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1 **TITLE PAGE**

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3 **TITLE**

4 **The TIPPME intervention typology for changing environments to change behaviour**

5

6 **AUTHORS**

7 *Gareth J Hollands, PhD¹; Giacomo Bignardi, MRes¹; Marie Johnston, PhD²; Michael P Kelly,
8 PhD³; David Ogilvie, PhD⁴; Mark Petticrew, PhD⁵; Andrew Prestwich, PhD⁶; Ian Shemilt, BA⁷;
9 Stephen Sutton, PhD³; Theresa M Marteau, PhD¹.

10

11 *CORRESPONDING AUTHOR (gareth.hollands@medschl.cam.ac.uk)

12

13 **AFFILIATIONS. ADDRESSES**

14 (1) Behaviour and Health Research Unit, University of Cambridge.

15 Institute of Public Health, Robinson Way, Cambridge CB2 0SR, UK.

16 (2) Institute of Applied Health Sciences, University of Aberdeen.

17 Polwarth Building, Aberdeen AB25 2ZD, UK.

18 (3) Department of Public Health and Primary Care, University of Cambridge.

19 Institute of Public Health, Robinson Way, Cambridge CB2 0SR, UK.

20 (4) MRC Epidemiology Unit, University of Cambridge.

21 University of Cambridge School of Clinical Medicine, Box 285 Institute of Metabolic Science

22 Cambridge Biomedical Campus, Cambridge CB2 0QQ, UK.

23 (5) Department of Social and Environmental Health Research, London School of Hygiene &
24 Tropical Medicine.

25 Keppel Street, London WC1E 7HT, UK.

26 (6) School of Psychology, University of Leeds.

27 University of Leeds, Leeds LS2 9JT, UK.

28 (7) EPPI-Centre, UCL Institute of Education.

29 University College London, 18 Woburn Square, London WC1H 0NR, UK.

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34 **The TIPPME intervention typology for changing environments to change behaviour**

35

36 **ABSTRACT**

37

38 Reflecting widespread interest in concepts of ‘nudging’ and ‘choice architecture’, there is
39 increasing research and policy attention on altering aspects of the small-scale physical environment,
40 such as portion sizes or product positioning, to change health-related behaviour at population-level.
41 There is, however, a lack of clarity in characterising these interventions, and no reliable framework
42 incorporating standardised definitions. This hampers both the synthesis of cumulative evidence
43 about intervention effects, and the identification of intervention opportunities. To address this, a
44 new tool, TIPPME (Typology of Interventions in Proximal Physical Micro-Environments) has been
45 developed, here applied to the selection, purchase and consumption of food, alcohol and tobacco.
46 This provides a framework to reliably classify and describe, and enable more systematic design,
47 reporting and analysis of, an important class of interventions. In doing so, it makes a distinct
48 contribution to collective efforts to build the cumulative evidence-base for effective ways of
49 changing behaviour across populations.

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59 Unhealthy patterns of food, alcohol and tobacco consumption are major contributors to the burden
60 of non-communicable diseases – currently accounting for more than two thirds of deaths
61 worldwide^{1,2}. It is now widely recognised that the physical environments that surround us exert
62 considerable influence on these patterns of consumption, and that changing these environments
63 holds corollary potential as a catalyst for changing consumption. Whilst not new, the idea that
64 behaviour can be changed in predictable ways, by changing the environments within which people
65 make choices – ‘choice architecture’³ - has gained traction globally among the public, the research
66 community, and policymakers^{4,5}. However, despite the recent popularisation and intuitive appeal of
67 these approaches, there has been an absence of definitional and conceptual clarity in characterising
68 such interventions, particularly regarding applications to public health. The absence of a reliable
69 framework that incorporates standardised labels and definitions has hampered the synthesis of
70 cumulative evidence about intervention effects, resulting in an evidence-base that remains uneven
71 and uncertain. It has also hindered the identification and discussion of opportunities to intervene to
72 change environments.

73

74 In response to these observations, we present and provide guidance for a new tool – TIPME
75 (Typology of Interventions in Proximal Physical Micro-Environments) - that aims to improve
76 researchers’ and practitioners’ ability to clearly and consistently classify and describe an important
77 class of behaviour change interventions related to concepts of ‘nudging’ and ‘choice architecture’.
78 The focus of the typology is on interventions that involve altering aspects of physical micro-
79 environments to change health-related behaviour, here specifically applied to the selection,
80 purchase and consumption of food, alcohol and tobacco products. A more detailed discussion of
81 definitions and concepts follows below, but in essence, these interventions involve changing
82 characteristics of products themselves and the environment in which they are available, within
83 places such as shops, restaurants, bars, and workplaces. Examples include altering the portion size
84 of food, alcohol and tobacco products, and changing their availability or positioning within an

85 environment, such as providing additional healthier options to select from or placing less healthy
86 options further away from potential consumers.

87

88 **Aims of TIPPME**

89

90 To provide a framework for reliably classifying and describing ways in which interventions can
91 alter proximal physical micro-environments to change selection, purchase and consumption of food,
92 alcohol and tobacco products, in order to:

93 i) Facilitate the synthesis of cumulative evidence about the effects of interventions that can
94 be mapped on to the areas of influence or responsibility of different potential actors (e.g.
95 industry, policy makers, public), including supporting clearer reporting of intervention
96 content in primary and secondary research; and,

97 ii) Facilitate identification and discussion of a broader range of opportunities for
98 interventions to be developed, implemented and evaluated. This is potentially useful for
99 researchers and those in positions to directly alter, or advocate for changes to,
100 commercial, public sector or domestic environments.

101

102 **Focus of TIPPME**

103

104 We define the focus of this typology as:

105 Interventions or ways to alter the properties or the placement of objects or stimuli within proximal
106 (sensorily perceptible) physical micro-environments, to elicit particular behaviours among people
107 within those environments. These interventions are implemented within the same environment as
108 that in which the target behaviour is performed, and are not designed to be interactive or tailored
109 to specific individuals.

