

# Rethinking wellbeing: Toward a more ethical science of wellbeing that considers current and future generations

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## 1 **Abstract**

2 The construct of wellbeing has been criticised as a neoliberal construction of western individualism that ignores  
3 wider systemic issues including increasing burden of chronic disease, widening inequality, concerns over environ-  
4 mental degradation and anthropogenic climate change. While these criticisms overlook recent developments, there  
5 remains a need for biopsychosocial models that extend theoretical grounding beyond individual wellbeing, incor-  
6 porating overlapping contextual issues relating to community and environment. Our first GENIAL model ([Kemp,  
7 Arias, & Fisher, 2017](#)) provided a more expansive view of pathways to longevity in the context of individual health  
8 and wellbeing, emphasising bidirectional links to positive social ties and the impact of sociocultural factors. In  
9 this paper, we build on these ideas and propose GENIAL 2.0, focusing on intersecting individual-community-  
10 environmental contributions to health and wellbeing, and laying an evidence-based, theoretical framework on  
11 which future research and innovative therapeutic innovations could be based. We suggest that our transdisci-  
12 plinary model of wellbeing - focusing on individual, community and environmental contributions to personal  
13 wellbeing - will help to move the research field forward. In reconceptualising wellbeing, GENIAL 2.0 bridges the  
14 gap between psychological science and population health health systems, and presents opportunities for enhancing  
15 the health and wellbeing of people living with chronic conditions. Implications for future generations including  
16 the very survival of our species are discussed.

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# 1 Introduction and Context

*‘But no time or nation will produce genius if there is a steady decline away from the integral unity of man and the earth. The break in this unity is swiftly apparent in the lack of “wholeness” in the individual person. Divorced from his roots, man loses his psychic stability.’*

– Elyne Mitchell, *Soil and Civilization* (1946)

There is now considerable research interest in the topic of ‘wellbeing’ and its relationship to ‘health’, yet there has also been much debate and criticism. The Oxford English Dictionary (OED) defines ‘wellbeing’ as ‘the state of being comfortable, healthy, and happy’, suggesting that the term relates to aspects of emotions and feelings, as well as ‘health’. By contrast, the OED defines ‘health’ as ‘the state of being free from illness or injury’, a definition that does not fully capture the meaning of ‘health’ as understood by researchers in population health: ‘there is no health without mental health’ (Prince et al., 2007). We further note that absence of illness is not necessarily ‘healthy’. It is possible for instance, to be unhealthy without having illness, as one can be *on course for an illness* through having poor diet, lack of sleep, being overweight and physically inactive. Similarly, ‘not being depressed’ is not the same thing as ‘being happy’. The World Health Organisation (World Health Organisation, n.d.) defines ‘health’ as complete mental, physical and social wellbeing, thus - according to this definition - wellbeing is subsumed by an overarching concept of ‘health’, which differs from the OED definition. Although superficially appealing, the WHO definition has been criticised as being unrealistic. Petr Skrabanek, a Professor of Medicine and sceptic reportedly joked that according to this definition, health is only achievable at ‘the moment of mutual orgasm’ (Smith, 2008). A critical observer might even query whether it is possible for people living with long-term disabling conditions such as common mental disorders, diabetes, obesity and cardiovascular disease to have opportunities for experiencing wellbeing. We suggest that they do have such opportunity, and that enhancing wellbeing in such people may also improve physical health. This is an important consideration as chronic conditions and disease now outstrip the societal burden imposed by acute conditions (GBD Collaborators, 2015). In 2017, as much as 79% percent of the years lived with disability (YLDs) globally are attributable to chronic conditions (“GBD Compare — IHME Viz Hub”, n.d.). Prominent conditions including depression and anxiety are associated with 5.05% and 3.18% of total global YLDs in 2017, respectively (Fig 1). Critically, our work is now focused on building wellbeing in people living with chronic conditions (see section 7 for further discussion).

Positive psychologists have approached the construct of wellbeing from a different perspective, emphasising life satisfaction (Pavot & Diener, 2008; Diener, 1984), psychological wellbeing (Ryff & Keyes, 1995; Ryff, 2014) and flourishing (Diener et al., 2009; Seligman, 2011; Seligman, 2018). ‘Resilience’ is another associated concept (American Psychological Association, Accessed Monday 17th June 2019), which emphasises the process of adapting well in the face of adversity or tragedy, and ‘bouncing back’ from difficult experiences. It is interesting

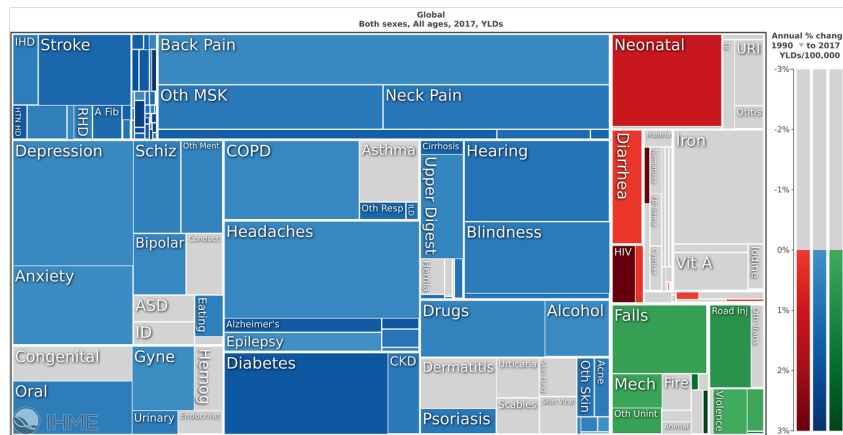


Figure 1: The global burden of disease (GBD) with respects to years lived with disability (YLDs) for all ages and both sexes in the year 2017. The entire figure represents 100% of YLDs; those conditions with increasing % annual change are highlighted in blue (non-communicable disease), red (communicable disease) and green (injuries) (“GBD Compare — IHME Viz Hub”, n.d.).

100 to observe that this psychological definition conflicts with those from other disciplines (e.g.  
 101 engineering), which highlight ‘stability’ and ‘efficiency’ (Quinlan, Berbés-Blázquez, Haider,  
 102 & Peterson, 2015). One need only think of a ‘stable bridge’ or an ‘efficient production line’  
 103 to appreciate the distinction between psychological science and engineering here. Others have  
 104 introduced the concept of ‘salutogenesis’ (Antonovsky, 1996), a word based on the Latin term  
 105 ‘salus’ (health, well-being) and the Greek word ‘genesis’ meaning emergence or creation. The  
 106 salutogenic concept counters the tendency of medicine to focus on ‘pathogenesis’, and empha-  
 107 sises a role for a ‘sense of coherence’ for managing and overcoming stress reflecting feelings  
 108 of confidence that the environment is comprehensible, manageable and meaningful. However,  
 109 psychological theories of wellbeing have also been criticised for ignoring wider systemic is-  
 110 sues such as loneliness, inequality, environmental degradation and climate change (Carlisle,  
 111 Henderson, & Hanlon, 2009; Ehrenreich, 2010; Frawley, 2015). These criticisms are being  
 112 tackled, in part, by developments in conservation and environmental psychology, which explic-  
 113 itly link psychological science to some of these challenges. Developments include for instance,  
 114 the positive psychology of sustainability (Corral-Verdugo & Frías-Armenta, 2015; Verdugo,  
 115 2012), sustainable happiness (O’Brien, 2010; O’Brien, 2012; O’Brien, 2016) and sustainable  
 116 wellbeing (Kjell, 2011). However, others have argued that the concepts of ‘resilience’ and ‘sus-  
 117 tainability’ have become so corrupted by neoliberalism, the fossil fuel industry and the Trump  
 118 administration, that these concepts are no longer useful (Albrecht, 2019).

119 Here we define the word ‘wellbeing’ to refer to positive psychological experience, which can be  
 120 impacted on by positive health behaviours, and is promoted through a sense of connectedness to  
 121 ourselves as individuals, as well as to the communities and environment within which we live.  
 122 Our GENIAL model provides and evidence-based and life-course framework for appreciating  
 123 how wellbeing (or illbeing) may arise. Our paper is organised as follows: Section 2 briefly re-  
 124 views our previously proposed model of wellbeing, the GENIAL model. The word GENIAL is  
 125 an acronym encompassing Genomics, Environment, vagus Nerve, social Interaction, Allostatic

126 regulation, and *Longevity*, providing a life course framework within which to understand the  
127 pathways to health and wellbeing versus premature mortality. GENIAL provides a theoretical  
128 context with which to understand key components which determine pathways to health and  
129 wellbeing for individuals, for example, psychological experiences, health behaviours, vagal  
130 function. However, a plethora of evidence shows that health and wellbeing are influenced by  
131 individual factors but by the systems and environment that surround people. Accordingly, Sec-  
132 tion 4 expands the focus of the GENIAL model to explicitly encompass individual, community  
133 and environmental wellbeing (see Fig 2), highlighting a key role for individual wellbeing as a  
134 foundation to build community and environmental wellbeing in line with social ecology theory,  
135 and their respective bidirectional impacts on the wellbeing of individuals. Section 5 provides a  
136 succinct summary of our updated model. Section 6 considers the implications of our updated  
137 model (GENIAL 2.0) for people living with chronic conditions, and section 7 draws some  
138 conclusions and provides some examples relating to our own work that we are doing in this  
139 regard.

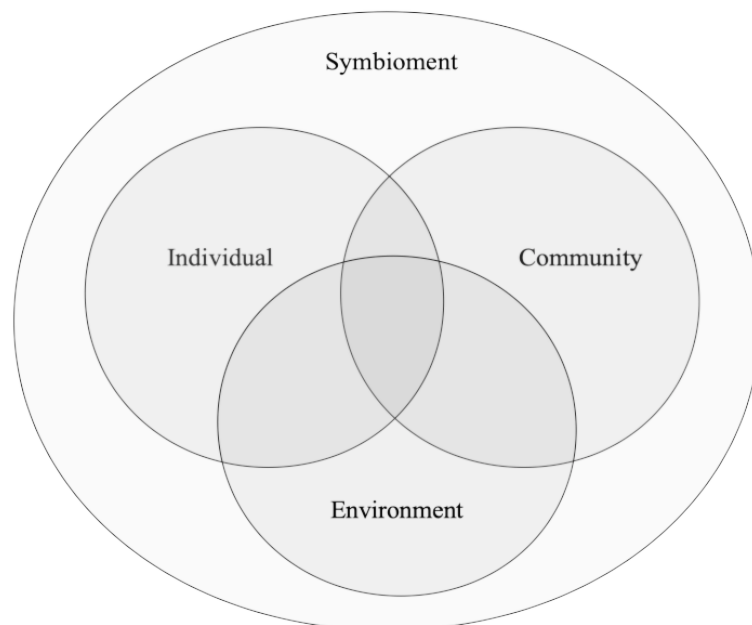


Figure 2: Venn diagram of key wellbeing domains: the individual, community and environment. These domains are placed within the ‘symbioment’ (Albrecht, 2019) to emphasise symbiotic coexistence of all life at various scales.

