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ARTICLE

A practical guide to mapping behaviour change objectives for health promotion interventions

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Abstract

Intervention Mapping (IM) is a theory- and evidence-based framework allowing to develop, implement, and evaluate an intervention in public health. The current paper presents a practical step-by-step guide of the second step of Intervention Mapping, which translates the needs assessment findings into specific objectives aiming at changing health behaviours and/or environmental conditions. This includes: (1) Stating the programme outcomes; (2) Listing the target behaviors and performance objectives; (3) Selecting the sub-determinants; and (4) Producing an overview of intervention targets: the matrix of change objectives. We provide practical guidelines for each of these tasks. In addition, intervention developers may benefit from the listed open tools that may be used in each stage to address the identified needs and achieve meaningful health outcomes.

Key words: Intervention Mapping, Health Promotion, Interventions, Behaviour Change, Determinants

Background

When reaching the second step of Intervention Mapping (IM), the focus shifts from clearly defining the problem and related problematic behaviours to setting a course of action to promote desirable behaviors (Bartholomew Eldredge et al., 2016). The main tasks of step 2 are as follows: (1) State the programme outcomes or the expected change for health-related behaviour and environmental conditions; (2) Subdivide the target behaviour and environmental conditions into sub-behaviours; (3) Select the relevant and changeable personal determinants of the at-risk population behaviour and environmental conditions; and (4) Create matrices of change objectives for each target population and environmental agent (at the interpersonal, organisational, community, and societal levels) by matching performance objectives with the selected determinants (Bartholomew Eldredge et al., 2016). While the Intervention Mapping book describes *what* actions to take in this step, the current practical guide provides suggestions on *how* to implement them. This contribution builds upon the practical guide to effective behaviour change published in the European Health Psychologist a decade ago (Peters, 2014). Therefore, we will not reiterate the fundamental basics outlined there (e.g. why does behaviour change actually mean changing people's psyche? and how does theory come into it?). One notable amendment is the replacement of "belief" (in the original article) with "sub-determinant" (in the current paper). Our focus here is on the practical steps. Readers seeking further guidance may refer to chapter two of the Intervention Mapping Work Book (Peters et al., 2024, available at im-wb.com).

Task 1: Stating the programme outcomes

The first task consists of listing the programme outcomes based on the key behaviours identified in the needs assessment. These outcomes reflect the desired change for both health-related behaviours and environmental conditions depending on the planned intervention and on the collected data in the first step of IM (Bartholomew Eldredge et al., 2016). It is important to emphasize that step 2 starts with "the flip" (visually illustrated in Figure 1): while in step 1, the focus was on clarifying the problem at hand (e.g. risk behaviours), step 2 involves establishing what you will strive for. The focus on the undesirable problem flips to a focus on the desirable behaviours that you will promote and the desirable state of the environmental conditions. We begin with the target population individuals (usually the programme participants) before proceeding to discussing the environmental agents (these could be family members, school principals, policymakers, etc; Bartholomew Eldredge et al. (2016)).

a) Health behaviours

First, the intervention developers state what is expected to change for health behaviours (Bartholomew Eldredge et al., 2016). The health behaviours may be divided into three categories:

1. Health-promoting behaviours: these behaviours aim to either improve health or provide protection (Bartholomew Eldredge et al., 2016). In the case of primary prevention which aims at preventing a disease from occurring (Kisling and Das, 2023), examples of health-promoting behaviours may include increasing physical activity level (Said et al., 2021), increasing the fruit and vegetable intake (Said et al., 2021), or establishing appropriate sleep duration patterns (Verbestel et al., 2011). In the case of secondary prevention which focuses on the early detection of the disease, screenings are a good example of such behaviours

Fig. 1. Representation of the flipped logic model in Intervention Mapping.

(e.g., mammography; Bartholomew Eldredge et al. (2016)).