110

111 Our choice of terminology regarding ‘proximal physical micro-environments’ is intended to reflect
112 the spatial focus of this class of interventions relative to the people exposed to them. It draws upon
113 a conceptual distinction made within the ANGELO (Analysis Grid for Environments Linked to
114 Obesity) framework⁶ between two levels of environment, micro- and macro-. Micro-environments
115 are settings which people use for specific purposes (e.g. shops, restaurants and bars) and where they
116 interact directly with objects and stimuli within those environments. In contrast, macro-
117 environments are the higher-level systems and infrastructure that influence the characteristics of
118 micro-environments and the relationship between them (e.g. the availability of micro-environments
119 themselves, such as the geographical distribution of shops, restaurants and bars in a given area).

120

121 ANGELO additionally distinguishes between four types of environment: physical, economic,
122 political and socio-cultural. As we are concerned with the consumption of food, alcohol and tobacco
123 products that are themselves objects within it, the stated focus of TIPPMME is on the physical micro-
124 environment. We have not attempted concurrently to map economic, political and socio-cultural
125 environments, though we acknowledge their importance and the complex interactive relationships
126 between them, and between interventions and outcomes. For example, these other environments
127 may be manifest in any changes made to physical environments (e.g. political environments may
128 influence physical environments) or changes made to physical environments may impact upon them
129 (e.g. providing information may influence social norms). As well as directly influencing the nature
130 of physical environments, economic, political and socio-cultural environments also determine the
131 background conditions in which people are exposed to physical environments, such as times when
132 the physical environments can be accessed, and the economic costs that are imposed upon them.
133 Applying a sociological lens, social structures constrain and enable the actions of individual human
134 agents and set the limits of behavioural possibilities. Humans operate in an environment which is
135 simultaneously social, biological, and physical⁷. Here our focus is on the physical, while
136 acknowledging this wider set of parameters.

137 Because physical micro-environments can be very large and encompass a wide range of functions
138 and purposes for the people in them (for example, neighbourhoods or streets), this term is not
139 specific enough to capture the focus of the interventions we aim to characterise. The addition of
140 ‘proximal’ reflects our conceptual focus, as these interventions are typically implemented close
141 (spatially and temporally) to the point of decision or performance of the people exposed to them, in
142 order to influence behaviour enacted in that same physical environment. We have bounded the
143 parameters of the physical environments characterised by our typology to those that are sensorily
144 perceptible (i.e. able to be seen, heard, smelt, touched, or tasted) by intervention recipients. In
145 combination with the other elements of our definition, this is intended to give an approximate
146 indication of the likely scale of the interventions of interest, given that precisely and accurately
147 quantifying the range of distances is not practicable. Finally, the focus of this typology excludes
148 interventions that are designed to be interactive or tailored, meaning those in which the intervention
149 content is not standardised for all recipients and is intended or enabled to vary dependent on their
150 characteristics or responses. This may result from an interaction with a person or machine, such as a
151 cafeteria worker or a computer-based system providing personalised nutritional guidance based on
152 food purchasing patterns, demographic characteristics or responses to questions. While
153 interventions included in TIPPE are not necessarily non-interactive - in so far as people could in
154 theory interact with them and change their content - they are not designed to elicit such interaction.

155

156 **The importance of interventions in proximal physical micro-environments**

157

158 Interventions in proximal physical micro-environments have significant potential to change
159 behaviour to improve population health⁸. This is reflected in current policy and research interest.
160 These interventions have key advantages over many other types of behaviour change interventions.
161 First, the nature of altering characteristics of physical environments means that these interventions
162 have the potential to shape the behaviour of all those exposed to that environment without the need

163 for interpersonal interaction. This means that once an intervention has been developed and
164 implemented, there are likely minimal ongoing resource costs associated with its continued use.
165 Second, because physical environments have the potential to be modified in a consistent and
166 directly measurable way, an intervention can be readily and reliably transferred to other locations,
167 and scaled up in its application to reach larger populations. Third, because these interventions
168 typically involve altering cues located proximally in time and space to the behaviour, their effects
169 are likely less reliant on people purposefully, consciously engaging with the intervention over time⁹,
170 or on high levels of personal agency¹⁰. This means that they may be less affected by differential,
171 often socially patterned, cognitive or motivational resources. They therefore, in theory, have the
172 potential to be effective across the populations to which they are applied, without widening existing
173 health inequalities. Such potential is reflected in evidence suggesting that interventions that alter the
174 environments to which people are exposed may be less likely to widen inequalities than individual-
175 level education and counselling¹¹. Finally, there is emerging evidence that this kind of public health
176 intervention is more acceptable to the public than economic interventions such as taxes on
177 products^{12,13}, public acceptability being a key determinant of whether an intervention is
178 implemented¹⁴.

179

180 **Previous attempts to characterise the proximal physical micro-environment**

181

182 In addition to the ANGELO framework⁶, there have been several complementary research efforts
183 that make reference to small-scale physical environments. The Behaviour Change Technique (BCT)
184 Taxonomy¹⁵ aims at comprehensively describing behaviour change techniques, including
185 ‘restructuring the physical environment’, although it does not further classify interventions within
186 this category. The Intervention Mapping approach¹⁶ describes a series of steps for developing
187 interventions, and includes ‘nudging’ as one possible approach to changing determinants underlying
188 behaviour, but does not disassemble this concept in terms of specific intervention content. Other

189 work has focused on classifying characteristics of ‘nudging’ or ‘choice architecture’ interventions
190 (e.g.^{17,18}), but these typically concern broad theoretical principles and do not describe ways of
191 changing physical environments in any detail. Previous attempts to map features of the physical
192 environment that cue our behaviour or ways in which it can be changed¹⁹⁻²² are unable to address
193 our aims adequately, as they are insufficiently detailed, not systematically developed and assessed,
194 or are not applied to consumptive health-related behaviours.

