Body

The second element of the Evo-Eco model is the body. This is our primary interface with the environment; we use it to modify our surroundings to better meet our needs. Several aspects of the body are important for behaviour change. First, every body has a morphology, and this determines what sorts of movements can be undertaken. Each body morphology is unique, and visible to others in the social group, which adds dimensions to identity – for example, ethnicity, gender and age-group. Many behaviour change programs in public health target populations with specific combinations of these features (e.g., anti-smoking campaigns target young people before they develop the habit).

Second, the body produces physiological changes in response to signals from the brain that action is imminent. For example, arousal (increasing activation of the autonomic nervous and endocrine systems, leading to increased heart rate, blood pressure and sensory awareness in the presence of a threat or opportunity in preparation for action) is part of the physiological system. Arousal is also a way the body prepares for goal pursuit, [58-60] so it can be considered an adaptation arising with mammals to 'energize' motivated action. More explicit use could perhaps be made of arousal in behaviour change efforts, for example, fear arousal can change risk perception, leading people to avoid risky behaviours, such as dangerous sex in an era of HIV. [61, 62]

Third, the body also requires physical energy in order to move, which in turn requires mobilization of the body's chemical machinery. The body thus experiences an energy drain as a consequence of engaging in behaviour; against this, it must acquire resources. Reducing energy expenditure, to make healthy behaviour easy, is a classic tenet of health promotion practice – for example, in encouraging recycling, or in using public transport. [63] There is also evidence that cognitive energy depletion can lead to reduced ability to maintain executive control over behaviour, leading, for example, to overeating. [64]

Fourth, the body enables people to engage subjectively with the environment through sensation. The senses provide the primary data from which the brain learns about its environment, and the effectiveness of its behavioural strategies. Manipulating the sensory quality of experience is a potential route for behaviour change, more often employed in marketing than in public health, for example, the addition of sweeteners to toothpaste, the fresh smell to surface cleaners or the visual aesthetic of cigarette packaging. The recent addition of disgusting images of diseased organs to cigarette packs has helped to counter their appeal [65, 66].

2.3 Environment

The third component of the Evo-Eco model is the environment. Though many models of behaviour mention environment, the term remains indistinct. In ecology, 'habitat', 'biome' and 'ecosystem' are all vague concepts, usually defined by the geographical features and ecological community of the species range (e.g., montane, acquatic, alpine). In evolution, the idea of a 'niche' – taken as a set of dimensions important to survival and reproduction – remains more abstract than useful for changing behaviour. At best, the niche has been conceptualized as a 'hyper-volume', or multi-dimensional space of resources such as nutrients, territory or mates used by organisms to satisfy biological needs. [67]

For behaviour change we need to be able to focus on the triggers of change that are extrinsic to people, or 'outside'. We have therefore divided environmental phenomena into three types– physical, biological, and social – as a function of how they influence behaviour (see Figure 1). This division is supported by the sort of response that these different types of environment make to behaviour. The physical environment responds in simple Newtonian terms to behaviour: if you kick a stone, it flies away. An animal, on the other hand, can be strategic in its response, such as when a rabbit avoids being caught by a predator by scampering randomly away. Finally, a component of the social environment, another human being, can respond in elaborate ways to behaviour – for example, forming a life-long plan to get revenge for a perceived wrong. Because these responses occur in different ways, human brains should perceive and respond to physical, biological and social factors in the environment differently when producing behaviour.

Indeed, it appears that different kinds of deductions are commonly made with respect to physical, biological and social objects, as suggested by 'folk' physics, biology and sociology. [68-71] Physical and biological objects tend to be distinguished in three ways: physical objects are not expected to have internal motivation, while biological objects are [72]; biological objects are embedded in unique hierarchies (i.e., the 'tree of life'), while artifacts can be in several hierarchies at once [73]; and animals don't have specific purposes (e.g., tigers are not 'for' anything in particular), but artifacts do (e.g., hammers are for hitting things). [74] So these three types of environment are real in folk psychological terms, and hence should be distinguished in behavioural models.

2.3.1 Physical environment

What components of the physical environment are most important for behaviour? First of all, it is not commonly appreciated that most of the behaviours public health workers are interested in changing involve manipulating a technological object: condoms for safe sex, soap for handwashing or seat belts and air bags to avoid injuries to car passengers. 'Focal' objects are key to the performance of many of the behaviours people seek to change. A key task for behaviour changers is thus to design or redesign objects so that they support healthy behaviour (for example, hypodermic needles that cannot be reused, or treated mosquito nets that are compatible with household cleaning routines).