## 140 2 The Original GENIAL Model

141 Our original GENIAL model (Kemp, Arias, & Fisher, 2017) (Fig 3) emphasised the pathways  
142 to health and wellbeing versus ill-health and premature mortality, highlighting key roles for va-  
143 gal function and social interaction along these pathways. The role for the vagus nerve – indexed

144 by heart rate variability (HRV) – built on well-established theoretical models including poly-  
145 vagal theory (Porges, 2011; Porges, 1995; Porges, 2001; Porges, 2003; Porges, 2007), which  
146 emphasises a role for the myelinated vagus nerve – in particular – in social engagement, and  
147 the neurovisceral integration model (Thayer & Lane, 2000; Thayer & Fischer, 2009; Thayer &  
148 Lane, 2009), which lays a neurophysiological foundation for understanding mind-brain-body  
149 linkage. The recent extension of the neurovisceral integration model named the ‘Neurovis-  
150 ceral Integration Across a Continuum of Time’ or ‘NIACT’ (Kemp, Koenig, & Thayer, 2017)  
151 laid a temporal framework for understanding linkage between emotion and - over time - mor-  
152 tality, bridging the gap between psychological science and epidemiology. This model was  
153 motivated by research (Tracey, 2002; Jarczok, Koenig, Mauss, Fischer, & Thayer, 2014; Jan-  
154 dackova, Britton, Malik, & Steptoe, 2016; Kemp et al., 2016) highlighting a mediating role  
155 of the vagus nerve over downstream health-relevant outcomes. NIACT provides a theoretical  
156 framework within which these disparate findings can be understood. Kevin Tracey, an Ameri-  
157 can neurosurgeon identified the ‘cholinergic anti-inflammatory reflex’ (Tracey, 2002), regulated  
158 by the vagus nerve, which if impaired may contribute to a host of conditions including poor  
159 metabolic outcomes, cardiovascular disease and associated mortality (Hillebrand et al., 2013;  
160 Wulsin, Horn, Perry, Massaro, & D’Agostino, 2015). The efferent vagus nerve achieves this  
161 through interaction with the peripheral  $\alpha 7$  subunit-containing nicotinic acetylcholine receptors  
162 expressed on macrophages. See (Pavlov, Wang, Czura, Friedman, & Tracey, 2003) for a de-  
163 tailed review of the cholinergic anti-inflammatory pathway. Jarczok and colleagues (Jarczok,  
164 Koenig, Mauss, Fischer, & Thayer, 2014) demonstrated that reduced vagal function (indexed  
165 by lower heart rate variability) predicts increased levels of C-reactive protein four years later,  
166 providing *in vivo* support for this cholinergic anti-inflammatory pathway in humans. Kemp  
167 and colleagues employed modern mediation modelling on the ELSA-Brasil cohort (Kemp et  
168 al., 2016), demonstrating that vagal function lies upstream of insulin resistance and carotid-  
169 intima media thickness, an early marker of atherosclerosis, which together leads to cognitive  
170 dysfunction. Jandackova and colleagues applied cross-lagged analysis to the Whitehall Stress  
171 and Health Study cohort (Jandackova, Britton, Malik, & Steptoe, 2016) and observed that vagal  
172 function precedes development of depression over a ten-year follow-up period. These studies  
173 are part of a larger body of work summarised previously (Kemp, Arias, & Fisher, 2017; Kemp,  
174 Koenig, & Thayer, 2017; Kemp, 2018) that demonstrate how early changes in vagal function-  
175 ing may contribute to downstream changes in wellbeing. The GENIAL model (Kemp, Arias,  
176 & Fisher, 2017) further developed NIACT (Kemp, Koenig, & Thayer, 2017) by highlighting  
177 the role of social relationships along the pathways to health and wellbeing, in addition to the  
178 moderating role of health behaviours (e.g. diet, physical activity, sleep, smoking and alcohol  
179 consumption) and sociostructural factors (e.g. inequality, collective efficacy). The GENIAL  
180 model draws and builds on research which highlights: 1) the role of social identity in the devel-  
181 opment of meaning and purpose in life and its impacts on health and wellbeing (Haslam, Jetten,  
182 Postmes, & Haslam, 2008); 2) that positive social ties reduce risk of early death to a degree that  
183 is equivalent to the effects of smoking cessation (Holt-Lunstad, Smith, & Layton, 2010), and  
184 3) the impact of sociostructural factors such as inequality (Kondo et al., 2009) and collective  
185 efficacy (Bandura, 2004) on individuals’ capacity to achieve health-related goals. These ideas  
186 are further developed in the following sections.



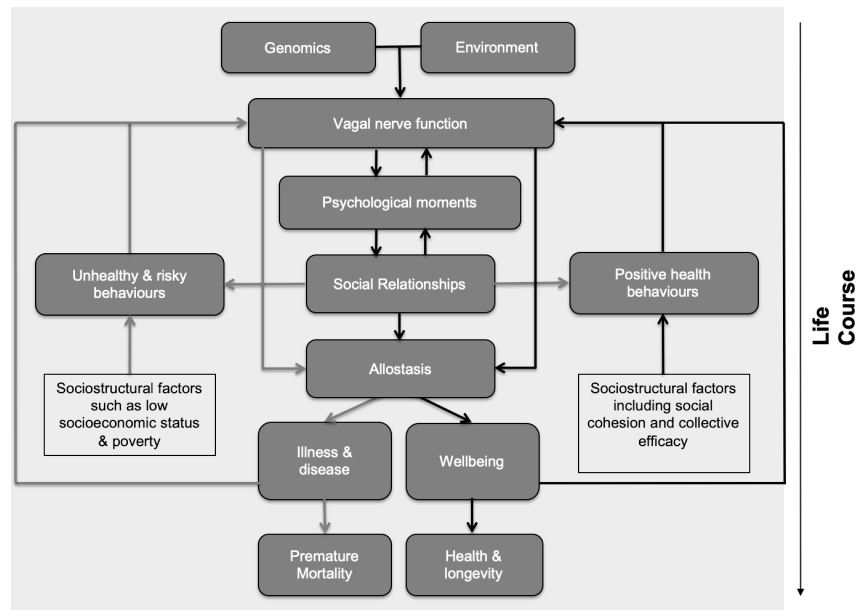


Figure 3: The original GENIAL model reprinted from (Kemp, Arias, & Fisher, 2017) with kind permission from Springer Nature. (License number: 4652451214375).

### 3

## 4 Expanding the focus of wellbeing

In this section, we emphasise a role for individual, community and environmental contributors to personal wellbeing, their overlap and impacts. Table 1 provides a summary of major theories and models in individual, social and environmental domains, which has helped to further develop our GENIAL model, as described in section 5. These models and supporting evidence are briefly described in the following sections.

### 3.1: Focus on the individual

In terms of individual factors contributing to health and wellbeing, our original GENIAL framework highlighted the critical role of positive psychological experiences as well as positive health behaviours. We use the term ‘psychological experiences’ to refer to an individual’s interpretation of life events and the temporal narrative relating to the events over one’s life course via cognitive and emotional processes. Although there is a wealth of evidence demonstrating a reciprocal relationship between health behaviours and psychological experiences, reviews on one typically do not discuss the other. There are two potential reasons for this: 1) the distinction between mind and body remains an issue of great philosophical debate, with consequences for mental and physical health, and, 2) researchers tend to work in disciplinary silos, a phenomenon reinforced by higher education, focused research areas and targeted funding initiatives. In this section we discuss both positive psychological experiences

206 and positive health behaviours, laying the foundation for improving individual wellbeing with  
207 an eye towards applying this information to improving wellbeing in people living with chronic  
208 conditions in future research.

#### 209 **4.0.1 Psychological experience**

210 Major theories relating to the wellbeing of individuals (Table 1) can be categorised according  
211 to two contrasting philosophical positions: hedonic and eudaimonic wellbeing. According to  
212 the hedonic standpoint, wellbeing is achieved by focusing on pleasurable experiences in order  
213 to enhance positive affect. A major theory is the ‘tripartite model of subjective wellbeing’,  
214 proposed by (Diener, 1984), highlighting a role for life satisfaction, decreases in negative af-  
215 fect and increases in positive affect. Another key model is the ‘broaden and build’ theory by  
216 Barbara Fredrickson (Fredrickson, 2001), which emphasises a role for positive emotions such  
217 as joy, interest, contentment, pride and love in broadening individual thought-action tenden-  
218 cies that subsequently build personal resources for individual growth, social connection and  
219 psychological resilience. Research has shown that positive emotions increase the perception of  
220 social connectedness, enhance vagal function, and facilitate the adoption of positive health be-  
221 haviours, among other factors (Kok & Fredrickson, 2010; Sin, Moskowitz, & Whooley, 2015;  
222 Kok et al., 2013). Recent longitudinal research (Petrie et al., 2018) observed that participants  
223 in a low positive affect grouping have a twofold increased risk for mortality, compared to those  
224 in the more favourable grouping over a 16.5 year follow-up period. Positive affect has been  
225 shown to affect health via inflammation, such that greater trait positive affect is associated  
226 with reduced pro-inflammatory cytokines (Stellar et al., 2015). Interested readers are also re-  
227 ferred to major reviews on this topic (Chida & Steptoe, 2008; DuBois et al., 2012; Boehm &  
228 Kubzansky, 2012). Our own work emphasises the role of vagal function over these allostatic  
229 systems (Kemp, Arias, & Fisher, 2017; Kemp, Koenig, & Thayer, 2017; Kemp, 2018; Kemp &  
230 Quintana, 2013; Kemp, 2016).

231 In contrast to a focus on hedonia, eudaimonic theories of wellbeing look beyond momentary  
232 happiness, focusing on purpose, meaning in life, and flourishing. According to this perspective,  
233 Carol Ryff’s Psychological Wellbeing theory (Ryff & Keyes, 1995; Ryff, 2014; Ryff, 1989)  
234 emphasises six elements that contribute to psychological wellbeing including self-acceptance,  
235 personal growth, purpose in life, positive relations with others, environmental mastery, and au-  
236 tonomy. As with hedonic wellbeing, psychological wellbeing has also been associated with  
237 improved health, including subjective health, chronic conditions, symptoms and functional im-  
238 pairment (Ryff, 2014). Purpose in life reduces risk of developing Alzheimer’s disease and mild  
239 cognitive impairment (Boyle, Buchman, Barnes, & Bennett, 2010) along with reducing risk  
240 of death (Boyle, Barnes, Buchman, & Bennett, 2009). Postmortem results have even revealed  
241 that - among those with high levels of brain pathology - those with greater purpose in life pre-  
242 sented with better cognitive functioning whilst they were still alive, highlighting a moderating  
243 role of purpose in life on the relationship between brain-based pathology and cognitive func-  
244 tioning (Boyle et al., 2012). A more recent study reported that a stronger sense of purpose is  
245 associated with decreased mortality (Alimujiang et al., 2019), an effect associated with a haz-  
246 ard ratio of 2.43 (95% CI, 1.57-3.75) when comparing those in the lowest life purpose category  
247 with those in the highest life purpose category.

248 However, these theoretical models - especially those focusing on hedonia - have faced criti-  
249 cism. As alluded to above, the focus on ‘happiology’ has been criticised as lacking in nuance.  
250 Positive affect alone is not sufficient for improving wellbeing and over-valuing the need to be  
251 happy can actually lead one to feel less happy (Mauss, Tamir, Anderson, & Savino, 2011),  
252 and may even be associated with the symptoms and diagnosis of unipolar depression (Ford,  
253 Shallcross, Mauss, Floerke, & Gruber, 2014) and bipolar depression (Ford, Mauss, & Gru-  
254 ber, 2015). Other writers have criticised the individualistic focus, which ignores the impact  
255 of community and wider environmental factors (Davies, 2015; Frawley, 2015; Carlisle, Hen-  
256 derson, & Hanlon, 2009). Eudaimonic theories have also attracted criticism for not recog-  
257 nising the importance of positive emotions, leading to proposals such as Seligman’s PERMA  
258 model (Seligman, 2011; Seligman, 2018), which incorporates aspects of both hedonic and  
259 eudaimonic theory. The PERMA model argues for a five-pronged model of wellbeing includ-  
260 ing positive emotions, engagement, positive relationships, meaning, and accomplishment (i.e.  
261 PERMA). According to this model, all five pillars of wellbeing contribute to flourishing in life.  
262 While theories relate to concepts of hedonia and eudaimonia as well as their combination, re-  
263 cent research has shown a large overlap between them. For instance, research by Todd Kashdan  
264 and colleagues (Disabato, Goodman, Kashdan, Short, & Jarden, 2016) reported a high latent  
265 correlation of .96 between Diener’s subjective wellbeing model of hedonia (Diener, 1984) and  
266 Ryff’s psychological wellbeing model of eudaimonia (Ryff, 1989) indicating that the discrim-  
267 inant validity of these constructs is negligible. Critically, analyses across seven geographical  
268 world regions revealed similar results. The authors however, noted three exceptions to this  
269 trend, which were ‘hope’, ‘meaning orientation’ and ‘grit’, which differentially related to he-  
270 donia and eudaimonia, giving some support to the discriminant validity of the two constructs.  
271 In another study by the same authors (Goodman, Disabato, Kashdan, & Kauffman, 2017),  
272 PERMA was observed to measure the same type of wellbeing as Diener’s model of subjective  
273 wellbeing with confirmatory factor analysis yielding a latent correlation as high as .98. The  
274 authors subsequently criticised PERMA for not offering any further insights into wellbeing be-  
275 yond the former theory of SWB. In response to this, Seligman has argued that PERMA is not  
276 “redundant” simply because different models correlate; instead, PERMA presents a model that  
277 constitutes the critical elements of wellbeing (Seligman, 2018) and one what that we draw and  
278 build on in our own applied research (see section 7).