2. Risk-reducing behaviours: some behaviours (e.g., smoking) may increase the likelihood of health risks (e.g., chronic diseases). So, the aim of the risk-reducing behaviours is to reduce or eliminate the practice of these "unhealthy" behaviours, such as limiting a sedentary lifestyle (Said et al., 2021), limiting the consumption of sweetened beverages (Ball et al., 2017), or smoking cessation (Dalum et al., 2011).

3. Self-management and adherence behaviours: effective disease management often relies heavily on self-management techniques and adherence to treatment, enabling individuals to take an active role in their own care and improve their health outcomes (Lenferink et al., 2017; Osterberg and Blaschke, 2005). Taking the right dose of the prescribed medication at the right time represents a good example of these types of behaviours (Bartholomew Eldredge et al., 2016). Another example includes tracking the number of steps throughout the day and adjusting them to reach the daily goal in case it was not achieved.

To identify these behaviours, intervention developers use the core processes (Ruiter and Crutzen, 2020a; Crutzen and Nalukwago, 2025). Specifically, in this case, when drawing upon existing literature, taxonomies of behaviour can be helpful (Nudelman and Shiloh, 2015, Larsen et al. (2021), Schenk et al. (2024)). Furthermore, to obtain a feasible list of behaviours to promote, brainstorms with target population members can be invaluable. Similarly, consultations with relevant professionals working in that area (for example, youth workers, teachers, etc.) may also be advantageous. The product is your list of target behaviours: behaviours that, if your target population would adopt them, would alleviate or eliminate the problem established in step 1.

b) Environmental conditions

Beyond establishing the target behaviours, intervention developers establish what the target population's environment should look like. Similarly to distinguishing several behaviours, it is necessary to distinguish the separate environmental conditions that make up an environment. The current task is to list those environmental conditions that affect your target population's behaviour, or that may even directly affect a consequence of their behaviour that you're interested in, such as their health.
Environmental conditions are controlled by environmental agents: people or (parts of) organisations, such as neighbours, managers, hospital board, and municipalities. This means that to change these conditions, it is also necessary to identify the controlling environmental agent, its level within the environment, and its required actions (the environmental agents' target behaviours). A list of examples is provided below:

- Interpersonal level: this represents the interaction between individuals with one another or with their surrounding social network such as their families, friends, peers, or colleagues at work (Boyle, 2017). For instance, significant positive associations were found between the smoking behaviour of the parents and of their offsprings (Kandel et al., 2015). Therefore, smoking prevention efforts among adolescents may also target their parents to improve the programme's outcomes. Another example is the Child and Adolescent Trial for Cardiovascular Health (CATCH, catch.org) which focused on the school environment to improve the students' cardiovascular behaviour by promoting healthy nutrition and physical activity (Perry et al., 1997).

- Organisational level: this represents the interaction between individuals and the structured communities they belong to (Scarneo et al., 2019; McLeroy et al., 1988), such as the schools, worksites, professional organisations, or local health clinics (Boyle, 2017). For example, the CATCH programme provided healthy meal options in the school cafeterias as part of the organisational practices to improve the cardiovascular health of the school students (Perry et al., 1997). Another example is the benefits offered by Greenpeace to its employees such as medical and dental health coverage to improve their wellness ().

- Community environment: this represents the interaction between various groups of institutions and organisations affecting the health of populations (Boyle, 2017). For instance, the availability and the design of the playgrounds may affect physical activity practices of kids (Cohen et al., 2020). Another example is the correlation between housing quality and asthma disparities (Bryant-Stephens et al., 2021). This means that an effective programme may require investing in the neighbourhoods and communities to improve health.

- Societal level: this represents the influence of the legislation, federal regulations, and governmental agencies at the local, national, and international level (Bartholomew Eldredge et al., 2016). One of the many examples is the tobacco-control act (Law 174) passed by the Lebanese parliament in 2011, which prohibited smoking in enclosed public spaces (World Health Organization, 2019). This affects both smokers and non-smokers, as it reduces both direct and passive exposure to smoke.