A second aspect of the physical environment, 'infrastructure' is the consequence of long-term niche construction, conducted by human beings, often over generations. Infrastructure is the 'big stuff', often called the 'built environment' – things like a city's electricity grid, roads, skyscrapers, or the world wide web. It consists of modified aspects of the environment which remain durable when used. [75] When infrastructure such as a public transport network or a hospital, for example, is designed appropriately it can facilitate sustained changes in healthy behaviour, encouraging exercise or safe patient care (such as bathroom facilities to inhibit slipping while showering in nursing homes).

2.3.2 Biological environment

Our basic model of the biological environment is simple, as any animal only adopts a few types of behavioural relationship with other species. An animal can be a predator on other species, or the prey of a predator, or serve as a host or vector to pathogens, or be a pathogen, which predates on a host from the inside. Each of these relationships is associated with a specific psychological motive: disgust helps us to avoid becoming a host (or vector) to parasites; hunger is designed to maximize our intake when we are acting as predators on plant and animal species; and fear (via the fight/flight/freeze mechanism) evolved for dealing with the proximity of predators (i.e., to help us avoid becoming prey). All of these relationships involve a biological agent passing through the body boundary in some form (e.g., by being eaten, taking a bite of the person, or infecting the individual as host). Finally, species can play symbiotic roles, for example as groomers or draft animals. Humans have complex funds of knowledge about the relevant behaviour and characteristics of the species in their environments to help them manage these relationships. [73, 76] The biological environment plays an important role in health-related behaviour, for example by stimulating handwashing when there is a perception that flu viruses are epidemic [77], offering foods containing plant toxins, or leading us to interact with companion species that can transfer infections such as nematode worms and toxoplasmosis.

2.3.3 Social environment

The human social environment is more complex than the biological one. Mammals were the first large-bodied animal group to spend a significant proportion of their lifespans in the presence of conspecifics. However, early mammalian social groups remained largely egalitarian in nature. Primates were the first group in our evolutionary lineage to develop hierarchical societies, in which there is privileged access to resources, including mates. [78, 79] Within these groups, there are can be particularly intense, and long-lasting, dyadic interactions, which we call ‘relationships’ (e.g., mother and offspring).

Humans have developed social life to a unique degree. We depend on others to figure out how we should best achieve even everyday aims, being the species most adept at sophisticated forms of social learning, like imitation. [80, 81] We live in large groups composed of multiple sub-groups. Institutions such as businesses, governments, sports clubs, and religious organisations may meet in particular locations, with associated infrastructure, facilitating new kinds of cooperative outcomes. Each of these can be thought of as a network of individuals linked through particular kinds of relationships, in which each individual is playing a particular role, helping the organization to achieve its ends. These networks can have regular kinds of structures (e.g., an organizational chart with a pyramidal shape) that dictate the ways in which it is possible to change roles within the organization. Institutional engineering represents a key strategy for changing behaviour. For example, doctors’ job performance reviews can explicitly include hand hygiene compliance in efforts to reduce health-care induced infections. [82]

Playing a given role in an organization, network or relationship can involve activation of a particular motive. For example, status maximization drives some people to become CEOs of businesses, while pleasure in skill development (the play motive) leads others to devote time to sport. Play has also been extended in primates from object-play to social play, for learning the skills to interact with conspecifics effectively. [83] Affiliation is the motive to belong to a particular group, to share membership with others in a common goal. [33] The Evo-Eco model thus draws attention to the need to understand the structure of social relationships and the motives that underpin them. For example, we have shown that the nurture motive underlies much maternal caring behaviour including hygiene, [84] and Slutkin has shown the importance of understanding the status and justice motives in gang networks to prevent cycles of revenge violence. [85]

2.4 Interactions

The three basic components of the Evo-Eco model interact in ways that are of importance to understanding how to change behaviour.

