

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 et al., 2017](#)) provided a more expansive view of pathways to longevity in the context of individual health and well-
8 being, emphasising bidirectional links to positive social ties and the impact of sociocultural factors. In this paper,
9 we build on these ideas and propose GENIAL 2.0, focusing on intersecting individual-community-environmental
10 contributions to health and wellbeing, and laying an evidence-based, theoretical framework on which future re-
11 search and innovative therapeutic innovations could be based. We suggest that our transdisciplinary model of
12 wellbeing - focusing on individual, community and environmental contributions to personal wellbeing - will help
13 to move the research field forward. In reconceptualising wellbeing, GENIAL 2.0 bridges the gap between psy-
14 chological science and population health health systems, and presents opportunities for enhancing the health and
15 wellbeing of people living with chronic conditions. Implications for future generations including the very survival
16 of our species are discussed.

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52		Aune et al., 2017; Mujcic & J.Oswald, 2016; Firth et al., 2019; O’Keefe et al.,	
53		2014; Plunk et al., 2013; Cao et al., 2015; Wen et al., 2011; Chekroud et al.,	
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57		PERMA model (Seligman, 2011; Seligman, 2018) and positive psychother-	
58		apy (Rashid & Seligman, 2018), which combines models of ‘hedonic’ and ‘eu-	
59		daimonic’ wellbeing, supplemented by a focus on positive health behaviours,	
60		behavior change and connections to the natural environment.	33

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

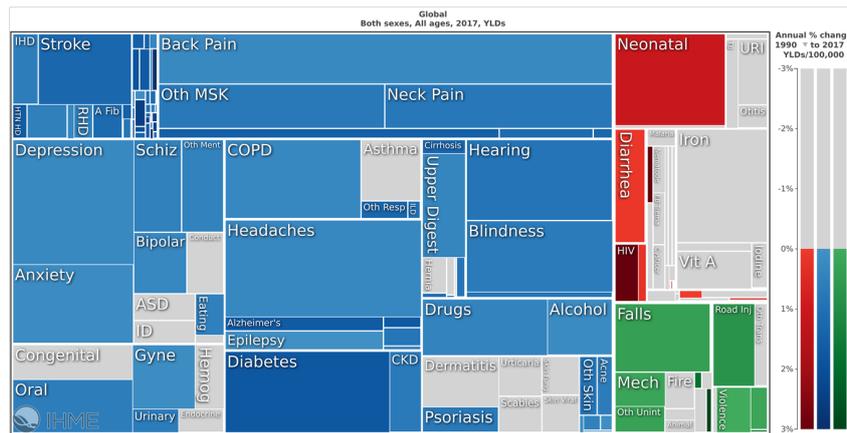


Figure 1: The global burden of disease (GBD) with respects to years lived with disability (YLDs) for all ages and both sexes in the year 2017. The entire figure represents 100% of YLDs; those conditions with increasing % annual change are highlighted in blue (non-communicable disease), red (communicable 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 et al., 2015). One need only
 102 think of a ‘stable bridge’ or an ‘efficient production line’ to appreciate the distinction between
 103 psychological science and engineering here. Others have introduced the concept of ‘saluto-
 104 genesis’ (Antonovsky, 1996), a word based on the Latin term ‘salus’ (health, well-being) and
 105 the Greek word ‘genesis’ meaning emergence or creation. The salutogenic concept counters
 106 the tendency of medicine to focus on ‘pathogenesis’, and emphasises a role for a ‘sense of
 107 coherence’ for managing and overcoming stress reflecting feelings of confidence that the en-
 108 vironment is comprehensible, manageable and meaningful. However, psychological theories
 109 of wellbeing have also been criticised for ignoring wider systemic issues such as loneliness,
 110 inequality, environmental degradation and climate change (Carlisle et al., 2009; Ehrenreich,
 111 2010; Frawley, 2015). These criticisms are being tackled, in part, by developments in conser-
 112 vation and environmental psychology, which explicitly link psychological science to some of
 113 these challenges. Developments include for instance, the positive psychology of sustainabil-
 114 ity (Corral-Verdugo & Frías-Armenta, 2015; Verdugo, 2012), sustainable happiness (O’Brien,
 115 2010; O’Brien, 2012; O’Brien, 2016) and sustainable wellbeing (Kjell, 2011). However, others
 116 have argued that the concepts of ‘resilience’ and ‘sustainability’ have become so corrupted by
 117 neoliberalism, the fossil fuel industry and the Trump administration, that these concepts are no
 118 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.

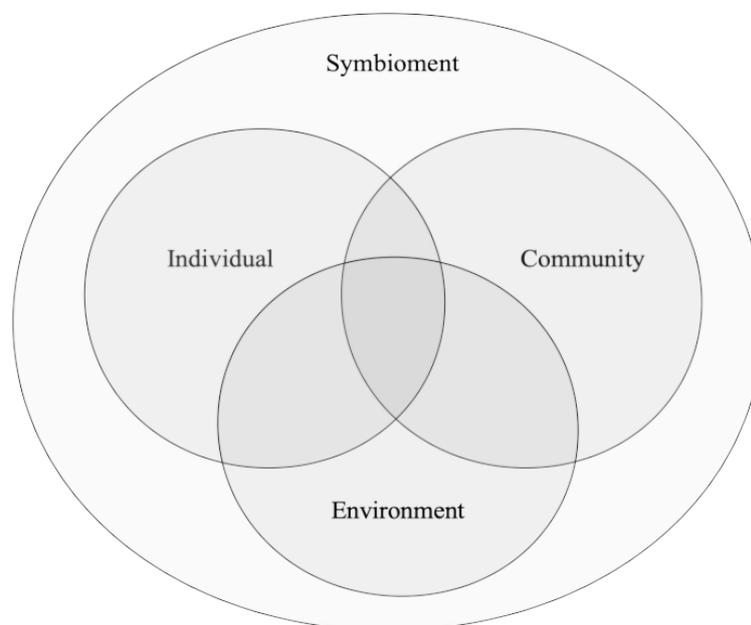


Figure 2: Venn diagram of key wellbeing domains: the individual, community and environment. These domains are placed within the ‘symbioment’ (Albrecht, 2019) to emphasise symbiotic coexistence of all life at various scales.

2 The Original GENIAL Model

Our original GENIAL model (Kemp et al., 2017) (Fig 3) emphasised the pathways to health and wellbeing versus ill-health and premature mortality, highlighting key roles for vagal function and social interaction along these pathways. The role for the vagus nerve – indexed by heart

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

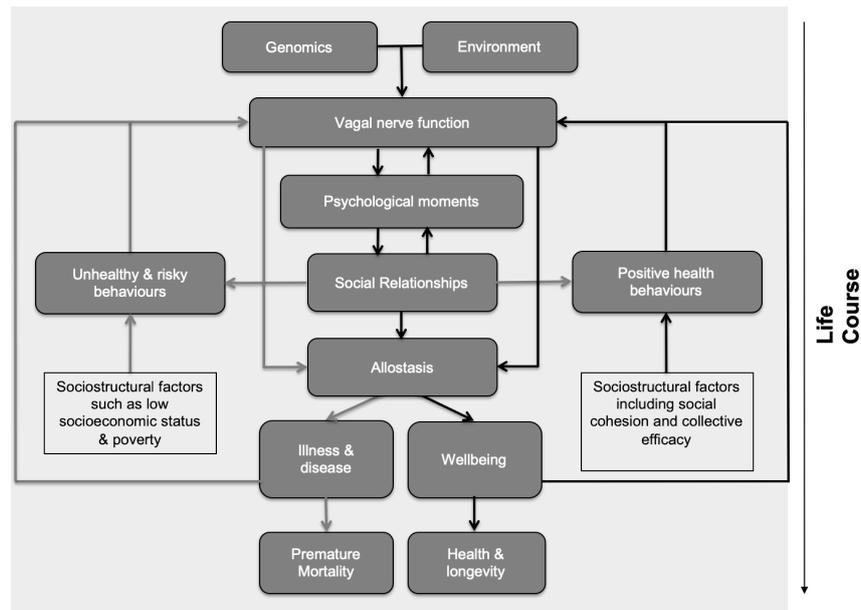


Figure 3: The original GENIAL model reprinted from (Kemp et al., 2017) with kind permission from Springer Nature. (License number: 4652451214375).