As with the target behaviours, the core processes may again be utilised (Ruiter and Crutzen, 2020a). However, while complex system maps are available in some fields (Luna Pinzon et al., 2023), this is not often the case. Since human behaviour is strongly contextualised, again convening with target population members and experts to map out the environmental influences for your target population often pays off. The resulting product is a list of ("post-flip", so *desirable*) environmental conditions that you will target, as well as the corresponding environmental agents, levels, and their target behaviours.

Task 2: Listing the sub-behaviours and performance objectives (PO)

After completing the first task, the intervention developers have an overview of the things they want to change in their target populations' behaviours and environments. However, these are the broad strokes as designing an intervention requires more intricate understanding of these behaviours. Therefore, the next step is to define the sub-behaviours for each target behaviour. This includes both the target behaviours for your target population members and the target behaviours for the environmental agents. The sub-behaviours represent the answers to the following question: "what should people do to reach the desired behaviour or environmental outcome?" (Bartholomew Eldredge et al., 2016). For instance, if the behavioural outcome is to "be physically active for two hours per day", then one of the sub-behaviours could be to "select a suitable sport activity" (Said et al., 2021).

These sub-behaviours represent a list of activities that, if a target population individual or environmental agent does them, together form their target behaviour. Of course, any behaviour can be subdivided into smaller units infinitely, but this soon loses its usefulness. A rule of thumb is that sub-behaviours are defined as being caused by different determinants or environmental conditions. For example, if the target behaviour is "consuming more fruits", you do distinguish "purchasing fruits" and "taking fruits to work", but not the acts making up the purchase (e.g. "queue at the register", "pay for the fruits"). It is crucial to note that defining sub-behaviours necessitates further information gathering, requiring an understanding of human behavior. For this, the core processes can be used (Ruiter and Crutzen, 2020a; Crutzen and Nalukwago, 2024).

When searching for existing relevant data, it is important to determine the specific type of data needed to select appropriate sources. For instance, if health promoters require general information, this can often be found in published articles or reputable websites. For more specific information related to nutrition, education, existing community services, or housing conditions, this may be obtained from sources such as the Department of Health, the Department of Education, or the Census Bureau (Boyle, 2017). Furthermore, the geographical location of the target population must be considered to ensure the accuracy and relevance of the collected information.

The new data, however, may be obtained from other sources such as:

- Surveys: they are used to collect information about the target population using various techniques such as printed or online questionnaires, face-to-face or telephone interviews, and observation (Jhangiani et al., 2019).

- Focus groups: they consist of interviewing a group of 5 to 12 individuals to share their experiences, opinions, or beliefs. They provide qualitative information helping health promoters to further understand their target population. They are also considered less expensive compared to other face-to-face methods (Boyle, 2017). To process the qualitative data resulting from focus groups, these are typically coded (Peters and Zorgo, 2022), for example with the ROCK (see the Tools section).

- Key informant interviews: they are an affordable method to understand the perspectives, behaviour, and motivations of the target group (USAID, 1996). They may also draw attention to relevant challenges before designing the intervention. More details about the key informants interviewing technique may be found at (). Similarly to the data from focus groups, individual interview data are also typically coded (Peters and Zorgo, 2022), for example with the ROCK (see the Open Tools section).

After obtaining a comprehensive understanding of the relevant sub-behaviours, the next step is to select which sub-behaviours will be objectives of the intervention. These will be called Performance Objectives (POs). This is usually based on the literature review as it helps in selecting the sub-behaviours that the intervention will be targeting and in determining the intervention levels (individual and/or environmental). Other methods may be used, as well. For instance,limited allocated funds may restrict the number of levels and POs. In addition, in some situations, it might be difficult to change the environment or it might be too disruptive to target several levels at the same time, thus intervention developers may consider limiting the number of levels to target (Dieberger et al., 2021; Bartholomew Eldredge et al., 2016; Said et al., 2021).