195

196 In an earlier phase of this research, we developed a provisional typology that focused specifically
197 on the ways in which small-scale physical environments have been altered to influence food,
198 alcohol, tobacco and physical activity behaviours^{23,24}. This was derived from a large-scale
199 systematic scoping review of the research literature on ‘choice architecture’ interventions, intended
200 to map the parameters of previous empirical research and provide a conceptual map of the evidence
201 base, in order to delineate and characterise more specific intervention types. In the current paper we
202 describe further development of this work, introducing TIPPME (Typology of Interventions in
203 Proximal Physical Micro-Environments), which is intended to improve upon and replace the
204 provisional typology. Such development was needed because the nature of the provisional typology
205 was determined by the extant research literature, and was therefore not designed to be applied
206 beyond organising that specific body of literature. Additionally, the early stages of developing
207 TIPPME (see Methods, Stages 1-3) identified various conceptual issues with the provisional
208 typology that undermined its validity and usefulness. TIPPME therefore represents an attempt to
209 produce a more generalisable typology with a conceptually and theoretically coherent structure that
210 can accommodate both interventions that have been developed and tested, and those that exist only
211 in theory. Using the original scoping review process as a platform, it has been shaped in accordance
212 with the collective understanding of experienced researchers and practitioners, with the aim of
213 producing as complete and parsimonious account of the phenomena of interest as possible.

214

215 Whilst related to these concepts, the focus of TIPPME has been deliberately distanced from the
216 terminology of ‘nudging’ and ‘choice architecture’, this being potentially contentious in terms of
217 how it has been bound to particular political and philosophical positions, and which has been
218 inconsistently interpreted and applied. As Oliver (2015) highlights²⁵, for a nudge to align with the
219 founding principles of libertarian paternalism³, it should fulfil a set of essential criteria (e.g. that it is
220 not regulatory, and does not rely on rational reasoning processes). Because interventions that are
221 claimed to represent nudges often do not meet these criteria, continued imprecise usage of the term
222 has resulted in the concept it denotes being obfuscated and confusion around its meaning and
223 potential policy value²⁶. While interventions within TIPPME may map on to the concept of nudging
224 in some respects, this is not a necessary feature of the typology. It is therefore instead linked to the
225 more generalised and readily definable concept of the physical environment and the ways in which
226 this can be altered to change behaviour.

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228

229

230 **RESULTS**

231

232 This section describes the final version of TIPPME that resulted from the seven sequential stages of
233 its development. Specific results from each stage of that process, including the results of reliability
234 testing exercises, are described in the Methods section.

235

236 The final, complete version of TIPPME (Typology of Interventions in Proximal Physical Micro-
237 Environments) is provided in Supplementary Information. It is also available at

238 <http://www.bhru.iph.cam.ac.uk/resources/TIPPME> (with training materials also provided at this

239 website) and at <https://doi.org/10.6084/m9.figshare.5053672>. This complete version includes full

240 definitions and guidance, a set of instructions for use, and provides examples of interventions within

241 each category in the typology. For illustration only, a simplified version of TIPPME is presented in
242 Figure 1. TIPPME includes and encompasses interventions that meet our stated definition of
243 proximal physical micro-environment interventions. In terms of the wording used and examples
244 provided, we have here applied it specifically to the selection, purchase and consumption of food,
245 alcohol and tobacco, acknowledging that it could potentially be applied and adapted to other
246 behaviours (see Discussion).

247
248
249

250 **PLEASE INSERT FIGURE 1 HERE**

251
252

253 **Figure 1. Simplified version of TIPPME (Typology of Interventions in Proximal Physical**
254 **Micro-Environments), for changing selection, purchase and consumption of food, alcohol and**
255 **tobacco (see Supplementary information for full version)**

256

257

258 TIPPME comprises a matrix classification structure defining six intervention types and three
259 different spatial foci. The rows of the typology represent different intervention types, i.e. ways in
260 which the proximal physical micro-environment can be altered to elicit changes in behaviour. There
261 are six different intervention types (rows), namely: Availability; Position; Functionality;
262 Presentation; Size; Information. These six intervention types can be aggregated into two higher-
263 order classes of intervention: i) those that involve altering the placement of objects or stimuli within
264 proximal physical micro-environments, and ii) those that involve altering the properties of objects
265 or stimuli within proximal physical micro-environments, indicated by the column on the left edge of
266 the figure. The typology also distinguishes between three intervention foci representing differences
267 in the spatial focus of interventions: Product; Related objects; Wider environment. The combination
268 of rows and columns means there are 18 possible intervention categories that can be applied to
269 describe an intervention.

270

271

272 DISCUSSION

273

274 The Typology of Interventions in Proximal Physical Micro-Environments, TIPPME, provides a
275 means of reliably classifying and describing an important class of interventions to change health-
276 related behaviour across populations. TIPPME has benefited from an extensive, iterative and
277 explicit development process that included reliability testing using a sample of people involved in
278 researching and implementing interventions, representing those ultimately likely to use it. In line
279 with other conceptual frameworks, this framework will, with use, be found to be imperfect, but it
280 represents an agreement that a point of development has been reached where we judge the typology
281 can usefully fulfil its stated aims.

282

283 First, it provides a reliable framework for the synthesis of cumulative evidence about the effects of
284 interventions, with the potential for a shared language. Second, it can facilitate systematic thinking
285 about and identification and discussion of a broader range of opportunities for interventions to be
286 developed, implemented and evaluated. In turn, resulting findings can be integrated with a growing
287 cumulative evidence base to facilitate the development of more effective interventions. In more
288 practical terms, this typology can feasibly be used in tasks such as classifying or organising bodies
289 of literature; identifying, framing and bounding primary research, as well as systematic and
290 conceptual reviews; and providing a way of listing possible intervention strategies. It is potentially
291 useful both for researchers and for framing the actions of those in positions to alter or influence
292 commercial, public sector or domestic environments. This could include public health practitioners
293 and policymakers, as well as those advocating for such changes. Finally, while the predominant
294 focus of TIPPME is on ways of altering environments, it may also be informative in attempts to
295 describe physical features of environments that (as opposed to being implemented as interventions)
296 already exist and may influence behaviour accordingly (or may moderate the effectiveness of
297 interventions that are introduced).