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

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

206 **4.0.1 Psychological experience**

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

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

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

272 Building on strong theoretical foundations and an extensive body of research, our previously
273 published models (Kemp et al., 2017; Kemp et al., 2017) argue that healthy vagal nerve func-
274 tion, underpin and are impacted on by positive psychological moments, facilitating longer-term
275 improvements in health and wellbeing. These insights are based on a strong body of evidence.
276 For instance, Todd Kashdan and Jonathan Rotenberg (Kashdan & Rotenberg, 2010) argued
277 that vagal function is an index of psychological flexibility (PF) that is fundamental for psycho-
278 logical health. Psychological flexibility is an important component of resilience, facilitating
279 ones capacity to assess and adapt to demands, alter mindset and behaviour when necessary, and
280 for commitment to behaviours that are congruent with deeply held values (Kashdan & Rotten-
281 berg, 2010). Conversely, psychological inflexibility has been associated with worsened mental
282 health and an exacerbated stress (Masuda & Tully, 2011; Kato, 2016; Chawla & Ostafin, 2007;
283 White et al., 2013; Smeekens et al., 2007). An inflexible response style - characterised by
284 withdrawal of the vagal brake - plays a key role in the development of and symptomatology of
285 depression (Nolen-Hoeksema et al., 2008), along with explanatory inflexibility (applying the
286 same attribution style cross different situations) and inflexible coping behaviours (Fresco et al.,

287 2006; Moore & Fresco, 2007). According to (Kashdan & Rottenberg, 2010), vagal function
288 underpins the capacity for psychological flexibility. Intriguingly, Bethany Kok and Barbara
289 Fredrickson (Kok & Fredrickson, 2010; Kok et al., 2013) demonstrated that change in vagal
290 function - following training in loving kindness meditation - is associated with increases in
291 positive emotions and enhanced perception of social connectedness, suggesting that positive
292 emotions facilitate physical health via the vagus nerve. The link between individual and com-
293 munity is a topic that we turn to following our discussion of positive health behaviours.

294 4.0.2 *Health behaviours*

295 Whilst health behaviours are typically thought of with respect to their impact on physical health,
296 there is now compelling evidence that health behaviours impact on both physical and mental
297 health. Accordingly, and in contrast to many other models of wellbeing (Ryff, 1989; Diener,
298 1984; Seligman, 2011), we have proposed a key role for health behaviours in facilitating indi-
299 vidual pathways to health, wellbeing and longevity (Kemp et al., 2017). Moreover, we propose
300 the vagal nerve acts as the structural link between physical and mental health and plays a criti-
301 cal role in reciprocal relationship between positive health behaviours, and physical and mental
302 health. In this section, we present some key studies highlighting the importance of health be-
303 haviours in physical and mental health outcomes. An exhaustive review is beyond the scope
304 of this paper however, and interested readers are referred to (Kemp et al., 2017). Given the
305 number of health behaviours, for brevity, we focus specifically on physical activity, diet and
306 sleep.

307 *Impact of health behaviours on physical health:*

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

310 Research on over 20,000 participants analysed the impact of key positive health behaviours
311 on mortality risk - non-smoking, physical activity, consumption of less than 14 units of alco-
312 hol per week and a diet rich in fruit and vegetables. Participants who adopted all four health
313 behaviours at baseline had a mortality risk that was equivalent to being 14-years younger at
314 follow-up (average of 11-years later), compared to those who adopted none of the positive
315 health behaviours (Khaw et al., 2008). A more recent study focused on six health behaviours:
316 non-smoking, physical activity, healthy diet, sleeping seven to eight hours a night, inactivity
317 less than eight hours a day, and daily social contact (Martínez-Gómez et al., 2013). Results
318 again highlighted a mortality risk that was equivalent to being 14-years younger for those who
319 adopted these behaviours relative to those who adopted none of them. Wen et al. (2011) conduc-
320 ted a prospective cohort study with over 400,000 individuals between 1996-2008. Surprisingly,
321 even those individuals in a low physical activity group (average of 15 mins a day or 92 mins per
322 week) had a 14% reduced risk of all-cause mortality. Moreover, every additional 15 minutes of
323 daily exercise beyond this minimum amount, reduced all-cause mortality by further 4%. The
324 authors argued that less exercise is easier to achieve for those who do not engage in any phy-

325 sical activity at all, and yet it may still be sufficient to achieve health benefits. Moreover, [Lee,](#)
326 [Pate, Lavie, Sui, Church, and Blair \(2014\)](#) concluded that running 5-10 minutes a day at slow
327 speeds (less than 6mph) is even associated with reduced all-cause risk of mortality, providing
328 further evidence that exercising below current minimum guidelines is sufficient for mortality
329 benefit. Once a routine is established individuals may then be able to be motivated to exercise
330 at higher levels.

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

347
348 *Impact of health behaviours on physical and mental health:* Focusing on health behaviours
349 - including exercise, diet and sleep - typically involves consideration of one's physical health,
350 however there is now convincing evidence that demonstrates the impact of positive health be-
351 haviours on mental wellbeing, supporting declarations that there is 'no health without mental
352 health' ([Prince et al., 2007](#)). In a study which included over 4,500 adolescents, health be-
353 haviours were measured across several domains; diet, specifically consumption of carbonated
354 soft drinks and fast food, tobacco use and physical activity. Participants were then allocated a
355 number ranging from zero to "four or more" depending on the number of unhealthy behaviours
356 they engaged in ([Rao et al., 2015](#)). Results highlighted that participants with a score of four
357 or more were significantly more likely to be anxious, experience suicidal ideation and have
358 been involved in a physical fight, compared to those who scored zero. Analysis of over 2,400
359 Chinese college students found those who frequently consumed alcohol, had disturbed sleep,
360 poor dietary behaviour and internet addiction disorder. This was associated with significant
361 increased risk of depression and anxiety ([Ye et al., 2016](#)).

362 With respects to physical activity and mental health, research on a sample of 49 unique prospec-
363 tive studies (N=266,939), showed that physical activity protected against depression, irrespec-
364 tive of age and geographic region ([Schuch et al., 2018](#)). In a cross-sectional study of more
365 than 1 million individuals in the U.S. ([Chekroud et al., 2018](#)), exercisers displayed 43% fewer
366 days of poor mental health than non-exercisers. The authors further reported that all exercise

367 types were associated with a lower mental health burden (from 11.8% to 22.3% reduction),
368 and the activities identified with the largest associations included popular team sports (22.3%
369 lower), cycling (21.6% lower), and aerobic and gym activities (20.1% lower). Exercise dura-
370 tion of 45 minutes and frequencies of three to five times per week were associated with the
371 lowest mental health burden.

372 With respects to diet and mental health, combined data from four longitudinal studies found
373 a risk estimate of highest vs. lowest adherence to the Mediterranean diet of 0.67 (95% CI
374 0.55-.82) for incident depression (Lassale et al., 2018). The Mediterranean diet has also been
375 implicated in slowing age-related deterioration, including improvements in cognitive function
376 and reducing risk of cognitive impairment and dementia (Pettersson 2016, Aridi 2017), with
377 B-vitamins and antioxidants playing a key role (Moore et al., 2018; Castelli et al., 2018). Sev-
378 eral randomised controlled studies, showed that a modified version of the Mediterranean diet
379 reduced depression symptomology (Parletta et al., 2017) and (Opie et al., 2017). Based on
380 the evidence, dietary recommendations for the prevention of depression have been proposed;
381 adopting “traditional” diets, such as the Mediterranean diet, increasing consumption of fruits,
382 vegetables, legumes, wholegrain cereals, nuts, seeds, foods rich in omega-3 polyunsaturated
383 fatty acids and limit consumption of processed foods (Opie et al., 2017). We note here that
384 socio-structural factors (e.g. inequality and poverty) will impact on individuals capacity to
385 follow such advice (Darnton-Hill et al., 2004).

