The Happiness Pulse – A Measure of Individual Wellbeing at a City Scale: Development and Validation

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Abstract

As part of the Happy City Index Project, Happy City have developed a survey instrument intended to measure citizens' experienced wellbeing – how people are feeling and functioning in their everyday lives. The survey instrument – called the "Happiness Pulse" – was developed in partnership with the New Economics Foundation (NEF) with the dual aim of collecting citywide wellbeing data and engaging individuals and communities in the measurement and promotion of their own wellbeing. The Happiness Pulse domains and items were selected through a review of the academic literature and a stakeholder engagement process, including local policy makers, community organisations and individuals. Three domains of wellbeing were identified: Being, Doing and Connecting. Items were collated from existing surveys and new items were developed.

The Happiness Pulse was included in the Bristol pilot of the Happy City Index (n=722). The experienced wellbeing items were subjected to factor analysis. A reduced number of items to be included in a revised scale for future data collection were again entered into a factor analysis. These revised factors were tested for reliability and validity.

Among items to be included in a revised scale for future data collection three factors emerged: 'Be', 'Do' and 'Connect'. The 'Be' factor had good reliability, convergent and criterion validity. The 'Do' factor had good discriminant validity. The 'Connect' factor had adequate reliability and good discriminant and criterion validity. Some age, gender and socioeconomic differentiation was found.

The properties of a new scale to measure experienced wellbeing, intended for use by municipal authorities, have been described. The scale can be benchmarked against other surveys and includes items intended to measure Being, Doing and Connecting and the 'Five Ways to Wellbeing'. Citywide data from the Happiness Pulse can be combined with local data on wellbeing conditions to determine what matters for people's wellbeing across a city and why.

1. Introduction

The success, or otherwise, of urban environments has traditionally been conceptualised through the use of material consumption indicators. Measures such as GDP, economic growth, and employment creation have previously been promoted as a means to measure progress (Fleurbaey 2009). However, more recently, the focus has shifted away from the economic domain into the wider framework of happiness and more especially wellbeing (Whitmee et al. 2015).

A number of academic wellbeing frameworks have been developed over the past 20 years. These frameworks differ to the extent to which they view wellbeing as having either 'objective', 'subjective' or 'behavioural' components. For instance, the capabilities and functioning approach views wellbeing as largely objective: the capability to achieve a good standard of living (Anand et al. 2009; Anand and Sen 1994; Sen 2008). In contrast, the positive mental state approach views wellbeing as largely subjective, consisting both evaluative and experiential aspects (WHO Regional Office for Europe 2013c; Dolan and Metcalfe 2012; Huppert and So 2013): "psychological functioning and affective states" (WHO Regional Office for Europe 2013c) and "a comparison of life circumstances with social norms and values" (WHO Regional Office for Europe 2012).

The New Economics Foundation (NEF), the UK's leading think tank promoting social, economic and environmental justice, describes wellbeing as having two components, one subjective and one behavioural: feeling good and functioning well (NEF 2008). The UK Government commissioned NEF, as part of the mental capital and wellbeing project (Government Office for Science 2008), to conduct an extensive literature review in order devise a set of actions that enhance an individual's personal well-being; NEF compiled a list of five ways to achieve wellbeing (NEF 2008). The first is 'connect' because more developed social networks are associated with reduced levels of mental illness; the second is 'be active' because physical activity is associated with feelings of wellbeing, reduced depression and may have a protective effect against future mental illness; the third is take notice as mindfulness has been associated with better mental health and ability to be make health promoting decisions; the fourth is 'keep learning' as goal setting and attainment can increase self esteem and wellbeing and the fifth is 'give'. Reciprocity provides meaning, happiness and volunteering can enhance social networks (NEF 2009).

Although the 'Beyond GDP' movement (Eurostat 2010; Fleurbaey 2009) has significantly developed on a national level, it has not done so on a local level. The Happy City Project[1], based in the city of Bristol (UK) seeks to extend the 'Beyond GDP' approach into local neighbourhoods and implement a step change in the city away from material consumption towards promoting well-being. A major part of this project is the development of a tailored city measure of wellbeing. Happy City and NEF (NEF undated), guided by the subjective/objective dichotomy approach, describe subjective aspects as 'experienced wellbeing' and objective aspects as 'drivers of wellbeing' in order to make the terms more user friendly (note that for other authors sometimes the term 'experienced wellbeing' is restricted to, particularly short term, emotional responses (Panel on Measuring Subjective Well-Being in a Policy-Relevant Framework et al. 2013) whereas here it is used interchangeably with subjective wellbeing). Drivers of wellbeing, such as availability of green space or local crime rates, form part of the Happy City index framework, but are described elsewhere. In this paper the focus is on the development of 'The Happiness Pulse', a survey instrument which cities can use to measure the experienced wellbeing of their population.

The aims of this paper are to:

1) describe the methodology through which the Happiness Pulse survey instrument was developed
2) describe the factor structure of the Happiness Pulse
3) revise the items in Happiness Pulse for future use and present the factor structure of this revised scale

[1] The Happy City Project is a charity working in collaboration with the New Economics Foundation (NEF) and the University of Bristol.

4) analyse the reliability and convergent, discriminant and criterion validity (through ability to distinguish between sociodemographic characteristics) of the revised Happiness Pulse

2. Methodology

The Happiness Pulse was constructed following an approach to scale development proposed by Churchill (Churchill and Gilbert 1979). The approach involves the following steps:

1) Specifying the domain: a domain or construct is specified (here the domain is experienced wellbeing). Methods to do so included a review of the literature and extensive consultations.
2) Generation of the sample of items: items for the domain are collected or created. Generation in this case was again through a review of the literature and consultations. The items are put together as a scale
3) Data collection: The scale is added to a questionnaire and data is collected
4) Purification: the scale is amended or 'purified'. Techniques used for purification include factor analysis and reliability analysis. However given concerns with the overreliance in the past on statistical techniques (Tavakol and Dennick 2011; Rossiter 2002), the results of these techniques were used as a guide rather than as definitive. Additionally construct validity is assessed through, for example, correlations with other measures.

2.1 Specifying the domain of wellbeing for the Happy City Wellbeing Index Framework including the domain of experienced wellbeing for the Happiness Pulse survey instrument.

In order to develop a measure of wellbeing it was initially necessary to identify how wellbeing is defined and its constituents. Two approaches were taken: firstly, an extensive review of literature and policy reports was conducted; secondly Happy City instigated an extensive consultation over a three year period working firstly with local communities through running community events and secondly working with local policy makers. As part of this consultation, interviews were conducted with six key stakeholders from Bristol City Council (representatives from the Strategy team, Public Health, Sustainability and Quality of Life Survey) and two focus groups with community organizations and a major housing association were conducted. These provided further information on what needed to be measured and how, and who would use the measures.

2.2 Generation of the sample of items for the Happiness Pulse

The main consideration in selecting survey items was to cover a substantial amount of *breadth* in experienced well-being but using as few items as possible. Items were found from existing surveys or created that would cover the domain of experienced wellbeing which had been specified (see section 3.1). In addition to their topic, survey items were included on the basis of three main considerations: comparability, performance and intelligibility. Comparability refers to whether the indicators were part of large national datasets to which Happiness Pulse data could be compared. Performance refers to whether the indicators were the best of their kind available (for example whether there was significant variation in response categories in previous surveys). Intelligibility concerns whether the indicators made sense to general members of the public taking the survey. In deciding between these factors, the intelligibility factor was often considered to be the most important, in order to achieve the aim of engaging people in measuring their own well-being using the online survey.

The final list of items were selected after consultation with the Happy City Advisory Board. The board includes representatives from Bristol City Council, Bristol community organisations and housing associations, the University of Bristol, the Office of National Statistics Measuring Wellbeing Programme and the University of Cambridge Wellbeing Institute.

2.3 Data Collection for the Happiness Pulse

The items identified to measure experienced wellbeing (see section 3.2) were included in a survey. Online, postal, telephone and face to face methodologies for data collection were considered. The main distribution method chosen was an online survey due to advantages of reduced cost, self-completion and the growth of use of the internet. The web survey sampling frame consisted of the DLG commercial mailing list of 55,000 people; the AskBristol council mailing list of 12,000 people and community organisations[2] with combined access to up to 2000 people. Paper questionnaires were also distributed in order to reach residents from all socio-economic backgrounds across the city of Bristol. The paper questionnaires were made available in libraries across Bristol and to some users of community organisations particularly if service users were elderly or disadvantaged. In addition to the experienced wellbeing items, information was collected on sociodemographic characteristics such as age, gender and income.

Commonly used measures of experienced wellbeing which were included within the Happiness Pulse (sWEMWBS score, % with a very high satisfaction rating and % with a very high worthwhile rating) were calculated and Happy City levels of wellbeing were compared with those published elsewhere.