Task 3: Identify determinants and sub-determinants

Human behaviour is caused by their psyche, which in Intervention Mapping, we consider through the lens of psychological constructs that we call determinants (as they are assumed to determine behaviour). However, people are situated in an environment that can also cause behaviour or limit behavioural alternatives. IM, therefore, distinguishes personal determinants (representing causes of behaviour within the person or psychological constructs such as knowledge, attitude, beliefs, self-efficacy, and skills) from environmental conditions (representing causes of behaviour outside the person such as norms, access to resources, policies, and laws).

Personal determinants are typically defined at a generic level (as psychological constructs are). They are designed to represent general regularities that manifest across populations and contexts. For example, knowledge, attitude, and habit are causal factors for many behaviours in many populations. Yet, interventions do not target knowledge, attitude or habit at that generic level: they always target more specific aspects of the human psyche, such as the knowledge that vaccines protect against serious diseases, the expectation that regular exercise makes you feel more fit, and the automatic trip to the coffee maker as soon as you arrive in the kitchen in the morning. These more specific aspects are called sub-determinants (also see Metz et al., 2022, and Peters and Crutzen (2017) for a more in-depth discussion). The primary goal of the third task in step 2, therefore, is not to identify determinants, but to identify *sub-determinants* — with the understanding that to select appropriate behaviour change methods to target a sub-determinant, it *is* necessary to know which overarching determinant it belongs to (this will be discussed more in-depth in the practical guide to step 3).

For personal determinants, the Map of Aspects of the Psyche (MAP) can be used as a scaffold to guide the selection of sub-determinants. This is a spreadsheet that helps with collating a long list of potentially relevant sub-determinants, as well as with documenting subsequent decisions to arrive at the final selection of sub-determinants that will be targeted in an intervention. It is explained in more detail in the Open Tools section at the end. The MAP can be used to keep track of all sub-determinants you encounter, from whichever source, that may be relevant for your target behaviour in your target population and context. It separates the work of gathering as many potential sub-determinants as possible from other important tasks (classifying to which overarching determinant each sub-determinant belongs; deciding which ones are selected for your intervention; and documenting this process, the decisions, and their justifications). This prevents derailing of the open-ended identification of all sub-determinants into discussions about which construct they belong to, whether they are actually relevant, or whether they are duplicates, while simultaneously providing space for those discussions in a later stage.

Although the MAP provides a concrete tool to organise the identification of (sub-)determinants, it does not itself help with that identification. There are several methods to identify (sub-)determinants and estimate their relevance to a given target behaviour, target population, and context. These again boil down to the core processes (Ruiter and Crutzen, 2020b). A list of these follows:

1. Literature: refer to the published ratings in the literature (especially systematic reviews or meta-analysis). Many researchers (e.g., Dedipac study and DONE framework) rated the determinants to make it easier to select the most relevant and changeable (reflecting the total evaluation of how feasible it is that a given (sub-) determinant is changed in an intervention) or modifiable (reflecting the extent to which currently known behaviour change principles can successfully change a (sub-) determinate) determinants. For instance, Stok et al. (2017) rated the determinants in terms of population-level effect and modifiability with scores ranging from one for having the lowest effect or being difficult to modify to three for being easy to modify or having a high effect (Stok et al., 2018, 2017).