386

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

396 Critically, each of these health behaviours - physical activity, diet and sleep - have a powerful
397 impact on vagal function (Kemp et al., 2017). Thus, improving positive health behaviours is
398 a powerful means to promote health and wellbeing. As with physical activity (Sandercock et
399 al., 2005; Raffin et al., 2019) and diet (Young & Benton, 2018), changes in sleep are associ-
400 ated with changes in vagal function, such that reduced vagal function (combined baseline and
401 reactivity measures) is associated with sleep disruption (El-Sheikh, Erath, and Bagley, 2013).
402 Intriguingly, increases in resting state vagal function have been shown to predict better sub-
403 jective and objective sleep quality (Werner et al., 2015; Grimaldi et al., 2016). By contrast,
404 reduced heart rate variability (HRV) - an index of vagal functioning - has also been detected
405 during early stages of sleep-related breathing disorders (Aeschbacher et al., 2016).

406

407 In summary, we highlight a role for positive psychological experience and positive health be-

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

422 4.1 Focus on Community

423 In this section we focus on the relevance of community to individual wellbeing, a major focus
424 of our original GENIAL model (Kemp et al., 2017). Unfortunately, there is much evidence to
425 suggest that community is deteriorating (Kushlev et al., 2017; Twenge, 2013; Twenge, 2014;
426 Putnam, 2001). The reasons for this are complicated, but may involve a host of interconnected
427 societal issues including generational shifts in narcissism (Twenge, 2013; Twenge, 2014), de-
428 clines in perspective taking and empathic concern (Konrath et al., 2010), increasing individu-
429 alism (versus collectivism) in western society (Heu et al., 2018; Brewer & Chen, 2007), and
430 inequalities (Scheffer et al., 2017; Scheidel, 2017; *The Spirit Level: Why Equality is Better for*
431 *Everyone*, 2010; Nolan & Valenzuela, 2019). It is worth noting here that others (Beery et al.,
432 2015; Nurse et al., 2010) have argued that the boundaries of ‘community’ should be extended
433 to the environment (section 4.2) including soil, water, plants and animals (to facilitate love and
434 respect, and a commitment to environmental sustainability). Considering the climate crisis as
435 issue we turn to in section 4.2, it is apparent that ‘community’ in its broadest sense is under
436 threat.

437 Although we would not describe ourselves as luddites, it is worth noting that despite tech-
438 nological advancements and online connectedness, the use and engagement of social media -
439 including Facebook, Twitter and WhatsApp - is negatively associated with eudaimonic wellbe-
440 ing (as defined by the extent to which respondents felt their life to be worthwhile) (“Subjective
441 Well-being and Social Media Use in Emerging Adulthood: Findings from two UK Univer-
442 sity Millennial Cohorts.”, 2019). Interestingly, decreases in sleep quality and self-esteem were
443 also observed (“Subjective Well-being and Social Media Use in Emerging Adulthood: Findings
444 from two UK University Millennial Cohorts.”, 2019). Young adults are increasingly connected,
445 however their online activities are adversely affecting their wellbeing: these findings were as-
446 sociated with a medium effect size (observed correlations for two cohorts, $r=-.32$ and $r=-.29$).
447 In fact, research has demonstrated that use of Facebook is associated with ill-being such that
448 “links clicked” or “status updates” are associated with a decrease of 5% to 8% of a standard

449 deviation in self-reported mental health (Shakya & Christakis, 2017). Importantly, this lon-
450 gitudinal research demonstrated that while those with compromised wellbeing may be more
451 likely to use Facebook, use of the Facebook platform is associated with reduced *future wellbe-*
452 *ing*, even when controlling for initial wellbeing. Research by the same authors has also shown
453 that loneliness occurs in clusters, extends up to three degrees of separation and may spread
454 through a contagious process (Cacioppo et al., 2008), a finding leading to social contagion the-
455 ory (Christakis & Fowler, 2012). On this background and in light of the 'The Great Hack' it
456 is clear that social media companies have much to learn about promoting wellbeing and social
457 cohesion as well as the ethical management of their platforms.

458 Critically, loneliness has important impacts on health and wellbeing. A meta-analysis of stud-
459 ies on more than 300,000 participants reported that a lack of social ties are associated with
460 a 50% increased risk of premature mortality over a 7.5 year follow-up period, an effect that
461 was stronger than physical activity, smoking (15 cigarettes daily) and body mass index (Holt-
462 Lunstad et al., 2010). In a more recent study on 48,673 participants, the same researchers (Holt-
463 Lunstad et al., 2015) observed that social isolation (29%), loneliness (26%), and living alone
464 (32%) increase risk for premature mortality, reporting no differences for objective and subjec-
465 tive measures. Furthermore, greater impacts on mortality were observed among those under
466 the age of 65 years. The Japanese even have a word to describe "lonely death": 'kodokushi', a
467 phenomenon that refers to people dying without friends or family. Sometimes these individuals
468 are not found for many weeks... or months. ("Dead people don't pay their bills"). Tragically,
469 these experiences characterise the modern world, and especially individualistic cultures.

470 Social isolation and loneliness impact on a host of behavioural, psychological and physiologi-
471 cal factors. Behavioural factors include physical inactivity and smoking (Shankar et al., 2011),
472 substance use and hazardous drinking (Stickley et al., 2014), while psychological factors in-
473 clude decreases in self-esteem, increased risk of depression, and feelings of hopelessness (Step-
474 toe et al., 2004), both of which subsequently contribute to dysregulation of cardiovascular,
475 metabolic, and neuroendocrine processes (Grant et al., 2009), higher systolic blood pressure,
476 independent of several factors such as age, gender, cardiovascular risk factors, medications,
477 social support and perceived stress (Hawkey et al., 2010). The NIACT (Kemp et al., 2017) and
478 GENIAL (Kemp et al., 2017) models integrate these behavioural, psychological and physio-
479 logical factors into innovative frameworks within which pathways to health and ill-health may
480 be understood, bridging the gap between psychological moments and mortality.

481 Further to our original GENIAL model (Kemp et al., 2017), the relationship between social ties
482 and health was recently comprehensively reviewed in a book titled 'The New Psychology of
483 Health: Unlocking the Social Cure' (Haslam, 2018). Social identity theory helped to contextu-
484 alise this research which refers to people conforming to the norms of the group to which they
485 identify. Actions and thoughts of the group become the reference point for the individual, thus,
486 if an individual's perception of others in a representative group is positive, individuals of that
487 group will think and behave similarly. Peer modelling has proven to be an effective interven-
488 tion to increase fruit and vegetable intake (Horne et al., 2008), although only when modelled by
489 someone that shares the same group identity (Cruwys et al., 2012). By contrast, if an individual

490 was to identify with a group whose health behaviours are risky, they are more likely to partici-
491 pate in negative health behaviours. Research has shown there is a relationship between strength
492 of group identification and smoking status when smoking is a normal group behaviour (Schoff-
493 fild et al., 2001). Intriguingly, the more group identities an individual has, the less likely they
494 are to engage in negative health behaviours, such as cigarette smoking, alcohol consumption,
495 and use of illicit drugs (Miller et al., 2016).

496 Social identity theory provides a useful context within which to understand the influence of
497 community on the health and wellbeing of the individual. For example, social identity provides
498 meaning, purpose and worth to an individuals life (de Vroome & Hooghe, 2013; Nakamura,
499 2013; Peterson et al., 2005), the importance of which was highlighted above in our discus-
500 sion of positive psychological experiences. Social identities also facilitate the extent to which
501 others are likely to provide social support (Cohen, 2004; Levine et al., 2002; Levine et al.,
502 2005; Platow et al., 2006), and provide a sense of efficacy, agency and power to an individual,
503 contributing to the sense that ‘the whole is greater than the sum of its parts’ (Haslam et al.,
504 2018). Strikingly, research has demonstrated that cardiac and respiratory patterns synchronise
505 when members of a choir sing in unison, compared to when singing independently (Timmons
506 et al., 2015). This phenomenon of ‘physiological linkage’ may help to explain relationship
507 connectedness (Timmons et al., 2015) and the vagus nerve underpins ones capacity for con-
508 necting with others, regulating downstream allostatic systems that are also involved (e.g. the
509 hypothalamic-pituitary-adrenal axis) (Porges, 2011; Kemp et al., 2017; Kemp et al., 2017).