2.4 Purification of the Happiness Pulse

2.4.1 Factor analyses of the original and revised Happiness Pulse

Factor analysis examines how underlying constructs influence the responses on a number of measured variables (DeCoster 1998). In this case factor analysis was undertaken to examine the way that Happiness Pulse items were linked through similarities in the way respondents to the survey responded. If links between items are found this suggests these groups of items are measuring a latent or underlying construct. If such constructs are found it can be possible to reduce the number of items in the scale. Given that wellbeing is sometimes seen as one construct but at other times made up of a number of constructs the authors were open to one or more factors being found underlying responses to the Happiness Pulse items.

All Happiness Pulse items were put forward for the factor analysis with the exception of 'Do you have a friend or family member with whom you can discuss personal matters?' because this item had a dichotomous response. Tests for the suitability of the data for factor analysis were inspection of the correlation matrix, the KMO test and Bartlett's test of sphericity. Factor analysis rather than principle components analysis was used because principle components analysis can cause variance inflation (Costello 2009). Principle axis factoring (PAF) was the extraction method because not all variables were normally distributed (Costello 2009). The number of factors to retain was decided through inspection of the spectral gap shown on scree tests (Johnstone and Lu 2009) although eigenvalues>1 and change in variance explained were also taken into account (Galbraith et al. 2002). Orthogonal and oblique rotation were tried. Oblique rotation was preferred for final models because of correlations above.32 in the orthogonal correlation matrix (Brown 2009). Oblimin rotation was used – tests with promax revealed similar results (not shown). A loading >.32 was indicated that an item loaded on a factor

The next stage for the Happy City Project is to develop an intuitive and accessible online survey that helps individuals better understand and promote their own wellbeing. One way to engage people will be through presenting the experienced wellbeing items. With a focus on engagement, item reduction was undertaken to

[2] The following community organisations were involved: Bristol Citizens Advice Bureau, Brunel Care, Canteen and No.1 Harbourside, Playing Out, BS3, re:work, Up Our Street, Quartet, Bristol Refugee Rights, St Werburgs Community Centre, Hotwells and Cliftonwood Community Association, Chase and Kings Forest Community Project, Knightstone Housing Association, Wellspring Healthy Living Centre, One Planet Bristol, Carers Support Centre, Voscur, Bristol Ageing Better and Bristol Older People's Forum.

reduce the risk of respondent fatigue. Further data collection is recommended for survey development (Churchill and Gilbert 1979) and this new collection of data will eventually enable further validation of the survey instrument.

After taking into account the academic literature, community and policy maker consultation and the factor analysis, commonly used experienced wellbeing items were retained so that the Happiness Pulse could be compared with national wellbeing surveys. In addition, items that could be used to measure NEF's five ways to wellbeing were preserved. In order to maximise the flexibility and applicability of the scale, most of the items on neighbourhood were removed.

To validate this amended scale, a factor analysis was undertaken in a similar way to the previous factor analysis. Factor scores were saved using the Bartlett method which allows factors to correlate. In addition reliability analysis was undertaken to establish the Cronbach's alphas of the factors underlying item response to the revised scale. If a scale is multidimensional (i.e. a factor analysis suggests more than one factor) than an alpha should be calculated for each factor (McCrae et al. 2010; Tavakol and Dennick 2011). Cronbach's alpha implies the equivalent of whether the average score from half the items would the same as if the other half of the items had been taken and all possible splits are taken into account (OECD 2013). Thus it is a measure of variability between items and is seen as a measure of reliability.

2.4.2 Reliability of the revised Happiness Pulse

Reliability is generally achieved if items are highly correlated (Tavakol and Dennick 2011). It is usually taken that alpha >0.7 indicates that a scale is reliable (OECD 2013) but that alpha>0.9 suggests that items are redundant (McCrae et al. 2010). However it has been argued that a Cronbach's alpha ranging from 0.6-0.7 is considered to demonstrate 'acceptable' internal consistency, 0.7-0.9 'good' internal consistency and >0.90 as 'excellent' internal consistency (Ilic et al. 2014). Values of alpha tend to increase as the number of items in a scale increase – thus it may not be appropriate if very few items are measuring a construct (Tavakol and Dennick 2011). Low alpha's are often found in wellbeing research (OECD 2013).

2.4.3 Construct validation of the revised Happiness Pulse

Means and skew of the factors derived from the revised scale were recorded. Pearson's correlations between each factor and with sWEMWBS and life satisfaction were undertaken in order to explore convergent and discriminant validity. A measure is convergent if it correlates with similar measures and discriminant if it does not correlate too strongly with other measures (Churchill and Gilbert 1979). ANOVA and t tests were performed to explore the age, gender and income distribution of the three factors in order to explore criterion validity – do the measures correctly behave as expected in relation to other constructs (Churchill and Gilbert 1979). If any factors did not differentiate between sociodemographic characteristics, non parametric tests (kruskall wallis for age and mann witney for gender and income) were used to explore relationships between constituent items and the factor.

3. Results

3.1 Specifying the domain of wellbeing for the Happy City Wellbeing Index Framework including the subdomain of experienced wellbeing for the Happiness Pulse survey instrument.

3.1.1. Results of the literature review of academic and policy literature on wellbeing

The literature review identified accepted drivers of wellbeing and that cities are able to collect data on these (see Manley et al (in preparation) (ONS 2015a) (Bristol City Council 2014)). However the results of the literature review suggested that there is no one universally accepted measure of experienced or subjective wellbeing and

all existing measures have drawbacks as well as advantages(e.g. Hiscock et al. 2014). Given the focus of this paper is experienced wellbeing this part of the literature review is expanded below.

The review identified that the domain of experienced wellbeing can be divided into hedonic or emotional aspects (Panel on Measuring Subjective Well-Being in a Policy-Relevant Framework et al. 2013); eudemonic aspects which involves concepts of meaning, purpose and flourishing (Huppert and Cooper 2014; Huppert et al. 2009; Huppert and So 2013; C. Ryff 1989; C. D. Ryff and Keyes 1995; C. D. Ryff and Singer 1998) and evaluative aspects which involves evaluating one's life compared to an ideal or other people and involves the concepts of goal setting and satisfaction (Diener et al. 1985; International Wellbeing Group 2013; Clarke et al. 2009). A review by WHO concluded that only measures of satisfaction should be used in surveys because the aetiology behind current measures of hedonic and eudemonic wellbeing were unsatisfactory (WHO Regional Office for Europe 2013c, 2013b, 2013a). However elsewhere it has been argued that given that hedonic and eudemonic aspects are frequently cited as having relevance, there should be some attempt made to measure them (Hiscock et al. 2014).

The review identified that data on experienced wellbeing was currently collected locally through the Bristol Quality of Life Survey (Bristol City Council 2014), nationally by the Office of National Statistics (ONS) (ONS 2015a) and the NHS (Stranges et al. 2014) and internationally via the European Social Survey (ESS) (Huppert et al. 2009).

From 2013 the Bristol Quality of Life Survey has measured experienced wellbeing through the sWEMWBS, (a short 7 item version of Warwick Edinburgh mental wellbeing scale (WEMWBS) (NHS Health Scotland et al. 2006; Stewart-Brown et al. 2009; Tennant et al. 2007)). Measures of life satisfaction, happiness and some measures of eudemonic wellbeing are also collected. ONS collates data on five measures of subjective wellbeing from various surveys including sWEMWBS, life satisfaction, doing things that are worthwhile, anxiety and happiness. However many surveys are now discontinued and ongoing funding plans for updating are unclear. WEMWBS is planned to be included in some years of the ongoing NHS funded Health Survey for England but results of the short version (sWEMWBS) are not published although they can be obtained by academic researchers.

The extent that data collected in these surveys can be disaggregated to a local level varies. The Bristol Quality of Life Survey is available at ward level and some ONS measures are available at local authority level.

3.1.2. Results of the consultation

The results of the stakeholder consultation process (with community representatives and policymakers) specified that the Happy City Wellbeing index framework should include drivers of wellbeing and experienced wellbeing. To reduce response burden, information on city levels of drivers of wellbeing, consultees suggested could be collected from pre-existing data.

Consultees suggested that an ideal survey instrument to measure experienced wellbeing in cities would include personal well-being (resilience, optimism), eudemonic wellbeing (sense of purpose, meaning, engagement), relational well-being (personal relationships and community well-being) as an integral aspect and mental and physical well-being (appreciation, humour, curiosity, gratitude, and bodily awareness). The Five Ways to Well-being (NEF 2008) is currently having a large influence on local health policy and Bristol policy makers recommended including measures of respondent behaviour that might lead to varying levels of wellbeing according to NEF's Five Ways to Wellbeing. Other than this, consultees suggested little emphasis should be put on goals or achievements.

There were also recommendations for how such an instrument could be used: firstly to inform local authorities about the wellbeing of their population and secondly to engage people to consider their own wellbeing. Interviewees suggested that a Happy City tool could be used to compare users with city averages. They suggested

that tablets should be made available to use the tool and that it should be linked to digital noticeboards. Features of the online tool should include small, easily achievable, steps for improving wellbeing and personalised results to make change attainable.

Other uses of the data could include the ability to monitor trends over time including before and after project assessments, compare neighbourhoods and various sociodemographic groups and look for inequalities, help define what are important goals for society, inform economic development and attract businesses.