2.4.1 Behaviour

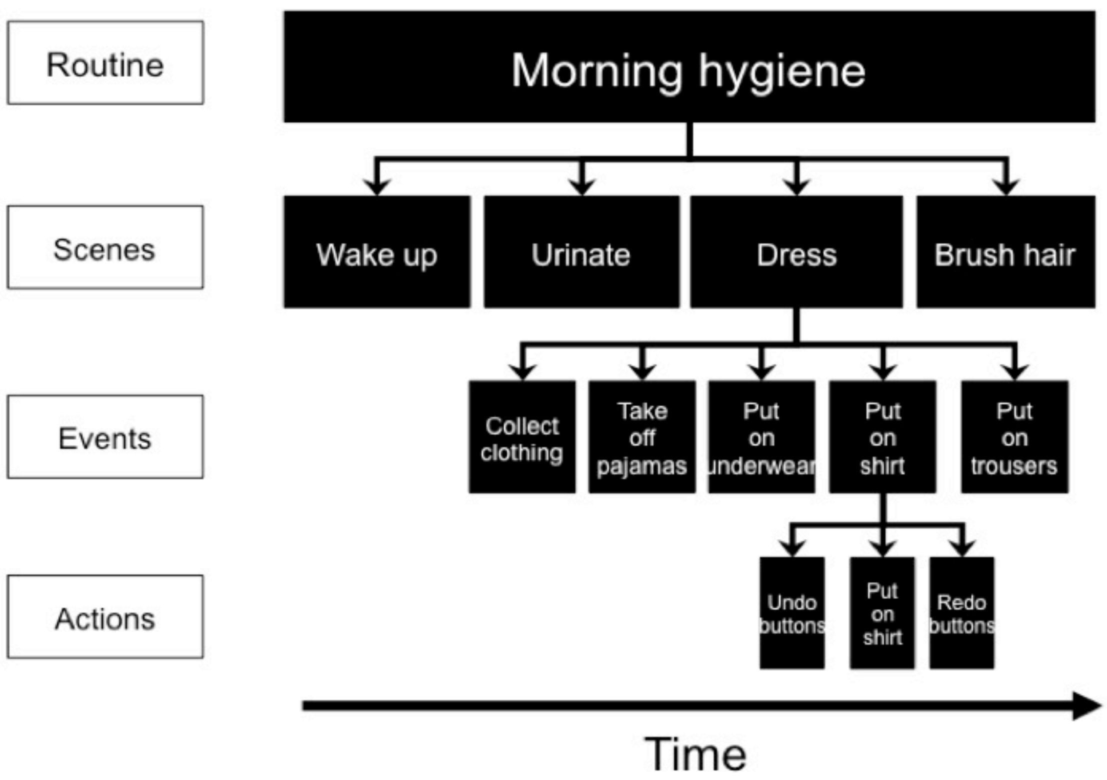
First, brains compel bodies to move, which is a dynamic phenomenon. Because behaviour is ephemeral (unlike brains, bodies and environments), behaviour is represented in the Evo-Eco model as a cloud at the intersection of bodies and environments. Behaviour arises at a particular point in time, at a specific place, and then disappears again. For this reason, investigations of behaviour are often based on self reports of past behaviour by those that have engaged in it, rather than on actual observation. However, this reliance on reporting can introduce major distortions in the understanding of what is really happening. [86, 87] Since many health behaviours are normative and morally loaded or too automatic to be accurately recalled it is important to document actual behaviour prior to development of behaviour change campaigns rather than rely on self-report (see below).

2.4.2 Routines

One implication of behavioural dynamism is that behaviours follow each other in a temporal stream. Behaviours often get chunked together in chains of actions that are statistically and functionally correlated in time and space. [88-90] The literature on routine behaviour divides behavioural chunks into routine, scene, event and action hierarchies [91]. Figure 2 shows an example of a hierarchically organized behaviour stream concerning morning hygiene. This multi-level hierarchicalization helps behaviour to be controlled efficiently.

Chunking has implications for behaviour change. In a study of daily routines, we hypothesized that the order in which flossing is carried out with respect to toothbrushing would influence its sustained adoption. Indeed, those study participants who flossed before tooth brushing were less successful in forming a habit than those who carried it out afterwards, because tooth-care events seem to be chunked together, with brushing reliably cuing the next dental care event, flossing. [27] We are currently investigating food hygiene in Nepal, oral rehydration solution preparation in Zambia and infant feeding in Indonesia with a view to finding ways of improving sub-optimal behavioural routines.