510 To conclude, community is important for individual health and wellbeing as it provides the en-
511 vironment in which individual health and wellbeing may be achieved. A supportive community
512 will therefore contribute to the health and wellbeing of individuals within that community, and
513 this relationship will be a bidirectional one such that improved health and wellbeing of the indi-
514 vidual will help to foster community wellbeing. It is helpful to consider the inter-connectedness
515 of individual, community and environmental wellbeing, consistent with social ecological the-
516 ory. In this regard, research not only highlights the importance of eating less meat for individual
517 health and wellbeing (Pan et al., 2011), (Micha et al., 2010), (Demeyer et al., 2016), it also
518 highlights the impacts of eating less meat to reduce adverse impacts on the environment (Poore
519 & Nemecek, 2018), reinforcing this concept of the ‘symbioment’ (Fig 2) which emphasises
520 symbiotic coexistence of all life at various scales. It is perhaps prudent to note however, that
521 although these findings (Poore & Nemecek, 2018) led to much fanfare in the media on the need
522 to ‘go vegan’ (*Avoiding meat and dairy is ‘single biggest way’ to reduce your impact on Earth,*
523 *n.d.*), other research (Peters et al., 2016) reports on findings from modelling that shows that the
524 diets with low to modest amounts of meat (the ‘omnivore diet’) actually outperform a vegan
525 diet in regards to the “carrying capacity” of an agricultural land base. The authors noted that
526 the carrying capacity of the vegan diet fell between the 60% and 40% omnivore diet options,
527 which reflect the percentage of vegetarian food consumed. These findings highlight - as al-
528 ways - that one should always be mindful of evidence-based nuance. Finally, and in closing
529 this section, we would like to highlight the relationship between individuals and community.
530 For instance, among Western cultures, positive feelings are associated with individual success,
531 high self-esteem, and good health (Heine et al., 1999; Kitayama et al., 2000; Taylor & Brown,
532 1988). In Japan however, individuals are more likely to associate happiness with negative social

533 consequences, such as jealousy and disharmony among relationships (Uchida et al., 2004). We
534 now turn our attention to the wider environment in which individuals live and work, focusing
535 on a major societal challenge to human health and wellbeing: the climate crisis.

536 4.2 Focus on the Environment

537 Psychological science has been criticised for a blinkered focus on the individual while ignoring
538 wider, systemic issues (Carlisle et al., 2009; Frawley, 2015). Critics have argued that the
539 construct of wellbeing is a socio-cultural construction of western individualism that places im-
540 portance on wealth, fame and materialistic pursuits, while neglecting our shared en-
541 vironment (Carlisle et al., 2009). These criticisms in combination with an ever-increasing body
542 of peer-reviewed literature on ‘happiness’ and ‘wellbeing’ were, in part, reason for proposing
543 our original GENIAL framework (Kemp et al., 2017), which extended theoretical frameworks
544 of individual wellbeing to community wellbeing. Here we focus on the contributions from the
545 wider environment to individual wellbeing, and on the implications for tackling the greatest so-
546 cietal challenge facing mankind: the climate. We use the term ‘environment’ in a very general
547 sense in this paper, encompassing natural as well as human-built environments, although we
548 place emphasis on the relationship between individual wellbeing and the natural environment
549 given the sheer scale of the challenge associated with the climate crisis.

550 It is now accepted in scientific circles (Intergovernmental Panel on Climate Change, 2007;
551 Intergovernmental Panel on Climate Change, 2014) that humanity will face catastrophic climate
552 change should we fail to commit to climate action. An increase in the frequency, duration
553 and intensity of extreme weather events increases risk of population distress and psychiatric
554 disorders through disruption to food supply and damage to community wellbeing (Berry et al.,
555 2009; Hayes et al., 2018). Extreme weather events have even been shown to influence the future
556 health and wellbeing of an unborn child with implications for brain development and metabolic
557 outcomes (Dancause et al., 2015; Dufoix et al., 2015). Other research has also shown that
558 climate change has increased global economic inequality by ~25% over the last 50 years, with
559 wealthy countries benefiting disproportionately (Diftenbaugh & Burke, 2019). Rising inequality
560 has been linked to the middle-class squeeze, intergenerational immobility, erosion of trust, more
561 divided societies, rising populism, poverty, crime, ill-health and ill-being. Interested readers are
562 referred to the excellent recent review by Brian Nolan and Luis Alenzuela in this regard (Nolan
563 & Valenzuela, 2019). Critically, ratings of peer-reviewed climate-science and self-ratings by
564 climate change scientists themselves has indicated that there is 97% endorsement that humans
565 are contributing to the warming climate (i.e. anthropogenic climate change) (Cook et al., 2013;
566 Cook et al., 2016). Unfortunately, this finding remains under appreciated in a brave new world
567 of alternative facts and disinformation (Lewandowsky et al., 2013; Lewandowsky et al., 2017).

568 Human beings have a strong, innate affiliation with the biological world, a phenomenon cap-
569 tured by the ‘biophilia hypothesis’. Recent research indicates that people who spend at least
570 two hours a week in nature are more likely to report good health and high levels of wellbeing
571 than those who spend no time in nature (White et al., 2019). Furthermore, these findings were
572 consistent across a variety of demographic variables including sex, age-group, occupational

573 social grade, presence of chronic illness and whether or not individuals met physical activity
 574 guidelines. Prior research had indicated that spending time in nature over a two-week period
 575 boosts hedonic as well as eudaimonic wellbeing (Howell, 2014), and that effect sizes are larger
 576 (*ds* from .37 to .63) than those reported for other positive psychology interventions (*ds* from .20
 577 to .34) (Bolier et al., 2013). Exposure to nature can lead to transcendent emotions (Bethelmy
 578 & Corraliza, 2019), peak experience (Maslow, 1964) and psychological flow (Csikszentmihalyi,
 579 2014). Interestingly, transcendent emotions - including compassion, gratitude and awe -
 580 foster healthy social relationships (Stellar et al., 2017) and such relationships are facilitated
 581 by spending time in nature (Mayer et al., 2008; Richardson et al., 2016), further highlighting
 582 the inter-connectedness between individual, community and environmental domains. Research
 583 also reports that exposure to nature is associated with stress reduction (Hansmann et al., 2007;
 584 Ulrich et al., 1991), feelings of restoration (White et al., 2013; Wyles et al., 2017), subjective
 585 wellbeing (Johansson et al., 2011; LUCK et al., 2011; White et al., 2017), and improved
 586 cognitive functioning (Berman et al., 2008; Berto, 2005). Human beings also have a strong
 587 affiliation with the local environment ('place'), driven by cultural experience (Beery et al.,
 588 2015; Sampson, 2012). This is known as the 'topophilia hypothesis'; the word topophilia
 589 combines *topos* (place) with *philia* (love). These biophilia and topophilia hypotheses provide a
 590 foundation on which to understand the distress, pain or sickness associated with environmental
 591 degradation of home or territory. Glenn (Albrecht, 2019), an Australian environmental philosopher
 592 coined the term 'solastalgia' after reflecting on the environmental impacts of open cut coal
 593 mining and pollution of local power stations on the residents of the Upper Hunter Region of
 594 NSW in Australia. He wrote that 'solastalgia' reflects a:

595 "specific form of melancholia connected to a lack of solace and intense desolation"
 596 associated with place-based distress (Albrecht, 2005).

597 Feelings of guilt, shame, fear, emotional discomfort and solastalgia have been associated with
 598 motivation to engage in environmental sustainability behaviours (Albrecht et al., 2007; Dickerson
 599 et al., 1992; Kaiser et al., 2008; Malott, 2010). In order to encourage such behaviours,
 600 scholars have proposed an 'aesthetics of elsewhere', which involves encouraging a double
 601 aesthetic judgment of 'here' and 'elsewhere' to induce an aesthetic melancholia to influence
 602 consumption decisions (Maskit, 2011). However, researchers have also begun to investigate
 603 the value of positive psychology in encouraging pro-environmental behaviours. Positive psy-
 604 chology refers to the scientific study of human flourishing and an applied approach to enabling
 605 individuals, communities and organisations to thrive (Gable & Haidt, 2005), (Sheldon & King,
 606 2001). The positive psychology of sustainability (Corral-Verdugo et al., 2014; Verdugo, 2012;
 607 O'Brien, 2016) is a strategy that may help to foster what has been described as sustainable
 608 wellbeing (Kjell, 2011). In a study on 606 undergraduate students in Mexico ("Happiness
 609 as Correlate of Sustainable Behavior", 2011), researchers reported that pro-ecological, altru-
 610 istic, frugal and equitable behaviours reflect the sustainably-oriented person, and that these
 611 behaviours have positive psychological consequences (i.e. greater happiness). A major goal
 612 of positive psychology should now be focused on developing interventions that promote pro-
 613 environmental behaviours, an effort that would have substantial benefits for the wellbeing of
 614 current and future of generations as well as the environment. In this regard, prior research has
 615 shown that individuals engaging in pro-ecological behaviours – such as resource conservation
 616 – report greater happiness (Brown & Kasser, 2005), that altruism leads to greater long-term

617 happiness (*The psychology of helping and altruism: Problems and puzzles*, 1995), and that fru-
618 gality predicts greater psychological wellbeing, satisfaction and motivation (Brown & Kasser,
619 2005). Notably however, equitable individuals have been reported to be less happy due to
620 the ‘negative hedonic impact of inequality in society’ as climate change exacerbates existing
621 inequities (Hayes et al., 2018), highlighting a need for sociostructural reforms that combat
622 various types of inequality. Importantly, (Nolan & Valenzuela, 2019) concluded that we now
623 have a window of opportunity for designing and implementing sociostructural changes through
624 strategies and policies to halt and reverse rising income and wealth inequality.

