

1 **Extinction of experience:**
2 **evidence, consequences and challenges of**
3 **loss of human-nature interactions**

4 Running title: The extinction of experience

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12

13 **ABSTRACT** (148/ about 150 words)

14 *A high proportion of people are becoming progressively less likely to have direct contact with nature*
15 *in their everyday lives. More than 20 years ago, Robert M. Pyle termed this ongoing alienation “the*
16 *extinction of experience”.* However, the phenomenon has continued to receive surprisingly limited
17 attention. Here, we present current understanding of the extinction of experience, with particular
18 emphasis on its causes and consequences, as well as suggesting future research directions. Our
19 review illustrates that the loss of interactions with nature does not just diminish a remarkable range
20 of health and wellbeing advantages, but also discourages people’s positive emotions, attitudes, and
21 behavior with regard to the environment, implying a cycle of disaffection towards nature. Such
22 serious implications highlight the significance of reconnecting people with nature, and the
23 importance of focusing research and public policy on addressing and building greater awareness
24 and better understanding of extinction of experience.

25 *Keywords: Biophilia; Ecosystem services; Green infrastructure; Outdoor recreation; Sustainability;*
26 *Urban parks*

27 **IN A NUTSHELL** (100/100words)

- 28 ● More and more people, especially children, have less and less contact with nature, an ongoing
29 alienation termed “the extinction of experience”.
- 30 ● Consequences of loss of interactions with nature include degradation of public health and
31 wellbeing, loss of emotional affinity to nature, and decline in pro-environmental attitudes and
32 behavior, implying a cycle of disaffection towards nature.
- 33 ● Researchers and policy makers need to focus more attention and efforts on planning how best to
34 reduce the extinction of experience and reconnect people with nature, which contributes greatly
35 both to achieving healthy societies and overcoming a wide range of environmental issues.

36

37 **MAIN TEXT** (3,489/ about 3,500 words)

38

39 **Escalating alienation of humanity from the natural world**

40 Humanity has for the vast majority of its existence been intimately connected with the natural world,
41 and has directly gained a broad range of benefits. However, this historical personal experience is
42 today drastically weakening. Indeed, in recent decades, in a trend being seen widely across the world,
43 more and more people, especially children, have less and less interaction with nature (Figure 1). This
44 is not simply limited to a loss of engagement with pristine or wilderness environments, but
45 comprises changes in a wide diversity of activities and experiences, including through spending time
46 in and observing urban greenspaces and their associated wildlife. Although it is difficult to pinpoint
47 exactly what has given rise to such a rapid decline in people's spontaneous outdoor activities, several
48 possible triggers have been identified including rapid growth in the number and proportion of people
49 living in urban areas (Turner *et al.* 2004; Zhang *et al.* 2014), technological advancement and the
50 emergence of sedentary pastimes, such as watching television, playing computer games, and using
51 the internet (Pergams and Zaradic 2006; Ballouard *et al.* 2011), and overscheduling and
52 micromanaging of children's lives (Clements 2004; Hofferth 2009). For the majority of people today,
53 outdoor nature experiences are vanishing and being replaced by virtual alternatives (Clements 2004;
54 Pergams and Zaradic 2006; Hofferth 2009; Ballouard *et al.* 2011).

55

56 In his memoir *The Thunder Tree*, Robert M. Pyle (1993) termed this ongoing alienation of humans
57 from nature "the extinction of experience", and argued that this "*is not just about losing the personal*
58 *benefits of the natural high. It also implies a cycle of disaffection that can have disastrous*
59 *consequences.*" Looking back to his childhood experiences near the suburbs of Denver, Colorado, he
60 emphasized that direct, personal contact with nearby nature (even that of a "ditch") is vital to forge a
61 person's emotional intimacy with nature, which is never replaced by other vicarious experiences
62 (Pyle 1993). Nabhan and Antoine (1993) have also warned that "*children's very ability to perceive*
63 *the environment may be diminished by replacement of multisensory experience richly textured*