Figure 2: A Hierarchical Behaviour Routine



2.4.3 Behaviour settings

Behaviour settings (shown as the dotted oval in Figure 1) are one of the most important concepts in the Evo-Eco approach, where the components interact. The behaviour setting concept derives from ecological psychology. [92] Settings can be thought of as networks of constraints on how animals can behave in specific situations. Settings first arose in the form of the stereotypical rituals and routines of animals – for example with respect to mating or territorial disputes. Conventional signals and accentuated body movements become ritualized in such specific contexts to secure the best outcome. [93, 94] These are situations of high risk and high reward in evolutionary terms; hence appropriate behavioural responses have been strongly selected.

Most animals, from ants to lizards to primates, have daily routines in which they choose the same places and times to conduct a particular behaviour (e.g., feeding, getting water, marking territorial boundaries, resting, sheltering), day after day. [4, 95, 96] Since reinforcement learning results in optimal behavioural choices over time, as long as conditions remain essentially the same, the same options should be chosen, and the same behaviours observed – hence the high degree of stereotypy in many animal behaviours. Behavioral rigidity – such as the preference to engage in specific acts at particular places and to take familiar routes between these places – is adaptive because it allows faster performance and enables attention to be directed to potentially varying aspects of the environment, such as the presence of predators. [97-100]

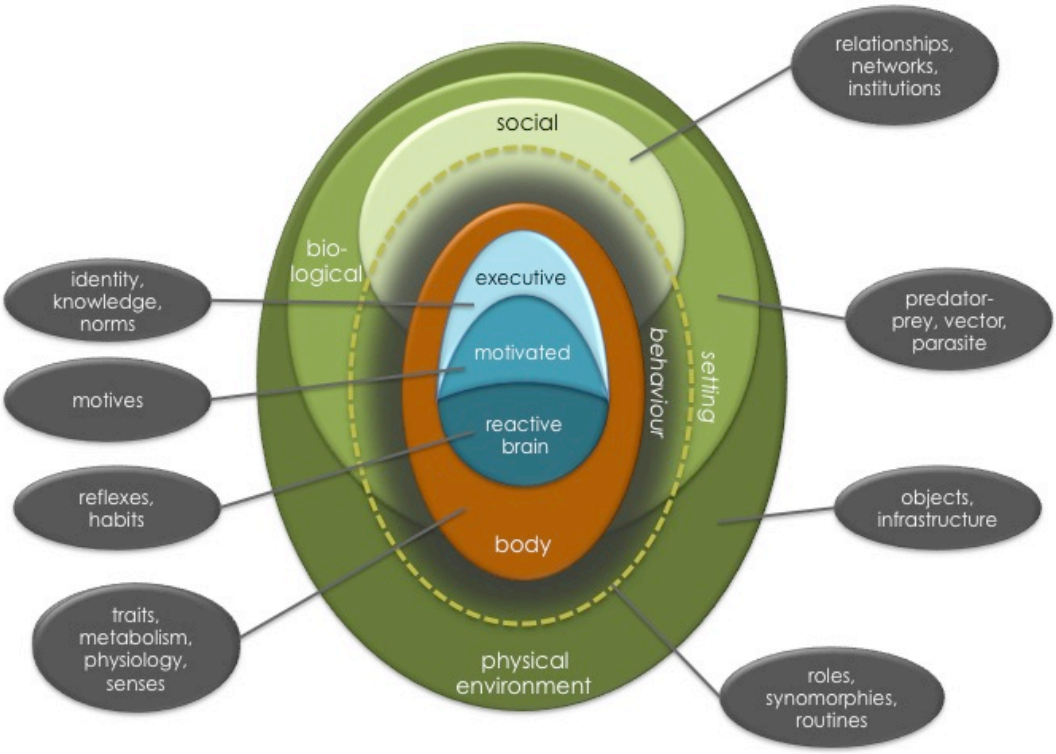
Humans have elaborate behavioural settings, thanks to our ability to play particular roles, using particular objects, in particular physical and social environments. For example, we may produce stereotypical sequences of behaviour (i.e., routines) in a particular type of infrastructure (e.g., a church) using particular focal objects (e.g., a Bible), with people playing complementary roles (e.g., choristers, parishioners, lay leaders). This can be due in part to humans' tendency to 'overimitate', or copy the most detailed, even non-functional aspects of other's behaviour. [101] People may (often simultaneously) enter into an implicit contract to complete the execution of a particular setting, such as a church service, school class, shopping trip, group celebration, or private routine. Each participant plays a particular role within the setting, and if one individual behaves in a way that disrupts the setting, for example by interrupting a wedding ceremony, others may feel that they have a license to 'correct' them (e.g., by 'shushing' them or ejecting them from the scene). Hence settings have a large degree of influence over the behaviours that most individuals exhibit in most social contexts. The ecological psychologist Roger Barker identified the powerful regulatory pressures that dictate behaviour in settings by collecting thousands of hours of observations and showing that behaviour within settings was 90% predictable, if one knew only the physical and social context, and the role an individual played. [102]