625 The grave threat of anthropogenic climate change - referring to the production of greenhouse
626 gases emitted by human activity - may help to inspire a variety of positive feelings such as
627 altruism, compassion, optimism as well as a sense of purpose “as people band together to sal-
628 vage, rebuild, and console amongst the chaos and loss of a changing climate” (Hayes et al.,
629 2018), feelings that reflect ‘active hope’ (Macy J, 2012). The concept of ‘sustainable hap-
630 piness’ (O’Brien, 2016) has been defined as “happiness that contributes to individual, com-
631 munity, and/or global well-being without exploiting other people, the environment, or future
632 generations”(O’Brien, 2010).

633 A central concept within the field of Positive Psychology is that of ‘character strengths’. In their
634 book ‘Character strengths and virtues: A handbook and classification’, (*Character strengths
635 and virtues: A hand-book and classification*, 2004) describes a framework for the identification
636 of individual cognitive, emotional, social and community strengths, protective strengths, and
637 spiritual strengths. In total (*Character strengths and virtues: A hand-book and classification*,
638 2004) describe 24 character strengths which individuals possess to more or less of a degree. A
639 structural model of the relationships between character strengths, virtues and sustainable be-
640 haviours (i.e. altruistic, frugal, equitable and pro-ecological behaviours) has been presented
641 such that all 24 character strengths are associated with all four sustainable behaviours (Corral-
642 Verdugo & Frías-Armenta, 2015). The knowledge that pro-environmental behaviours provide
643 opportunities to promote happiness and build resources for resilience, in addition to much-
644 needed environmental benefits provides a useful foundation on which psychological scientists
645 could address environmental challenges through targeted interventions focusing on the individ-
646 ual (Clayton et al., 2016; “Happiness as Correlate of Sustainable Behavior”, 2011; Verdugo,
647 2012). Recommendations included the need for psychological scientists to incorporate a con-
648 textualised or ‘place-based’ approach - including aspects of the built environment and different
649 cultures - into initiatives designed to facilitate pro-environmental behaviours and to engage in
650 more interdisciplinary research.

651 Unfortunately, the vast majority of people do not engage in pro-environmental behaviours, a
652 result of helplessness and low self-efficacy (Salomon et al., 2017). The difficulty in com-
653 prehending problems associated with climate change, and the intangibility and invisibility
654 of such change may lead individuals to ‘sit on their hands and do nothing’, a phenomenon
655 known as ‘Giddens Paradox’ (Giddens, 2009). Recent qualitative research (“Learning from
656 Co-Founders of Grassroots Initiatives: Personal Resilience, Transition, and Behavioral Change
657 – a Salutogenic Approach”, 2017) has investigated the psychological processes that foster pro-

658 environmental behaviours. Findings were interpreted in the context of ‘salutogenesis’ (Antonovsky,
659 1996), which emphasises a role for a ‘sense of coherence’ for managing and overcoming stress.
660 This ‘sense of coherence’ reflect feelings of confidence that stimuli in the (internal and exter-
661 nal) environment are comprehensible, manageable and meaningful. The researchers reported
662 that grassroots activists relied on values and attitudes, emphasising that the problems are so vast
663 that limits are imposed on knowledge (i.e. comprehensibility), arguing that emotions are a key
664 mediator between the appraisal of a situation and motivation to take action. A sense of personal
665 responsibility for change was associated with an improved perceived quality of life, attributable
666 to empowerment and social cohesion, which provides a sense of meaning and purpose in life.
667 Concrete and collective action was also observed to enhance positive emotions and mastery
668 experiences subsequently enhancing beliefs about self-efficacy (i.e. manageability) (“[Learning
669 from Co-Founders of Grassroots Initiatives: Personal Resilience, Transition, and Behavioral
670 Change – a Salutogenic Approach](#)”, 2017).

671 In summary, we have observed emerging research interest in the concepts of sustainable hap-
672 piness and wellbeing, directly linking positive psychology to concepts relating to sustainability
673 and pro-environmental behaviours. Although much work remains to be done, these efforts
674 serve to combat criticisms of psychological science relating to a blinkered focus on personal
675 happiness that ignores important societal challenges. Spending time in and caring for for the
676 natural environment may also provide an under-appreciated means to promote wellbeing that is
677 over and above the beneficial impacts of outdoor physical activity (Franco et al., 2017; Capaldi
678 et al., 2015; Bowler et al., 2010) and may even promote commitment to pro-environmental
679 behaviours, supporting efforts to combat the climate crisis.

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 (Haidt)	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.

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 et al., 2017; Kemp et al., 2017; Kemp, 2018). While our original GENIAL model highlighted the importance of positive social ties for individual health and wellbeing (Kemp et al., 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 et al., 2017; Kemp et al., 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 et al., 2019; Chakhssi et al., 2018; Sin & Lyubomirsky, 2009; White et al., 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 et al., 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 demonstrates that despite the different theories that have been proposed for wellbeing, each of these contributes to the same higher order construct of wellbeing (Goodman

721 [et al., 2017](#); [Disabato et al., 2016](#)). In other words, there are many strategies through which
722 positive psychological experience may be enhanced.

723 Other meta-analyses on health behaviours have emphasised the role of physical activity ([Chekroud](#)
724 [et al., 2018](#)), diet ([Firth et al., 2019](#)) and sleep ([Baglioni et al., 2016](#)) on our mental lives. Our
725 recent review on vagal function ([Kemp et al., 2017](#)) concluded that higher resting state vagal
726 function is associated with positive mood states, highlighting the utility of PPIs for enhancing
727 a critical regulator of health and wellbeing. Our work further emphasises the structural link be-
728 tween the vagus nerve, and physical and mental health ([Kemp et al., 2017](#); [Kemp et al., 2017](#);
729 [Kemp, 2018](#); [Kemp & Quintana, 2013](#); [Kemp, 2016](#)). It is interesting to note here that purpose
730 in life has been shown to predict allostatic load ten years later ([Zilioli et al., 2015](#)) as mea-
731 sured by the sum of seven scores across multiple physiological systems including cardiovascu-
732 lar, lipid, glucose metabolism, inflammation, autonomic function, and hypothalamic-pituitary-
733 adrenal risk scores. Unfortunately however, this study did not distinguish between upstream
734 and downstream systems driving increases in metabolic risk as we do here. Critically, vagal
735 function plays a known regulatory role over inflammatory processes, as demonstrated previ-
736 ously: ([Tracey, 2002](#)).

737 In addition to focusing on positive psychological experience and health behaviours, recent de-
738 velopments in psychological science have highlighted a key role for social relationships for the
739 health and wellbeing of the individual. Therefore, individual wellbeing may also be promoted
740 by focusing on community, the focus of our original GENIAL model ([Kemp et al., 2017](#)). The
741 implications of social relationships for the health and wellbeing of the individual were recently
742 summarised by ([Haslam, 2018](#)). ([Haslam et al., 2016](#)) evaluated a new intervention that targets
743 social isolation and disconnection, “Groups 4 Health” (G4H). Results highlighted the inter-
744 vention to improve mental health, wellbeing, and social connectedness up to 6-months post
745 intervention. In addition to this, improvements in depression, anxiety, stress, loneliness, and
746 life satisfaction correlated with heightened identification with the G4H group and with multiple
747 groups. The work by Barbara Fredrickson and colleagues is especially relevant here, empha-
748 sising the upward spiral of positive emotions, social connectedness and vagal function ([Kok &](#)
749 [Fredrickson, 2010](#); [Kok et al., 2013](#)). Other well established theories of vagal function, such as
750 the polyvagal theory ([Porges, 2011](#); [Porges, 1995](#); [Porges, 2001](#); [Porges, 2003](#); [Porges, 2007](#))
751 highlight a role for the vagus in promoting capacity to engage with others and regulating our
752 emotions during such encounters.