3.1.3. Resultant framework

The results of the literature review and consultation both specified that available data on drivers of wellbeing could be collated by cities for the purpose of measuring progress towards a context engendering high levels of wellbeing.

The literature review identified that experienced wellbeing has hedonic, eudemonic and evaluative aspects and that data is collected on these aspects locally in Bristol, nationally by ONS and internationally by European bodies. However the results of the consultation process implied that current data collection is inadequate. Firstly consultation participants requested disaggregation to lower super output area (1000 to 3000 people) and ward level (average 5500 people (ONS 2015b) is currently the lowest available disaggregation. Secondly measures of satisfaction and WEMWBS available at ward level in Bristol may not give insight into the level of eudemonic wellbeing or flourishing and mental and physical wellbeing that was discussed by communities and policy makers and the existing data does not make the users' social context central. Thirdly existing data is not available in a form that would be helpful for the uses described by consultees. Fourthly most towns and cities do not have quality of life surveys and the happy cities framework could be used an alternative. Thus a new measure of experienced wellbeing should be developed.

The resulting Index framework (fig 1) combines 2 elements: (a) experienced well-being frameworks and (b) local policy considerations. This resulted in combining resources, capabilities, evaluative, hedonic and eudemonic subjective wellbeing into a single framework, involving indicators of external objective 'drivers of well-being' (resources and capabilities) and internal subjective indicators of experienced well-being. In order to engage citizens and communities the Index consists of intuitive and informative measures of experienced well-being. Thus the experienced wellbeing indicators were grouped into three themes (Do, Be and Connect) which were each divided into two sub themes. 'Doing' was comprised of enjoyment and purpose. Enjoyment reflected short term aspects such as affect balance whereas purpose reflected long term aspects such as competence, autonomy resilience and optimism. 'Being' involved the Body with subthemes of vitality, physical activity and bodily awareness and the mind with subthemes of appreciation, curiosity , humour, peace of mind and connection with nature. Connecting involved relationships which can produce connection, intimacy, social activity and altruism and community which can provide community belonging, community trust, social capital, opportunities to volunteer and participation.,

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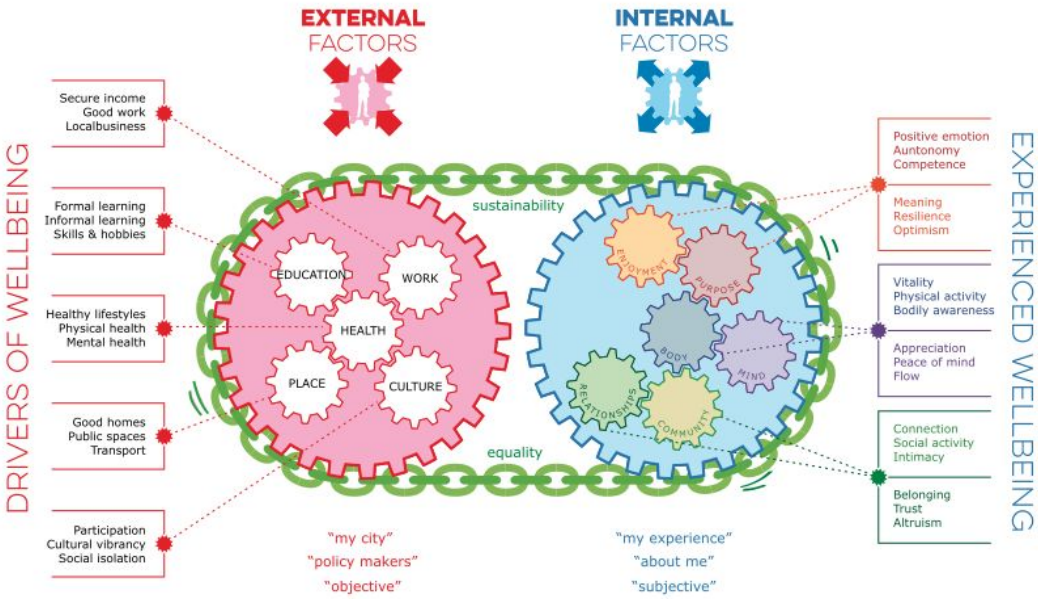
Fig 1 Happy City Index Framework



3.2 Generate sample of items

The Happiness Pulse included items available in national and international datasets such as life satisfaction and worthwhile life (ONS 2014a, 2014b) and sWEMWBS collected by ONS so results from a city could be compared with national data. ONS personal well-being questions on affect balance were rejected, in favour of adding a question on sadness as well as happiness and anxiety (from the European Social Survey). The items included under each subjective wellbeing domain are detailed in table 1.2.

Table 1 Happy City Index items

Question & domain	Response scale
Overall, how satisfied are you with your life as a whole?	0 (Not at all) - 10 (Completely)
DOING	
enjoyment	
How much of the time in the past week did you feel happy?	1 (Never) - 4 (Always)
How much of the time in the past week did you feel sad?	1 (Never) - 4 (Always)
How much of the time in the past week did you feel anxious?	1 (Never) - 4 (Always)
In my daily life, I seldom have time to do things I really enjoy	1 (Disagree Strongly) - 5 (Agree Strongly)
At the moment, how often do you attend courses of some kind? [3]	1 (Never) - 5 (Everyday)
At the moment, how often do you spend time informally learning about something new? [3]	1 (Never) - 5 (Everyday)
Purpose	
Overall, to what extent do you feel the things that you do in your life are worthwhile?	0 (Not at all) - 10 (Completely)
Over the past two weeks, I have been feeling useful	1 (Never) - 5 (Always)
Over the past two weeks, I have been thinking clearly	1 (Never) - 5 (Always)
Over the past two weeks, I have been feeling optimistic about the future	1 (Never) - 5 (Always)
Over the past two weeks, I have been dealing with problems well	1 (Never) - 5 (Always)
Over the past two weeks, I have been able to make up my own mind about things	1 (Never) - 5 (Always)
When things go wrong in my life, it takes a long time to get back to normal	1 (Disagree Strongly) - 5 (Agree Strongly)
BEING	
Body	
How much of the time in the past week did you have a lot of energy?	1 (Never) - 4 (Always)
At the moment, how often do you spend 30 minutes playing sports or physical exercise? [1]	1 (Never) - 5 (Everyday)
At the moment, how often do you walk or cycle for at least 15 minutes? [1]	1 (Never) - 5 (Everyday)
I notice and think about how I feel [2]	1 (Disagree Strongly) – 5 (Agree Strongly)
Mind	
How much of the time in the past week did you feel absorbed in what you are doing?	1 (Never) - 4 (Always)
Despite life's ups and downs, I am usually able to appreciate the good things life has given me	1 (Disagree Strongly) - 5 (Agree Strongly)
"I see beauty around me, even in small things"	1 (Never) - 4 (Always)
"I am the kind of person who likes to give new things a try"	1 (Never) - 4 (Always)
"I can laugh and see the funny side of things"	1 (Never) - 4 (Always)
Over the past two weeks, I have been feeling relaxed	1 (Never) - 5 (Always)
At the moment, how often do you spend your leisure time outdoors? [2]	1 (Never) - 5 (Everyday)
CONNECTING	
Relationships	
Over the past two weeks, I have been feeling close to other people	1 (Never) - 5 (Always)
Do you have a friend or family member with whom you can discuss personal matters?	Yes/No
How much of the time in the past week did you feel lonely?	1 (Never) - 4 (Always)
At the moment, how often do you meet socially with friends, relatives or work colleagues? [4]	1 (Never) - 5 (Everyday)
At the moment, how often do you help out informally with friends or neighbours? [5]	1 (Never) - 5 (Everyday)
Community	
I feel like I belong to this neighbourhood	1 (Disagree Strongly) - 5 (Agree Strongly)
Most people in my neighbourhood can be trusted	1 (Disagree Strongly) - 5 (Agree Strongly)
I borrow things and exchange favours with my neighbours	1 (Disagree Strongly) - 5 (Agree Strongly)
I don't have much contact with people of different ages to me	1 (Disagree Strongly) - 5 (Agree Strongly)
At the moment, how often do you get involved in work for voluntary or charitable organisations? [5]	1 (Never) - 5 (Everyday)
At the moment, how often do you participate in social activities of a club, society or an association? [4]	1 (Never) - 5 (Everyday)

[1]Intended to measure 'be active' from NEF's five ways to wellbeing

[2]Intended to measure 'take notice' from NEF's five ways to wellbeing

[3]Intended to measure 'keep learning' from NEF's five ways to wellbeing

[4]Intended to measure 'connect' from NEF's five ways to wellbeing
[5]Intended to measure 'give' from NEF's five ways to wellbeing
*APS: ONS Annual Population Survey; ESS European Population Survey; sWEMWBS: short version of the Warwick Edinburgh Mental Wellbeing Scale; IPAQ: International Physical Activity Questionnaire; Ryff: Ryff Scales of Psychological Wellbeing; HADS: Hospital Anxiety and Depression Scale; SILC: EU statistics on income and living conditions; USS: Understanding Society Survey

3.3 Data Collection

There were 722 completed responses to the Happy City pilot data received. Thus from a respondent pool of roughly 65000, there was a 1% response rate. The AskBristol e-bulletin, provided about 400 responses. The DLG marketing database yielded about 200 responses. The remaining responses resulted from community organisations, charities, and library services who distributed the survey across Bristol using volunteers and the people in which they came into contact. Despite this attempted holistic approach to data collection, the dataset has fewer young people and ethnic minorities than expected from the demographic distribution of Bristol (Goodfellow 2015). The distributions of the Happiness Pulse items are described in the supplemental material (Table S1).