64 *landscapes with two-dimensional world of books or the audiovisual world of TV, videos, and*
65 *movies*". From an evolutionary perspective, Wilson (1984, 1993) further argued that human's have a
66 deep and intimate emotional tendency to affiliate with nature, particularly its living biota, because it
67 is rooted in our biology. He proposed that, as humans have for a long time evolved with (and been
68 part of) nature, we still show inherited earlier adaptations and are likely to function well when we
69 interact with nature, the so-called *Biophilia hypothesis* (Wilson 1993). In a similar vein, Kellert
70 (2002) observed that society has become "*so estranged from its natural origins, it has failed to*
71 *recognize our species' basic dependence on nature as a condition of growth and development.*"

72

73 Over the decades since its conception, researchers from a wide range of disciplines have provided
74 evidence showing serious consequences of extinction of experience. Those who do not directly
75 interact with nature are likely to lose substantial health and wellbeing advantages (Keniger *et al.*
76 2013; Shanahan *et al.* 2015), are less likely to perceive the benefits that it brings and positively to
77 value it (Bixler *et al.* 2002; Ewert *et al.* 2005), and are less motivated to want to visit and protect it
78 (Wells and Lekies 2006; Ward Thompson *et al.* 2008). In consequence, extinction of experience has
79 increasingly been seen both as a major public health issue (Groenewegen *et al.* 2012; Shanahan *et al.*
80 2015) and one of the most fundamental obstacles to halting and reversing global environmental
81 degradation (Miller 2005; Balmford and Cowling 2006). Despite increasing awareness of the
82 extinction of experience, however, it is astonishing how little is known about the phenomenon.
83 Indeed, although there is a growing literature that concerns the loss of human-nature interactions, the
84 majority of attention to date has been paid to the health and wellbeing benefits of nature (Keniger *et*
85 *al.* 2013; Hartig *et al.* 2014; Shanahan *et al.* 2015). A more comprehensive discussion is still wanting.
86 Here, we present the current state of understanding (with particular emphasis on the causes and
87 consequences of the loss of human-nature interactions), summarize key previous findings, and
88 suggest future research directions. In so doing we consider a wide diversity of types of human-nature
89 interactions, and assume that the "experience of nature" of concern is not limited to engagement with
90 pristine or wilderness nature, but includes, for example, urban parks (Lin *et al.* 2014), planted

91 vegetation (Kardan *et al.* 2015), and allotments (van den Verg *et al.* 2010).

92

93 **Causes**

94 **Loss of opportunity.** Arguably, the root driver of the loss of human-nature interactions is the loss of
95 opportunity to experience nature (Figures 2a and 3a). Over the past half century humans have rapidly
96 concentrated themselves and their activities into urban areas where a high proportion of space is
97 composed of artificial material and is segregated from natural systems and processes (Turner *et al.*
98 2004; Grimm *et al.* 2008). There is plenty of evidence that people living in areas with lesser amounts
99 of, and who are further from, natural environments interact with nature less frequently (Figure 2a;
100 e.g. Neuvonen *et al.* 2007; Soga *et al.* in press). In China, for example, a survey of more than 1,000
101 elementary school students clearly demonstrated that those living in rural environments more
102 frequently visited neighborhood natural environments than did those living in city centres, and
103 participated in a wide range of nature-based activities (Zhang *et al.* 2014). Impoverishment of local
104 flora and fauna also endangers people's opportunities to experience nature, as neighborhood
105 environments are the only ones in which many people encounter nature in their daily lives (Turner *et*
106 *al.* 2004; Samways 2007). Indeed, Kai *et al.* (2014) recently suggested that extirpation of local
107 woodland birds in SW China eroded local people's knowledge of these species, especially amongst
108 younger generations who cannot experience the sights and sounds of these birds directly.

109

110 **Loss of orientation.** Not only the opportunity to interact with nature, but the loss of people's
111 positive orientation towards engaging with it - their emotional affinity with nature - is an important
112 cause of the loss of human-nature interactions (Figures 2b and 3b). Developing a variety of
113 methodologies and measures (e.g. The Connectedness to Nature Scale, The Nature Relatedness
114 Scale), researchers have reported a positive relationship between levels of people's emotional
115 connectedness to nature and the frequency of their visits to natural environments (Mayer and Frantz
116 2004; Nisbet *et al.* 2009). Cheng and Monroe (2012), for example, observed that those with a strong
117 emotional connectedness to nature reported being more likely to spend time in nature, suggesting

118 that the more one has an orientation towards nature, the greater one's motivations and intentions to
119 use it.