298 TIPPME also contributes to and complements ongoing efforts by the wider research community to
299 build the foundations of a cumulative evidence base by developing domain ontologies to encode
300 and curate research knowledge about the effects of interventions, and enable its more efficient
301 identification, synthesis and use. Such domain ontologies include representation of the common and
302 distinct features (or attributes) of different types of interventions, and of the proposed ‘active
303 ingredient(s)’ that determine their effectiveness²⁷⁻²⁹. This encompasses representation of the content
304 of interventions¹⁵ and of the mode, or form, of their delivery³⁰. TIPPME contributes to these efforts
305 by specifying the common and distinct features of a specific class of interventions. In particular, it
306 delineates these interventions in terms of: (i) their content - this being the proposed ‘active
307 ingredient(s)’ that elicit the behavioural response - which in this case concerns the alteration of
308 attributes of objects or stimuli within the proximal physical micro-environment, such as their size or
309 position; and (ii) the focus of that content. Ontological relationships both within TIPPME, and
310 between TIPPME and other relevant typologies or taxonomies, are likely to be complex -
311 particularly as there may be variation in the level of explanation or granularity applied in each case.
312 Further development work is therefore needed to clarify and specify the form and structure of these
313 relationships, as well as the ways in which different frameworks may be usefully applied in
314 combination. Relatedly, TIPPME does not at present attempt to delineate the mechanisms of action
315 that underlie each intervention type but, if it fulfils its stated aims, this should facilitate primary and
316 secondary research directed towards furthering understanding of such mechanisms.

317

318 Whether TIPPME is viewed as a typology, or, with additional development and validation, a more
319 definitive taxonomy, depends on the epistemological position that one adopts. The way that some
320 authors describe ontologies is unequivocally realist, whereby a properly developed ontology will
321 describe the real world as it is, rather than just as it appears to be to the observer³¹. Contrary to this,
322 phenomenologists such as Schutz³² view ontologies as theories about the nature of being in the
323 world, and typologies and typifications as the means of seeing and interpreting that world; the

324 plastic nature of such conceptual constructs is emphasised. A true ontology would take full account
325 of both realist and phenomenalist perspectives and indeed our approach to developing TIPPME has
326 drawn on both of these traditions. In the initial phase of development, we derived provisional types
327 from empirical studies; while in latter phases we have sought to use a mix of realist and other forms
328 of knowledge to refine the typology to align with various priors (including theoretical
329 understandings) about relations between concepts and ideas, either as we imagine the world appears
330 to be, or as we imagine the world should be if it conformed to our prior beliefs.

331

332 We judge the level of granularity of TIPPME to be appropriate to fulfil our aims; being relatively
333 simple but enabling discrimination between multiple intervention types. Evidence of how our
334 provisional typology²³ has been used to, for example, frame funding calls, inform policy documents
335 and to characterise interventions in systematic reviews (see Methods), suggests that TIPPME has
336 the potential to be similarly useable. However, its granularity could be increased, should important
337 intervention sub-types or additional characteristics be highlighted. This could be through
338 conducting systematic reviews of specific intervention types in which key intervention
339 characteristics are identified (e.g.³³⁻³⁵), or mapping relationships between TIPPME and other
340 classification systems.

341

342 TIPPME and the methods used to generate it have several limitations. Our first reliability testing
343 exercise, while demonstrating that TIPPME can be reliably used by those outside of the research
344 team, used a relatively small sample of experts, predominantly academic researchers. Whilst such a
345 sample is likely to be broadly representative of some of the most likely users of the typology, there
346 will be other groups that were inadequately represented. Furthermore, the majority of the
347 development process was conducted by the core research team. While a wide range of disciplinary
348 backgrounds was represented, and many of the group had extensive policy and guidance
349 development experience, the team was weighted towards research expertise. A more rigorous and

350 comprehensive series of assessments, likely also integrating responses from a wider cross-section of
351 potential user groups, will be required for greater confidence in TIPPME's reliability, particularly
352 for use outside of the research community. A further limitation is that TIPPME is currently only
353 applied to three consumption behaviours, which, while highly important – with metabolic and
354 dietary risk factors linked to food consumption, as well as smoking and alcohol use, all being
355 amongst the most significant risk factors contributing to global disease burden² – do not encompass
356 all of the human behaviours that significantly impact on health. Most notably, although it was
357 included in the provisional typology²³, physical activity was not included here. We judged that it
358 was not practicable to include due to it being conceptually distinct. This is because, unlike selection,
359 purchase and consumption of food, alcohol and tobacco, physical activity does not necessarily
360 relate to products that are separable from and placed within a given environment (see Methods,
361 Stage 3 for further details).

362

363 While the current behavioural focus of TIPPME limits its generalisability, the typology is intended
364 to be broad in scope so that it could potentially be adapted to apply to other behaviours. When
365 considering the current and potential future scope of TIPPME in terms of the behavioural domains
366 to which it applies, it may be helpful to map its categories to a systematically-developed framework
367 of behaviours, such as Nudelman and Shiloh's taxonomy of health behaviours³⁶. Within this
368 taxonomy, TIPPME is currently aligned to nutrition and risk avoidance behaviours, these being
369 related to consumption of products that are linked to non-communicable disease. In theory,
370 TIPPME may be applicable to a wide range of other behaviours, including those unrelated to
371 product consumption (e.g. physical activity or gambling behaviours), those linked to the prevention
372 of communicable disease (e.g. hygiene-related behaviours) and pro-environmental behaviours to
373 mitigate climate change (e.g. energy use or recycling behaviours). Such translation will require
374 specific programmes of development and testing.