3.3.1 Comparison of subjective wellbeing of the Bristol Happy City sample with national levels.

The overall mean sWEMWBS score in the Bristol Happy City survey was 22.9 which is lower than the UK ONS estimates. They are also lower than the estimate for the 2013 Bristol Quality of Life survey which was 24.9 (Bristol City Council 2014).

ONS (the UK Office of National Statistics) reported that UK personal wellbeing (based on SWEMWBS) is 24.6 (24.2 to 25.0). (ONS 2015a). This was based on 2012/2013 data from the longitudinal study "Understanding Society" (ONS 2014a; NatCen 2013; ONS 2014b). Every year Understanding Society aims to interview every adult aged 16 and over living in a cohort of 40,000 UK households (NatCen 2013). In 2009/2010 the score was 25.2 (24.8 to 25.6). In 2008 the mean was SWEMWBS score was 24.3 (ONS 2014b). However at that point the dataset was called the British Household Panel Survey (BHPS) and the two samples are not strictly comparable (ONS 2014b). Similarly life satisfaction living a worthwhile life were lower among Bristol Happy City respondents than in ONS data (ONS 2015a) (table 3).

Table 2 Comparison of Bristol Happy City and UK SWEMWBS scores

	Bristol Happy City	Understanding Society	Understanding Society
Location	Bristol and surrounding areas	UK	UK
Date	Jan/Feb 2015	2009/2010	2012/2013
Age range	18+	16+	16+
N	701	38395	
Mean	22.9	25.2 (24.8-25.6)	24.6(24.2-25.0) 24.7(South West)
Median	23.2	26	26
Bottom 15%	19.3	21	21
Top 15%	26.0	29	29

Table 3 % very high rating (9 to 10 on a scale of 0 to 10 where 0 was not at all and 10 was completely) of life satisfaction and living a worthwhile life

Survey	Happy City	APS	APS	APS	APS	APS
Dates	Jan/Feb 2015	April 2011 to March 2012	April 2012 to March 2013	April 2013 to March 2014	April 2014 to March 2015	April 2014 to March 2015
Area	Sample	UK	UK	UK	UK	South West
Very high rating of satisfaction with their lives overall	18.0	26.1	26.0	26.8	28.8	29.7
Upper confidence interval		26.4	26.3	27.1	29.1	
Lower confidence interval		25.8	25.7	26.5	28.5	
Sample	718	165,592	165,657	166,325	165,210	
Very high rating of how worthwhile the things they do are	24.0	31.4	31.4	32.6	34.4	35.6
Upper confidence interval		31.7	31.7	32.9	34.8	
Lower confidence interval		31.1	31.1	32.3	34.1	
Sample	719	164,883	165,030	165,719	164,670	

APS: Office for National Statistics, Annual Population Survey
* weighted

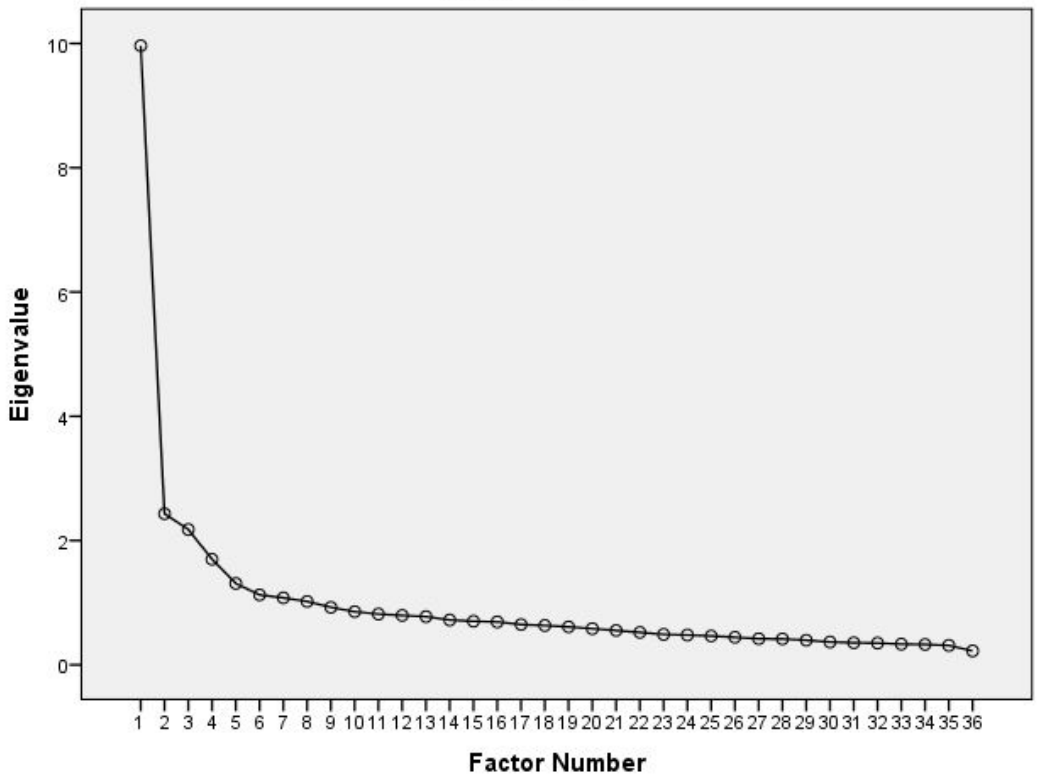
3.4 Purification

3.4.1 Factor analyses of the original Happiness Pulses items

A factor analysis was conducted. The results of suitability tests found that no correlations between items were above .9 so all variables were retained (Field 2005). The KMO test was >.5 and Bartlett's test was significant ($p<.001$) suggesting that the data was suitable (Field 2005).

There were seven factors with eigen values >1 but the scree plot, which demonstrates the spectral gap between potential factor extraction numbers and takes precedence (Rougier 2015 Pers Comm), suggested four or arguably five factors (fig 2). The factor number before the line starts to plateau is said to represent the number of factors that should be extracted. Although here four factors are presented, the five factor structure is provided in the supplemental material as both four and five factor extraction were taken into account for item reduction (section 3.6).

Figure 2 Scree Plot for all Happy City subjective wellbeing items



The factor correlation matrix revealed factors which were correlated >.32 so oblique rotation was preferred. Two tables are provided showing rotated factor loadings: the pattern matrix (table 4) and the structure matrix (table 5). The pattern matrix provides a clearer separation of item loadings so is used for the main interpretation. Perusing the structure matrix is also worthwhile to provide an understanding of the underlying structure.

According to the pattern matrix (table 4), items which loaded on the first of the four factors were life satisfaction, feeling worthwhile, all the sWEMWBS items and a few of the new items including energy, long time back to

normal and seldom have time to do the things I enjoy and appreciating the good life. The second factor included items about the neighbourhood. The third factor included items about doing things such as attending courses, sports and outdoor leisure. The fourth factor included new items devised by Happy City: think how I feel, feeling absorbed, appreciating the good things in life, seeing beauty, enjoying new things and laughing. Three items loaded on two factors (seldom_enjoy, energy and appreciating the good things in life) and the volunteering item did not load on any of the factors.

In summary four factors were extracted. The first three factors could correspond to 'Be', 'Connect' and 'Do'. The fourth factor could perhaps correspond to enjoyment.

Table 4 Pattern matrix

	Factor			
	1	2	3	4
life satisfaction	.718	.107	.147	-.033
Happy	.622	.112	.022	.120
Anxious	-.670	-.002	.016	.154
Sad	-.585	.026	-.035	.081
Worthwhile	.510	.162	.125	.179
Feeling_Useful	.413	.195	-.011	.235
Thinking_Clearly	.578	-.070	.045	.110
Optimistic_Future	.654	-.018	.116	.130
Dealing_Problems	.652	-.009	.067	.100
Own_Mind_Up	.438	.033	-.005	.194
Long_Time_Back_To_Normal	-.498	-.044	.005	-.113
Seldom_Enjoy	-.391	-.004	-.343	-.038
Attend_Course	-.026	.025	.405	.089
Informal_Learning	.009	-.025	.402	.210
Energy	.525	-.039	.445	-.057
@30_Min_Sport	.092	-.061	.590	-.070
@15_Min_Sport	.103	-.075	.566	-.075
Think_How_I_Feel	-.101	-.023	.144	.373
Feeling_Absorbed	.322	.021	.015	.388

Appreciate_Good_Life	.410	.102	.015	.422
See_Beauty	.169	.058	-.007	.533
New_Things	.068	-.007	.012	.514
Laugh	.296	-.022	-.040	.476
Relaxed	.598	.053	.102	.137
Outdoor_Leisure	.170	.066	.511	-.086
Close_To_Others	.350	.269	-.142	.307
Lonely	-.588	-.197	.059	.123
Social_Occassions	.040	.192	.430	.124
Help_Out_Friends	-.087	.473	.143	.089
Belonging_Neighbourghood	.109	.698	.017	-.032
Trust_Neighbourhood	.173	.571	-.002	-.098
Favours_Neighbourhood	.034	.727	-.032	-.052
NOT Talk_Different_Ages	-.057	-.372	-.020	-.140
Volunteering	-.155	.244	.271	.137
Club_Societies	-.095	.201	.430	.053
neighname	-.022	.639	-.045	-.094

Extraction Method: Principal Axis Factoring.
Rotation Method: Oblimin with Kaiser Normalization.