120

121 Although the relative contribution of orientation to the loss of interactions with nature is still poorly
122 understood, recent studies indicate that its influence on people's use of nature is long-lasting and is
123 comparable to, and sometimes stronger than, that of opportunity. For example, Hinds and Sparks
124 (2008) and Ward Thompson *et al.* (2008) have demonstrated that greater frequency of exposure to
125 nature in childhood enhances a person's feeling of being emotionally connected with nature, which
126 positively affects their intentions to visit nature. In Brisbane, Australia, Lin *et al.* (2014) also found
127 that the frequency of people's use of urban greenspace was driven more by levels of emotional
128 connectedness to nature than neighborhood greenspace coverage. Since completely different
129 measures are required to deal with the loss of opportunity and of orientation, more research should
130 investigate their relative importance and interaction.

131

132 **Consequences**

133 Researchers have explored the consequences of the loss of daily contact with nature, which can be
134 roughly categorized into four types: changes in (1) health and wellbeing, (2) emotions, (3) attitudes,
135 and (4) behavior towards nature (Figures 2, 4, and 5). Although not mutually exclusive, here for
136 convenience we discuss these separately.

137

138 **Health and wellbeing changes.** The most immediate outcome of the loss of interactions with nature
139 is the loss of the associated health and wellbeing benefits (Figures 2c and 4). Indeed, Keniger *et al.*
140 (2013) and Hartig *et al.* (2014) have identified a remarkable range of such benefits. Studies have
141 provided evidence showing a positive relationship between levels of exposure to nature and those of
142 physical health and psychological wellbeing (Figure 4, a and b; van den Berg *et al.* 2010; Kardan *et*
143 *al.* 2015), and social cohesion (Figure 4c; Sugiyama *et al.* 2008). Whilst the majority of such
144 analyses have examined short-term health benefits, recent studies have documented long-lasting

145 influences, such as on diabetes (Lachowycz and Jones 2011), circulatory and heart disease (Maas *et*
146 *al.* 2009), and longevity (Takano *et al.* 2002). Additionally, it has long been held that regular contact
147 with nature is vital for children’s social, emotional, cognitive, and motor development (Keniger *et al.*
148 2013; Dadvand *et al.* 2015). Hence, overall, it is widely acknowledged that, much like a vitamin, a
149 regular dose of exposure to natural environments is a necessary ingredient for a healthy life
150 (so-called “Vitamin G”), and can in some instances be equally as effective as more conventional
151 forms of medical treatment (Groenewegen *et al.* 2006; Shanahan *et al.* 2015).

152

153 **Emotional changes.** Not only does the loss of interactions with nature undermine human health and
154 wellbeing, it also changes people’s emotions towards nature, including their affinity to, interest in,
155 and love of nature (Figures 2d and 5a). In the U.S., Bixler *et al.* (2002) showed that recreational play
156 in wild natural environments in childhood positively influenced people’s later interest in natural
157 environments and outdoor recreation activities. In the U.K., Hinds and Sparks (2008) reported that
158 survey respondents who had grown up in rural environments exhibited more positive emotional
159 connections to nature than those from urban environments (Figure 5a). Zhang *et al.* (2014) also
160 observed that exposure to natural environments and direct contact with nature decreased people’s
161 *Biophobia*, i.e. the fear of and aversion to nature. Importantly, these positive emotional changes
162 towards nature are not only triggers for environmental attitudes and behavior, but they are also
163 closely associated with mental health and wellbeing, such as vitality and life satisfaction (Figure 2e;
164 see also Capaldi *et al.* 2014).

165

166 **Attitudinal changes.** Evidence shows that loss of interactions with nature changes people’s attitudes
167 towards nature, including the values they place on it, beliefs concerning the environment,
168 environmental ethical norms, and their willingness to protect nature (Figures 2f and 5b). Based on an
169 interview study of 576 university undergraduate students, Ewert *et al.* (2005) showed that the current
170 beliefs of adults concerning the environment are associated with participation in early-life outdoor
171 activities. Among 1,002 U.S. citizens, Wells and Lekies (2006) reported that childhood activities in

172 natural environments (e.g. hiking or playing in the woods or planting trees or seeds) had a positive
173 effect on adult environmental attitudes (Figures 5b). In Hong Kong, Lo and Jim (2010) demonstrated
174 that people's willingness to pay for recovering the loss of neighborhood greenspace was
175 significantly positively related to the frequency of their greenspace visits. Importantly, it has also
176 been shown that not only regular contacts with nature, but even a few days of outdoor experience
177 could have long-term effects on children's emotional affinity with nature, ecological beliefs and
178 knowledge, and willingness to display pro-environmental behavior (e.g. Collado *et al.* 2013).