2. The confidence interval-based estimation of relevance (CIBER): the CIBER method provides a complementary insight into the relevance of various sub-determinants by visualising the comparison of means and confidence intervals (CI) using graphical representations (Crutzen et al., 2017; Peters and Crutzen, 2018). CIBER plots visualize correlation coefficients, means, and their confidence intervals. Although the means suggest how much room for improvement (i.e., the distance of the bulk of a (sub-) determinant's distribution to its desired value) each (sub-)determinant has, it is important to note that behaviour change expertise is still needed to evaluate the changeability and modifiability (Crutzen et al., 2017). In summary, this method involves the following steps: (1) data collection through surveys; (2) data visualization of the means of the sub-determinants, as well as the their CIs; (3) correlation analysis with target behaviour or relevant determinant and distribution examination of the sub-determinants (e.g., checking how skewed distribution affect interventions); and (4) selection of sub-determinants based on simultaneous consideration of the room for improvement and correlation strength (Crutzen et al., 2017). This method has limited use in determining the changeability and modifiability of the determinants. The methodology is explained in detail elsewhere (Crutzen et al., 2017; Peters and Crutzen, 2018).

3. CIBERlite: the CIBERlite method is a simplified approach of the Confidence Interval-Based Estimation of Relevance (CIBER) plot for selecting sub-determinants in the development of behavior change interventions. It aims to provide insights into the relevance of a limited number of determinants using short and theoretically informed measurements (Crutzen and Peters, 2023a). It presents several advantages: (i) Resource efficiency: It is suitable in cases of limited resources as it requires minimal investment in data collection while maximizing insights; (ii) Theoretical guidance: it is guided by theories, allowing for systematic behaviour-change interventions based on relevant determinants; (iii) User-friendly visualisation: It employs a simple visualisation technique that helps in comparing determinants and understanding their associations with target behaviors; and

(iv) Time-saving: It reduces the complexity and time typically involved in comprehensive determinant studies (Crutzen and Peters, 2023a). However, the flipside of its lean nature means that it does not lend itself to selecting sub-determinants, and it only works well for a limited number of determinants. In other words, CIBERlite offers a valuable solution when resources are scarce. It's not meant to replace the full inventory but provides a valuable alternative to solely relying on expert opinions without any empirical data (Crutzen and Peters, 2023a).

Just like the sub-behaviours that were selected as intervention objectives are called Performance Objectives, the smaller list of sub-determinants that will be targeted in the intervention will be called Change Objectives (CO). These Change Objectives are reformulated according to specific rules, which are explained in the next section.

Task 4: Build Matrices of Change Objectives

Once you have decided on your Performance Objectives (POs) and your Change Objectives (COs), you combine this information in a matrix (for each ecological level) that is structured as follows:

- Rows correspond to Performance Objectives (POs; i.e. the selected sub-behaviours).
- Columns correspond to determinants (psychological constructs).
- Cells contain all Change Objectives (COs) that link POs to determinants.

The COs are reformulations of the corresponding sub-determinants that follow a number of rules (Bartholomew Eldredge et al., 2016). When writing a CO, start with the appropriate action verb, followed by the desired change at the end of the intervention. The action verbs depend on two factors: (i) The learning task: For instance, if the CO is related to knowledge, action verbs such as "define", "list", or "record" may be used. Whereas, if the CO is related to evaluation, different action verbs (e.g., "compare", "assess", or "justify") will be used; and (ii) The corresponding determinant: For example, when writing COs related to attitude, start the COs with "express positive feelings towards ..." (e.g., express positive feelings towards being less sedentary). As for self-efficacy, most COs start with "express confidence about ..." (e.g., express confidence about decreasing total sitting time). It would be also useful to use one action verb per objective and to avoid the use terms that are vague or cannot be measured (e.g., be interested in practicing physical activity).

Examples of good COs:

- Knowledge: describe the benefits of physical activity.
- Self-efficacy: express confidence in practicing physical activity at school.
- Skills: demonstrate ability to monitor the daily intake of fruits and vegetables.

Examples of COs to avoid:

- Enjoy the practice of physical activity at school.
- Remember to eat two fruits per day.

Typically, the Matrix of Change Objectives (MoCO) contains the matrix's target population followed by an ellipsis in its top-left corner (e.g., "adolescents in suburban Tangier..."), and each PO and CO starts with an ellipsis to signal that it can be considered a continuation of the sentence in the MoCO's top-left corner (e.g., a PO could be "... discuss engaging in physical activity together with their friends.", and a CO could be "... describe at least three benefits of physical exercise."). As such, one MoCO is developed for each targeted group (i.e., the target population as well as each environmental agent), and each MoCO summarises what you aim to change to achieve your intervention's goals.