In social settings, this means that people performing their roles can help train others to perform theirs more appropriately – in effect, socially reinforced behaviour change. We have added 'Eco' to our Evo model in honour of Barker's important, but now largely forgotten, work on the ecologically determined psychology of everyday human behaviour. [103] Such regulatory mechanisms can be discovered by observing them in action. Settings are key to most health-related behaviours, for example by determining when smoking is, or is not, allowed, by providing stereotypical rules for mealtimes, for ritualized ablutions and for patient-health care worker interactions.

A further insightful contribution from Barker to the topic of behaviour change is the concept of 'synomorphy'. (A related notion is that of environmental 'affordance'. [104] However, it is not as specific, nor part of as powerful an 'ecology of ideas', as the synomorphy notion developed by the Barker school.) Barker proposed that objects and infrastructure involved in settings often have design features that invite or dictate the performance of certain kinds of behaviour. [92, 104] Synomorphies are adaptive kinds of 'fit' between environment, brain and body. For example, a bar of soap has a number of features that enable it to remove dirt from hands. It is about the size of a hand so it can be readily picked up and rubbed; it is solid, so that it will last a long time, yet when wet, bits are left on the hand, and further friction will cause the bits of soap to foam, providing transport of dirt from the hand when washed off under a flow of water. From the perspective of behaviour change it could almost be said that the object dictates the behaviour, and hence attention must be paid to the design of the focal objects involved in the target behaviours.

In Figure 3 we have added the additional components that we have discussed in this section to the basic model.

Figure 3: The 'Exploded' Evo-Eco Model (with sub-components)



3. Comparison to alternative approaches

The Evo-Eco approach represents a powerful new way of thinking about behaviour, and should have an impact on how interventions to change behaviour are formulated. It represents a major departure from the current dominant models of behaviour change – such as the Theory of Planned Behaviour, [105] and Health Action Process Approach [106] in health psychology, and the 'heuristics and biases' approach in behavioural economics, based on deviations from rational choice theory [107]. (A few alternative models are available, primarily the Social Ecology approach, [108] Diffusion of Innovations model, [109] Transtheoretical approach, [110] and Social Marketing approach, [111] but each of these occupies a small, specialized niche in the practical world of behaviour change programs.) Both types of approach begin with the assumption that behavior maximises expected utility – that is, the idea that behaviour is driven by the choice of that future outcome which is most highly valued, discounted by beliefs about how likely it is that such an outcome can be achieved. Similarly, self-help programs typically rely on will-power, a high-level form of cognition which is known to be limited in important ways, [64] while policy-makers have normally assumed that people respond rationally to the constraints their policies place on people's activity. [112, 113]

But campaigns that emphasize enhancing knowledge or altering attitudes frequently have little effect upon behavior; there is often a weak relationship between attitudes and/or knowledge, and behavior. [114, 115]. This is because the assumption of rational or cognitive causation is often false: behaviour – or at least the behaviours of interest to behaviour change specialists – is often largely caused by automatic (e.g., habitual) processes [116-118] and environmental factors, [119] both of which tend to be ignored by expected utility models. For example, many illnesses are significantly influenced by the degree of economic inequality in a society, [120] and physical activity depends upon civic resources for exercise. [121, 122] Further, whenever behaviour change models *are* augmented with demographic or environmental factors [123, 124], these tend to be included as distal variables that have no direct impact on behaviour, but rather filter through cognition.