179

180 **Behavioral changes.** Loss of interactions with nature changes people's behavior towards nature,
181 such as their participation in environmentally friendly activities (Figures 2g and 5b). In the U.S.,
182 Nord *et al.* (1998) demonstrated that participation in forest recreational activities (e.g. hiking,
183 birdwatching, fishing) had a positive influence on a wide range of pro-environmental behaviors,
184 including donation to nature protection, environmentally conscious consumption, and voting for a
185 candidate who was committed to the environment. Wells and Lekies (2006) also reported that the
186 frequency of participating in nature-related activities in childhood has a significant positive influence
187 on current levels of participation in pro-environmental behavior (e.g. recycling) (Figure 5b). In Spain,
188 Collado *et al.* (2015) showed that children who participated in environmental actions (e.g. recycling,
189 saving water and energy) used natural environments more frequently than those who did not. These
190 behavioral changes are mediated by the health and wellbeing, emotional, and attitudinal changes
191 mentioned above (Figure 2h-k). Wells and Lekies (2006) and Collado *et al.* (2015), for example,
192 observed that nature experience has both direct and indirect (i.e. through environmental attitudes)
193 influences on the levels of participation in pro-environment behaviour, suggesting close associations
194 among people's emotional connectedness to nature, their environmentalism, and environmental
195 friendly actions. Doubtless, complex associations exist amongst health and wellbeing, emotion,
196 attitudes, and behavior towards nature.

197

198 **Feedback loops**

199 Unfortunately, there are likely to be several feedback pathways by which the consequences of loss of
200 human-nature interactions cause further disaffection and apathy towards nature, through loss of
201 orientation and opportunity (Figure 2). First, not surprisingly, changes in an individual's emotions
202 towards nature, such as a loss of emotional affinity to, love of, and interest in nature, may decrease
203 their future personal orientation towards engaging with nature. It has been reported that direct
204 experience of nature increases people's further willingness to visit and be in nature, sometimes after
205 several decades (e.g. Bixler *et al.* 2002; Ward Thompson *et al.* 2008). Second, erosion of an
206 individual's nature orientation also influences that of other individuals, especially those in younger
207 (and ultimately future) generations. Indeed, the levels of children's emotional affinity to and
208 experiences of nature are likely to be influenced by the beliefs and lifestyles of other members of the
209 society to which they belong, including family, peers, and school teachers (Milligan and Bingley
210 2007; Cheng and Monroe 2012). Third, changes in public attitudes towards nature, i.e. people's loss
211 of value of nature and of environmental norms and concerns, may also lead to further loss of
212 opportunity to experience nature. To quote Miller (2005), "[i]f people no longer value nature or see
213 it as relevant to their lives, will they be willing to invest in its protection?". Dallimer *et al.* (2014)
214 reported that people's environmental attitudes (willingness to pay for biodiversity enhancement)
215 were positively related to self-reported psychological wellbeing benefits derived from nature.
216 Through this feedback loop, unfortunately, publically acceptable standards with regard to
217 environmental health may also decline, as most people measure the normal state of the environment
218 against the best that they remember from their early years ("shifting environmental and cognitive
219 baselines"; Lozano-Montes *et al.* 2008). Lastly, and obviously, a decline in positive behavior to the
220 environment, such as recycling, environmentally conscious consumption, and donation for nature
221 protection, may also reduce opportunity of experience nature more directly.

222

223 **Reducing the extinction of experience**

224 Given the substantial benefits of interactions with nature for human health and wellbeing, it is
225 important to limit, and reverse, the extinction of experience and the associated negative feedback

226 loops (Keniger *et al.* 2013; Hartig *et al.* 2014). It is also argued that if there is to be broad-based
227 public support to overcome global anthropogenic environmental pressures it is vital to provide
228 opportunities for people to experience nature on a daily basis so as to forge their emotional ties to
229 nature (Miller 2005; Balmford and Cowling 2006).