375

376 In the process of developing TIPPME, some challenging conceptual issues were encountered. Most
377 notably, to ensure TIPPME had the potential to discriminate, it was intended that each intervention
378 type (typology row) would represent a distinct way in which the proximal physical micro-
379 environment can be altered, with any single discrete intervention component being assignable to a
380 single intervention type. However, it was quickly apparent that there was an inevitable degree of
381 conceptual overlap or co-dependence between the different intervention categories. For example, if
382 we consider an intervention in which restaurant patrons are provided with smaller (versus larger)
383 spoons to attempt to reduce dessert consumption, we would expect most users would characterise
384 this as a 'Size' intervention. Manipulating the size of a spoon will also likely affect the way the
385 spoon looks and feels i.e. 'Presentation', however, and so either or both types could feasibly be
386 applied for all 'Size' interventions. While this is a fundamental conceptual issue linked to the nature
387 of the sensory, spatial and morphological attributes of objects and stimuli, for the purposes of the
388 typology it can be addressed by distinguishing between the primary target of the intervention and
389 secondary consequences. As explained in the typology and its accompanying instructions
390 (Supplementary information), assuming a single discrete intervention component or manipulation is
391 present, the user applying TIPPME will aim to identify a primary intervention type that best
392 captures it. Should there be multiple discrete, separable intervention components implemented
393 within the same environment, multiple different intervention types can correspondingly be applied.
394 In practice, reports of interventions will often support judgements of what the primary target of the
395 intervention is via their stated aims and hypotheses, and the way in which they describe intervention
396 content. Importantly, results of the reliability testing exercises suggest that despite these potential
397 challenges, the typology can be consistently applied by users.

398

399 Because reliable application of TIPPME, as with any classification system, is dependent on making
400 informed judgements from the information that is provided, the increased attention that is being
401 given to improving the reporting of intervention studies^{37,38} will be beneficial. Additionally, we

402 would hope that TIPPME will enable those reporting on proximal physical micro-environment
403 interventions to specify the primary target of their intervention, thereby reducing future ambiguities.
404 The Typology of Interventions in Proximal Physical Micro-Environments, TIPPME, provides a
405 framework to reliably classify and describe an important class of interventions, and enable more
406 systematic design, reporting and analysis of interventions to change health-related behaviour at
407 population level. In doing so, we propose TIPPME makes a distinct contribution to collective
408 efforts to build the cumulative evidence base for effective ways of changing behaviour across
409 populations.

410

411

412

413

414 **METHODS**

415

416 The development of TIPPME is summarised in Table 1 and involved three phases of work: a)
417 identifying the need for a typology; b) developing and elaborating on this typology; and c)
418 reliability testing and finalising. These were completed in seven main stages. Throughout, the
419 development process was integrated with formal and informal discussions between the core
420 research team as well as wider academic networks. The core research team (the authors) comprised
421 ten members with a range of disciplinary backgrounds across public health, health policy,
422 psychology and behavioural science, sociology, and evidence synthesis, and many of the group had
423 extensive policy and guidance development experience. They represented varied expertise in
424 developing and applying prominent typologies or classification systems relating to behaviour
425 change interventions and theory, developing, implementing and evaluating public health and
426 behaviour change interventions in a range of behavioural and population contexts, and developing
427 practice and research reporting guidelines.

428 **Table 1. Development process for TIPPME**

429

Phase	Stage	Methods	Results and actions
a) Identifying need	1. Developing a provisional typology of physical micro-environment interventions	Large-scale systematic scoping review to map available empirical evidence.	Produced provisional typology to configure extant literature. Agreed that further development needed to apply more widely.
	2. Receiving feedback from expert workshops	Two workshops, attended by researchers and practitioners (n=45), involving a questionnaire and group discussion.	Support obtained from attendees for value of further development. Considering other indicators of likely value, research team proceeded with development.
b) Developing and elaborating	3. Generating a preliminary version of TIPPME	Two-day residential meeting of research team, with series of structured discussions.	Generated a preliminary version of TIPPME.
	4. Identifying conceptual and practical problems with a preliminary version	Research team completed intervention description coding task, followed by structured discussion via teleconference.	Produced revised version of TIPPME to be subject to reliability testing.
c) Reliability testing and finalising	5. Reliability testing exercise (i): Coding of intervention descriptions by external experts	External experts (n=33) with backgrounds in public health and behaviour change completed exercise involving coding content of 40 short intervention descriptions.	Demonstrated strong reliability in applying TIPPME using short intervention descriptions. Two-day residential meeting of research team held to discuss findings.
	6. Reliability testing exercise (ii): Coding of intervention descriptions using full-text papers	Four members of the research team completed exercise involving coding content of 24 full-text papers.	Demonstrated strong reliability in applying TIPPME to the coding of full-text papers.
	7. Agreement on a final version of TIPPME	Research team members completed final check of the typology and wording, to ensure clear and consistent throughout. Teleconference held to agree on final version.	Produced final version of TIPPME. See Figure 1 for simplified version and Supplementary information for full version.

430

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434

435 **Stage 1. Developing a provisional typology of physical micro-environment interventions**

436

437 **Aim:** To generate a refined definition and provisional typology of choice architecture interventions

438 in physical micro-environments, and to map the available empirical evidence for the effects of these

439 interventions on diet, physical activity, alcohol and tobacco use.

440

441 **Methods:** We conducted a large-scale systematic scoping review, published in 2013²³ In brief, the
442 methods used to develop the provisional typology involved highly sensitive searches of 15
443 electronic literature databases, combined with parallel snowball searches, retrieving over 800,000
444 unique title and abstract records. We used text mining methods to prioritise these records for
445 screening³⁹ and manually screened over 54,000 prioritised records to identify 346 eligible full-text
446 articles.

447

448 **Results:** Data extracted from these 346 articles (reporting primary evaluation studies and reviews of
449 such studies) were then used to configure, describe and synthesise the key characteristics of
450 interventions. This was an iterative process, incorporating regular discussion among members of the
451 review team, and resulted in the provisional typology in Figure 2, comprising nine types of
452 interventions: Ambience, Functional design, Labelling, Presentation, Sizing, Availability,
453 Proximity, Priming, Prompting.

454

455

456

457 **PLEASE INSERT FIGURE 2 HERE**

458

459 **Figure 2. Typology at end of Stage 1**

460

461

462

463 **Subsequent actions:** The research team sought feedback on the typology from a wider group of
464 potential users concerning its usefulness and the scope for further development, including
465 discussion of conceptual issues that had been identified by the research team over the course of
466 conducting the scoping review.