279 Building on strong theoretical foundations and an extensive body of research, our previously  
280 published models (Kemp, Koenig, & Thayer, 2017; Kemp, Arias, & Fisher, 2017) argue that  
281 healthy vagal nerve function, underpin and are impacted on by positive psychological moments,  
282 facilitating longer-term improvements in health and wellbeing. These insights are based on a  
283 strong body of evidence. For instance, Todd Kashdan and Jonathan Rotenberg (Kashdan &  
284 Rottenberg, 2010) argued that vagal function is an index of psychological flexibility (PF) that  
285 is fundamental for psychological health. Psychological flexibility is an important component  
286 of resilience, facilitating ones capacity to assess and adapt to demands, alter mindset and be-  
287 haviour when necessary, and for commitment to behaviours that are congruent with deeply held  
288 values (Kashdan & Rottenberg, 2010). Conversely, psychological inflexibility has been asso-  
289 ciated with worsened mental health and an exacerbated stress (Masuda & Tully, 2011; Kato,  
290 2016; Chawla & Ostafin, 2007; White et al., 2013; Smeekens, Marianne, & van, 2007). An in-

291 flexible response style - characterised by withdrawal of the vagal brake - plays a key role in the  
292 development of and symptomatology of depression (Nolen-Hoeksema, Wisco, & Lyubomirsky,  
293 2008), along with explanatory inflexibility (applying the same attribution style cross different  
294 situations) and inflexible coping behaviours (Fresco, Williams, & Nugent, 2006; Moore &  
295 Fresco, 2007). According to (Kashdan & Rottenberg, 2010), vagal function underpins the ca-  
296 pacity for psychological flexibility. Intriguingly, Bethany Kok and Barbara Fredrickson (Kok  
297 & Fredrickson, 2010; Kok et al., 2013) demonstrated that change in vagal function - following  
298 training in loving kindness meditation - is associated with increases in positive emotions and  
299 enhanced perception of social connectedness, suggesting that positive emotions facilitate phys-  
300 ical health via the vagus nerve. The link between individual and community is a topic that we  
301 turn to following our discussion of positive health behaviours.

## 302 **4.0.2 Health behaviours**

303 Whilst health behaviours are typically thought of with respect to their impact on physical health,  
304 there is now compelling evidence that health behaviours impact on both physical and mental  
305 health. Accordingly, and in contrast to many other models of wellbeing (Ryff, 1989; Diener,  
306 1984; Seligman, 2011), we have proposed a key role for health behaviours in facilitating indi-  
307 vidual pathways to health, wellbeing and longevity (Kemp, Arias, & Fisher, 2017). Moreover,  
308 we propose the vagal nerve acts as the structural link between physical and mental health and  
309 plays a critical role in reciprocal relationship between positive health behaviours, and physical  
310 and mental health. In this section, we present some key studies highlighting the importance  
311 of health behaviours in physical and mental health outcomes. An exhaustive review is beyond  
312 the scope of this paper however, and interested readers are referred to (Kemp, Arias, & Fisher,  
313 2017). Given the number of health behaviours, for brevity, we focus specifically on physical  
314 activity, diet and sleep.

### 315 *Impact of health behaviours on physical health:*

316 A summary of public health guidelines and associated evidence-base relating to physical activ-  
317 ity, diet and sleep is provided in Table 2.

318 Research on over 20,000 participants analysed the impact of key positive health behaviours  
319 on mortality risk - non-smoking, physical activity, consumption of less than 14 units of alco-  
320 hol per week and a diet rich in fruit and vegetables. Participants who adopted all four health  
321 behaviours at baseline had a mortality risk that was equivalent to being 14-years younger at  
322 follow-up (average of 11-years later), compared to those who adopted none of the positive  
323 health behaviours (Khaw et al., 2008). A more recent study focused on six health behaviours:  
324 non-smoking, physical activity, healthy diet, sleeping seven to eight hours a night, inactivity  
325 less than eight hours a day, and daily social contact (Martínez-Gómez et al., 2013). Results  
326 again highlighted a mortality risk that was equivalent to being 14-years younger for those who  
327 adopted these behaviours relative to those who adopted none of them. Wen et al. (2011) conduc-  
328 ted a prospective cohort study with over 400,000 individuals between 1996-2008. Surprisingly,

329 even those individuals in a low physical activity group (average of 15 mins a day or 92 mins per  
330 week) had a 14% reduced risk of all-cause mortality. Moreover, every additional 15 minutes of  
331 daily exercise beyond this minimum amount, reduced all-cause mortality by further 4%. The  
332 authors argued that less exercise is easier to achieve for those who do not engage in any phy-  
333 sical activity at all, and yet it may still be sufficient to achieve health benefits. Moreover, [Lee,  
334 Pate, Lavie, Sui, Church, and Blair \(2014\)](#) concluded that running 5-10 minutes a day at slow  
335 speeds (less than 6mph) is even associated with reduced all-cause risk of mortality, providing  
336 further evidence that exercising below current minimum guidelines is sufficient for mortality  
337 benefit. Once a routine is established individuals may then be able to be motivated to exercise  
338 at higher levels.

339 The relationship between diet and physical health has been widely reported in the literature. For  
340 example, the vegetarian diet has been associated with a reduced risk for disease development,  
341 including coronary heart disease and type 2 diabetes, compared with a diet containing red and  
342 processed meat ([McEvoy, Temple, and Woodside, 2012](#)). Insufficient fibre has been associated  
343 with colon cancer, high blood cholesterol, diabetes, coronary heart disease and obesity ([Jef-  
344 ferson and Cowbrough, 2005](#)). Diet is also associated with all-cause mortality, with one study  
345 reporting findings based on a sample of 2000 individuals, finding that those adhering to a Medi-  
346 terranean diet had an all-cause mortality risk that was 34% lower than those who did not adhere  
347 to the diet ([Limongi et al., 2017](#)). ([Watson et al., 2015](#)) concluded that 7 hours or more sleep  
348 per night produces optimal health in adults. Sleeping less than 7 hours a night is associated with  
349 obesity diabetes, hypertension, heart disease, stroke, depression and increased mortality. Mo-  
350 reover, a recent prospective twin study ([Åkerstedt 2017](#)) found that both short (defined as <6.5  
351 hours) and long (defined as [?]9.5 hours) sleep were linked to increased mortality. However, it  
352 is important to note that these statistics are generalisations and that other research has shown  
353 that small groups of people are able to function healthily on shorter periods of sleep ([Pellegri-  
354 no et al., 2014; He et al., 2009](#)).

355

356 *Impact of health behaviours on physical and mental health:* Focusing on health behaviours  
357 - including exercise, diet and sleep - typically involves consideration of one's physical health,  
358 however there is now convincing evidence that demonstrates the impact of positive health be-  
359 haviours on mental wellbeing, supporting declarations that there is 'no health without mental  
360 health' ([Prince et al., 2007](#)). In a study which included over 4,500 adolescents, health be-  
361 haviours were measured across several domains; diet, specifically consumption of carbonated  
362 soft drinks and fast food, tobacco use and physical activity. Participants were then allocated a  
363 number ranging from zero to "four or more" depending on the number of unhealthy behaviours  
364 they engaged in ([Rao et al., 2015](#)). Results highlighted that participants with a score of four  
365 or more were significantly more likely to be anxious, experience suicidal ideation and have  
366 been involved in a physical fight, compared to those who scored zero. Analysis of over 2,400  
367 Chinese college students found those who frequently consumed alcohol, had disturbed sleep,  
368 poor dietary behaviour and internet addiction disorder. This was associated with significant  
369 increased risk of depression and anxiety ([Ye et al., 2016](#)).

370 With respects to physical activity and mental health, research on a sample of 49 unique prospec-

371 tive studies (N=266,939), showed that physical activity protected against depression, irrespec-  
372 tive of age and geographic region (Schuch et al., 2018). In a cross-sectional study of more  
373 than 1 million individuals in the U.S. (Chekroud et al., 2018), exercisers displayed 43% fewer  
374 days of poor mental health than non-exercisers. The authors further reported that all exercise  
375 types were associated with a lower mental health burden (from 11.8% to 22.3% reduction),  
376 and the activities identified with the largest associations included popular team sports (22.3%  
377 lower), cycling (21.6% lower), and aerobic and gym activities (20.1% lower). Exercise dura-  
378 tion of 45 minutes and frequencies of three to five times per week were associated with the  
379 lowest mental health burden.

380 With respects to diet and mental health, combined data from four longitudinal studies found  
381 a risk estimate of highest vs. lowest adherence to the Mediterranean diet of 0.67 (95% CI  
382 0.55-.82) for incident depression (Lassale et al., 2018). The Mediterranean diet has also been  
383 implicated in slowing age-related deterioration, including improvements in cognitive function  
384 and reducing risk of cognitive impairment and dementia (Petersson 2016, Aridi 2017), with  
385 B-vitamins and antioxidants playing a key role (Moore et al., 2018; Castelli et al., 2018). Sev-  
386 eral randomised controlled studies, showed that a modified version of the Mediterranean diet  
387 reduced depression symptomology (Parletta et al., 2017) and (Opie, O'Neil, Jacka, Pizzinga,  
388 & Itsiopoulos, 2017). Based on the evidence, dietary recommendations for the prevention of  
389 depression have been proposed; adopting "traditional" diets, such as the Mediterranean diet,  
390 increasing consumption of fruits, vegetables, legumes, wholegrain cereals, nuts, seeds, foods  
391 rich in omega-3 polyunsaturated fatty acids and limit consumption of processed foods (Opie et  
392 al., 2017). We note here that socio-structural factors (e.g. inequality and poverty) will impact  
393 on individuals capacity to follow such advice (Darnton-Hill, Nishida, & James, 2004).

394

395 With regards to sleep, a systematic review and meta-analysis of 14 studies found sleep distur-  
396 bances significantly predicted the risk of suicidal ideation; an effect not moderated by depres-  
397 sion (Liu et al., 2019). Poor sleep is also associated with common mental disorders, while im-  
398 proving sleep in these patients can lead to mental health improvements (Freeman et al., 2017).  
399 Analyses on nearly 100,000 adolescents in Japan found a U-shaped association between men-  
400 tal health status and sleep duration (Kaneita et al., 2007). The authors also reported a positive  
401 correlation between mental health status and subjective sleep assessment. Similarly, among an  
402 elderly population, sleep problems were associated with worsened mental and physical health-  
403 related quality of life (Reid et al., 2006).

404 Critically, each of these health behaviours - physical activity, diet and sleep - have a pow-  
405 erful impact on vagal function (Kemp, Koenig, & Thayer, 2017). Thus, improving positive  
406 health behaviours is a powerful means to promote health and wellbeing. As with physical  
407 activity (Sandercock, Bromley, & Brodie, 2005; Raffin et al., 2019) and diet (Young & Ben-  
408 ton, 2018), changes in sleep are associated with changes in vagal function, such that reduced  
409 vagal function (combined baseline and reactivity measures) is associated with sleep disrup-  
410 tion (El-Sheikh, Erath, and Bagley, 2013). Intriguingly, increases in resting state vagal func-  
411 tion have been shown to predict better subjective and objective sleep quality (Werner et al.,  
412 2015; Grimaldi et al., 2016). By contrast, reduced heart rate variability (HRV) - an index of

413 vagal functioning - has also been detected during early stages of sleep-related breathing disor-  
414 ders (Aeschbacher et al., 2016).

415

416 In summary, we highlight a role for positive psychological experience and positive health be-  
417 haviours in facilitating individual pathways to health and wellbeing. We argue that this effect is  
418 moderated by vagal function which triggers a cascade of downstream physiological processes  
419 (Kemp et al, 2017). Accordingly, in order to facilitate pathways to health and wellbeing, inter-  
420 ventions should be considered that both enhance psychological experiences and positive health  
421 behaviours. Nonetheless, individual factors are not the only determinants of health and wellbe-  
422 ing and so in the next section we explore community or societal determinants. Before doing so  
423 however, it is instructive to point out the importance of building individual wellbeing in order  
424 to achieve community and environmental wellbeing. For instance, it has been argued that com-  
425 munity resilience is underpinned by the individuals within it. This work highlighted the role  
426 of a positive outlook and individual strengths, which underpin a community's capacity for re-  
427 siliance and agency (Berkes & Ross, 2013). A greater appreciation of the interconnectedness  
428 between individuals, and the communities and environment in which they reside is important  
429 for considerations relating to how we might improve the wellbeing of current and future gener-  
430 ations.