230

231 **Increasing the opportunity.** Arguably the simplest approach to reduce the extinction of experience,
232 and reconnect people to nature, is to increase their opportunity to interact directly with nature by
233 providing more green infrastructure in the towns and cities where the majority of people live or work
234 (Shanahan *et al.* 2015; Soga *et al.* in press). Indeed, the level of outdoor physical exercise that
235 people take and their exposure to nature tend to be positively associated with the amount of
236 neighborhood urban greenspace (e.g. Neuvonen *et al.* 2007; Soga *et al.* in press). Key is that these
237 natural places must be located such that they are easily accessible from people's homes and be
238 designed in such a way that they can be reached on foot or by bicycle (Soga *et al.* in press).
239 Increasingly, both the amount of, and proximity to urban greenspace are reflected in public policy
240 commitments. In the U.K., for example, Natural England (a government body) recommends that
241 everyone should have accessible natural greenspaces of at least 2 ha within 300m from their home
242 (available via www.naturalengland.org.uk/). In Australia, a national campaign called "The 202020
243 Vision" aims to increase urban greenspace in Australia by 20% by 2020 (available via
244 202020vision.com.au/). To frame such recommendations, campaigns and actions as optimally as
245 possible, there is an urgent need to determine how much greenspace is sufficient to attain particular
246 public health and wellbeing outcomes and the form of dose-response relationships between these
247 variables (Shanahan *et al.* 2015).

248

249 As well as traditional parks and managed playgrounds, lightly-managed natural environments (i.e.
250 areas managed for nature) also have an important role in reducing the extinction of experience, as
251 such high-quality natural environments provide urban dwellers with memorable experiences, which
252 may enhance their emotional attachment to, and further motivation to visit, nature (Bixler *et al.*

253 2002). Also importantly, these natural environments in close proximity to the built environments
254 could provide an additional opportunity to experience nature for urban dwellers, as some wildlife
255 species would spill out from them into residential areas. Hence, even if in small and scattered pieces,
256 preserving and restoring greenspace managed for nature in urban areas would be beneficial not only
257 for biodiversity conservation itself, but also for rescuing the extinction of experience (Pyle 1993;
258 Samways 2007), although these experiences can be both positive and negative.

259

260 **Increasing the orientation.** Unfortunately, in many cases merely increasing the opportunity for
261 interacting with nature will be inadequate for redressing the extinction of experience, although city
262 planning has previously commonly employed area-based targets as a means to get people to visit
263 greenspace. A significant number of people are not likely to use neighborhood natural environments
264 even if these areas have a high aesthetic and recreational value and are available close to their homes
265 (Lin *et al.* 2014). This clearly highlights that to get people to interact with nature, and receive a
266 variety of benefits from it, we need to enhance both opportunity and orientation components in
267 tandem.

268

269 Both theory and evidence have suggested that an individual's orientation towards nature is
270 encouraged by regular outdoor play during childhood (Kals *et al.* 1999; Bixler *et al.* 2002; Ward
271 Thompson *et al.* 2008). This first requires parents to encourage their children to spend plenty of time
272 in outdoor recreational activities, especially unstructured, freely-chosen play (Vadala *et al.* 2007).
273 Broader environmental and policy changes are also needed (e.g. social marketing campaigns and
274 educational and outreach programs). Indeed, in response to increased societal attention to
275 nature-deficit phenomena, and consequences thereof, public policies and agencies are today focusing
276 efforts toward developing children's emotional affinity to nature. The National Environmental
277 Education Foundation, for example, has a national "Children in Nature Initiative", which is aimed at
278 encouraging children and families to participate in outdoor recreation activities for physical and
279 mental health benefits (available via www.neefusa.org/). In order to make these policies more

280 effective, future research ought to examine in more detail how long influences of childhood
281 experience of interacting with nature last and whether past experience of nature has cumulative
282 effects.

283

284 Although much attention is being focused on childhood experiences, people's orientation towards
285 nature is also likely to be reinforced by adulthood experiences of directly interacting with nature.
286 Indeed, Scott *et al.* (2014) recently observed that adults' participation in nature-based activities
287 enhances their emotional ties to nature, which in turn affects their self-reported individual
288 pro-environmental behaviors. Falxa-Raymond *et al.* (2013) also pointed out that green job training
289 can reinforce young adults' positive attitudes and behavior to the environment. Given these potential
290 implications, future policy should pay more attention to adult-oriented social marketing campaigns
291 and nature-based job training programs.