753 Finally, our updated model emphasises the environmental context within which individual
754 health and wellbeing is promoted and communities reside. Glenn ([Albrecht, 2019](#)) provides a
755 solid foundation for understanding the link between human emotion and the environment, coin-
756 ing numerous words to emphasise the negative and positive ‘psychoterratic’ states that have im-
757 portant implications for the health and wellbeing of individuals, communities and nations now
758 and into the future. Environmental contributors include negative and positive psychoterratic
759 states such as solastalgia (chronic place-based distress) and soliphila (a neutral political term
760 for combatting solastalgia) ([Albrecht, 2019](#)). A review of the literature on potential mechanisms
761 linking nature to health identified 21 potential pathways empirically linked to nature ([Kuo,](#)

762 2015). These pathways included environmental factors including phytoncides - antimicrobial
763 volatile organic compounds with physiological effects - and vegetation filtering of pollutants,
764 physiological factors such as elevation of vagal function and immune function, psychological
765 factors involving positive emotions and attention restoration, and behavioural factors including
766 positive health behaviours such as the promotion of physical activity and social ties. Interest-
767 ingly, this paper suggested that enhanced immune functioning might reflect a central pathway
768 for mediating the beneficial effects of nature on health. It is apparent however, that vagal
769 function plays a regulatory role over immune function via the cholinergic anti-inflammatory
770 response (Pavlov et al., 2003). Other research has shown that vagal function may be facil-
771 itated by spending time in nature. For instance, a recent review of the literature (Kondo et
772 al., 2018) on the impacts of spending time outdoors on stress reported that of 17 studies re-
773 porting on measures of HRV, 14 reported significant findings. Measures of the high frequency
774 (HF) component - a commonly reported measure of vagal function - increased for participants
775 spending time outdoors. It is relevant to note here that measures of HF HRV are generally
776 negatively correlated with measures of heart rate. That is, high levels of vagal function - as
777 typically indexed by high HF HRV - are associated with a low heart rate. Interested readers are
778 referred to recently published reference values for short-term resting-state HRV (Dantas et al.,
779 2018). Thus, it is against this background of findings that we suggest that vagal function both
780 affects and are affected by the effects of psychological experience, health behaviours, social
781 ties, as well as the environment.

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

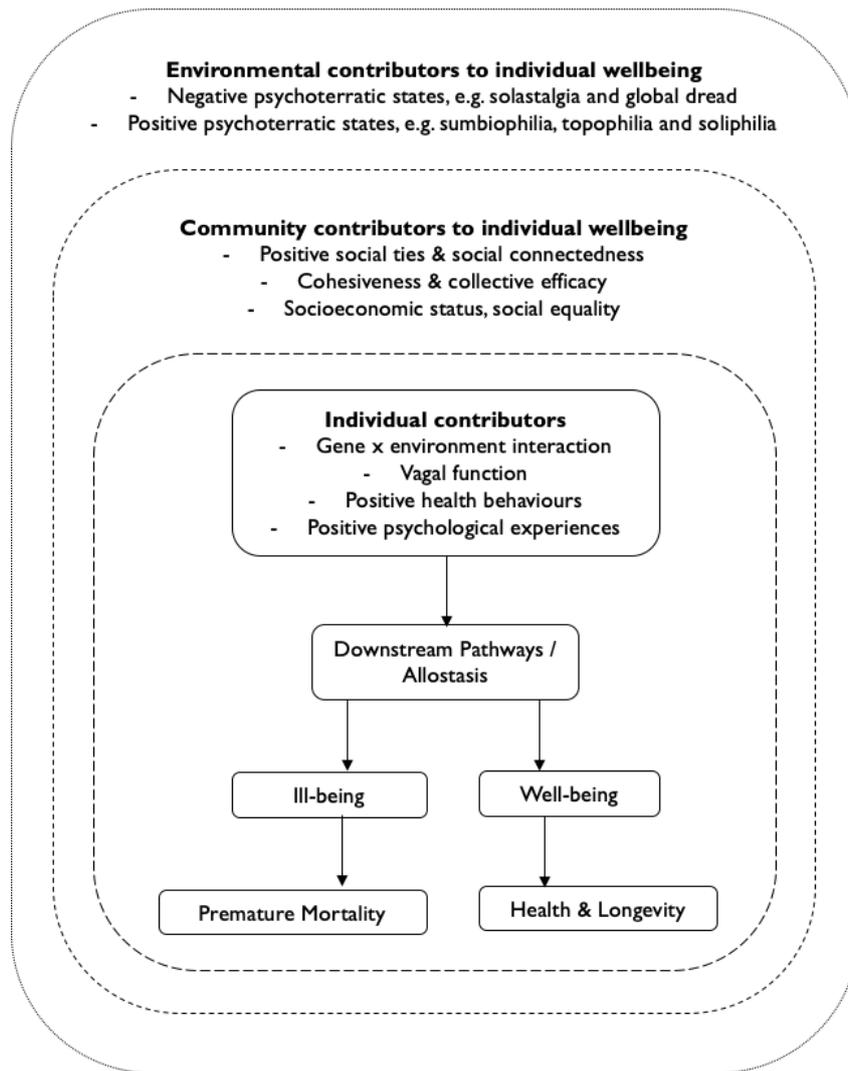


Figure 4: GENIAL 2.0: Illustrates pathways to premature mortality versus longevity within the context of community and environmental contributors to health and wellbeing. Our original paper (Kemp et al., 2017) provides a detailed review on which our life-course model was based.

6 Implications for Chronic Conditions and Non-Communicable Disease

Chronic conditions include diabetes, obesity, cardiovascular disease, cancer, chronic respiratory diseases, some neurological conditions and mental health conditions. Chronic conditions are also referred to as non-communicable disease (NCDs) (Non communicable dise...). The global burden of disease attributable to NCDs has now outstripped the burden of communicable conditions (Fig 1), a phenomenon known as the ‘epidemiological transition’. The worldwide increasing burden of chronic conditions (Fig 1), treatment gaps and treatment lag (Wang et al., 2004; PATEL et al., 2010) are major obstacles to be overcome. The treatment gap refers to the numbers of people who need treatment that are not receiving it. As an example, the treatment

798 gap for mental health disorders has been estimated to exceed 50% in all countries of the world,
799 and to reach 90% in those with less resources (PATEL et al., 2010). The amount of time taken
800 to receive mental health treatment when it does exist—treatment lag— has been estimated to
801 be longer than a decade (Wang et al., 2004).

802

803 As a function of this epidemiological transition, healthcare systems are struggling to meet
804 increasing demand (Guzman-Castillo et al., 2017). In the United Kingdom (UK), it is estimated
805 that approximately 30% of the UK population have one or more chronic conditions and that this
806 30% accounts for 70% of the spend (Department of Health, 2012). People living with chronic
807 conditions are the biggest users of the National Health Service (NHS). They are more likely
808 to see their general practitioner (accounting for approximately 50% of consultations), to be
809 admitted as inpatients and to use more inpatient days than those without such conditions (70%
810 of all inpatient bed days), and account for 64% more outpatient appointments (Department of
811 Health, 2012). Our theoretical models of health and wellbeing allow several inferences to be
812 drawn regarding health care for people with chronic conditions.