Table 5 Structure matrix

	Factor			
	1	2	3	4
life satisfaction	.783	.371	.364	.284
Happy	.704	.353	.262	.365
Anxious	-.615	-.174	-.121	-.066
Sad	-.559	-.152	-.163	-.119
Worthwhile	.657	.410	.367	.435
Feeling_Useful	.552	.391	.232	.423
Thinking_Clearly	.604	.160	.221	.298
Optimistic_Future	.723	.261	.333	.381
Dealing_Problems	.701	.249	.277	.337
Own_Mind_Up	.512	.227	.187	.348
Long_Time_Back_To_Normal	-.548	-.235	-.181	-.290
Seldom_Enjoy	-.500	-.234	-.464	-.281
Attend_Course	.124	.149	.433	.218
Informal_Learning	.183	.143	.466	.336
Energy	.617	.236	.561	.251
@30_Min_Sport	.212	.108	.576	.134
@15_Min_Sport	.210	.090	.550	.121
Think_How_I_Feel	.057	.085	.230	.380
Feeling_Absorbed	.463	.236	.235	.506
Appreciate_Good_Life	.589	.355	.292	.593
See_Beauty	.364	.257	.227	.603
New_Things	.241	.158	.195	.538
Laugh	.437	.194	.189	.556
Relaxed	.689	.312	.325	.384
Outdoor_Leisure	.304	.235	.548	.154
Close_To_Others	.501	.428	.126	.452
Lonely	-.595	-.339	-.117	-.108
Social_Occassions	.263	.354	.532	.329
Help_Out_Friends	.136	.507	.274	.235
Belonging_Neighbourghood	.330	.729	.223	.200
Trust_Neighbourhood	.326	.600	.167	.115
Favours_Neighbourhood	.244	.715	.156	.148
NOT Talk_Different_Ages	-.231	-.434	-.181	-.268
Volunteering	.045	.303	.337	.239
Club_Societies	.108	.300	.475	.215
neighname	.142	.594	.090	.059

3.4.2 Modification of the scale – item reduction

The retained items are presented in table 6. They reflect the 'Be', 'Do' and 'Connect' domains. They include measures that are available in other surveys (life satisfaction, worthwhile, sWEMWBS) and include measures of the Five Ways to Wellbeing (Be active, Keep learning, Take notice, Connect and Give).

Table 6 Items in the revised Happy City subjective wellbeing scale

DOMAIN	TOPIC	ITEM	SOURCE
BE	Life satisfaction	Overall, how satisfied are you with your life nowadays?	ONS
	Worthwhile	Overall, to what extent do you feel the things you do in your life are worthwhile?	ONS
	Optimism	I've been feeling optimistic about the future	SWEMWBS
	Worth	I've been feeling useful	SWEMWBS
	Peace of mind	I've been feeling relaxed	SWEMWBS
	Resilience	I've been dealing with problems well	SWEMWBS
	Competence	I've been thinking clearly	SWEMWBS
	Autonomy	I've been able to make my own mind up about things	SWEMWBS
DO	Be Active *(5 ways)**	How often do you spend 30 minutes playing sports or physical exercise?	New
		How often do you spend 15 minutes walking or cycling?	New
	Keep Learning *(5 ways)*	How often do you attend courses of some kind?	New
		How often do you spend time informally learning about something new?	New
	Take Notice *(5 ways)*	I see beauty around me, even in small things	New
		I can laugh and see the funny side of things	HADS
CONNECT	Connect *(5 ways)*	How often do you meet socially with friends, relatives or work colleagues?	New
		How often do you participate in social activities of a club, society or an association?	New
	Give *(5 ways*)	How often do you help out informally with friends or neighbours?	New
		How often do you get involved in work for voluntary or charitable organisations?	New
	Belonging	I have been feeling close to other people	SWEMWBS
	Neighbourhood belonging	I feel like I belong to this neighbourhood	USS

*'5 ways' refers to NEF's Five ways to wellbeing

3.4.3 Factor analysis of the retained items

No correlations were found above .9 so all entered variables were retained (Field 2005). The KMO test was >.5 (Field 2005) and Bartlett's test was significant ($p<.001$) suggesting that the data was suitable. The spectral gap in the scree plot suggested three factors (fig 4). However there were four factors with eigenvalues>1 and the change in variance explained could be argued with three or four factors (table 7). However given that the spectral gap should be paramount (Rougier (2015) personal communication), three factors were extracted.

Figure 4 Factor analysis scree plot (revised items)

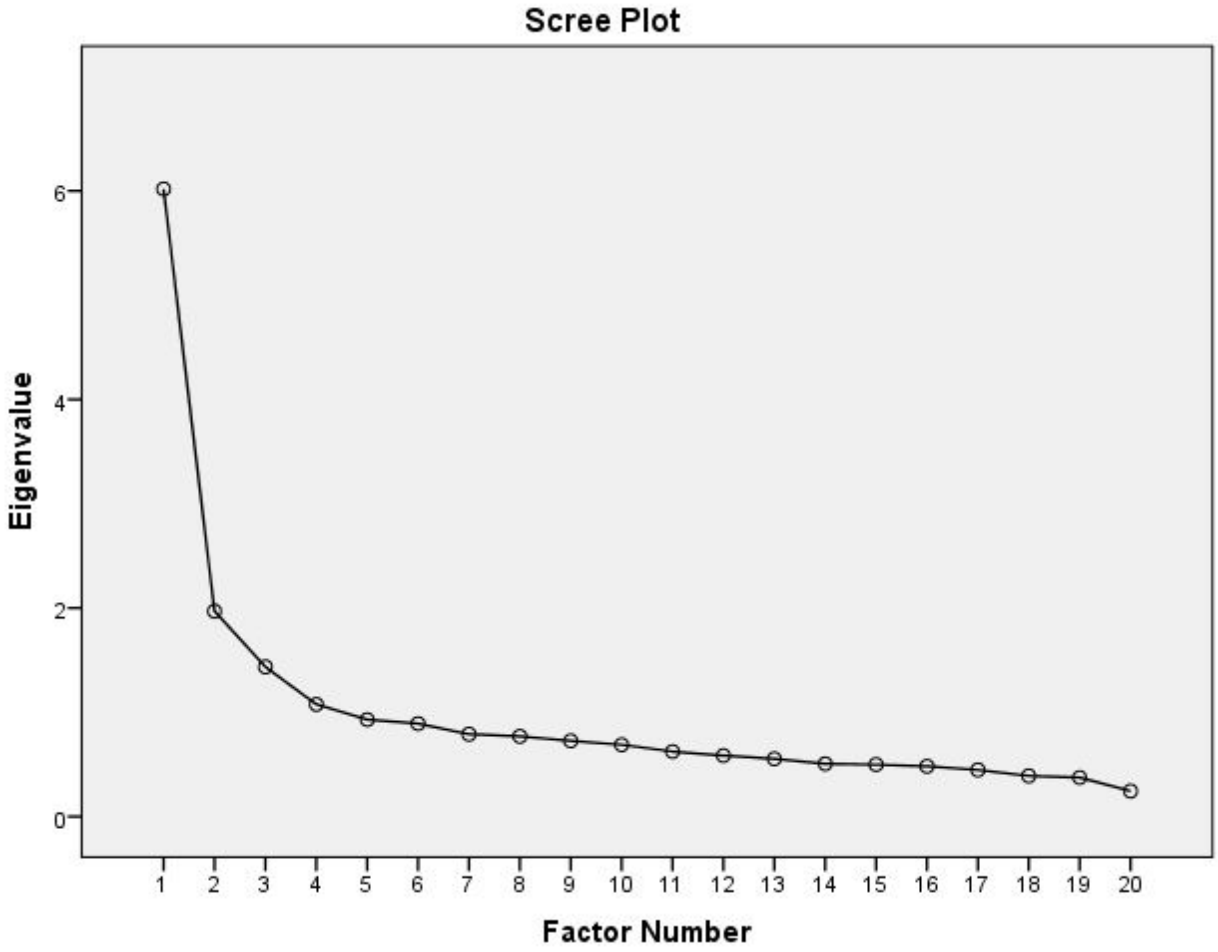


Table 7 Total Variance Explained (revised items)

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	6.019	30.094	30.094	5.484	27.420	27.420	4.514
2	1.969	9.847	39.941	1.320	6.600	34.020	2.198
3	1.435	7.177	47.118	.794	3.969	37.988	1.757
4	1.076	5.381	52.500	.473	2.365	40.354	3.878
5	.929	4.647	57.147				
6	.892	4.458	61.605				
7	.790	3.949	65.554				
8	.769	3.847	69.401				
9	.726	3.629	73.030				
10	.689	3.443	76.474				
11	.624	3.119	79.593				
12	.585	2.925	82.518				
13	.554	2.768	85.286				
14	.507	2.534	87.819				
15	.498	2.491	90.310				
16	.483	2.413	92.723				
17	.447	2.237	94.960				
18	.390	1.949	96.909				
19	.374	1.872	98.781				
20	.244	1.219	100.000				

Extraction Method: Principal Axis Factoring.