467

468 **Stage 2. Receiving feedback from expert workshops**

469

470 **Aim:** To elicit feedback about issues with understanding and using the provisional typology of
471 choice architecture interventions.

472

473 **Methods:** Two typology development workshops were conducted, attended by a total of 45
474 participants working in areas of behaviour change and public health intervention. Participants were
475 predominantly in research roles (80%, with 20% in policy or practitioner roles), with a range of
476 disciplinary backgrounds represented (psychology or behavioural science (38%); public health or
477 medicine (20%); nutrition (7%), policy (11%) sociology (2%), other or missing (20%)). To
478 encourage engagement with the provisional typology and elicit feedback, the workshops involved
479 completing the same brief intervention description coding task (classifying 14 intervention
480 descriptions by reference to the provisional typology) followed by a questionnaire assessing
481 perceived value of the work and its development, concluding with a structured group discussion.

482

483 **Results:** There was strong support expressed for the value of developing the provisional typology
484 from academics and practitioners who attended: 95% (41/43 responses) of participants agreed with
485 the statement “developing this typology is valuable and important”. There was recurrent feedback
486 that further development would be necessary in order for the typology to be more widely applied.
487 Issues highlighted that would need to be considered in future included: identifying some
488 inconsistencies in the intervention types concerning whether they related to the content or the
489 mechanism of the intervention (for example, one of the intervention types, ‘priming’, related
490 primarily to a mechanism of effect and was therefore not equivalent to other intervention types);
491 whether the ‘labelling’ and ‘prompting’ intervention types were clearly distinct; and the difficulty
492 of coding physical activity interventions. The intervention description coding task was principally
493 intended only to encourage engagement and general feedback within the workshops. However, in
494 line with qualitative feedback received from participants, its results did suggest that typology

495 categories could be applied consistently (Fleiss' kappa =.83), supporting using the basic structure
496 and content of the provisional typology as a foundation for future development.

497

498 **Subsequent actions:** In preparation for future development of the typology, the initial research team
499 was extended to include two behaviour change experts with expertise in developing and applying
500 prominent typologies of behaviour change interventions and theory, and a public health expert with
501 expertise in environmental determinants of health and the evaluation of public health interventions.
502 It was agreed by the research team that development of a new typology would be valuable,
503 informed by both the workshops and other external indicators of potential value. For example, the
504 provisional typology had been used to frame two calls from a national research funding body
505 (National Institute for Health Research (UK)), had directly informed policy documents and
506 guidelines (e.g. NICE (2014), Department of Health (2015)) and was being used for characterising
507 and defining interventions in several systematic reviews (e.g.^{33-35,40,41}).

508

509 **Stage 3. Generating a preliminary version of TIPPME**

510

511 **Aim:** To generate by consensus a preliminary version of TIPPME that would be subject to further
512 development.

513

514 **Methods:** A two-day residential meeting of the core research team (the authors) was held. This
515 meeting comprised a series of structured discussions, informed by feedback received from the
516 expert workshops (Stage 2) and from colleagues within wider networks.

517 **Results:** A preliminary version of TIPPME was generated. Principal developments agreed at this
518 stage, representing changes to the provisional typology (Figure 2), were as follows:

519 i. A new matrix classification structure was created to enable representation of both different
520 intervention types (the rows of the typology), as well as differences in the spatial focus of

- 521 the intervention (the columns of the typology). This structural change stemmed from
522 agreement that a more conceptually coherent position would be to view any given physical
523 micro-environment as a set of objects or stimuli that could feasibly all be manipulated. This
524 would also allow greater flexibility in thinking about the range of possible interventions
525 within this space, whether these are only theoretically possible or are represented in the
526 current body of empirical literature.
- 527 ii. Intervention type ‘Ambience’ was removed and its place taken by the ‘Presentation’
528 intervention type applied on the scale of the wider environment. This was because the new
529 typology structure means that objects and stimuli within the wider environment are
530 considered subject to the same intervention types as are the products themselves.
- 531 iii. Intervention types ‘Labelling’ and ‘Prompting’ were subsumed within a generic intervention
532 type pertaining to the communication of explicit textual, numeric or pictorial information.
533 This more inclusive category of information-based interventions – initially named ‘Words,
534 Numbers and Pictures’ and ultimately ‘Information’ - was considered more coherent, as
535 previous conceptual distinctions between ‘Labelling’ and ‘Prompting’ interventions were
536 unclear. This still allowed differentiation from other intervention types that focus on the
537 alteration of sensory, spatial and morphological characteristics.
- 538 iv. Intervention type ‘Priming’ was removed as there was agreement that this represented a
539 specific mechanism rather than an equivalent intervention type.
- 540 v. Notably, physical activity was excluded as a behaviour of interest. It was agreed that it was
541 not practicable to include this in a coherent and concise typology, given that, unlike food,
542 alcohol and tobacco, it does not involve the selection, purchase and consumption of products
543 that are separable from and placed within a given environment. It would be possible to adapt
544 the typology to physical activity, with the equivalent of the target product or object being the
545 physical space in which, or on which, the physical activity is performed. This physical space
546 may be a permanent part of, or the whole of, the proximal physical micro-environment

547 itself. However, adapting the typology to physical activity would be complex and require its
548 own specific explanation and translation.

549

550 **Stage 4. Identifying conceptual and practical problems with a preliminary version**

551

552 **Aim:** To attempt to use the preliminary typology in order to identify outstanding conceptual and
553 practical problems with TIPPME.