292

293 **In conclusion**

294 This review has highlighted that interaction with nature is beneficial, and even vital, in maintaining
295 human quality of life and in reducing the challenges of a wide range of physical and mental diseases
296 and illnesses. Doubtless, urban nature plays a central role in reducing extinction of experience and
297 reconnecting humans with nature (Miller 2005; Shanahan *et al.* 2015; Soga *et al.* in press).
298 Nevertheless, the majority of people, even those participating in city planning and policy making,
299 still often consider that urban greenspace, and other natural components in residential areas, are a
300 luxury rather than a necessity (Groenewegen *et al.* 2006). In order to bridge this knowledge gap,
301 more attention must be paid to conveying the significance of experiencing nature to a larger
302 audience. By participating in broad-based partnerships with policy makers, city planners, educational
303 professionals, and local citizens, researchers can further contribute greatly to reducing the extinction
304 of experience.

305

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421

Figure legends

Figure 1. Empirical evidence demonstrating that today's children spend less time in outdoor nature experiences, compared with the previous generation. Data from (a) the U.K. (England Marketing 2009), (b) the U.S. (Clements 2004), (c, d) the U.S. (Hofferth 2009), (e, f) Japan ((e) Report to Ministry of the Environment, available via www.env.go.jp/ and (f) Report to Cabinet Office, Government of Japan, available via www.cao.go.jp/), (g) the U.S. (Report to Minnesota Department of Natural Resources, available via www.dnr.state.mn.us/), and (h) the U.S. (Report to National Park Service, available via www.nps.gov/), respectively.

Figure 2. The causes (opportunity and orientation) and consequences (changes in health and wellbeing and emotions, attitudes, and behavior towards nature) of extinction of experience, i.e. loss of interactions with nature, and potential pathways among them. Each letter (a to k) is cited in the main text. Extinction of experience can have a feedback loop in which the consequences accelerate further loss of interactions with nature. Note that this schematic diagram does not necessarily represent all potential factors and processes.

Figure 3. Causes of loss of interactions with nature. (a) Effects of opportunity to experience nature (distance to greenspace) on the frequency of contact with nature reported in Finland (Neuvonen et al. 2007). (b) Effects of orientation towards nature (measured by Nature Relatedness Scale, see Nisbet et al. 2009) on the frequency of visits to urban parks reported in Australia (Lin et al. 2014).

Figure 4. Health and wellbeing changes due to loss of interactions with nature. (a) Physical health (physical constraints) and (b) psychological wellbeing (life satisfaction) reported in the Netherlands (van den Berg et al. 2010). (c) Social health (social coherence scores) reported in Australia (Sugiyama et al. 2008). Exposure to nature was measured by (a, b) participation in allotment gardening and (c) levels of neighborhood greenspace. In the panels (a) and (b),

“neighbors” means the control group (i.e. those who did not participate in allotment gardening). Higher scores of physical constraints, life satisfaction, and social coherence mean higher levels of physical constraints, life satisfaction, and emotional connectedness with neighborhood communities, respectively.

Figure 5. *Emotional, attitudinal, and behavioral changes due to loss of interactions with nature. (a) Emotional change (affective connection with nature) reported in the U.K. (Hinds and Sparks 2008). (b) Attitudinal and behavioral change (levels of environmentalism and participation in pro-environmental behavior) reported in the U.S. (Wells and Lekies 2006). Exposure to nature was measured by (a) childhood environments and (b) participation in nature-based activities in childhood. Higher scores of affective connection mean higher levels of individual’s emotional affinity to nature. Values on panel (b) mean standardized effect size of participation in nature-based activities in childhood and environmental attitudes on pro-environmental behavior estimated by structural equation modeling (see more details in Wells and Lekies 2006).*