The Pattern matrix showed that all items only loaded on one factor (table 8). The first factor included ONS and sWEMWBS items and the items intended to measure the 'Take notice' Five Ways to Wellbeing items. The presence of these 'Take notice' items on the 'Be' factor demonstrates the importance of our interpretation of our environment to wellbeing. Thus items loading on this factor could be said to be about 'Being'.

Items which loaded on the second factor could be said to be about 'Connecting': attending social occasions and clubs and societies, helping out friends, volunteering and feelings of belonging to the neighbourhood. It should be noted that the sWEMWBS item 'close to other's which was intended to measure 'belonging' (see table 8) loaded on the 'Be' factor rather than the 'Connect' factor. This illustrates the importance of good relationships with other people to wellbeing.

Items on the third factor are perhaps reflective of 'Doing': attending courses, learning informally and taking part in physical activity.

Table 8 Pattern matrix

	Factor		
	1	2	3
Life satisfaction	.701	.036	.076
Worthwhile	.677	.184	.020
Feeling_Useful	.646	.157	-.100
Thinking_Clearly	.634	-.146	.059
Optimistic_Future	.710	-.049	.083
Dealing_Problems	.740	-.193	.122
Own_Mind_Up	.580	-.135	.081
Attend_Course	.002	.149	.396
Informal_Learning	.135	.112	.361
@30_Min_Sport	.041	.045	.509
@15_Min_Sport	.087	-.091	.574
See_Beauty	.472	.097	-.012
Laugh	.515	.002	.012
Relaxed	.645	.011	.069
Close_To_Others	.575	.294	-.259
Social_Occassions	.148	.400	.309
Club_Societies	-.049	.447	.294
Help_Out_Friends	.104	.573	-.058
Volunteering	-.082	.514	.151
Belonging_Neighbourhood	.310	.325	-.021

Extraction Method: Principal Axis Factoring.
Rotation Method: Oblimin with Kaiser Normalization.
a. Rotation converged in 14 iterations.

Table 9 Structure matrix

	Factor		
	1	2	3
Life satisfaction	.734	.264	.296
Worthwhile	.739	.392	.269
Feeling_Useful	.663	.326	.133
Thinking_Clearly	.608	.059	.214
Optimistic_Future	.721	.184	.285
Dealing_Problems	.719	.059	.298
Own_Mind_Up	.564	.058	.223
Attend_Course	.166	.246	.433
Informal_Learning	.277	.240	.428
@30_Min_Sport	.208	.181	.532
@15_Min_Sport	.232	.074	.578
See_Beauty	.498	.236	.154
Laugh	.519	.159	.168

Relaxed	.669	.221	.266
Close_To_Others	.586	.404	-.014
Social_Occassions	.361	.520	.451
Club_Societies	.174	.504	.388
Help_Out_Friends	.258	.590	.112
Volunteering	.118	.526	.252
Belonging_Neighbourhood	.401	.413	.151

3.4.4 Results of the reliability analysis of the revised scale

The 'Be' factor has eleven items and the Cronbach alpha=.850 which indicates that the scale has good reliability (table 10). The 'Connect 'factor has only five items and the Cronbach alpha is 0.661. Given the small number of items this may be high enough to indicate acceptable consistency. The 'Do' factor has only four items. The Cronbach's alpha is only .573 which does not indicate good reliability. However there are only four items. The structure matrix (table 9) suggested that attending social occasions and clubs and societies also were related to 'Doing'. If these items are added then there are 6 items in total and the alpha reaches an acceptable level (0.663). This lends weight to the assertion that the Cronbach alpha was inadequate because of too few items.

Table 10 Reliability analysis results

Factor and items	Cronbach's Alpha
'be' factor	.850
	Cronbach's Alpha if Item Deleted
Life satisfaction	.833
Worthwhile	.833
Feeling_Useful	.833
Thinking_Clearly	.840
Optimistic_Future	.829
Dealing_Problems	.835
Own_Mind_Up	.843
See_Beauty	.844
Laugh	.844
Relaxed	.835
Close_To_Others	.837
'connect' factor	.661
	Cronbach's Alpha if Item Deleted
Social_Occassions	.592
Help_Out_Friends	.591
Belonging_Neighbourghood	.642
Volunteering	.618
Club_Societies	.600
'do' factor	.573
	Cronbach's Alpha if Item Deleted
Attend_Course	.526
Informal_Learning	.527
@30_Min_Sport	.488
@15_Min_Sport	.458
'do' factor plus structural items	.663
	Cronbach's Alpha if Item Deleted
Attend_Course	.619
Informal_Learning	.624
@30_Min_Sport	.608
@15_Min_Sport	.605
Social_Occassions	.600

Club_Societies	.623

To summarise, to maximise engagement with the public, a new version of the Happiness Pulse was tested with a subset of 20 of the original items. These items were found to have a factor structure of three factors corresponding to 'Be' 'Do' and 'Connect'. The 'Be' factor had good reliability and the 'Connect' factor had adequate reliability. The 'Do' factor did not reach adequate reliability probably because there were too few items on this factor to test for reliability. However given that the 'Do' items reflected physical activity and learning it is quite plausible that these things would appeal to different groups of respondents.

3.4.5 Construct validation of the revised scale

The factors were not significantly skewed (table 11). Thus parametric statistics could be used. First convergent and discriminant validity were tested. The factors were significantly correlated with each other and SWEMWB and life satisfaction. The being factor had good convergent validity. There was a very high correlation between the 'Be' factor and sWEMWBS (r=.953) so it did not have good discriminant validity. Convergent validity was low for the 'Connect' factor as although the factor was significantly correlated with the other factors and sWEMWBS and life satisfaction correlations were low (<.22).The 'Do' factor had good discriminant validity; however although the factor was significantly correlated with the other factors and sWEMWBS and life satisfaction correlations were low (<.26);

Second criterion validity was tested. Women had higher scores on the 'Connect' factor than men but there was no gender difference for the other factors. There was a U shaped relationship between age and the 'Be' factor, a linear relationship between age and the 'Connect' factor and no relationship between age and the 'Do' factor. Low income respondents had lower scores on the 'Be' factor than other respondents but there was no association between income and the other two factors. Thus there was evidence of critierion validity for the 'Be' factor and the 'Connect' factor.

Table 11bBivariable analysis of the factors, correlation analysis and comparison of means

		'be' factor	'connect' factor	'do' factor	swemwbs	Life satisfaction
N	Valid	677	677	677	701	718
	Missing	45	45	45	21	4
Mean		0	0	0	22.9	6.70
Skewness		-.561	-.211	-.449	.248	-.971
Minimum		-3.7	-5.7	-4.7	12.40	0
Maximum		2.57	2.9	3.3	35.00	10
Correlation r (p) (n=677)						
'be' factor		1	.214 (<.001)	.205 (<.001)	.953 (<.001)	.778 (<.001)
'connect' factor		.214 (<.001)	1	.112 (.003)	.204 (<.001)	.221 (<.001)
'do' factor		.205 (<.001)	.112 (.003)	1	.192 (<.001)	.251 (<.001)
Means (sd)						
Gender						
Women (n=426)		0.03(1.01)	0.09(1.19)	-0.01(1.24)		
Men (n=243)		-0.05(1.14)	-0.15(1.19)	-0.02(1.29)		

p	.389	.014	.885
Age group			
18-34 (n=98)	-0.01(1.03)	-0.29(1.18)	0.16(1.06)
35-44 (n=126)	-0.09(1.00)	-0.01(1.03)	-0.05(1.16)
45-54 (n=147)	-0.16(1.07)	-0.14(1.14)	-0.18(1.33)
55-64 (n=159)	-0.03(1.16)	0.02(1.22)	0.03(1.28)
65 + (n=145)	0.26(0.96)	0.33(1.41)	0.06(1.35)
	.010	.001	.274
Income			
Not low income (n=497)	0.08(0.97)	0.01(1.19)	-0.02(1.24)
Low income (n=180)	-0.21(1.25)	-0.02(1.31)	0.05(1.31)
p	.006	.843	.554

Given that the 'Do' factor did not discriminate between genders, age groups or SES groups, relationships with individual constituent items were explored. Women were more likely to attend courses. The youngest and oldest age groups were more likely to engage in informal learning and 55 to 64 year olds were less likely to engage in active transport. Low SES respondents were less likely to often be doing 30 minutes of sport.