554

555 **Methods:** The research team (n=8, excluding the first two listed authors who were responsible for
556 producing the exercise materials), completed a task which encouraged engagement with the detail
557 of the preliminary typology and its application. Each participant was given a link to an online
558 Qualtrics task comprising 40 short (<150 words) intervention descriptions. These represented a
559 sample of descriptions of interventions from the 346 papers that were included in the
560 aforementioned scoping review of choice architecture interventions²³. We selected intervention
561 descriptions on a quota basis that covered a wide range of intervention content, aiming to include at
562 least 5 examples that could feasibly be mapped to each of the six intervention types within the
563 typology, with a spread across the three intervention foci and across food, alcohol and tobacco. We
564 used the first example that met our criteria that was encountered via random searching to ensure that
565 the intervention descriptions were varied in nature and broadly representative of the wider empirical
566 literature. The 40 intervention descriptions were presented to each participant in a random order.
567 For each intervention example, participants were asked to assess which category in the typology
568 best captured the example, how much overlap existed between the intervention types they
569 considered selecting, and to describe any difficulties they encountered in coding the example and
570 any possible alterations to the typology that would have ameliorated these difficulties. For each
571 intervention example, they were encouraged to provide further qualitative feedback concerning each
572 intervention example, and the overall structure and content of the typology.

573 **Results:** Quantitative and qualitative responses from the task were synthesised. While quantitative
574 results suggested that intervention types could be applied consistently (Fleiss' kappa=.69), the task
575 was principally intended to highlight areas in which there were significant levels of disagreement,
576 comment or criticism, in order to prioritise focused discussion.

577

578 **Subsequent actions:** A teleconference of the research team was convened, and a structured
579 discussion was conducted. This involved assessing problematic intervention descriptions in a
580 structured format, in order to reach agreement on steps to be taken to improve the conceptual
581 coherence and ease of use of the typology. Intervention examples where $\geq 50\%$ of responses were
582 discordant were flagged for prioritised discussion. Discussion began in order of the intervention
583 descriptions that were coded least consistently, and terminated after all flagged examples had been
584 discussed. For each flagged example, individuals were encouraged to justify their responses and
585 propose and discuss solutions which could overcome the reasons why individuals coded
586 discrepantly. A vote then took place to assess if participants could converge on the same answer i)
587 without any further changes to the typology and ii) with specific changes to the typology (if agreed
588 upon). As a result of this process, various changes were made to wording of definitions, including a
589 clarification of the distinction between the columns within the typology. Additional guidance text
590 was added where it was agreed there was likely to be a greater chance of perceived overlap between
591 intervention types. Figure 3 shows the typology version at this stage.

592

593

594

595

596 **PLEASE INSERT FIGURE 3 HERE**

597

598 **Figure 3. Typology at end of Stage 4**

599

600

601 **Stage 5. Reliability testing exercise (i): Coding of intervention descriptions by external experts**

602

603 **Aim:** To test whether participants likely to use TIPPME, namely those involved in researching or
604 implementing interventions to change health-related behaviours, were consistent in identifying its
605 intervention types and foci in short descriptions of interventions.

606

607 **Methods:** We recruited external experts with backgrounds in public health and behavioural science
608 as researchers or practitioners, meeting the following criteria (adapted from¹⁵): “active in their field
609 and engaged in designing, delivering and/or evaluating interventions to change health-related
610 behaviour that could be delivered at scale to impact on population health”. Recruitment was via
611 email and Twitter enquiries to possible participants within our wider academic networks. A similar
612 exercise to that described in Stage 4 was used, involving coding 40 short intervention descriptions
613 (<150 words) selected on a quota basis to represent a range of intervention content and of targeted
614 products. These were presented in a random order, using the question “Which intervention category
615 best captures the above description?”. Quantitative reliability statistics were calculated for the pre-
616 specified primary outcome of discrimination of intervention type (the rows of the typology), as well
617 as for intervention focus (the columns of the typology) and a combined total. As some agreement
618 would be achieved by chance alone, two different ‘chance-corrected’ agreement measures were
619 used, Fleiss’ kappa and prevalence and bias adjusted kappa (PABAK)^{42,43}.

620

621 **Results:** Potential participants (n=52) who had initially expressed an interest in participating were
622 contacted via email with a link to the exercise. All participants (n=33) who started the exercise
623 completed it. 58% were female, and most were in research roles (94%, with 6% in policy or
624 practitioner roles), with a range of disciplinary backgrounds represented (psychology or behavioural
625 science (45%); public health or medicine (18%); nutrition (15%); epidemiology (6%); economics
626 (6%); other (urban planning, marketing, human factors) (9%)). Inter-rater reliability values for the
627 exercise are provided in Table 2. A kappa value of .41-.60 is conventionally considered to represent
628 “moderate” agreement, a value of 0.61–0.80, “substantial” agreement, and a value of >.80, “almost

629 perfect” agreement⁴⁴. Fleiss classified a kappa between .40-.75 as “Intermediate to Good” and >.75
630 as “Excellent”⁴³. Therefore, the observed values indicate that the intervention types within the
631 typology in its current form are strongly distinguishable from one another. Furthermore, category-
632 wise statistics indicate that each of the six intervention types and each of the three intervention foci
633 were able to be applied reliably.

634

635 **Subsequent actions:** A two-day residential meeting of the research team was held to further refine
636 the typology. Although the structure of the typology was not altered, each intervention type was
637 given a concise single-word title (e.g. ‘Words, numbers and pictures’ was changed to
638 ‘Information’), and some minor changes to wording of definitions were made. It was agreed that,
639 because intervention descriptions used in this exercise comprised short passages focused on the
640 intervention characteristics, this was not representative of how these might more typically be
641 encountered in full-text papers, where details may be spread disparately within papers, in
642 potentially complex formats. Furthermore, it was important that participants were able to code the
643 presence of multiple discrete intervention types identified within one paper, where previously they
644 had been asked to identify a single category that best captured an intervention. Therefore, a second
645 reliability testing exercise intended to be less artificial and more generalisable to real-world use was
646 planned.

647

648 **Stage 6. Reliability testing exercise (ii): Coding of intervention descriptions using full-text**
649 **papers**

650

651 **Aim:** To assess whether interventions described in full-text papers can be reliably coded to
652 categories within TIPPME.