Once the matrix is set, the corresponding logic model may be produced using the Acyclic Behavior Change Diagrams (ABCD). The ABCDs are machine-readable representations of the intervention development and present several advantages (Metz et al., 2022). First, they ensure that all relevant sub-determinants were targeted. They also clearly visualise the assumptions of an intervention which facilitates possible improvements along the way. In addition, these diagrams allow rigorous intervention evaluation as several components such as the sub-determinants, determinants, and sub-behaviours can be measured. Next, they save time by being produced from machine-readable ABCD matrices and allow a more transparent reporting of the intervention components (Metz et al., 2022).

In this step, only the last four (of the seven) steps of the ABCDs may be established: the description of your assumptions as to what to target with your intervention for a given target population. The first three steps show *How* you plan to do this, and those will be filled in Step 3 of Intervention Mapping.

Open tools for determinant studies

Many tools exist to support the tasks described here. Because we advocate for open science as well as general transparency and openness, we believe that whenever at all possible, researchers, practitioners, and intervention developers should use open infrastructure. That means using tools that are open source. In this section, we alphabetically list and describe a selection of these.

ABCDs (for documenting the logic model of change underlying an intervention)

Acyclic Behavior Change Diagrams are visualisations of the so-called causal-structural chains that describe a number of your assumptions about why an intervention would work (Metz et al., 2022). A causal-structural chain consists of seven links that connect the target behaviour and its sub-behaviours (called Performance Objectives in Intervention Mapping vocabulary) to the relevant determinants of those behaviours and the relevant sub-determinants (called Change Objectives in Intervention Mapping vocabulary) and to the behaviour change principles (BCPs; called behaviour change methods in Intervention Mapping vocabulary, also known as behaviour change techniques) you plan use to target these (sub-)determinants, how you will apply these BCPs in practical applications, and how you will satisfy the conditions for effectiveness (such as Intervention Mapping's Parameters of Use, as discussed in Metz et al., 2025).

An ABCD is produced from an ABCD matrix: a table, usually as a spreadsheet, that contains seven columns corresponding to the seven links of the causal-structural chains: BCPs, conditions for effectiveness, applications, sub-determinants, determinants, sub-behaviours, and target behaviour. Each row forms one self-contained causal-structural chain. To produce an ABCD matrix, you can use any spreadsheet software, such as LibreOffice Calc (available from `https://libreoffice.org`), jamovi or JASP (available from `https://jamovi.org` and `https://jasp-stats.org`, respectively), or proprietary alternatives such as Microsoft Office or Google Sheets. An example is available from `https://im-wb.com/abcd-matrix`; you can copy it and complete it for your intervention.

You can convert ABCD matrices to the corresponding diagrams (the ABCDs themselves) using a number of tools. The first is a web app, which you can access at `https://a-bc.eu/apps/abcd`. You can upload a spreadsheet or enter the link to a Google Sheet, and the app will import your ABCD matrix and produce the ABCD. You can then download the ABCD as PDF, SVG, PNG, or PS file. If you want to edit it further, we recommend downloading it as an SVG file (this stands for Scalable Vector Graphic). You can edit this file with the open source and userfriendly InkScape application (available at `https://inkscape.org`). You can also produce an ABCD with the open source data analytics suite jamovi (available at `https://jamovi.org`). The module library of jamovi contains the "behaviorchange" module, which allows creation of the ABCD. The advantage of this is that you can use the same application to edit the ABCD matrix and to produce the ABCD itself; but the drawback is that this lends itself less well to collaboration with others. Finally, you can use the `behaviorchange::ABCD()` function in the R package {`behaviorchange`} (see `https://behaviorchange.opens.science` for the documentation). R is a powerful open source data analysis package. Where jamovi and JASP are based on graphical user interfaces, R is based on scripting. The web app and jamovi module in fact use this R package behind the scenes. Using the {behaviorchange} R package therefore gives you the most control, but if you're not familiar with R yet, it is not the most accessible option.