813

814 *Models of health care:* Despite the epidemiological transition, healthcare models have not
815 adapted to the changed landscape. The dominant model of health care, ‘the acute medical
816 model’ was designed to treat acute conditions. Inherent in the medical model are several as-
817 sumptions that are ‘not a good fit’ when applied to people with chronic conditions. For exam-
818 ple, the acute model is underpinned by the assumption that a person’s ‘acute problem’ can be
819 fixed and that they can be returned to a ‘pre-injury state’. However, chronic conditions cannot
820 be fixed and whereas impairment may be reduced to some extent, a healthcare approach that
821 attempts only to reduce symptoms misses opportunities to promote wellbeing. The absence of
822 illness or impairment does not equate to wellbeing, and interventions which focus only on re-
823 ducing impairment are insufficient to tackle the challenge of chronic conditions. With reference
824 to our framework we argue that by building positive psychological experiences (e.g. individ-
825 ual strengths, optimism and resilience) within a supportive social network and environment,
826 pathways to self-sustaining cycles of positive health and wellbeing may be triggered and main-
827 tained, supporting and facilitating wellbeing despite the limitations imposed by the condition.
828 Accordingly, the management of people with chronic conditions requires a holistic approach
829 both within the health service and beyond – an approach that extends beyond a) medicine which
830 by definition is the science and practice of establishing diagnosis, treatment and prevention of
831 disease; and b) the health service given major determinants of health are influenced by the
832 communities and the environment we live in. Another assumption of the medical model is that
833 patients are ‘passive recipient of care’. However, treatment outcomes for people with chronic
834 conditions are contingent on active collaboration between clinician and patient. For example,
835 adherence to treatment regimens, and adoption of recommended lifestyle changes etc. With
836 respect to interventions to promote psychological experiences, interventions cannot be ‘done
837 to the patient’ and successful outcomes depend on an active and collaborative approach.

838

839 *Organisational and institutional barriers within health services and beyond:* Epidemiological
840 studies have shown that common mental health disorders and physical diseases are strongly

841 inter-connected, highly co-morbid and share critical pathways to ill health and disease (Druss,
842 Walker, 2011), (O’Neil 2015). This evidence has been captured by the tagline: ‘there is no
843 health without mental health’ (Prince 2007). As an example, the senior author on the current re-
844 view (AHK) investigated the relationship between the mood and anxiety disorders and coronary
845 heart disease (CHD) in Brazil (Kemp 2015), observing that these common mental disorders are
846 associated with a threefold increase in CHD, after full adjustment for potentially confounding
847 factors. Common mood disorders share an underlying diathesis whereby mechanisms that pre-
848 dispose individuals to depression and anxiety for example, contribute to the development of
849 a range of chronic physical health conditions across the life span, and vice versa. While the
850 mechanisms for such a relationship are complex, our work on this topic (Kemp 2017, Kemp
851 2017a, Kemp 2018, Kemp 2013, Kemp 2016) - including our GENIAL model (Kemp 2017)
852 - have emphasised a role for vagal function as a mediating link between mental and physical
853 health (Kemp 2017, Kemp 2017a, Kemp 2018, Kemp 2013, Kemp 2016). A greater apprecia-
854 tion - and understanding - of the relationships between mental and physical illnesses and their
855 underlying mechanisms are needed so that improved interventions and treatments may be de-
856 veloped which bridge the gap between physical and mental health services. Accordingly, this
857 tight interconnection between physical and mental health needs to be reflected in the models,
858 infrastructure and commissioning of health services that support people with chronic condi-
859 tions. For example, relative to physical health conditions, mental disorders are much less
860 likely to receive treatment and this holds true across the world (Book Authors, 2009). How-
861 ever, if one considers the global burden of chronic conditions in terms of disability rather than
862 mortality, major depression is the second leading cause of disability (O’Neil et al., 2015) pre-
863 ceded only by cardiovascular disease. Moreover, there is a high degree of co-morbidity with
864 mental and physical health conditions and we know that mental ill health affects adherence
865 to treatments and prognosis (DiMatteo et al., 2002). Accordingly, the commissioning bias in
866 favour of physical health services actually disadvantages the majority of people with chronic
867 conditions given the tight linkage between physical and mental health and serves to exacerbate
868 the challenges for the prevention and amelioration of chronic conditions.

869 There are also biases in the types of interventions offered by mental and physical health services
870 (with the exception of pharmacological treatment). People with physical health difficulties are
871 typically prescribed physical health treatments. For example, people with cardiovascular dis-
872 ease (CVD) are typically advised to partake in healthier diets and physical activity. However,
873 we know that there is a strong reciprocal relationship between CVD and depression (Gasse et
874 al., 2012; Kemp et al., 2015). This bias misses several opportunities to enhance health and
875 wellbeing for people with CVD. For example, positive psychological experiences have been
876 associated with decreased risk of secondary cardiovascular events and mortality (Boehm &
877 Kubzansky, 2012); (DuBois et al., 2015). It has been argued that psychological wellbeing is
878 a modifiable protective factor that could decrease the impact of CVD through its potential in-
879 fluences on health behaviours and CVD-related biomarkers (DuBois et al., 2012); (Sin et al.,
880 2015). Conversely, mental health services typically focus on offering psychological therapies
881 in addition to medication whereas much research has shown that people with mental health con-
882 ditions have poor diets (Storlien et al., 1996), disturbed sleep (Lee 2012, Ancoli-Israel 2006),
883 lower levels of physical activity (Goodwin, 2003) and social isolation (Domènech-Abella et
884 al., 2019). Moreover, interventions that target these health behaviours significantly ameliorate

885 symptoms (Trauer et al., 2015), (Stathopoulou et al., 2006), (Opie et al., 2015; Parletta et
886 al., 2019). Given that undesirable health behaviours contribute to the aetiology and amelio-
887 ration of chronic conditions; a plethora of guidelines and recommendations regarding optimal
888 diet, physical activity etc. have been developed (for a summary, see Table 2). Often treatment
889 approaches for people with chronic conditions includes educating them about healthier life
890 choices. Despite such education, the majority of individuals fall short of pursuing a healthier
891 lifestyle (Newsom et al., 2011).

892 Evidence shows that such strategies have minimal impact upon inducing sustained change, es-
893 pecially in individuals of a lower socio-economic status (Angermayr et al., 2010). That is,
894 ‘common knowledge is not common action’. There is an inherent disconnect between what
895 people know and what they do - often referred to as the intention-behaviour gap (Sheeran,
896 2002). It is this intention-behaviour gap that creates a barrier to the uptake of evidence sur-
897 rounding well-being activities into healthcare practice (Francis et al., 2012). This is because
898 successful change requires more than education or communication of personalised risk infor-
899 mation (French et al., 2017). Accordingly, in order to better understand how to effectively target
900 health behaviours we must move beyond giving information and attempt to better understand
901 how to facilitate behavioural change. Moreover, our GENIAL framework demonstrates that
902 social relationships offer a target for intervention that is typically not exploited by the health
903 service despite research showing that a) people with chronic conditions are often socially iso-
904 lated and, b) a lack of social ties predicts premature mortality to a greater degree than physical
905 activity, smoking (15 cigarettes daily) and body mass index (Holt-Lunstad et al., 2010). Ac-
906 cordingly, interventions which seek to foster positive social ties may have much to contribute to
907 tackling the challenge of chronic conditions. This may be achieved by creating networks based
908 on collaborations between the health service and community organisations, with both parties
909 having a theoretical and applied understanding of how to create environments that promote so-
910 cial connectivity and wellbeing - we describe an example of this from our own clinical practice
911 below.

912 The original GENIAL framework highlights individual pathways to illness and premature death
913 and health, wellbeing and longevity. When negative, health behaviours, psychological experi-
914 ences and social ties (social relationships, integration and cohesion) contribute to the aetiology
915 of chronic conditions and exacerbate the condition when present. Accordingly, we have argued
916 that they should be targeted in the prevention and amelioration of chronic conditions. Given that
917 the health service is typically organised by ‘disease specific’ services as discussed above, and
918 given that health behaviours, psychological experiences and social ties offer a common target
919 for intervention across a range of diseases, we advocate for a transdiagnostic approach to man-
920 agement. That is, creating a balance between the need for disease specific ‘specialisms’, but
921 also for transdiagnostic approaches that treat some of the common diathesis that many people
922 with chronic conditions share (undesirable health behaviours, negative psychological experi-
923 ences, social isolation and exclusion). This approach would mean that people with chronic
924 conditions would be able to access interventions based on need and efficacy not diagnosis.
925 Transdiagnostic services would hold expertise in; a) interventions for optimal sleep, nutrition
926 and adapted physical activity interventions couple with an understanding of promoting be-
927 havioural change; b) links with the community to facilitate community integration and positive

928 relationships with others; c) psychological interventions to both reduce impairment, but also
929 to improve wellbeing; d) links with academic institutions to promote urgently needed cross
930 disciplinary research into effective management strategies. With a mind to the financial diffi-
931 culties facing the health service, the addition of transdiagnostic services would negate the need
932 to resource and skill-up all diagnostic specific services to deliver interventions targeting heath
933 behaviours, psychological experiences and social connectivity. Moreover, in relation to bridg-
934 ing the gap between the health service and the community, this would be difficult for diagnostic
935 services to do in reality.