#### 431 **4.1 Focus on Community**

432 In this section we focus on the relevance of community to individual wellbeing, a major focus  
433 of our original GENIAL model (Kemp, Arias, & Fisher, 2017). Unfortunately, there is much  
434 evidence to suggest that community is deteriorating (Kushlev, Proulx, & Dunn, 2017; Twenge,  
435 2013; Twenge, 2014; Putnam, 2001). The reasons for this are complicated, but may involve  
436 a host of interconnected societal issues including generational shifts in narcissism (Twenge,  
437 2013; Twenge, 2014), declines in perspective taking and empathic concern (Konrath, O'Brien,  
438 & Hsing, 2010), increasing individualism (versus collectivism) in western society (Heu, van  
439 Zomeren, & Hansen, 2018; Brewer & Chen, 2007), and inequalities (Scheffer, van Bavel, van  
440 de Leemput, & van Nes, 2017; Scheidel, 2017; *The Spirit Level: Why Equality is Better for  
441 Everyone*, 2010; Nolan & Valenzuela, 2019). It is worth noting here that others (Beery, Jöns-  
442 son, & Elmberg, 2015; Nurse, Basher, Bone, & Bird, 2010) have argued that the boundaries of  
443 'community' should be extended to the environment (section 4.2) including soil, water, plants  
444 and animals (to facilitate love and respect, and a commitment to environmental sustainability).  
445 Considering the climate crisis as issue we turn to in section 4.2, it is apparent that 'community'  
446 in its broadest sense is under threat.

447 Although we would not describe ourselves as luddites, it is worth noting that despite tech-  
448 nological advancements and online connectedness, the use and engagement of social media -  
449 including Facebook, Twitter and WhatsApp - is negatively associated with eudaimonic wellbe-  
450 ing (as defined by the extent to which respondents felt their life to be worthwhile) ("*Subjective  
451 Well-being and Social Media Use in Emerging Adulthood: Findings from two UK Univer-  
452 sity Millennial Cohorts.*", 2019). Interestingly, decreases in sleep quality and self-esteem were

453 also observed (“Subjective Well-being and Social Media Use in Emerging Adulthood: Findings  
454 from two UK University Millennial Cohorts.”, 2019). Young adults are increasingly connected,  
455 however their online activities are adversely affecting their wellbeing: these findings were as-  
456 sociated with a medium effect size (observed correlations for two cohorts,  $r=-.32$  and  $r=-.29$ ).  
457 In fact, research has demonstrated that use of Facebook is associated with ill-being such that  
458 “links clicked” or “status updates” are associated with a decrease of 5% to 8% of a standard  
459 deviation in self-reported mental health (Shakya & Christakis, 2017). Importantly, this longitu-  
460 dinal research demonstrated that while those with compromised wellbeing may be more likely  
461 to use Facebook, use of the Facebook platform is associated with reduced *future wellbeing*,  
462 even when controlling for initial wellbeing. Research by the same authors has also shown that  
463 loneliness occurs in clusters, extends up to three degrees of separation and may spread through  
464 a contagious process (Cacioppo, Fowler, & Christakis, 2008), a finding leading to social con-  
465 tagion theory (Christakis & Fowler, 2012). On this background and in light of the ‘The Great  
466 Hack’ it is clear that social media companies have much to learn about promoting wellbeing  
467 and social cohesion as well as the ethical management of their platforms.

468 Critically, loneliness has important impacts on health and wellbeing. A meta-analysis of studies  
469 on more than 300,000 participants reported that a lack of social ties are associated with a  
470 50% increased risk of premature mortality over a 7.5 year follow-up period, an effect that  
471 was stronger than physical activity, smoking (15 cigarettes daily) and body mass index (Holt-  
472 Lunstad, Smith, & Layton, 2010). In a more recent study on 48,673 participants, the same  
473 researchers (Holt-Lunstad, Smith, Baker, Harris, & Stephenson, 2015) observed that social  
474 isolation (29%), loneliness (26%), and living alone (32%) increase risk for premature mortality,  
475 reporting no differences for objective and subjective measures. Furthermore, greater impacts  
476 on mortality were observed among those under the age of 65 years. The Japanese even have  
477 a word to describe “lonely death”: ‘kodokushi’, a phenomenon that refers to people dying  
478 without friends or family. Sometimes these individuals are not found for many weeks... or  
479 months. (“Dead people don’t pay their bills”). Tragically, these experiences characterise the  
480 modern world, and especially individualistic cultures.

481 Social isolation and loneliness impact on a host of behavioural, psychological and physio-  
482 logical factors. Behavioural factors include physical inactivity and smoking (Shankar, Mc-  
483 Munn, Banks, & Steptoe, 2011), substance use and hazardous drinking (Stickley, Koyanagi,  
484 Koposov, Schwab-Stone, & Ruchkin, 2014), while psychological factors include decreases in  
485 self-esteem, increased risk of depression, and feelings of hopelessness (Steptoe, Owen, Kunz-  
486 Ebrecht, & Brydon, 2004), both of which subsequently contribute to dysregulation of cardio-  
487 vascular, metabolic, and neuroendocrine processes (Grant, Hamer, & Steptoe, 2009), higher  
488 systolic blood pressure, independent of several factors such as age, gender, cardiovascular risk  
489 factors, medications, social support and perceived stress (Hawkley, Thisted, Masi, & Cacioppo,  
490 2010). The NIACT (Kemp, Koenig, & Thayer, 2017) and GENIAL (Kemp, Arias, & Fisher,  
491 2017) models integrate these behavioural, psychological and physiological factors into innova-  
492 tive frameworks within which pathways to health and ill-health may be understood, bridging  
493 the gap between psychological moments and mortality.



494 Further to our original GENIAL model (Kemp, Arias, & Fisher, 2017), the relationship be-  
495 tween social ties and health was recently comprehensively reviewed in a book titled ‘The New  
496 Psychology of Health: Unlocking the Social Cure’ (Haslam, 2018). Social identity theory  
497 helped to contextualise this research which refers to people conforming to the norms of the  
498 group to which they identify. Actions and thoughts of the group become the reference point for  
499 the individual, thus, if an individual’s perception of others in a representative group is positive,  
500 individuals of that group will think and behave similarly. Peer modelling has proven to be an  
501 effective intervention to increase fruit and vegetable intake (Horne et al., 2008), although only  
502 when modelled by someone that shares the same group identity (Cruwys et al., 2012). By con-  
503 trast, if an individual was to identify with a group whose health behaviours are risky, they are  
504 more likely to participate in negative health behaviours. Research has shown there is a relation-  
505 ship between strength of group identification and smoking status when smoking is a normal  
506 group behaviour (Schoffield, Pattison, Hill, & Borland, 2001). Intriguingly, the more group  
507 identities an individual has, the less likely they are to engage in negative health behaviours,  
508 such as cigarette smoking, alcohol consumption, and use of illicit drugs (Miller, Wakefield, &  
509 Sani, 2016).

510 Social identity theory provides a useful context within which to understand the influence of  
511 community on the health and wellbeing of the individual. For example, social identity provides  
512 meaning, purpose and worth to an individuals life (de Vroome & Hooghe, 2013; Nakamura,  
513 2013; Peterson, Park, & Seligman, 2005), the importance of which was highlighted above in  
514 our discussion of positive psychological experiences. Social identities also facilitate the extent  
515 to which others are likely to provide social support (Cohen, 2004; Levine, Cassidy, Brazier, &  
516 Reicher, 2002; Levine, Prosser, Evans, & Reicher, 2005; Platow et al., 2006), and provide a  
517 sense of efficacy, agency and power to an individual, contributing to the sense that ‘the whole is  
518 greater than the sum of its parts’ (Haslam, Jetten, Cruwys, Dingle, & Haslam, 2018). Strikingly,  
519 research has demonstrated that cardiac and respiratory patterns synchronise when members of a  
520 choir sing in unison, compared to when singing independently (Timmons, Margolin, & Saxbe,  
521 2015). This phenomenon of ‘physiological linkage’ may help to explain relationship connect-  
522 edness (Timmons, Margolin, & Saxbe, 2015) and the vagus nerve underpins ones capacity for  
523 connecting with others, regulating downstream allostatic systems that are also involved (e.g.  
524 the hypothalamic-pituitary-adrenal axis) (Porges, 2011; Kemp, Arias, & Fisher, 2017; Kemp,  
525 Koenig, & Thayer, 2017).

526 To conclude, community is important for individual health and wellbeing as it provides the en-  
527 vironment in which individual health and wellbeing may be achieved. A supportive community  
528 will therefore contribute to the health and wellbeing of individuals within that community, and  
529 this relationship will be a bidirectional one such that improved health and wellbeing of the indi-  
530 vidual will help to foster community wellbeing. It is helpful to consider the inter-connectedness  
531 of individual, community and environmental wellbeing, consistent with social ecological the-  
532 ory. In this regard, research not only highlights the importance of eating less meat for individ-  
533 ual health and wellbeing (Pan et al., 2011), (Micha, Wallace, & Mozaffarian, 2010), (Demeyer,  
534 Mertens, De, & Ulens, 2016), it also highlights the impacts of eating less meat to reduce ad-  
535 verse impacts on the environment (Poore & Nemecek, 2018), reinforcing this concept of the  
536 ‘symbioment’ (Fig 2) which emphasises symbiotic coexistence of all life at various scales. It

537 is perhaps prudent to note however, that although these findings (Poore & Nemecek, 2018) led  
538 to much fanfare in the media on the need to ‘go vegan’ (“Avoiding meat and dairy is ‘single  
539 biggest way’ to reduce your impact on Earth”, n.d.), other research (Peters et al., 2016) re-  
540 ports on findings from modelling that shows that the diets with low to modest amounts of meat  
541 (the ‘omnivore diet’) actually outperform a vegan diet in regards to the “carrying capacity” of  
542 an agricultural land base. The authors noted that the carrying capacity of the vegan diet fell  
543 between the 60% and 40% omnivore diet options, which reflect the percentage of vegetarian  
544 food consumed. These findings highlight - as always - that one should always be mindful of  
545 evidence-based nuance. Finally, and in closing this section, we would like to highlight the  
546 relationship between individuals and community. For instance, among Western cultures, posi-  
547 tive feelings are associated with individual success, high self-esteem, and good health (Heine,  
548 Lehman, Markus, & Kitayama, 1999; Kitayama, Markus, & Kurokawa, 2000; Taylor & Brown,  
549 1988). In Japan however, individuals are more likely to associate happiness with negative social  
550 consequences, such as jealousy and disharmony among relationships (Uchida, Norasakkunkit,  
551 & Kitayama, 2004). We now turn our attention to the wider environment in which individu-  
552 als live and work, focusing on a major societal challenge to human health and wellbeing: the  
553 climate crisis.

## 554 4.2 Focus on the Environment

555 Psychological science has been criticised for a blinkered focus on the individual while ignoring  
556 wider, systemic issues (Carlisle, Henderson, & Hanlon, 2009; Frawley, 2015). Critics  
557 have argued that the construct of wellbeing is a socio-cultural construction of western indi-  
558 vidualism that places importance on wealth, fame and materialistic pursuits, while neglecting  
559 neglecting our shared environment (Carlisle, Henderson, & Hanlon, 2009). These criticisms in  
560 combination with an ever-increasing body of peer-reviewed literature on ‘happiness’ and ‘well-  
561 being’ were, in part, reason for proposing our original GENIAL framework (Kemp, Arias, &  
562 Fisher, 2017), which extended theoretical frameworks of individual wellbeing to community  
563 wellbeing. Here we focus on the contributions from the wider environment to individual well-  
564 being, and on the implications for tackling the greatest societal challenge facing mankind: the  
565 climate. We use the term ‘environment’ in a very general sense in this paper, encompassing  
566 natural as well as human-built environments, although we place emphasis on the relationship  
567 between individual wellbeing and the natural environment given the sheer scale of the challenge  
568 associated with the climate crisis.