CIBER plots (for analysing the results of a quantitative determinant study)

Confidence Interval-Based Estimation of Relevance (CIBER) plots (Crutzen et al., 2017; Peters and Crutzen, 2018) are data visualisations meant to alleviate some of the problems of common analyses of behavioural (sub-)determinants (see e.g. Crutzen and Peters, 2023b) as well as combine the relevant results in one visualisation. CIBER plots consist of two panels: the left-hand panel shows the univariate distributions of a (sub-)determinant, and the right-hand panel shows the correlation with behaviour, intention, or a proximal overarching determinant (e.g. attitude or perceived norms). When selecting which (sub-)determinants to target in an intervention, the left-hand panel is inspected to evaluate the room for improvement. For example, when comparing people's expectations of a behavior's consequences (e.g., `https://psycore.one/expAttitude_expectation_73dnt5z1`), you usually select those expectations that most people do not already have as intervention targets (i.e., those where most people do not already score at the high end of the scale). The right-hand panel is inspected to evaluate how strongly a (sub-)determinant correlates with behaviour (or a proxy of behaviour). If a (sub-)determinant does not correlate with behaviour, this may mean that even if you successfully change it, that may not in turn cause the behaviour to change. The goal, therefore, is to select determinants that have both room for improvement and are associated with the target behavior. To produce a CIBER plot, you can use either jamovi with the "behaviorchange" module or R with the {`behaviorchange`} R package, specifically with the `behaviorchange::CIBER()` function.

CIBERlite (for analysing the results of a quantitative determinant study when constrained in time or money)

CIBER plots were designed to show a comprehensive overview of the relevant information about a (potentially quite large) set of (sub-)determinants. These work well when resources are available to map these (sub-)determinants. However, sometimes an intervention has to be developed in a situation with very few resources, where collection of new empirical data at all is a luxury. It can be the case that the intervention development team does not have access to the behavior change and methodological expertise required to design and conduct the data collection and analysis, or that very few funds or very little time is available. For such scenarios, the CIBERlite approach was developed. The CIBERlite approach was developed when only a few questions can be asked to target population members, and when the results have to be presented in a simple format. To provide a starting point, a set of seven questions was prepared (available in English and Dutch at `https://osf.io/2uwxp/wiki`) that assess intention and three determinants. These questions can be adjusted to a target behaviour and presented to a sample from the target population. The resulting data can then be visualised in CIBERlite plot. As yet, this has only been implemented in the {`behaviorchange`} R package, specifically with the `behaviorchange::CIBERlite()` function. More background information and a number of examples are available in Crutzen & Peters (2023a).

MAP (for selecting sub-determinants to target in an intervention)

The Map of Aspects of the Psyche (MAP) can be used in step 2 of Intervention Mapping to help create a long list and subsequently a selection of sub-determinants to target in a behaviour change intervention. It is a spreadsheet with five worksheets that can be found at `https://im-wb.com/map`. You can copy that spreadsheet and use it for your own project. It is explained more in-depth at `https://bookofbehaviorchange.com/identifying-sub-determinants.html`.

OpenAlex (for searching literature)

For searching scientific literature, you can find the OpenAlex database at `https://openalex.org`. Since this database is not restricted to one or more disciplines, you can sometimes get an overwhelming number of results. In that case, you can use a number of strategies to find the most usable articles. First, instead of searching in the full text or in the title and abstract, search only in the title of articles. Second, only search for open access articles. Third, you *can* limit your search to specific disciplines by selecting one or more domains (e.g. "social sciences" or "health sciences") or fields (e.g., "psychology", "health professions", or "social sciences"). You can visit the search at `https://openalex.org/works?page=1/&filter=display_name.search%3A%28%22determinants%22%20OR%20%22predictors%22%29%20AND%20%28%22behavior%22%29,primary_topic.field.id%3Afields%2F27%7Cfields%2F33%7Cfields%2F32%7Cfields%2F36,type%3Atypes%2Farticle,open_access.is_oa%3Atrue` and edit it if you want, for example replacing the "behavior" search term with your target behavior.