936 Finally, our extended GENIAL 2.0 framework makes it clear that in order to promote the health
937 and wellbeing of entire populations, the healthcare cannot and should not shoulder the burden
938 alone. We present a range of compelling evidence that the health and wellbeing of individuals
939 are not just determined by individual factors alone, and that community and environmental de-
940 terminants of health must also be targeted to reduce the burden imposed by chronic conditions.
941 This requires a shared understanding of the problems and solutions and joined up working
942 between the healthcare services, community organisations and academia. Our own work in
943 the National Health Service has focused on re-developing our services for people living with
944 acquired brain injury. In addition to traditional impairment focused services, we are develop-
945 ing interventions to improve wellbeing, social relationships, community integration and social
946 identity in addition to some interventions that involve environmental sustainability. We are
947 doing so in collaboration with academic institutions as well as community, third sector and
948 industry organisations. This service development, based on our GENIAL framework, has ap-
949 plication across chronic conditions. We discuss our work further in the following section and
950 draw some conclusions.

951 **7 Discussion**

952 Here we have presented a modern understanding of wellbeing; one that involves ‘connection’...
953 connection to ourselves, to others and to the environment. We suggest that vagal function pro-
954 vides an important mediator of wellbeing that affects and is affected by activities to promote
955 wellbeing across these multiple domains. The vagus nerve connects us to ourselves (i.e. 80%
956 of vagal nerve fibres are afferent nerves (Agostoni et al., 1957) providing a structural link be-
957 tween mental and physical health), to others (increases in vagal function facilitate a ‘calm and
958 connect’ response promoting social connectedness, (Porges, 2011; Kemp et al., 2017; Kok et
959 al., 2013)), and to nature (vagal function is impacted on by a host of environmental factors,
960 as discussed in section 5, that will subsequently promote individual health and wellbeing).
961 Vagal function may be considered as an index of resilience, underpinned by psychological flex-
962 ibility (Kashdan & Rottenberg, 2010) that can be enhanced through a variety of interventions
963 within individual, community and environmental domains, providing a target for focused in-
964 terventions. We suggest that benefits to vagal function could be maximised by drawing upon
965 multiple interventions that span these multiple domains of wellbeing. While we have been
966 greatly influenced by the maturing discipline of positive psychology, we argue that the field has
967 been limited by a restricted focus on strategies that promote positive psychological moments

968 and experience. As recent research has argued that the impacts of positive psychological inter-
969 ventions are smaller in size than previously reported (White et al., 2019), we argue that their
970 impact could be improved by integrating interventions that also focus on physical health, which
971 we now know to have important impacts on mental - in addition to physical - health (Chekroud
972 et al., 2018). Integrating interventions within community and environmental domains will
973 likely improve the impact of interventions further. It is also important to note that wellbeing
974 can be influenced through sociostructural factors such as governmental policy, a consideration
975 highlighted in our original GENIAL model (Kemp et al., 2017) (see section 2). Our updated
976 GENIAL model (section 5) further extends beyond the individual and community, to incorpo-
977 rate the broader impacts of the environment. Mindful of previously proposed social ecological
978 theories such as Glenn Albrecht’s work on ‘Earth Emotions’ (Albrecht, 2019), which empha-
979 sise the connectedness between human emotions and the state of our natural environment, we
980 emphasise that the individual is intimately connected to the community and environment within
981 which they live, in a ‘symbioment’. In this regard it is interesting to observe calls (Bratman et
982 al., 2019) for the modification of the natural environment in ways that will promote the mental
983 health of communities, with research even demonstrating relationships between urban tree den-
984 sity and numbers of antidepressant medications prescribed (Taylor et al., 2015). Researchers
985 have also argued that sociostructural changes aimed at improving the natural environment will
986 further contribute to improvements in wellbeing through the reduction of inequalities (Bratman
987 et al., 2019). As noted earlier, income and wealth inequalities have substantial impacts on so-
988 cietal wellbeing, and this topic is now the subject of major international and interdisciplinary
989 reviews on the subject (e.g. the 5-year Deaton Review: <https://www.ifs.org.uk> funded by the
990 Nuffield Foundation).

991 Over the last few years, we have developed a novel 8-week positive psychotherapy interven-
992 tion (see table 3 for a summary of individual components) built on our innovative GENIAL
993 framework, incorporating interventions that focus on the individual, community and envi-
994 ronmental domains. Presently, we are working with university undergraduate students and
995 people living with acquired brain injury, although we are seeking to broaden our focus to
996 patients with a variety of chronic conditions including for example, diabetes, obesity, car-
997 diovascular disease, common mental disorders and their comorbidity. Interventions focus-
998 ing on the individual include activities from positive psychology (section 4.0.1) as well as
999 education relating to positive health behaviours (section 4.0.2). Interventions involving the
1000 community domain focus on building positive relationships with others in line with social
1001 identity theory (Haslam, 2018), supported by partnership working with community organi-
1002 sations, such as “Surfability” (<https://surfabilityukcic.org/>) and “Bikeability”
1003 (<https://bikeability.org.uk/>), which serve to encourage community integration
1004 (section 4.1). Finally, interventions focusing on the environment include activities such as
1005 mindful photography, as well as partnership working with the community organisation, ‘Down
1006 to Earth’ (<https://www.downtoearthproject.org.uk/>). This organisation pro-
1007 motes wellbeing in disadvantaged populations through engagement with the environment, es-
1008 pecially in regards to environmental sustainability and social ecology. For instance, our patients
1009 with acquired brain injury were recently involved in the construction of a ‘community building’
1010 using sustainable and locally sourced raw materials on the Gower Peninsula, the first place in
1011 Britain to be named an Area of Outstanding Natural Beauty. These are just some selected exam-

1012 ples to illustrate the potential to promote wellbeing in each of the domains, and we are always
1013 seeking to engage with other academic groups, health boards and community organisations to
1014 improve health and wellbeing in the community, based on strong theoretical foundations. In
1015 conclusion, we have presented a novel approach to understanding and improving wellbeing,
1016 connecting psychological science with a social ecological approach that considers the individ-
1017 ual in the context of community and the wider environment (Fig 1). Our GENIAL framework
1018 bridges the gap between psychological science and [population health health systems](#), and pro-
1019 vides a solid foundation for future research on the wellbeing of the individual as well as the
1020 communities and environments within which individuals live. In doing so, we hope that this
1021 framework and updated theoretical review helps to move the science of wellbeing forward to a
1022 more ethical and moral science that considers the wellbeing of current as well as future gener-
1023 ations, providing an evidence base for groundbreaking national polices such as the '[Well-being
1024 of Future Generations \(Wales\) Act](#)' (2015), and alerting researchers to consider the implications
1025 and context of human wellbeing in relation to major societal challenges such as the climate cri-
1026 sis. Wellbeing researchers ignore this context at their peril, and it is time that funding bodies
1027 take a more supportive stance of the transdisciplinary science that is urgently needed to achieve
1028 this goal, let alone, better understand relationships and inter-dependencies between individual,
1029 community and environmental wellbeing. We look forward to a future - well-funded - scientific
1030 effort that embraces the science of behavioural change to improve the wellbeing of not just the
1031 individual, but also of communities, and the wider environment, bearing in mind the potential
1032 positive impacts that improved community and environmental wellbeing will also have at the
1033 individual level.

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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1039 and Learning (2018). We also acknowledge the partial funding that we have received from our
1040 partner, Fieldbay, which has been used to co-fund a PhD studentship that was awarded to the
1041 first author of this manuscript (JM). Finally, we would like to express our heartfelt thanks
1042 for the support of our service users, with whom we have built and implemented our novel
1043 and innovative positive psychotherapy intervention that is based on the GENIAL theoretical
1044 framework. This intervention is now being supported by grant funding from Health and Care
1045 Research Wales through the Research for Public Patient Benefit Scheme.

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