653

654 **Methods:** Following a pilot phase to develop the exercise, members of the research team (n=4) each
655 coded 24 study reports within full-text articles that were randomly selected (using a random number
656 generator) from those included in the initial scoping review²³ but excluding review papers and those
657 not describing any intervention, those concerning physical activity interventions, and those that had
658 been used in previous stages of the typology development process. To ensure that a range of
659 behaviours was covered, randomisation was stratified by behaviour so that half of the papers related
660 to food and half to alcohol or tobacco. Where there were multiple eligible separate studies within a
661 single full-text paper, the first was used. The exercise involved each participant coding which (if
662 any) categories in the typology were identified in each study. The number of study reports to be
663 coded in this exercise was derived using the KappaSize R Package⁴⁵, given that, to our knowledge,
664 there are no gold-standard methods to precisely estimate the required sample sizes for determining
665 reliability kappas in cases where there are both multiple coders and a large number of coding
666 categories. We estimated an approximate, conservative sample size based on the following
667 parameters: an alpha value of 0.05; power of 0.80, using 4 coders; an assumption that categories
668 will not be perfectly balanced and instead may be moderately unbalanced; a null hypothesis of a
669 kappa of 0.4 (i.e., the lower bound of ‘intermediate to good’ agreement on Fleiss’ Kappa
670 Benchmark Scale); and, an expected kappa of 0.7 (based on observed kappa values from reliability
671 testing exercise (i)). This suggested that at least 22 study reports would be required to test whether
672 the kappa exceeds 0.4.

673

674 **Results:** Inter-rater reliability values are provided in Table 2. The observed values indicate that the
675 intervention types within the typology in its current form are strongly distinguishable from one
676 another when full-text papers are coded. Furthermore, category-wise statistics indicate that
677 underlying the summary statistics, each of the six intervention types and each of the three
678 intervention foci was able to be applied reliably.

679

680 **Stage 7. Agreement on a final version of TIPPME**

681

682 **Aim:** To reach consensus on a final version of TIPPME including terminology, wording and
683 presentation.

684

685 **Methods:** Research team members completed a final check of the typology and its wording, to
686 ensure it was clear and consistent throughout. A teleconference of the research team was convened
687 to discuss any identified issues.

688

689 **Results:** Further descriptive notes and additional examples were added to the full version of the
690 typology to aid in its use. A final version of TIPPME was agreed upon by the research team,
691 described in the 'Results' section.

692

693

Table 2. Inter-rater reliability statistics (Fleiss' kappa, prevalence and bias adjusted kappa (PABAK), and percent agreement) for reliability testing exercises (i) (left) and (ii) (right)

Reliability testing exercise (i) – external experts (33 coders, 40 codings each)				Reliability testing exercise (ii) – full-text papers (4 coders, 24 codings each)			
Summary statistics				Summary statistics			
	Intervention type (primary outcome)	Intervention focus	Total		Intervention type (primary outcome)	Intervention focus	Total
Fleiss' kappa [95% CI]	.76 [.70, .83]	.62 [.53, .72]	.61 [.55, .67]	Fleiss' kappa	.80	.71	.73
PABAK [95% CI]	.77 [.71, .84]	.69 [.62, .76]	.63 [.57, .69]	PABAK	.87	.77	.87
Agreement	.81	.77	.65	Agreement	.93	.88	.94
Category-wise statistics				Category-wise statistics			
	Fleiss' kappa [95% CI]	PABAK [95% CI]			Fleiss' kappa [95% CI]	PABAK [95% CI]	
<u>Intervention type</u>				<u>Intervention type</u>			
Availability	.65 [.43, .87]	.85 [.77, .93]		Availability	.68 [.36, 1.00]	.81 [.62, 1.00]	
Position	.93 [.88, .97]	.97 [.95, .99]		Position	1.00 [1.00, 1.00] *	1.00 [1.00, 1.00] *	
Functionality	.67 [.48, .87]	.92 [.86, .98]		Functionality	N/A	N/A	
Presentation	.77 [.68, .87]	.82 [.74, .90]		Presentation	.79 [.61, .98]	.82 [.64, 1.00]	
Size	.75 [.63, .87]	.87 [.79, .95]		Size	.87 [.70, 1.00]	.90 [.76, 1.00]	
Information	.82 [.74, .89]	.86 [.79, .94]		Information	.90 [.77, 1.00]	.92 [.80, 1.00]	
Other	.01 [-.01, .04] *	.94 [.91, .97] *		Other	-.04 [-.09, .00] *	.83 [.67, .99] *	
<u>Intervention focus</u>				<u>Intervention focus</u>			
Product	.65 [.55, .74]	.65 [.55, .74]		Product	.76 [.54, .97]	.76 [.56, .97]	
Related Objects	.51 [.37, .64]	.62 [.52, .72]		Related Objects	.72 [.41, 1.00]	.86 [.70, 1.00]	
Wider Environment	.79 [.67, .91]	.86 [.79, .94]		Wider Environment	.72 [.53, .92]	.74 [.54, .94]	
Other	.01 [-.01, .04] *	.94 [.91, .97] *		Other	-.04 [-.09, .00] *	.83 [.67, .99] *	

* Very few datapoints contained this code (being applied on average less than once per coder over the set of intervention descriptions). Due to its low frequency, this does not allow confidence in associated kappa statistics, which are therefore reported only for completeness.

N/A= Code not used by any coder

488 **SUPPLEMENTARY INFORMATION**

489

490 Full version of TIPPME and guidance for use.

491

492 **CONFLICT OF INTEREST STATEMENT**

493

494 The authors declare no conflict of interest.

495

496 **DATA AVAILABILITY**

497

498 The data that support the findings of this study are available from the corresponding author upon
499 request.

500

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615 **CORRESPONDENCE**

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617 Correspondence concerning this article should be addressed to Gareth Hollands, Behaviour and
618 Health Research Unit, University of Cambridge, Institute of Public Health, Robinson Way,
619 Cambridge CB2 0SR, UK. E-mail: gareth.hollands@medschl.cam.ac.uk

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630 Conceived the study: GJH MPK DO IS SS TMM. Designed and conducted workshops and
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