PsyCoRe.one (for finding psychological constructs and seeing how to study them in a systematic review, qualitative study, or quantitative study)

The (sub-)determinants of behaviour are psychological constructs. These are components of psychological theories that are used to understand, explain, predict, and change behaviour in psychological research. A given construct, such as attitude, can have a variety of definitions (for more background information, see Peters and Crutzen, 2024). The repository at `https://psycore.one` contains a list of psychological constructs, many of them determinants or subdeterminants of behaviour.

In addition to a comprehensive construct definition, PsyCoRe.one contains instructions for measuring the construct, instructions for classifying an existing measurement instrument as a measurement instrument that measures the construct, instructions for coding qualitative data as informative about the construct, and instructions for eliciting qualitative data about the constructs. This repository can therefore be useful both for deciding which determinants to include in a determinant study and for then designing the qualitative or quantitative study itself. In addition, the repository contains unique identifiers for each construct, enabling you to unequivocally refer to the construct(s) you use (e.g. `https://psycore.one/action_plan_79n2w1bh` and `https://psycore.one/self_identity_79n2fh4t`).

ROCK (for qualitative research, for example qualitative determinant studies)

The Reproducible Open Coding Kit (the ROCK) is a standard for qualitative research. It allows specifying qualitative data, metadata, and codes in a format that is easy to understand for both humans and machines. Because of the ROCK's simplicity, developing new applications to work with ROCK files is relatively easy. For example, a number of Shiny ROCK web apps have been developed, each with a specific function.

To code with the ROCK, a good starting point is the Shiny ROCK Diamond web app, available at `https://shiny.rock.science/diamond`. This app allows you to upload (or paste) a source containing qualitative data (such as an interview transcript) and attach codes to the data fragments. Once you played around a bit and are ready to start for real, we recommend first preparing your data for coding using Shiny ROCK Emerald (`https://shiny.rock.science/emerald`). This truncates each line at 40 characters (by default) and prepends unique identifiers to each data fragment called Utterance Identifiers (UIDs), which enable easy but unequivocal reference to individual data fragments. You can then attach codes to the data fragments using Shiny ROCK Diamond.

Once you finish coding the data, you can upload your source (or multiple sources in a ZIP file) to Shiny ROCK Feldspar (`https://shiny.rock.science/feldspar`). This will parse all sources and your codes and supply you with a Qualitative Data Table: a tabular representation of your coded dataset, which you can then further analyse in whichever software you are comfortable with.

If you use R, you can also use the {`rock`} R package to analyse ROCK files. For example, after parsing your sources with the `rock::parse_sources()` function (see `https://rock.opens.science/reference/parsing_sources.html`), you can supply the resulting object to the `rock::collect_coded_fragments()` function to get an overview of the data fragments coded with a specific code (see `https://rock.opens.science/reference/collect_coded_fragments.html`), or to `rock::show_fullyMergedCodeTrees()` to see the tree of codes if you used hierarchical coding (see `https://rock.opens.science/reference/show_fullyMergedCodeTrees.html`).

More information about the ROCK is available in a tutorial (Zörgő and Peters, 2022) and at its website, `https://rock.science`, which also contains workshop materials that were designed to be usable on their own.

Other Open Resources

For a more general list of open infrastructure tools, see `https://guide.opens.science/open-infra.html`. A list of open access textbooks with psychological theories is available at `https://guide.opens.science/open-educational-resources.html`.

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