569 It is now accepted in scientific circles (Intergovernmental Panel on Climate Change, 2007; In-  
570 tergovernmental Panel on Climate Change, 2014) that humanity will face catastrophic climate  
571 change should we fail to commit to climate action. An increase in the frequency, duration and  
572 intensity of extreme weather events increases risk of population distress and psychiatric disor-  
573 ders through disruption to food supply and damage to community wellbeing (Berry, Bowen,  
574 & Kjellstrom, 2009; Hayes, Blashki, Wiseman, Burke, & Reifels, 2018). Extreme weather  
575 events have even been shown to influence the future health and wellbeing of an unborn child  
576 with implications for brain development and metabolic outcomes (Dancause et al., 2015; Du-  
577 foix et al., 2015). Other research has also shown that climate change has increased global

578 economic inequality by ~25% over the last 50 years, with wealthy countries benefiting dispro-  
579 portionally (Diffenbaugh & Burke, 2019). Rising inequality has been linked to the middle-class  
580 squeeze, intergenerational immobility, erosion of trust, more divided societies, rising populism,  
581 poverty, crime, ill-health and ill-being. Interested readers are referred to the excellent recent  
582 review by Brian Nolan and Luis Alenzuela in this regard (Nolan & Valenzuela, 2019). Crit-  
583 ically, ratings of peer-reviewed climate-science and self-ratings by climate change scientists  
584 themselves has indicated that there is 97% endorsement that humans are contributing to the  
585 warming climate (i.e. anthropogenic climate change) (Cook et al., 2013; Cook et al., 2016).  
586 Unfortunately, this finding remains under appreciated in a brave new world of alternative facts  
587 and disinformation (Lewandowsky, Oberauer, & Gignac, 2013; Lewandowsky, Ecker, & Cook,  
588 2017).

589 Human beings have a strong, innate affiliation with the biological world, a phenomenon cap-  
590 tured by the ‘biophilia hypothesis’. Recent research indicates that people who spend at least  
591 two hours a week in nature are more likely to report good health and high levels of wellbeing  
592 than those who spend no time in nature (White et al., 2019). Furthermore, these findings were  
593 consistent across a variety of demographic variables including sex, age-group, occupational  
594 social grade, presence of chronic illness and whether or not individuals met physical activity  
595 guidelines. Prior research had indicated that spending time in nature over a two-week period  
596 boosts hedonic as well as eudaimonic wellbeing (Howell, 2014), and that effect sizes are larger  
597 (*ds* from .37 to .63) than those reported for other positive psychology interventions (*ds* from .20  
598 to .34) (Bolier et al., 2013). Exposure to nature can lead to transcendent emotions (Bethelmy  
599 & Corraliza, 2019), peak experience (Maslow, 1964) and psychological flow (Csikszentmihalyi,  
600 2014). Interestingly, transcendent emotions - including compassion, gratitude and awe -  
601 foster healthy social relationships (Stellar et al., 2017) and such relationships are facilitated  
602 by spending time in nature (Mayer, Frantz, Bruehlman-Senecal, & Dolliver, 2008; Richardson,  
603 Cormack, McRobert, & Underhill, 2016), further highlighting the inter-connectedness between  
604 individual, community and environmental domains. Research also reports that exposure to na-  
605 ture is associated with stress reduction (Hansmann, Hug, & Seeland, 2007; Ulrich et al., 1991),  
606 feelings of restoration (White, Pahl, Ashbullby, Herbert, & Depledge, 2013; Wyles et al., 2017),  
607 subjective wellbeing (Johansson, Hartig, & Staats, 2011; LUCK, DAVIDSON, BOXALL, &  
608 SMALLBONE, 2011; White, Pahl, Wheeler, Depledge, & Fleming, 2017), and improved cog-  
609 nitive functioning (Berman, Jonides, & Kaplan, 2008; Berto, 2005). Human beings also have  
610 a strong affiliation with the local environment (‘place’), driven by cultural experience (Beery,  
611 Jönsson, & Elmberg, 2015; Sampson, 2012). This is known as the ‘topophilia hypothesis’; the  
612 word topophilia combines *topos* (place) with *philia* (love). These biophilia and topophilia hy-  
613 potheses provide a foundation on which to understand the distress, pain or sickness associated  
614 with environmental degradation of home or territory. Glenn (Albrecht, 2019), an Australian  
615 environmental philosopher coined the term ‘solastalgia’ after reflecting on the environmental  
616 impacts of open cut coal mining and pollution of local power stations on the residents of the  
617 Upper Hunter Region of NSW in Australia. He wrote that ‘solastalgia’ reflects a:

618 | “specific form of melancholia connected to a lack of solace and intense deso-  
619 | lation” associated with place-based distress (Albrecht, 2005).

619 Feelings of guilt, shame, fear, emotional discomfort and solastalgia have been associated with

620 motivation to engage in environmental sustainability behaviours (Albrecht et al., 2007; Dick-  
621 erson, Thibodeau, Aronson, & Miller, 1992; Kaiser, Schultz, Berenguer, Corral-Verdugo, &  
622 Tankha, 2008; Malott, 2010). In order to encourage such behaviours, scholars have proposed  
623 an ‘aesthetics of elsewhere’, which involves encouraging a double aesthetic judgment of ‘here’  
624 and ‘elsewhere’ to induce an aesthetic melancholia to influence consumption decisions (Maskit,  
625 2011). However, researchers have also begun to investigate the value of positive psychology in  
626 encouraging pro-environmental behaviours. Positive psychology refers to the scientific study  
627 of human flourishing and an applied approach to enabling individuals, communities and or-  
628 ganisations to thrive (Gable & Haidt, 2005), (Sheldon & King, 2001). The positive psychol-  
629 ogy of sustainability (Corral-Verdugo, Tapia-Fonllem, & Ortiz-Valdez, 2014; Verdugo, 2012;  
630 O’Brien, 2016) is a strategy that may help to foster what has been described as sustainable  
631 wellbeing (Kjell, 2011). In a study on 606 undergraduate students in Mexico (“Happiness  
632 as Correlate of Sustainable Behavior”, 2011), researchers reported that pro-ecological, altru-  
633 istic, frugal and equitable behaviours reflect the sustainably-oriented person, and that these  
634 behaviours have positive psychological consequences (i.e. greater happiness). A major goal  
635 of positive psychology should now be focused on developing interventions that promote pro-  
636 environmental behaviours, an effort that would have substantial benefits for the wellbeing of  
637 current and future of generations as well as the environment. In this regard, prior research  
638 has shown that individuals engaging in pro-ecological behaviours – such as resource conser-  
639 vation – report greater happiness (Brown & Kasser, 2005), that altruism leads to greater long-  
640 term happiness (*The psychology of helping and altruism: Problems and puzzles*, 1995), and  
641 that frugality predicts greater psychological wellbeing, satisfaction and motivation (Brown &  
642 Kasser, 2005). Notably however, equitable individuals have been reported to be less happy  
643 due to the ‘negative hedonic impact of inequality in society’ as climate change exacerbates  
644 existing inequities (Hayes, Blashki, Wiseman, Burke, & Reifels, 2018), highlighting a need  
645 for sociostructural reforms that combat various types of inequality. Importantly, (Nolan &  
646 Valenzuela, 2019) concluded that we now have a window of opportunity for designing and  
647 implementing sociostructural changes through strategies and policies to halt and reverse rising  
648 income and wealth inequality.

649 The grave threat of anthropogenic climate change - referring to the production of greenhouse  
650 gases emitted by human activity - may help to inspire a variety of positive feelings such as  
651 altruism, compassion, optimism as well as a sense of purpose “as people band together to sal-  
652 vage, rebuild, and console amongst the chaos and loss of a changing climate” (Hayes, Blashki,  
653 Wiseman, Burke, & Reifels, 2018), feelings that reflect ‘active hope’ (Macy J, 2012). The  
654 concept of ‘sustainable happiness’ (O’Brien, 2016) has been defined as “happiness that con-  
655 tributes to individual, community, and/or global well-being without exploiting other people, the  
656 environment, or future generations”(O’Brien, 2010).

657 A central concept within the field of Positive Psychology is that of ‘character strengths’. In their  
658 book ‘Character strengths and virtues: A handbook and classification’, (*Character strengths  
659 and virtues: A hand-book and classification*, 2004) describes a framework for the identification  
660 of individual cognitive, emotional, social and community strengths, protective strengths, and  
661 spiritual strengths. In total (*Character strengths and virtues: A hand-book and classification*,  
662 2004) describe 24 character strengths which individuals possess to more or less of a degree. A

663 structural model of the relationships between character strengths, virtues and sustainable be-  
664 haviours (i.e. altruistic, frugal, equitable and pro-ecological behaviours) has been presented  
665 such that all 24 character strengths are associated with all four sustainable behaviours (Corral-  
666 Verdugo & Frías-Armenta, 2015). The knowledge that pro-environmental behaviours provide  
667 opportunities to promote happiness and build resources for resilience, in addition to much-  
668 needed environmental benefits provides a useful foundation on which psychological scientists  
669 could address environmental challenges through targeted interventions focusing on the individ-  
670 ual (Clayton et al., 2016; “Happiness as Correlate of Sustainable Behavior”, 2011; Verdugo,  
671 2012). Recommendations included the need for psychological scientists to incorporate a con-  
672 textualised or ‘place-based’ approach - including aspects of the built environment and different  
673 cultures - into initiatives designed to facilitate pro-environmental behaviours and to engage in  
674 more interdisciplinary research.

675 Unfortunately, the vast majority of people do not engage in pro-environmental behaviours, a  
676 result of helplessness and low self-efficacy (Salomon, Preston, & Tannenbaum, 2017). The  
677 difficulty in comprehending problems associated with climate change, and the intangibility and  
678 invisibility of such change may lead individuals to ‘sit on their hands and do nothing’, a phe-  
679 nomenon known as ‘Giddens Paradox’ (Giddens, 2009). Recent qualitative research (“Learning  
680 from Co-Founders of Grassroots Initiatives: Personal Resilience, Transition, and Behavioral  
681 Change – a Salutogenic Approach”, 2017) has investigated the psychological processes that  
682 foster pro-environmental behaviours. Findings were interpreted in the context of ‘salutogen-  
683 esis’ (Antonovsky, 1996), which emphasises a role for a ‘sense of coherence’ for managing  
684 and overcoming stress. This ‘sense of coherence’ reflect feelings of confidence that stimuli in  
685 the (internal and external) environment are comprehensible, manageable and meaningful. The  
686 researchers reported that grassroots activists relied on values and attitudes, emphasising that  
687 the problems are so vast that limits are imposed on knowledge (i.e. comprehensibility), arguing  
688 that emotions are a key mediator between the appraisal of a situation and motivation to take ac-  
689 tion. A sense of personal responsibility for change was associated with an improved perceived  
690 quality of life, attributable to empowerment and social cohesion, which provides a sense of  
691 meaning and purpose in life. Concrete and collective action was also observed to enhance pos-  
692 itive emotions and mastery experiences subsequently enhancing beliefs about self-efficacy (i.e.  
693 manageability) (“Learning from Co-Founders of Grassroots Initiatives: Personal Resilience,  
694 Transition, and Behavioral Change – a Salutogenic Approach”, 2017).

695 In summary, we have observed emerging research interest in the concepts of sustainable hap-  
696 piness and wellbeing, directly linking positive psychology to concepts relating to sustainability  
697 and pro-environmental behaviours. Although much work remains to be done, these efforts  
698 serve to combat criticisms of psychological science relating to a blinkered focus on personal  
699 happiness that ignores important societal challenges. Spending time in and caring for for the  
700 natural environment may also provide an under-appreciated means to promote wellbeing that is  
701 over and above the beneficial impacts of outdoor physical activity (Franco, Shanahan, & Fuller,  
702 2017; Capaldi, Passmore, Nisbet, Zelenski, & Dopko, 2015; Bowler, Buyung-Ali, Knight, &  
703 Pullin, 2010) and may even promote commitment to pro-environmental behaviours, supporting  
704 efforts to combat the climate crisis.

## 5 The Updated GENIAL model: GENIAL 2.0

”Models, of course, are never true, but fortunately it is only necessary that they be useful”.

– George Box, 1979, *Journal of the American Statistical Association*, 74:365, 1-4

The GENIAL framework illustrates common pathways to ill-health and ill-being versus health and wellbeing. The evidence-base for these pathways - including a key regulatory role for vagal function - have been described previously (Kemp, Arias, & Fisher, 2017; Kemp, Koenig, & Thayer, 2017; Kemp, 2018). While our original GENIAL model highlighted the importance of positive social ties for individual health and wellbeing (Kemp, Arias, & Fisher, 2017), our updated model (see Fig 4) provides an important update to our original GENIAL model, emphasising individual, community and environmental contributors to personal wellbeing. In doing so, our model characterises the relationships between individuals, communities and their environments, as well as the impacts of sociostructural factors (e.g. inequality) and their impact on the health and wellbeing of the individual. Key features of the individual, community and environmental domains are now briefly described with a particular focus on vagal function.