Table 12 Median levels of the four constituent variables* of the 'do' factor

	Attending a course	Informal Learning	30 minutes of sport	15 minutes of active transport
Gender				
female	2	3	3	5
male	1	4	3	4
Total	2	4	3	5
p	<.001	.139	.579	.219
Age				
18-34	2	4	3	5
35-44	2	3	3	5
45-54	2	3	3	5
55-64	2	3	3	4
75 or over	2	4	2.5	5
Total	2	4	3	5
p	.466	<.001	.515	.024
SES				
Not low income	2	3	3	5
Low income	1	4	3	5
Total	2	4	3	5
p	.162	.125	.012**	.846

*All constituent variables ranged between 1 (never) and 5 (everyday)

**The mean rank for low income respondents was 328.92 and for other respondents was 370.72. Thus those with low income were less likely to do 30 minutes of sport a day.

4. Discussion

4.1 Substantive conclusions

Happy City designed an experienced wellbeing instrument based on a review of the literature and consultation with policy makers and community organisations in Bristol. From these it was determined that the most important domains in wellbeing were 'Being' 'Doing' and 'Connecting'. An experienced wellbeing scale was created to measure these domains from a mixture of existing items and new items.

The factor structure of the happiness pulse was found to include four factors: a 'Being' factor which encompassed existing measures of ONS and sWEMWBS items on personal wellbeing and items about being positive relationships with other people; a 'Connecting' factor which generally concerned connections in their local neighbourhood; a 'Doing' factor which included items on behaviours and activities such as attending courses, social events, being outside and doing physical activity; the final factor was made up of newly devised items and could be said to reflect 'enjoyment', for example appreciating the good things in life and being absorbed in activities.

Happy City regarded this data collection as a pilot for a later data collection. They wished to shorten the scale to 20 items but to include items for benchmarking against other studies and include measures of NEF's Five Ways to Wellbeing. This revised scale had a three factor structure. These factors corresponded to Being, Doing and Connecting. A reliability analysis indicated that the 'Be' factor had good reliability, the 'Connect' factor had adequate reliability and that there were too few items loading on the 'Do' factor for testing.

The 'Be', 'Do' and 'Connect' factors were significantly correlated with each other and sWEMWBS and life satisfaction. The correlation between the 'Be' factor and sWEMWBS was markedly high (r=.953). However the inclusion of other items on this factor (life satisfaction, worthwhile, and take notice items) is useful in order to benchmark wellbeing in local populations and measure progress towards attaining wellbeing. Demographic differences were found: older people were more likely to feel connected than younger people. Other studies have also found increasing social capital over the life course, at least until very old age (McDonald and Mair 2010), although other patterns have been found (Fortin et al. 2015) and patterns may depend on the precise measures used (McDonald and Mair 2010). The 'Be' factor recorded a dip in wellbeing in middle age. This is a common finding in studies of subjective wellbeing (Cheng et al. 2015).

Women's scores were significantly higher than men's scores on the 'Connect' factor. A review concluded that women are more likely to give and receive social support (Taylor 2011). Low SES respondents had significantly lower scores than other respondents on the 'Be' factor. Low SES is often associated with low levels of wellbeing (Wood et al. 2012). The 'Do' factor did not discriminate between sociodemographic groups. Further analysis suggested this occurred because there were not consistent patterns between sociodemographic characteristics and the constituent items. Other studies have shown complex relationships between sociodemographic characteristics and different leisure time activities (Hiscock et al. 2015; Livingstone 1999; Beenackers et al. 2012; Pampel 2012).

4.2 Methodological conclusions

Some measures of connecting to other people (feeling close to others and loneliness) loaded on the 'Being' factor rather than the 'Connecting' factor. Thus when thinking about their lives people do not appear to think about relationships separately from other aspects of 'Being'. This has been found elsewhere (Tennant et al. 2007).

There was the possibility of item placing effects given that the items were presented to respondents in topic order. However given that some items did not load where expected and that there were a number of different response scales, this effect may have been limited. However Happy City might need to think about item ordering in future. There was a low level of item non-response suggesting that respondent fatigue was not a major concern.

4.3 Limitations

The data analysed here was collected for the city of Bristol. Thus the findings cannot be generalised to the UK or beyond. There were only 722 respondents to the survey which was an extremely low response rate given a sampling frame of around 65000. The levels of sWEMWBS, life satisfaction and life worthwhileness collected in the questionnaire were lower than those collected by ONS at a national level. In future data collection effort will be made to simplify the sampling frame.

4.4 Conclusions

Happy City have designed a new measure of wellbeing which encompasses several existing measures and measures of NEF's Five Ways to Wellbeing. The revised Happiness Pulse which is intended to be implemented in a new wave of data collection has a factor structure reflecting the domains of wellbeing: Being, Doing and Connecting.

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Electronic supplementary material

Distribution of happy city items

Table S.1 Distribution of happy city items

	N	%
TOTAL	722	100.0
Life satisfaction		
not at all	10	1.4
1	12	1.7
2	26	3.6
3	25	3.5
4	37	5.1
5	56	7.8
6	90	12.5
7	164	22.7
8	168	23.3
9	90	12.5
completely	40	5.5
Total	718	99.4
Missing	4	.6
Total		
Happy		
never	15	2.1
2	244	33.8
3	416	57.6
always	35	4.8
Total	710	98.3
Missing	12	1.7
Anxious		
never	129	17.9
2	482	66.8
3	85	11.8
always	11	1.5
Total	707	97.9
Missing	15	2.1
Sad		
never	155	21.5
2	496	68.7
3	48	6.6
always	5	.7
Total	704	97.5
Missing	18	2.5
Worthwhile		
not at all	9	1.2
1	8	1.1
2	20	2.8
3	30	4.2
4	32	4.4
5	51	7.1
6	82	11.4

7	156	21.6
8	158	21.9
9	106	14.7
completely	67	9.3
Total	719	99.6
Missing	3	.4
Feeling_Useful		
never	12	1.7
2	62	8.6
3	236	32.7
4	349	48.3
always	56	7.8
Total	715	99.0
Missing	7	1.0
Thinking_Clearly		
never	1	.1
2	32	4.4
3	193	26.7
4	400	55.4
always	89	12.3
Total	715	99.0
Missing	7	1.0
Optimistic_Future		
never	17	2.4
2	90	12.5
3	247	34.2
4	285	39.5
always	77	10.7
Total	716	99.2
Missing	6	.8
Dealing_Problems		
never	3	.4
2	35	4.8
3	263	36.4
4	349	48.3
always	71	9.8
Total	721	99.9
Missing	1	.1
Own_Mind_Up		
never	1	.1
2	18	2.5
3	134	18.6
4	363	50.3
always	202	28.0
Total	718	99.4
Missing	4	.6
Long_Time_Back_To_Normal		
disagree strongly	94	13.0
2	256	35.5
3	198	27.4

4	141	19.5
agree strongly	32	4.4
Total	721	99.9
Missing	1	.1
Seldom_Enjoy		
disagree strongly	121	16.8
2	271	37.5
3	150	20.8
4	126	17.5
agree strongly	49	6.8
Total	717	99.3
Missing	5	.7
Attend_Course		
never	311	43.1
2	182	25.2
3	88	12.2
4	119	16.5
everyday	18	2.5
Total	718	99.4
Missing	4	.6
Informal_Learning		
never	39	5.4
2	118	16.3
3	193	26.7
4	195	27.0
everyday	173	24.0
Total	718	99.4
Missing	4	.6
Energy		
never	98	13.6
2	330	45.7
3	267	37.0
always	25	3.5
Total	720	99.7
Missing	2	.3
30_Min_Sport		
never	206	28.5
2	104	14.4
3	83	11.5
4	209	28.9
everyday	115	15.9
Total	717	99.3
Missing	5	.7
15_Min_Sport		
never	66	9.1
2	37	5.1
3	56	7.8
4	175	24.2
everyday	383	53.0
Total	717	99.3

Missing	5	.7
Think_How_I_Feel		
disagree strongly	5	.7
2	41	5.7
3	183	25.3
4	312	43.2
agree strongly	179	24.8
Total	720	99.7
Missing	2	.3
Feeling_Absorbed		
never	17	2.4
2	245	33.9
3	419	58.0
always	41	5.7
Total	722	100.0
Appreciate_Good_Life		
disagree strongly	8	1.1
2	33	4.6
3	93	12.9
4	360	49.9
agree strongly	226	31.3
Total	720	99.7
Missing	2	.3
See_Beauty		
never	12	1.7
2	178	24.7
3	342	47.4
always	186	25.8
Total	718	99.4
Missing	4	.6
New_Things		
never	10	1.4
2	269	37.3
3	294	40.7
always	145	20.1
Total	718	99.4
Missing	4	.6
Laugh		
never	2	.3
2	135	18.7
3	385	53.3
always	196	27.1
Total	718	99.4
Missing	4	.6
Relaxed		
never	23	3.2
2	109	15.1
3	298	41.3
4	266	36.8

always	24	3.3
Total	720	99.7
Missing	2	.3

Outdoor_Leisure

never	27	3.7
2	109	15.1
3	182	25.2
4	275	38.1
everyday	128	17.7
Total	721	99.9
Missing	1	.1