In contrast, an evolutionary approach begins with the assumption that behaviour has evolved to provide responses that were adaptive in the environment in which the animal in question evolved. In particular, the Evo-Eco approach sees behaviour as radically embodied and situated. [92, 104, 125-127] That is, factors other than cognition are considered active and present in the moment of behaviour, having independent causal influence on activity. For example, the environment is theorized to have its own structure, and hence plays a formative role in behaviour production, rather than being seen as an amorphous set of 'barriers' (its typical role in behaviour change models). Further, we emphasize the intrinsic dynamism of behaviour, and its ephemeral nature, with the target behaviour occurring within a stream of prior- and post-activity. Thus, behaviour is seen as a dynamic interaction with other model elements, rather than as the consequence of previous steps in a linear causal model (i.e., the 'box-and-arrows' diagram other approaches tend to use).

Compared to health psychology and behavioural economics, then, our approach places greater emphasis on:

- the physicality of behaviour (physical environment, bodies)
- place (e.g., space with designed infrastructure)
- time (e.g., weekends)
- brain-based mental processes (e.g., mental representation, goal achievement, memory)
- objects and product design (especially synomorphic relationships)
- different forms of learning (associative, affective and habitual as well as cognitive)
- non-cognitive behavioural control processes (e.g., motivation, habit)
- bodily states (e.g., hunger, sexual arousal)
- behavioural dynamics (i.e., setting-based routines, chunking, sequence dependence)

Such a wide range of novel influences should provide rich new material and insights for effective behaviour change programs.

4. Using the Evo-Eco approach

The Evo-Eco approach offers a new way of understanding the psychological and environmental determinants of behaviour. It organizes both well-established and novel factors derived from evolutionary biology of behaviour and ecological psychology into a simple schema of behaviour determination. But how does the approach help us to actually *change* behaviour?

It helps in a number of ways. First, the model can be used to generate hypotheses about the determinants of the behaviour that we seek to change. Second, we use it to organize field investigation of the target behaviours in formative research, testing whether our hypotheses about behaviour are correct and providing a structure for investigation. Third, we use the model to schematise the design principles for an intervention to change behaviour, and as a creative tool and finally we use it to explore the process by which behaviour change has come about, providing lessons for future efforts.

Below we give a brief example of how the Evo-Eco model helped us to design a successful intervention to change handwashing behaviour in rural India. We describe how the model helped to organize formative research, helped to generate insights into the drivers of deeply habitual, ritualized and normative hygiene behaviour, helped us to come up with design principles for the campaign, how the intervention was tested and how we learnt something of the mechanisms of change that led to the intervention's success.

4.1 Handwashing behaviour

Handwashing with soap (HWWS) appears able to substantially reduce the risk of disease associated with infectious pathogens such as those that cause diarrhoeal disease and respiratory tract infections [128, 129]. Though knowledge about the health relevance of handwashing with soap is widespread, HWWS at key occasions is rare, for example, being practiced by less than 20% of people in low-income settings after the toilet [130]. New approaches are clearly needed that go beyond education to address the non-cognitive determinants of handwashing behaviour.

4.2 Formative research

Formative research is a phase of field-based investigation prior to intervention design which aims to provide design principles for behaviour change. In a series of formative research studies in eleven countries we sought the factors that could be made relevant to changing handwashing behaviour. Whilst there was some variation from country to country, many of the drivers of handwashing behaviour were common [84]. Pertinent aspects of the *physical environment* included lack of *infrastructure* (water was often scarce, although some was always available) and inappropriate or difficult-to-use *objects* such as basins placed on the ground, requiring stooping and soap bars that could not easily be used since they were slippery and fell on the ground. The *biological environment* played an important role in HWWS when there were epidemics such as cholera or bird flu, however, we found that HWWS tended to return to baseline once epidemics were perceived to be over [77]. The *social environment* played an important role, with much handwashing happening in public. In the UK we found that HWWS increased when more people were present in a public toilet [131]. However, in low-income settings we found handwashing not to be the norm, and the *settings* tended to correct behaviour away from HWWS, as mothers were sometimes accused of being profligate with water and soap and mocked by neighbours for being too fastidious. In behavioural trials we saw how physically difficult it can be for *bodies* to actually manage the practice of HWWS, juggling infants, water jugs, soap and waste water with multiple other daily tasks.