Fig. 1

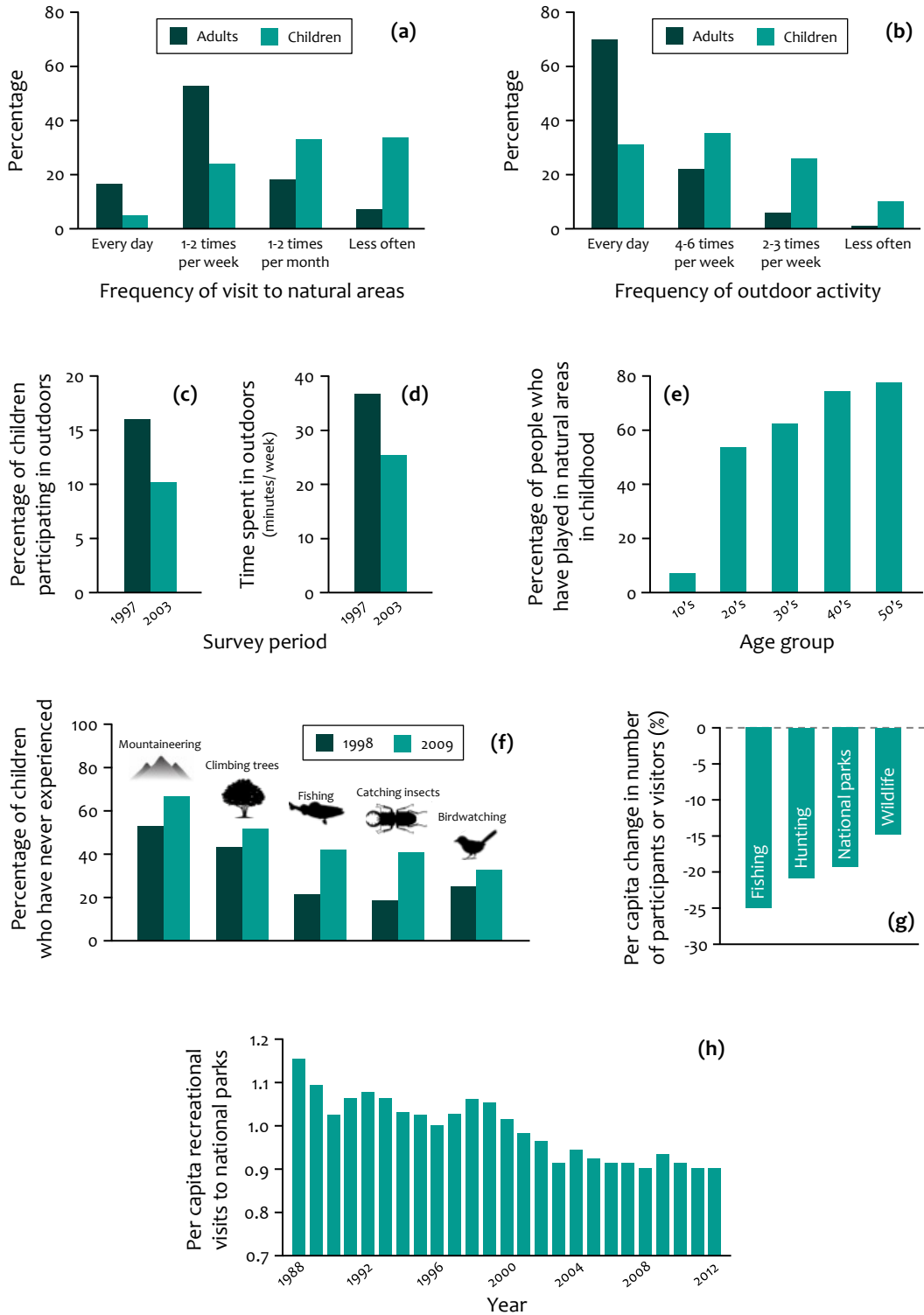


Fig. 2

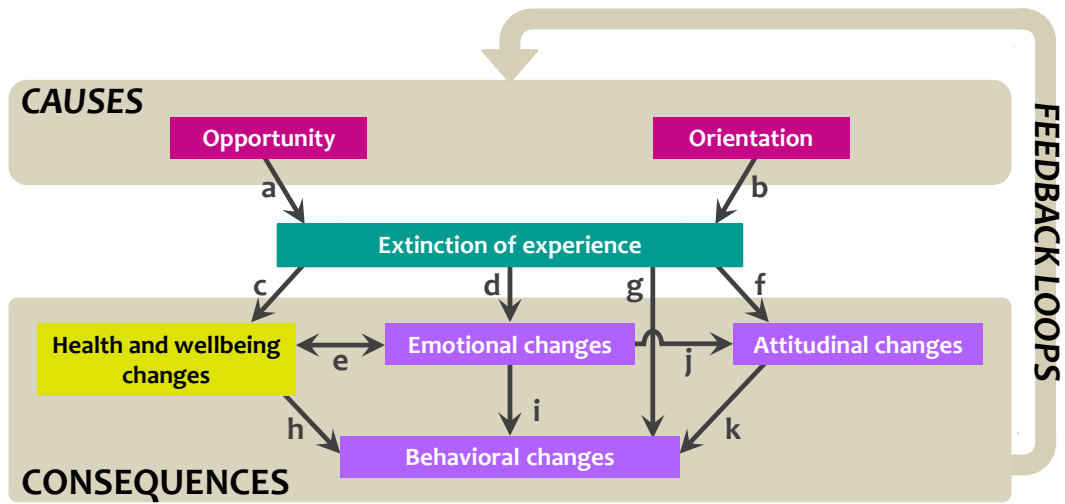