Close_To_Others

never	18	2.5
2	69	9.6
3	218	30.2
4	277	38.4
always	139	19.3
Total	721	99.9
Missing	1	.1

Lonely

never	398	55.1
2	248	34.3
3	64	8.9
always	9	1.2
Total	719	99.6
Missing	3	.4

Social_Occassions

never	22	3.0
2	109	15.1
3	216	29.9
4	299	41.4
everyday	75	10.4
Total	721	99.9
Missing	1	.1

Help_Out_Friends

never	89	12.3
2	240	33.2
3	229	31.7
4	137	19.0
everyday	24	3.3
Total	719	99.6
Missing	3	.4

Belonging_Neighbourghood

disagree strongly	28	3.9
2	76	10.5
3	201	27.8
4	284	39.3
agree strongly	132	18.3
Total	721	99.9
Missing	1	.1

Trust_Neighbourhood		
disagree strongly	20	2.8
2	42	5.8
3	251	34.8
4	325	45.0
agree strongly	83	11.5
Total	721	99.9
Missing	1	.1
Favours_Neighbourhood		
disagree strongly	84	11.6
2	120	16.6
3	198	27.4
4	254	35.2
agree strongly	62	8.6
Total	718	99.4
Missing	4	.6
NOT Talk_Different_Ages		
disagree strongly	135	18.7
2	287	39.8
3	171	23.7
4	95	13.2
agree strongly	29	4.0
Total	717	99.3
Missing	5	.7
Volunteering		
never	224	31.0
2	193	26.7
3	119	16.5
4	131	18.1
everyday	54	7.5
Total	721	99.9
Missing	1	.1
Club_Societies		
never	244	33.8
2	175	24.2
3	154	21.3
4	125	17.3
everyday	18	2.5
Total	716	99.2
Missing	6	.8
neighname		
None	37	5.1
1 or 2	140	19.4
3 to 6	228	31.6
7 to 10	164	22.7
11 or more	151	20.9
Total	720	99.7
Missing	2	.3

Table S2 Sociodemographic characteristics

	N	%
TOTAL	722	100.0
Age group		
18-34	100	13.9
35-44	132	18.3
45-54	157	21.7
55-64	170	23.5
75 or over	159	22.0
Total	718	99.4
Missing	4	.6
gender		
female	451	62.5
male	260	36.0
Total	711	98.5
Missing	11	1.5
Low_Income		
Not low income	521	72.2
Low income	201	27.8
	722	100.0

Factor structure if five factors were extracted from original happy city items

There were some indications from the scree plot that the factor structure of the Happy City scale could have a five factor structure

Table S3 Variance explained for Happy City items if five factors extracted

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	9.890	28.256	28.256	9.348	26.708	26.708	7.941
2	2.347	6.706	34.962	1.711	4.888	31.595	2.921
3	1.977	5.649	40.611	1.414	4.040	35.636	4.155
4	1.685	4.813	45.425	1.070	3.057	38.693	4.477
5	1.287	3.677	49.102	.703	2.008	40.701	2.803
6	1.121	3.202	52.304				
7	1.063	3.038	55.342				
8	1.006	2.874	58.216				
9	.914	2.611	60.827				
10	.848	2.424	63.251				
11	.815	2.329	65.580				
12	.793	2.267	67.847				

13	.771	2.202	70.048				
14	.711	2.032	72.080				
15	.695	1.985	74.066				
16	.683	1.951	76.016				
17	.643	1.838	77.854				
18	.611	1.746	79.600				
19	.594	1.698	81.299				
20	.567	1.621	82.920				
21	.552	1.578	84.498				
22	.505	1.444	85.942				
23	.480	1.370	87.312				
24	.471	1.347	88.659				
25	.448	1.281	89.940				
26	.422	1.205	91.145				
27	.416	1.189	92.334				
28	.403	1.151	93.485				
29	.366	1.047	94.532				
30	.358	1.023	95.555				
31	.350	1.000	96.555				
32	.334	.953	97.508				
33	.331	.945	98.453				
34	.317	.906	99.359				
35	.224	.641	100.000				

Extraction Method: Principal Axis Factoring.

Table S4 Five factor structure pattern matrix

	Factor				
	1	2	3	4	5
Life satisfaction	.736	.076	-.086	-.046	.102
Happy	.638	.098	-.077	.081	-.039
Anxious	-.663	.107	.027	.128	-.033
Sad	-.593	.030	-.009	.085	-.039
Worthwhile	.611	.330	.013	.086	-.051
Feeling_Useful	.489	.269	-.026	.150	-.152
Thinking_Clearly	.591	-.015	.097	.124	.038
Optimistic_Future	.653	.042	.003	.118	.076
Dealing_Problems	.607	-.110	-.044	.156	.115
Own_Mind_Up	.370	-.122	-.094	.257	.053
Long_Time_Back_To_Normal	-.450	.082	.099	-.145	-.030
Seldom_Enjoy	-.393	-.109	.012	-.056	-.274
Attend_Course	-.016	.196	-.018	.091	.297
Informal_Learning	.002	.152	.033	.241	.319
Energy	.524	.072	.011	-.015	.398
@30_Min_Sport	.100	.156	.037	-.031	.502

@15_Min_Sport	.011	-.074	-.075	.042	.639
Feeling_Absorbed	.341	.120	.063	.371	-.059
Appreciate_Good_Life	.366	.044	-.103	.435	-.015
See_Beauty	.084	-.028	-.093	.593	-.003
New_Things	.021	.052	-.020	.511	-.029
Laugh	.192	-.126	-.074	.547	.008
Relaxed	.549	-.049	-.105	.179	.118
Outdoor_Leisure	.122	.037	-.128	.003	.510
Close_To_Others	.371	.193	-.174	.234	-.244
Lonely	-.602	-.022	.169	.146	.065
Social_Occassions	.097	.392	-.080	.071	.238
Help_Out_Friends	-.006	.467	-.261	-.014	-.066
Belonging_Neighbourghood	-.011	.047	-.759	.013	.043
Trust_Neighbourhood	.040	-.076	-.686	-.028	.079
Favours_Neighbourhood	-.061	.053	-.716	.000	.000
Talk_Different_Ages	-.064	-.192	.269	-.115	.054
Volunteering	-.055	.502	-.045	.026	.032
Club_Societies	.024	.535	.012	-.054	.182
Think_How_I_Feel	-.144	.038	.012	.418	.120

Extraction Method: Principal Axis Factoring.
Rotation Method: Oblimin with Kaiser Normalization.
a. Rotation converged in 14 iterations.

Table S5 Five factor structure structure matrix

	Factor				
	1	2	3	4	5
Life satisfation	.791	.260	-.413	.325	.292
Happy	.713	.260	-.389	.382	.164
Anxious	-.608	.000	.236	-.127	-.131
Sad	-.558	-.067	.209	-.157	-.149
Worthwhile	.692	.455	-.364	.419	.199
Feeling_Useful	.578	.375	-.339	.401	.073
Thinking_Clearly	.607	.114	-.177	.346	.191
Optimistic_Future	.726	.222	-.318	.416	.268
Dealing_Problems	.694	.098	-.309	.411	.268
Own_Mind_Up	.504	.070	-.278	.410	.177
Long_Time_Back_To_Normal	-.542	-.088	.298	-.338	-.158
Seldom_Enjoy	-.506	-.279	.252	-.318	-.410
Attend_Course	.136	.306	-.128	.217	.370
Informal_Learning	.191	.298	-.110	.354	.414
Energy	.619	.272	-.264	.312	.535
@30_Min_Sport	.219	.289	-.097	.165	.556
@15_Min_Sport	.194	.137	-.130	.195	.639
Feeling_Absorbed	.477	.258	-.205	.517	.135
Appreciate_Good_Life	.592	.272	-.377	.621	.195
See_Beauty	.360	.193	-.269	.642	.159

New_Things	.243	.206	-.172	.534	.113
Laugh	.425	.098	-.252	.609	.155
Relaxed	.684	.176	-.373	.444	.286
Outdoor_Leisure	.302	.240	-.242	.216	.562
Close_To_Others	.520	.325	-.426	.430	-.033
Lonely	-.600	-.132	.381	-.135	-.064
Social_Occassions	.290	.521	-.289	.302	.391
Help_Out_Friends	.170	.529	-.401	.172	.081
Belonging_Neighbourghood	.327	.309	-.777	.225	.133
Trust_Neighbourhood	.316	.169	-.679	.159	.130
Favours_Neighbourhood	.245	.276	-.709	.172	.072
Talk_Different_Ages	-.246	-.312	.382	-.253	-.067
Volunteering	.078	.522	-.196	.170	.165
Club_Societies	.142	.568	-.177	.154	.317
Think_How_I_Feel	.058	.161	-.059	.395	.194