Our original GENIAL and NIACT models suggest that enhancing positive psychological experiences and positive health behaviours can facilitate individual pathways to health and wellbeing (Kemp, Arias, & Fisher, 2017; Kemp, Koenig, & Thayer, 2017). In terms of enhancing psychological experiences, broadly speaking, there have been two approaches; the reduction of impairment or the promotion of wellbeing. Historically psychological interventions have typically been weighted towards interventions that seek to reduce impairment (Ryff & Singer, 1996). This approach assumes that health and wellbeing are synonymous with the absence of illness, as opposed to the presence of wellness. However, (Ryff & Singer, 1996) suggest that the ‘absence of wellbeing’ facilitates pathways to ill-health and ill-being, and they argue that the route to recovery will not come from only attempting to ameliorate negative symptoms associated with ill-health. We also advocate interventions that create a platform for the experience of ‘positive psychological experiences’ because environments that promote positive emotions may help people learn to better short circuit downward spirals to illness. In this regard, interventions from the field of Positive Psychology have much to offer. Meta-analyses have demonstrated that positive psychological interventions (PPIs) are effective for people with or without diagnosed disorders (Bolier et al., 2013; Hendriks, Schotanus-Dijkstra, Hassankhan, de Jong, & Bohlmeijer, 2019; Chakhssi, Kraiss, Sommers-Spijkerman, & Bohlmeijer, 2018; Sin & Lyubomirsky, 2009; White, Uttl, & Holder, 2019), with effect sizes ranging from small to large. Meta-analyses have further demonstrated the effectiveness of specific positive psychological interventions (PPIs) on increasing SWB, PWB, optimism, positive affect and life satisfaction, including the practicing of gratitude (Davis et al., 2016), the ‘best possible self’ intervention (Malouff & Schutte, 2016), savouring positive emotions (Smith, Harrison, Kurtz, & Bryant, 2014), mindfulness-based interventions (Simpson et al., 2019), and performing acts of kindness (Curry et al., 2018). The three main models of wellbeing (Seligman, 2018; Diener, 1984; Ryff & Keyes, 1995) provide a theoretical foundation for developing new and novel interventions for enhancing positive psychological experience. Importantly, research demon-

744 strates that despite the different theories that have been proposed for wellbeing, each of these  
745 contributes to the same higher order construct of wellbeing (Goodman, Disabato, Kashdan, &  
746 Kauffman, 2017; Disabato, Goodman, Kashdan, Short, & Jarden, 2016). In other words, there  
747 are many strategies through which positive psychological experience may be enhanced.

748 Other meta-analyses on health behaviours have emphasised the role of physical activity (Chekroud  
749 et al., 2018), diet (Firth et al., 2019) and sleep (Baglioni et al., 2016) on our mental lives. Our  
750 recent review on vagal function (Kemp, Koenig, & Thayer, 2017) concluded that higher resting  
751 state vagal function is associated with positive mood states, highlighting the utility of PPIs for  
752 enhancing a critical regulator of health and wellbeing. Our work further emphasises the struc-  
753 tural link between the vagus nerve, and physical and mental health (Kemp, Arias, & Fisher,  
754 2017; Kemp, Koenig, & Thayer, 2017; Kemp, 2018; Kemp & Quintana, 2013; Kemp, 2016). It  
755 is interesting to note here that purpose in life has been shown to predict allostatic load ten years  
756 later (Zilioli, Slatcher, Ong, & Gruenewald, 2015) as measured by the sum of seven scores  
757 across multiple physiological systems including cardiovascular, lipid, glucose metabolism, in-  
758 flammation, autonomic function, and hypothalamic-pituitary-adrenal risk scores. Unfortunately  
759 however, this study did not distinguish between upstream and downstream systems driving in-  
760 creases in metabolic risk as we do here. Critically, vagal function plays a known regulatory  
761 role over inflammatory processes, as demonstrated previously: (Tracey, 2002).

762 In addition to focusing on positive psychological experience and health behaviours, recent de-  
763 velopments in psychological science have highlighted a key role for social relationships for the  
764 health and wellbeing of the individual. Therefore, individual wellbeing may also be promoted  
765 by focusing on community, the focus of our original GENIAL model (Kemp, Arias, & Fisher,  
766 2017). The implications of social relationships for the health and wellbeing of the individual  
767 were recently summarised by (Haslam, 2018). (Haslam, Cruwys, Haslam, Dingle, & Chang,  
768 2016) evaluated a new intervention that targets social isolation and disconnection, “Groups 4  
769 Health” (G4H). Results highlighted the intervention to improve mental health, wellbeing, and  
770 social connectedness up to 6-months post intervention. In addition to this, improvements in  
771 depression, anxiety, stress, loneliness, and life satisfaction correlated with heightened identifi-  
772 cation with the G4H group and with multiple groups. The work by Barbara Fredrickson and  
773 colleagues is especially relevant here, emphasising the upward spiral of positive emotions, so-  
774 cial connectedness and vagal function (Kok & Fredrickson, 2010; Kok et al., 2013). Other  
775 well established theories of vagal function, such as the polyvagal theory (Porges, 2011; Porges,  
776 1995; Porges, 2001; Porges, 2003; Porges, 2007) highlight a role for the vagus in promoting  
777 capacity to engage with others and regulating our emotions during such encounters.

778 Finally, our updated model emphasises the environmental context within which individual  
779 health and wellbeing is promoted and communities reside. Glenn (Albrecht, 2019) provides a  
780 solid foundation for understanding the link between human emotion and the environment, coin-  
781 ing numerous words to emphasise the negative and positive ‘psychoterratic’ states that have im-  
782 portant implications for the health and wellbeing of individuals, communities and nations now  
783 and into the future. Environmental contributors include negative and positive psychoterratic  
784 states such as solastalgia (chronic place-based distress) and soliphila (a neutral political term

785 for combatting solastalgia) (Albrecht, 2019). A review of the literature on potential mechanisms  
786 linking nature to health identified 21 potential pathways empirically linked to nature (Kuo,  
787 2015). These pathways included environmental factors including phytoncides - antimicrobial  
788 volatile organic compounds with physiological effects - and vegetation filtering of pollutants,  
789 physiological factors such as elevation of vagal function and immune function, psychological  
790 factors involving positive emotions and attention restoration, and behavioural factors including  
791 positive health behaviours such as the promotion of physical activity and social ties. Interest-  
792 ingly, this paper suggested that enhanced immune functioning might reflect a central pathway  
793 for mediating the beneficial effects of nature on health. It is apparent however, that vagal  
794 function plays a regulatory role over immune function via the cholinergic anti-inflammatory  
795 response (Pavlov, Wang, Czura, Friedman, & Tracey, 2003). Other research has shown that  
796 vagal function may be facilitated by spending time in nature. For instance, a recent review  
797 of the literature (Kondo, Jacoby, & South, 2018) on the impacts of spending time outdoors  
798 on stress reported that of 17 studies reporting on measures of HRV, 14 reported significant  
799 findings. Measures of the high frequency (HF) component - a commonly reported measure of  
800 vagal function - increased for participants spending time outdoors. It is relevant to note here  
801 that measures of HF HRV are generally negatively correlated with measures of heart rate. That  
802 is, high levels of vagal function - as is typically indexed by high HF HRV - are associated with  
803 a low heart rate. Interested readers are referred to recently published reference values for short-  
804 term resting-state HRV (Dantas et al., 2018). Thus, it is against this background of findings  
805 that we suggest that vagal function both affects and are affected by the effects of psychological  
806 experience, health behaviours, social ties, as well as the environment.

807 In conclusion, our updated GENIAL model (fig 4) summarises individual, community and en-  
808 vironmental contributors to human health and wellbeing. Our model also characterises the ma-  
809 jor targets for potentially improving wellbeing in the community including, potentially, those  
810 people living with chronic conditions and disorders. Clinical targets include psychological ex-  
811 perience, health behaviour, social connections and outdoor nature-based activities to which the  
812 tools from positive psychology and behaviour change may be applied.

## 813 **6 Implications for Chronic Conditions and Non-Communicable** 814 **Disease**

815 Chronic conditions include diabetes, obesity, cardiovascular disease, cancer, chronic respira-  
816 tory diseases, some neurological conditions and mental health conditions. Chronic conditions  
817 are also referred to as non-communicable disease (NCDs) (Non communicable dise...). The  
818 global burden of disease attributable to NCDs has now outstripped the burden of communica-  
819 ble conditions (Fig 1), a phenomenon known as the ‘epidemiological transition’. The world-  
820 wide increasing burden of chronic conditions (Fig 1), treatment gaps and treatment lag (Wang,  
821 Berglund, Olfson, & Kessler, 2004; PATEL et al., 2010) are major obstacles to be overcome.  
822 The treatment gap refers to the numbers of people who need treatment that are not receiving  
823 it. As an example, the treatment gap for mental health disorders has been estimated to exceed  
824 50% in all countries of the world, and to reach 90% in those with less resources (PATEL et



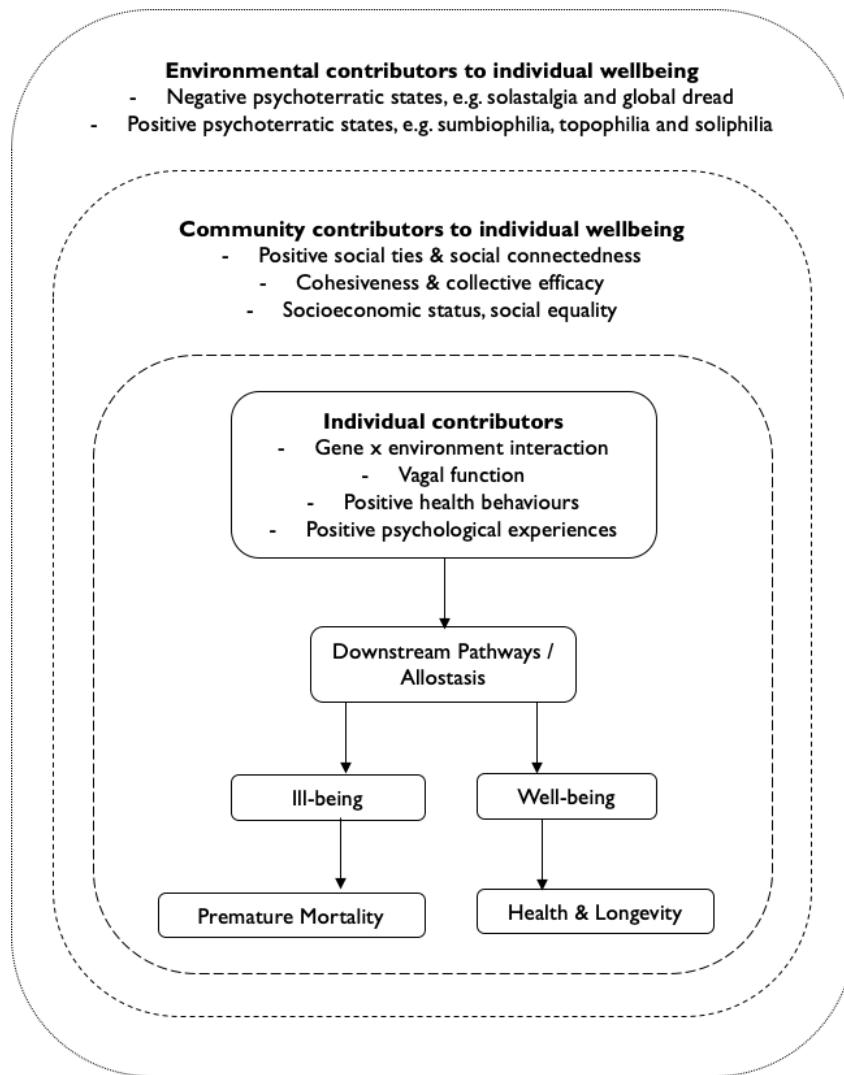


Figure 4: GENIAL 2.0: Illustrates pathways to premature mortality versus longevity within the context of community and environmental contributors to health and wellbeing. Our original paper (Kemp, Arias, & Fisher, 2017) provides a detailed review on which our life-course model was based.

825 al., 2010). The amount of time taken to receive mental health treatment when it does exist—  
 826 treatment lag— has been estimated to be longer than a decade (Wang, Berglund, Olfson, &  
 827 Kessler, 2004).