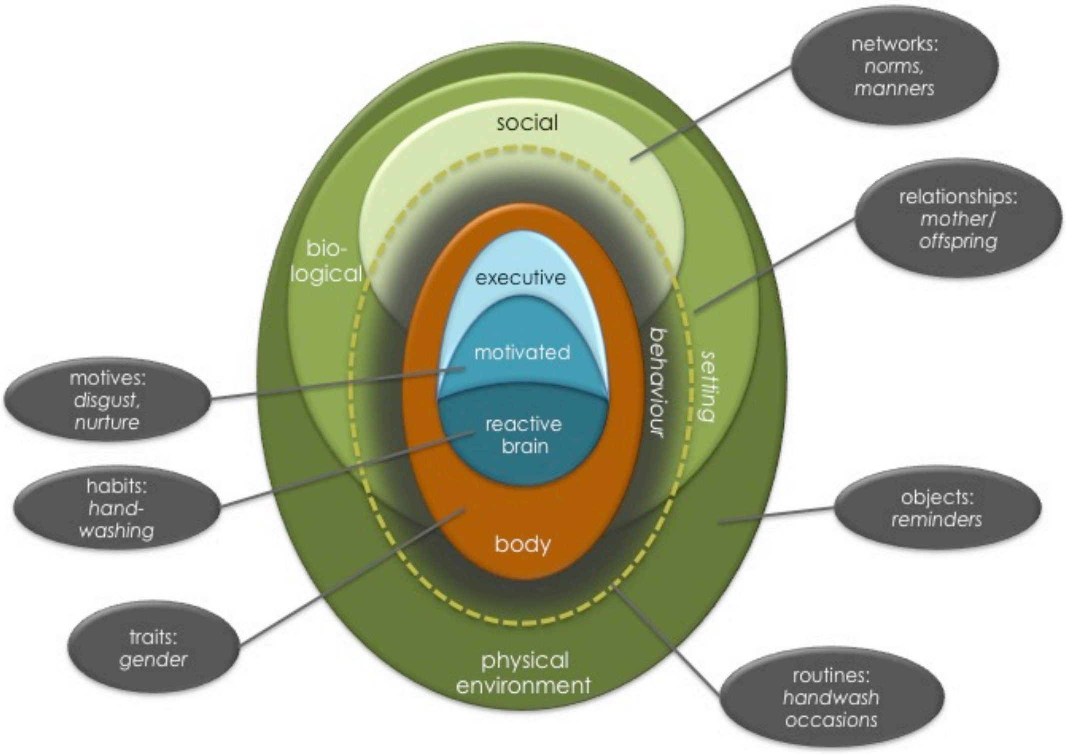
As regards the *brain* aspects of the Evo-Eco model of handwashing, we found that HWWS was a reflexive *habit* for some, however, these people tended to be exceptional, perhaps because of working in the health sector, having a particular upbringing or being excessively concerned about contamination. Hygiene rituals, however, were deeply habitual, with washing routines being highly stereotypic and almost identical from person to person across whole villages. *Motives* for handwashing included *disgust;* the concern that contamination from toilets was brought into the home environment on hands, and making them smell bad, *nurture;* the desire to see a child responding to love and caring by being happy, thriving and successful, *affiliation;* which influenced mothers to wash their hands less (in tune with local norms, which did not involve practicing HWWS), and *status*, in which hygienic people were, on the whole, admired and respected. The formative research used methods including filming, behavioural trials, motive mapping and settings observations, and did not rely on verbal accounts by target groups and key informants to get insights into the drivers of handwashing behaviour.

4.3 Design principles

Design principles are the key determinants of behaviour which a campaign seeks to use as 'levers of change'. Most public health behaviour change campaigns in the developing world are based around approaches that target intentional change – that is, cognitive, often conscious decision-making on the part of the target population, as the most popular health psychological approaches deal exclusively in such variables (see section above). Figure 4 shows the design principles that we developed from the insights from formative research using the Evo-Eco approach. We asked a local Bangalore-based creative agency to focus on *disgust* and *nurture* and to try and change local norms, through making HWWS seem common and introducing handwashing as good manners. We asked them to look at how to change *settings*, such that there were physical reminders to serve as cues, and for there to be social support for handwashing from influential members of society. We also asked them to focus on inserting HWWS into daily routines. Changing the infrastructure and objects involved in handwashing proved infeasible, as expected, in a rapid intervention, but is planned for other initiatives (working with the private sector to redesign soap and handwash stands). We briefed the agency not to rely on cognitive approaches, such as talking about diarrhea and disease, although we did allow, on the basis of prior success, that mothers could be asked to express their intentions to HWWS in public pledges.