Fig. 3

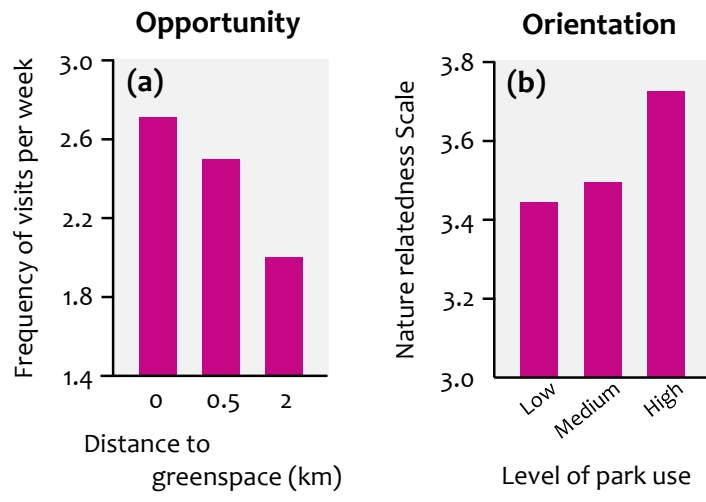


Fig. 4

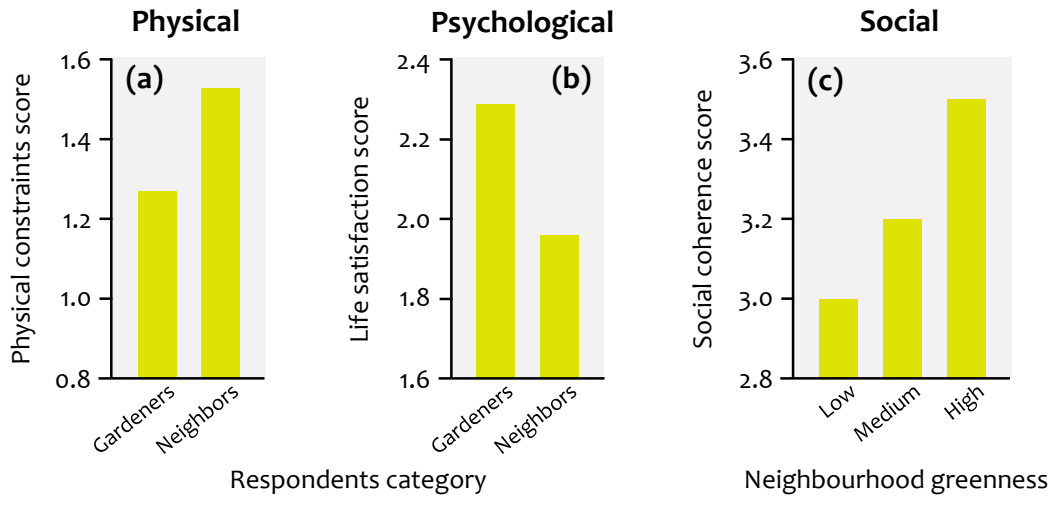


Fig. 5