828

829 As a function of this epidemiological transition, healthcare systems are struggling to meet  
 830 increasing demand (Guzman-Castillo et al., 2017). In the United Kingdom (UK), it is estimated  
 831 that approximately 30% of the UK population have one or more chronic conditions and that this  
 832 30% accounts for 70% of the spend (Department of Health, 2012). People living with chronic  
 833 conditions are the biggest users of the National Health Service (NHS). They are more likely  
 834 to see their general practitioner (accounting for approximately 50% of consultations), to be  
 835 admitted as inpatients and to use more inpatient days than those without such conditions (70%

836 of all inpatient bed days), and account for 64% more outpatient appointments (Department of  
837 Health, 2012). Our theoretical models of health and wellbeing allow several inferences to be  
838 drawn regarding health care for people with chronic conditions.

839

840 *Models of health care:* Despite the epidemiological transition, healthcare models have not  
841 adapted to the changed landscape. The dominant model of health care, ‘the acute medical  
842 model’ was designed to treat acute conditions. Inherent in the medical model are several as-  
843 sumptions that are ‘not a good fit’ when applied to people with chronic conditions. For exam-  
844 ple, the acute model is underpinned by the assumption that a person’s ‘acute problem’ can be  
845 fixed and that they can be returned to a ‘pre-injury state’. However, chronic conditions cannot  
846 be fixed and whereas impairment may be reduced to some extent, a healthcare approach that  
847 attempts only to reduce symptoms misses opportunities to promote wellbeing. The absence of  
848 illness or impairment does not equate to wellbeing, and interventions which focus only on re-  
849 ducing impairment are insufficient to tackle the challenge of chronic conditions. With reference  
850 to our framework we argue that by building positive psychological experiences (e.g. individ-  
851 ual strengths, optimism and resilience) within a supportive social network and environment,  
852 pathways to self-sustaining cycles of positive health and wellbeing may be triggered and main-  
853 tained, supporting and facilitating wellbeing despite the limitations imposed by the condition.  
854 Accordingly, the management of people with chronic conditions requires a holistic approach  
855 both within the health service and beyond – an approach that extends beyond a) medicine which  
856 by definition is the science and practice of establishing diagnosis, treatment and prevention of  
857 disease; and b) the health service given major determinants of health are influenced by the  
858 communities and the environment we live in. Another assumption of the medical model is that  
859 patients are ‘passive recipient of care’. However, treatment outcomes for people with chronic  
860 conditions are contingent on active collaboration between clinician and patient. For example,  
861 adherence to treatment regimens, and adoption of recommended lifestyle changes etc. With  
862 respect to interventions to promote psychological experiences, interventions cannot be ‘done  
863 to the patient’ and successful outcomes depend on an active and collaborative approach.

864

865 *Organisational and institutional barriers within health services and beyond:* Epidemiological  
866 studies have shown that common mental health disorders and physical diseases are strongly  
867 inter-connected, highly co-morbid and share critical pathways to ill health and disease (Druss,  
868 Walker, 2011 ), (O’Neil 2015). This evidence has been captured by the tagline: ‘there is no  
869 health without mental health’ (Prince 2007). As an example, the senior author on the current re-  
870 view (AHK) investigated the relationship between the mood and anxiety disorders and coronary  
871 heart disease (CHD) in Brazil (Kemp 2015), observing that these common mental disorders are  
872 associated with a threefold increase in CHD, after full adjustment for potentially confounding  
873 factors. Common mood disorders share an underlying diathesis whereby mechanisms that pre-  
874 dispose individuals to depression and anxiety for example, contribute to the development of  
875 a range of chronic physical health conditions across the life span, and vice versa. While the  
876 mechanisms for such a relationship are complex, our work on this topic (Kemp 2017, Kemp  
877 2017a, Kemp 2018, Kemp 2013, Kemp 2016) - including our GENIAL model (Kemp 2017)  
878 - have emphasised a role for vagal function as a mediating link between mental and physical  
879 health (Kemp 2017, Kemp 2017a, Kemp 2018, Kemp 2013, Kemp 2016). A greater apprecia-

880 tion - and understanding - of the relationships between mental and physical illnesses and their  
881 underlying mechanisms are needed so that improved interventions and treatments may be de-  
882 veloped which bridge the gap between physical and mental health services. Accordingly, this  
883 tight interconnection between physical and mental health needs to be reflected in the models,  
884 infrastructure and commissioning of health services that support people with chronic condi-  
885 tions. For example, relative to physical health conditions, mental disorders are much less  
886 likely to receive treatment and this holds true across the world (Book Authors, 2009). How-  
887 ever, if one considers the global burden of chronic conditions in terms of disability rather than  
888 mortality, major depression is the second leading cause of disability (O'Neil et al., 2015) pre-  
889 ceded only by cardiovascular disease. Moreover, there is a high degree of co-morbidity with  
890 mental and physical health conditions and we know that mental ill health affects adherence to  
891 treatments and prognosis (DiMatteo, Giordani, Lepper, & Croghan, 2002). Accordingly, the  
892 commissioning bias in favour of physical health services actually disadvantages the majority of  
893 people with chronic conditions given the tight linkage between physical and mental health and  
894 serves to exacerbate the challenges for the prevention and amelioration of chronic conditions.

895 There are also biases in the types of interventions offered by mental and physical health services  
896 (with the exception of pharmacological treatment). People with physical health difficulties are  
897 typically prescribed physical health treatments. For example, people with cardiovascular dis-  
898 ease (CVD) are typically advised to partake in healthier diets and physical activity. However,  
899 we know that there is a strong reciprocal relationship between CVD and depression (Gasse,  
900 Laursen, & Baune, 2012; Kemp et al., 2015). This bias misses several opportunities to en-  
901 hance health and wellbeing for people with CVD. For example, positive psychological ex-  
902 periences have been associated with decreased risk of secondary cardiovascular events and  
903 mortality (Boehm & Kubzansky, 2012); (DuBois et al., 2015). It has been argued that psy-  
904 chological wellbeing is a modifiable protective factor that could decrease the impact of CVD  
905 through its potential influences on health behaviours and CVD-related biomarkers (DuBois et  
906 al., 2012); (Sin, Moskowitz, & Whooley, 2015). Conversely, mental health services typically  
907 focus on offering psychological therapies in addition to medication whereas much research has  
908 shown that people with mental health conditions have poor diets (Storlien et al., 1996), dis-  
909 turbed sleep (Lee 2012, Ancoli-Israel 2006), lower levels of physical activity (Goodwin, 2003)  
910 and social isolation (Domènech-Abella, Mundó, Haro, & Rubio-Valera, 2019). Moreover, in-  
911 terventions that target these health behaviours significantly ameliorate symptoms (Trauer et  
912 al., 2015), (Stathopoulou, Powers, Berry, Smits, & Otto, 2006), (Opie et al., 2015; Parletta et  
913 al., 2019). Given that undesirable health behaviours contribute to the aetiology and amelio-  
914 ration of chronic conditions; a plethora of guidelines and recommendations regarding optimal  
915 diet, physical activity etc. have been developed (for a summary, see Table 2). Often treatment  
916 approaches for people with chronic conditions includes educating them about healthier life  
917 choices. Despite such education, the majority of individuals fall short of pursuing a healthier  
918 lifestyle (Newsom et al., 2011).

919 Evidence shows that such strategies have minimal impact upon inducing sustained change,  
920 especially in individuals of a lower socio-economic status (Angermayr, Melchart, & Linde,  
921 2010). That is, 'common knowledge is not common action'. There is an inherent disconnect  
922 between what people know and what they do - often referred to as the intention-behaviour

923 gap (Sheeran, 2002). It is this intention-behaviour gap that creates a barrier to the uptake of  
924 evidence surrounding well-being activities into healthcare practice (Francis, O'Connor, & Cur-  
925 ran, 2012). This is because successful change requires more than education or communication  
926 of personalised risk information (French, Cameron, Benton, Deaton, & Harvie, 2017). Ac-  
927 cordingly, in order to better understand how to effectively target health behaviours we must  
928 move beyond giving information and attempt to better understand how to facilitate behavioural  
929 change. Moreover, our GENIAL framework demonstrates that social relationships offer a target  
930 for intervention that is typically not exploited by the health service despite research showing  
931 that a) people with chronic conditions are often socially isolated and, b) a lack of social ties  
932 predicts premature mortality to a greater degree than physical activity, smoking (15 cigarettes  
933 daily) and body mass index (Holt-Lunstad, Smith, & Layton, 2010). Accordingly, interven-  
934 tions which seek to foster positive social ties may have much to contribute to tackling the  
935 challenge of chronic conditions. This may be achieved by creating networks based on collab-  
936 orations between the health service and community organisations, with both parties having a  
937 theoretical and applied understanding of how to create environments that promote social con-  
938 nectivity and wellbeing - we describe an example of this from our own clinical practice below.

939 The original GENIAL framework highlights individual pathways to illness and premature death  
940 and health, wellbeing and longevity. When negative, health behaviours, psychological experi-  
941 ences and social ties (social relationships, integration and cohesion) contribute to the aetiology  
942 of chronic conditions and exacerbate the condition when present. Accordingly, we have argued  
943 that they should be targeted in the prevention and amelioration of chronic conditions. Given that  
944 the health service is typically organised by 'disease specific' services as discussed above, and  
945 given that health behaviours, psychological experiences and social ties offer a common target  
946 for intervention across a range of diseases, we advocate for a transdiagnostic approach to man-  
947 agement. That is, creating a balance between the need for disease specific 'specialisms', but  
948 also for transdiagnostic approaches that treat some of the common diathesis that many people  
949 with chronic conditions share (undesirable health behaviours, negative psychological experi-  
950 ences, social isolation and exclusion). This approach would mean that people with chronic  
951 conditions would be able to access interventions based on need and efficacy not diagnosis.  
952 Transdiagnostic services would hold expertise in; a) interventions for optimal sleep, nutrition  
953 and adapted physical activity interventions couple with an understanding of promoting be-  
954 havioural change; b) links with the community to facilitate community integration and positive  
955 relationships with others; c) psychological interventions to both reduce impairment, but also  
956 to improve wellbeing; d) links with academic institutions to promote urgently needed cross  
957 disciplinary research into effective management strategies. With a mind to the financial diffi-  
958 culties facing the health service, the addition of transdiagnostic services would negate the need  
959 to resource and skill-up all diagnostic specific services to deliver interventions targeting heath  
960 behaviours, psychological experiences and social connectivity. Moreover, in relation to bridg-  
961 ing the gap between the health service and the community, this would be difficult for diagnostic  
962 services to do in reality.

963 Finally, our extended GENIAL 2.0 framework makes it clear that in order to promote the health  
964 and wellbeing of entire populations, the healthcare cannot and should not shoulder the burden  
965 alone. We present a range of compelling evidence that the health and wellbeing of individuals

966 are not just determined by individual factors alone, and that community and environmental de-  
967 terminants of health must also be targeted to reduce the burden imposed by chronic conditions.  
968 This requires a shared understanding of the problems and solutions and joined up working  
969 between the healthcare services, community organisations and academia. Our own work in  
970 the National Health Service has focused on re-developing our services for people living with  
971 acquired brain injury. In addition to traditional impairment focused services, we are develop-  
972 ing interventions to improve wellbeing, social relationships, community integration and social  
973 identity in addition to some interventions that involve environmental sustainability. We are  
974 doing so in collaboration with academic institutions as well as community, third sector and  
975 industry organisations. This service development, based on our GENIAL framework, has ap-  
976 plication across chronic conditions. We discuss our work further in the following section and  
977 draw some conclusions.