A further part of the challenge to the creative agency was to design the HWWS intervention in such a way that it could be delivered by only two people over two days in each village. This was because we wanted an intervention that was capable of being scaled to the whole of India. The design team developed and tested a multifaceted campaign that involved school children, community events, neighbourhood visits and a village rally. Activities included the showing of a cartoon film (http://www.youtube.com/watch?v=tLoNTe9ifCA) with a powerful emotional message about a mother (SuperAmma) teaching child manners including handwashing and being rewarded with its success and love.

Figure 4: Handwashing Trial Design Principles



4.4 Content of the intervention

To change the social environment in favour of HWWS we involved village authorities such as the Sarpanch (village chief), school and preschool teachers. Short video clips of them making statements about HWWS were shown at community events and their images appeared in HWWS posters that were displayed in public places. These individuals also appeared in person at the two community events. Women were asked to pledge to HWWS in public and when they did so, stickers were placed on their doors identifying them as HWWS supporters; their names also went up on a public display board in the centre of the village. Children also participated in a rally around each village to add to the 'presence' of HWWS as a norm.

4.5 Behavioural and process outcomes

The intervention was run in seven villages; HWWS behaviour was measured at start and finish and at several times following the intervention in intervention and control villages. The full details of this randomized controlled trial are described elsewhere. [132] In brief, this experiment showed that directly observed HWWS went from being virtually absent (about 2% in both intervention and control groups) to being practiced by roughly one-third of the population, six months post-intervention. Process indicators showed that there was also a significant shift in the proportion of people who reported thinking that handwashing with soap was a social norm in their village (from 8% to 35%).

5. Conclusion

Behaviour is an evolved phenomenon. Evolutionary theory is therefore the obvious place to start if one wishes to understand, and ultimately change, behaviour. Whilst some approaches to behaviour change reflect some evolutionary reasoning, the Evo-Eco approach is the first comprehensive approach to behaviour change based explicitly in evolutionary theory. (Recently, there has been another call to base behaviour change in evolutionary theory. [133] However, the strategy advocated in this case is restricted largely to intentional cultural evolution, or self-aware change by small groups or communities, which we believe is too restrictive, as it may be difficult to get explicit agreement from groups of the need for behaviour change, especially as many public health behaviours are practiced habitually so that awareness of the need for change may be low.) The Evo-Eco Approach is also current with relevant sciences, including content from neuroscience and psychology – sources broader than the cognitive psychology that constitutes the foundation of behaviour change approaches in health psychology and behavioural economics.

The Evo-Eco model has the advantage of being more comprehensive than alternatives, including explicit treatment of the environment and body, not just the brain, and so provides a much richer source of potential insights. It emphasizes behaviour as a complex, dynamic interaction between bodies and environments. It focuses squarely on behaviour in settings and not on cognition and self-report as the locus for proper understanding. [87, 92] With its view of the brain as an evolved organ, not a failed computer (as in behavioural economics), the Evo-Eco approach also provides a more positive view of human capabilities: rather than trying to make use of 'biases', it emphasizes the behaviour change 'problem' as one of channeling natural, internally-generated action impulses. People are naturally active – in order to stay alive in constantly changing environments, we must explore our surroundings to keep up-to-date on what threats and opportunities have arisen. [7, 12] The Evo-eco approach can be seen as seeking to help people harness this 'energy' more profitably.

Of course, the ultimate proof of utility is evidence that the approach changes relevant behaviours. In this regard, the Evo-Eco approach has been used to develop a scalable program to promote handwashing with soap after key events in rural Indian villages. Based on this success (and earlier successes with precursors to this general model) [134, 135], Evo-Eco is currently being used to develop interventions in other projects, such as child complementary feeding practices in Indonesia and multiple behaviours related to diarrhea prevention in Zambia.

Another proof of the utility of any theory is its ability to help people generate novel predictions. One such prediction was that the ability to learn to repeatedly perform a novel behaviour within a behaviour setting is affected by its placement in the setting's routine. We have demonstrated that this routine placement effect is significant when learning a new flossing habit. [27]

The Evo-Eco approach has thus been shown to change behaviour in public health projects, and to inspire new empirical hypotheses about constraints on behaviour change in real world contexts. We believe it has great potential to be used by public health workers and (social) marketers to devise more effective campaigns, by policy-makers to improve general well-being, and perhaps also by the general public as inspiration for their own self-help projects.

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