## 978 **7 Discussion**

979 Here we have presented a modern understanding of wellbeing; one that involves ‘connection’ . . .  
980 connection to ourselves, to others and to the environment. We suggest that vagal function pro-  
981 vides an important mediator of wellbeing that affects and is affected by activities to promote  
982 wellbeing across these multiple domains. The vagus nerve connects us to ourselves (i.e. 80% of  
983 vagal nerve fibres are afferent nerves (Agostoni, Chinnock, Daly, & Murray, 1957) providing  
984 a structural link between mental and physical health), to others (increases in vagal function fa-  
985 cilitate a ‘calm and connect’ response promoting social connectedness, (Porges, 2011; Kemp,  
986 Arias, & Fisher, 2017; Kok et al., 2013)), and to nature (vagal function is impacted on by a  
987 host of environmental factors, as discussed in section 5, that will subsequently promote in-  
988 dividual health and wellbeing). Vagal function may be considered as an index of resilience,  
989 underpinned by psychological flexibility (Kashdan & Rottenberg, 2010) that can be enhanced  
990 through a variety of interventions within individual, community and environmental domains,  
991 providing a target for focused interventions. We suggest that benefits to vagal function could be  
992 maximised by drawing upon multiple interventions that span these multiple domains of wellbe-  
993 ing. While we have been greatly influenced by the maturing discipline of positive psychology,  
994 we argue that the field has been limited by a restricted focus on strategies that promote posi-  
995 tive psychological moments and experience. As recent research has argued that the impacts of  
996 positive psychological interventions are smaller in size than previously reported (White, Uttl,  
997 & Holder, 2019), we argue that their impact could be improved by integrating interventions  
998 that also focus on physical health, which we now know to have important impacts on mental -  
999 in addition to physical - health (Chekroud et al., 2018). Integrating interventions within com-  
1000 munity and environmental domains will likely improve the impact of interventions further. It  
1001 is also important to note that wellbeing can be influenced through sociostructural factors such  
1002 as governmental policy, a consideration highlighted in our original GENIAL model (Kemp,  
1003 Arias, & Fisher, 2017) (see section 2). Our updated GENIAL model (section 5) further extends  
1004 beyond the individual and community, to incorporate the broader impacts of the environment.  
1005 Mindful of previously proposed social ecological theories such as Glenn Albrecht’s work on  
1006 ‘Earth Emotions’ (Albrecht, 2019), which emphasise the connectedness between human emo-  
1007 tions and the state of our natural environment, we emphasise that the individual is intimately

1008 connected to the community and environment within which they live, in a ‘symbioment’. In this  
1009 regard it is interesting to observe calls (Bratman et al., 2019) for the modification of the natural  
1010 environment in ways that will promote the mental health of communities, with research even  
1011 demonstrating relationships between urban tree density and numbers of antidepressant medi-  
1012 cations prescribed (Taylor, Wheeler, White, Economou, & Osborne, 2015). Researchers have  
1013 also argued that sociostructural changes aimed at improving the natural environment will fur-  
1014 ther contribute to improvements in wellbeing through the reduction of inequalities (Bratman et  
1015 al., 2019). As noted earlier, income and wealth inequalities have substantial impacts on societal  
1016 wellbeing, and this topic is now the subject of major international and interdisciplinary reviews  
1017 on the subject (e.g. the 5-year Deaton Review: <https://www.ifs.org.uk> funded by the Nuffield  
1018 Foundation).

1019 Over the last few years, we have developed a novel 8-week positive psychotherapy interven-  
1020 tion (see table 3 for a summary of individual components) built on our innovative GENIAL  
1021 framework, incorporating interventions that focus on the individual, community and envi-  
1022 ronmental domains. Presently, we are working with university undergraduate students and  
1023 people living with acquired brain injury, although we are seeking to broaden our focus to  
1024 patients with a variety of chronic conditions including for example, diabetes, obesity, car-  
1025 diovascular disease, common mental disorders and their comorbidity. Interventions focus-  
1026 ing on the individual include activities from positive psychology (section 4.0.1) as well as  
1027 education relating to positive health behaviours (section 4.0.2). Interventions involving the  
1028 community domain focus on building positive relationships with others in line with social  
1029 identity theory (Haslam, 2018), supported by partnership working with community organi-  
1030 sations, such as “Surfability” (<https://surfabilityukcic.org/>) and “Bikeability”  
1031 (<https://bikeability.org.uk/>), which serve to encourage community integration  
1032 (section 4.1). Finally, interventions focusing on the environment include activities such as  
1033 mindful photography, as well as partnership working with the community organisation, ‘Down  
1034 to Earth’ (<https://www.downtoearthproject.org.uk/>). This organisation pro-  
1035 motes wellbeing in disadvantaged populations through engagement with the environment, es-  
1036 pecially in regards to environmental sustainability and social ecology. For instance, our patients  
1037 with acquired brain injury were recently involved in the construction of a ‘community building’  
1038 using sustainable and locally sourced raw materials on the Gower Peninsula, the first place in  
1039 Britain to be named an Area of Outstanding Natural Beauty. These are just some selected exam-  
1040 ples to illustrate the potential to promote wellbeing in each of the domains, and we are always  
1041 seeking to engage with other academic groups, health boards and community organisations to  
1042 improve health and wellbeing in the community, based on strong theoretical foundations. In  
1043 conclusion, we have presented a novel approach to understanding and improving wellbeing,  
1044 connecting psychological science with a social ecological approach that considers the individ-  
1045 ual in the context of community and the wider environment (Fig 1). Our GENIAL framework  
1046 bridges the gap between psychological science and population health health systems, and pro-  
1047 vides a solid foundation for future research on the wellbeing of the individual as well as the  
1048 communities and environments within which individuals live. In doing so, we hope that this  
1049 framework and updated theoretical review helps to move the science of wellbeing forward to a  
1050 more ethical and moral science that considers the wellbeing of current as well as future gener-  
1051 ations, providing an evidence base for groundbreaking national policies such as the ‘Well-being

1052 of Future Generations (Wales) Act' (2015), and alerting researchers to consider the implications  
1053 and context of human wellbeing in relation to major societal challenges such as the climate cri-  
1054 sis. Wellbeing researchers ignore this context at their peril, and it is time that funding bodies  
1055 take a more supportive stance of the transdisciplinary science that is urgently needed to achieve  
1056 this goal, let alone, better understand relationships and inter-dependencies between individual,  
1057 community and environmental wellbeing. We look forward to a future - well-funded - scientific  
1058 effort that embraces the science of behavioural change to improve the wellbeing of not just the  
1059 individual, but also of communities, and the wider environment, bearing in mind the potential  
1060 positive impacts that improved community and environmental wellbeing will also have at the  
1061 individual level.

## 1062 **8 Acknowledgements**

1063 We would like to acknowledge the support of Swansea University and the National Health  
1064 Service in recognising and promoting our work through various awards including the University  
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1073 Research Wales through the Research for Public Patient Benefit Scheme.

Do-main	Theory	Description
In-di-vid-ual	Tripartite model of subjective wellbeing (Diener)	Life satisfaction, positive and negative affect. Typically characterised as tapping into hedonic wellbeing. Diener has argued that subjective wellbeing does not involve making value judgments by 'experts' on what a good life entails (Kesebir & Diener, 2008), such as proponents of 'eudaimonic wellbeing'.
	Six-factor model of psychological wellbeing (Ryff)	Argues that wellbeing cannot be reduced to hedonic wellbeing. Spans positive relationships with others, personal mastery, autonomy, a feeling of purpose and meaning in life, and personal growth and development. This model is characterised as tapping into 'eudaimonic wellbeing'.
	PERMA model (Seligman)	Positive emotion, engagement, social relationships, meaning and achievement all contribute to wellbeing. Spans both hedonic (affect) and eudaimonic (psychological wellbeing) aspects of wellbeing.
	Salutogenesis theory (Antonovsky)	'Salutogenesis' is based on the Latin term 'salus' (health, well-being) and the Greek word 'genesis' meaning emergence or creation. The salutogenic concept emphasises a role for a 'sense of coherence' in managing and overcoming stress.
	Neurovisceral Integration Across the Continuum of Time (NIACT) model (Kemp)	A life-course theoretical framework for wellbeing, characterising pathways to ill-being versus wellbeing, highlighting a key role for the vagus nerve. NIACT is complimentary to the GENIAL model of wellbeing (see below).
Com-mu-nity	Social identity theory (Haslam)	Groups provide individuals with a sense of meaning, purpose and meaning with positive psychological consequences. This theory has led to the publication of a book titled 'The New Psychology of Health', which emphasises the importance of positive social ties.
	Conceptual models on the social determinants of health (SDOH)	Multiple models have been proposed, however a recent review by Lucyk and McLaren (2017) emphasised the role of health equity and social gradients as major concepts.
	GENIAL 1.0 [genomics-environment-vagus nerve-social interaction-allostatic regulation-longevity] model (Kemp)	Builds on the NIACT model, again emphasising a role for the vagus nerve in a host of psychological and physiological processes. Novel aspects include the role of social ties and sociostructural factors.
En-vi-ron-men-tal	Biophilia hypothesis (Wilson)	Core assumption is that human beings have a strong, innate affiliation with the biological world.
	Psycho-evolutionary theory (Holt)	Restorative influences of nature involve a shift



Health Behaviours	UK Government Guidelines (Adults 18+)	Peer-reviewed literature	Comparison: Guidelines vs Research
Diet: Fruit and Vegetable Intake	Consume at least five portions a day (or 400g) (Public Health England, 2016)	Dutch guidelines based on 29 systematic reviews of meta-analyses comprising RCTs and the risk of chronic disease based on diet choices - 200g of fruit and 200g of vegetables daily (Kromhout et al., 2016). Although research highlights benefits in increasing fruit and vegetable intake up to 800g per day in regards to reducing risk for heart disease, cardiovascular disease and all-cause mortality (Aune et al., 2017). In addition to these physical health benefits, increasing fruit and vegetable portions has been shown to be beneficial in improving wellbeing (Mujcic & Oswald, 2016): 8 portions a day increases life satisfaction by 0.24 points, equivalent to the psychological gain of moving from unemployed to employed.	UK guidelines may be an underestimate of the ideal amount of fruit and vegetable consumption given the health benefits of eating more than 5 a day for both physical and mental health.
Diet: Other food items	Consume at least two portions of fish (2x 140g) weekly (one of which is oily fish), consume some beans, pulses, eggs, meat and other proteins, and limit unsaturated oils and spreads (Public Health England, 2016)	Dutch guidelines - Limit consumption of red meat, a few dairy portions daily, eat legumes weekly, consume at least 15g of unsalted nuts daily, consume oily fish weekly, zero alcohol (or less than one glass daily), less than 6g salt daily (Kromhout et al., 2016). Dietary interventions have also been shown to improve mental health (symptoms of depression and anxiety) (Firth et al., 2019) - examples include adherence to a Mediterranean diet,	Guidelines do not specify recommended amounts of more general food items, such as legumes and red meat. It would be beneficial to provide evidence-based recommendations on these foods.

Week	Focus	Comment
1	Character strengths	Identifying one's character strengths is the foundation to 'building on what is strong, rather than fixing what is wrong'. Ryan Niemiec's work in this regard provides a solid foundation in this regard.
2	Emotions	Positive emotions are fundamental to theories of hedonic wellbeing. While Barbara Fredrickson's 'Broaden and Build Model' is the major focus of this section - as is Martin Seligman's 'learned optimism' and Ed Diener's tripartite model - we also emphasise the utility negative emotions, as described by Todd Kashdan & Robert Biswas-Diener in their 'Upside of Your Darkside'.
3	Engagement and 'Flow'	A core feature of positive psychology is to promote task engagement by facilitating 'psychological flow' as coined by Mihály Csíkszentmihályi. Flow is facilitated through activities that involve both a high level of skill and challenge.
4	Positive health behaviours	Recent research highlights that positive psychological interventions may be associated with smaller effect sizes than prior studies suggested. We emphasise here the importance of building positive health behaviours to facilitate vagal function that will have positive impacts on psychological experience. We further draw upon behaviour change theory to reinforce sustain positive change.
5	Positive social relationships	Our original GENIAL model emphasised the need to move beyond a focus on the individual given recent findings highlighting the impacts of social ties on health and wellbeing. We emphasise here the need to focus on positive social relationships to facilitate individual wellbeing in line with Alex Haslam's 'social identity theory'.
6	Reconnecting with nature	A more moral and ethical science of wellbeing is needed that tackles criticisms of positive psychology relating to western neoliberalism and rampant individualism. We emphasise a need for reconnecting with nature and in doing so, suggest that a modern science of wellbeing could be applied to tackle major societal challenges including the climate crisis.
7	Meaning and purpose	Meaning and purpose in life are major component to eudaimonic wellbeing. The work by Viktor Frankl and Paul Wong are particularly influential in this regard. We argue that meaning and purpose in life might be enhanced and facilitated through a combination of interventions that focus on the individual, community and environment.
8	Achievement	Achievement orientation is also considered to be a fundamental component to the promotion of wellbeing. Influencers include Angela Duckworth and Carol Dweck.

Table 3: Overview of our 8-week positive psychotherapy intervention. Astute readers will note that our intervention has been built around Martin Seligman's PERMA model (Seligman, 2011; Seligman, 2018) and positive psychotherapy (Rashid & Seligman, 2018), which combines models of 'hedonic' and 'eudaimonic' wellbeing, supplemented by a focus on positive health behaviours, behavior change and connections to the natural environment.

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