

## FOOD WASTE NINJAS AND SLEEPING SHEEP: UNDERSTANDING THE ROLE OF VERNACULAR DATA VISUALISATION DESIGN IN CIVIC ENGAGEMENT AND INFLUENCING FOOD- WASTING HABITUAL BEHAVIOURS.

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**ABSTRACT** | Studies have shown that data visualisations designed into eco-feedback technology have the persuasive capacity to change consumer habits that lead to significant financial and environmental consequences. There is, however, growing concern over their ethical, equitable, and psychological implications. This study looks at vernacular data visualisations — analogue representations of self-tracking data collectively designed by non-experts — and how they can be used as a bottom-up strategy for civic engagement and forming new habitual behaviours. Using consumer food waste as a case, this research was deployed as a nine-week, longitudinal, mixed-method study amongst working parents and their children in Australia (104 participants with a control group). Using theories in consumer behaviour psychology as a framework together with the literature in data physicalisation, play, and vernacular design, the participants were provided with a design probe that contained: 1) visual nudges and information demonstrating how to build food-saving habits and 2) a paper-based self-tracker to encode and share how they used the items in Part 1 using their own material and visual fluency. By triangulating the results through thematic, content, and paired samples frequency analysis, the results revealed that the group with access to the trackers was able to sustain newly formed habits for longer. Using visual metaphors like ninjas and sheep facilitated a deeper understanding of their unique household dynamics and instilled a sense of autonomy and accountability. This paper presents vernacular visualisations as democratic behaviour change interventions that have a place amidst their digital counterparts.

# 1. Introduction

The use of eco-feedback technology has become ubiquitous in Western households, with institutions providing consumers with digital self-tracking tools aimed at examining behaviours that can have both financial consequences and harmful impacts on the environment. For example, these apps and online tools<sup>1</sup> can track expiring food in the fridge and explain how much money, water, and energy is wasted resulting from disposing edible grocery items. These digital self-trackers use data visualisations — charts, graphs, and icons that transform abstract concepts into easily interpretable representations — as a primary means of persuasion (Dragicevic et al., 2020; Bohman, 2015). Several studies support the potential of these design-based interventions in expanding the capacity for self-knowledge, increasing awareness of social issues, and motivating individuals to adopt specific behaviours (Chalal et al., 2022; Lim et al., 2021; Tai et al., 2020; Kouroupetroglou et al., 2015; Normark & Tholander, 2015; Froehlich et al., 2010).

However, growing concern about the ethical implications of these quantitative trackers as a top-down initiative reveal that they can facilitate high levels of surveillance and extend regulatory control of authorities over the general public, resulting in a lack of agency in decision-making about one's own behaviours (Sanders, 2017). Furthermore, digital self-trackers can perpetuate existing social and economic disparities (Lifkova 2019). Requiring access to expensive technology and advanced levels of visual literacy, digital self-trackers can often exclude individuals from low-income households and children. Children, in particular, have the potential to benefit from understanding the mechanics of self-tracking as they have been found to be effective agents of collective behaviour change (Burrows, 2017; Robinson et al., 2011). Finally, digital self-tracking data visualisations can be an unreliable measure of lived experience. Referred to by Porter (2020, p.87) as 'technologies of trust,' over-reliance on data visualisations can arise from their impersonal, objective, authoritative appearance. Normative visualisation design practices that use geometric shapes can promote unhealthy self-scrutiny and fail to capture the complexities of everyday reality essential to understanding human behaviour (Snyder et al., 2019).

To address these issues, this study looks at an analogue, participatory approach to designing self-tracking data visualisations. Used in tandem with digital tools, this method aims to mitigate reductionist assessments of the self and unproductive behaviour changes like removing the pleasures of eating (van Dijk et al., 2015). Designed as a probe, this approach looks at the intersection between data physicalisation, play, and vernacular design and grounds the research on theories in consumer behaviour. Data physicalisation, a practice that encodes data through bespoke, meaningful objects, can engage designers and audiences in novel ways by encouraging reflection on behaviour (Khot et al., 2020; Lupton, 2017; Botros et al. 2016; Nissen & Bowers, 2015). These often-idiosyncratic forms leverage on the *eudaimonic* function of play, which suggests that even if play is not tangibly productive, it can elicit high levels of creative, independent behaviour (Sharp & Thomas, 2019). Theories in play are also closely linked to vernacular approaches to design, where non-experts rely on their intuitive visual fluency and access to materials instead of standards set by existing systems of power to address specific pain points (Hearst & Rosner, 2008).

Food waste coming from working parents and their children was used as a case in this research. Also known as Over Providers, this group was identified as being the largest contributor to the \$36.6 billion dollar per year food waste problem in Australia (Karunasena & Pearson, 2022). Aiming to answer the question, "How can designing vernacular data visualisations in self-trackers influence consumer food-wasting habitual behaviours?" this paper critically examines theories in consumer behaviour psychology to provide a theoretical framework for designing the probe and evaluating the results. It then triangulates results to provide a new framework for designers to use in creating democratic interventions that develop environmentally- and mentally-beneficial habitual behaviours.

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<sup>1</sup> IGA online food calculator: <https://www.iga.com.au/food-smart/calculator/>, Bhojan food waste app: <https://www.abc.net.au/news/2023-12-23/ai-food-waste-app-kingston-council-melbourne-school-student/103089438>

## 2. Theoretical Framework

Grounding the research in behaviour change theory was critical for designing effective, long-lasting habitual behaviour change interventions. Using principles from Willmott & Rundle-Thiele's (2022) TITE process to guide theory selection (T), iterative schematisation (I), testing (T), and explicit reporting (E), three consumer behaviour models were critiqued and selected. The Theory of Planned Behaviour or TBP (Ajzen, 1991) was valuable in explaining how perceived behavioural control (an internal assessment of one's own ability to perform a skill) and subjective norms (the extent to which social pressure from people of importance can influence behaviour) could lead to behavioural intention. However, the TBP did not account for affective factors nor contextual cues that trigger habitual responses. The Habit Alteration Model, or HAM (Pinder et al., 2018), was also considered useful in defining habits and understanding the stages of context-response links. While the model was able to sufficiently pinpoint where self-tracking feedback could be beneficial, it focuses largely on actions at a given point in time rather than wider contexts. Lastly, the Motivation, Opportunity, and Ability or MOA framework (Binney et al., 2006) was also considered for its strength in identifying situational factors (Opportunity) and articulating the difference between external and internal motivation. While it provided a pragmatic overview of behaviour formation, the MOA does not consider whether behaviour needs to be performed multiple times or be part of a broader set to provide benefit (Parkinson et al., 2016). It was, therefore, essential to use a combination of the three theories in understanding how design can influence habitual behaviour (Figure 1).

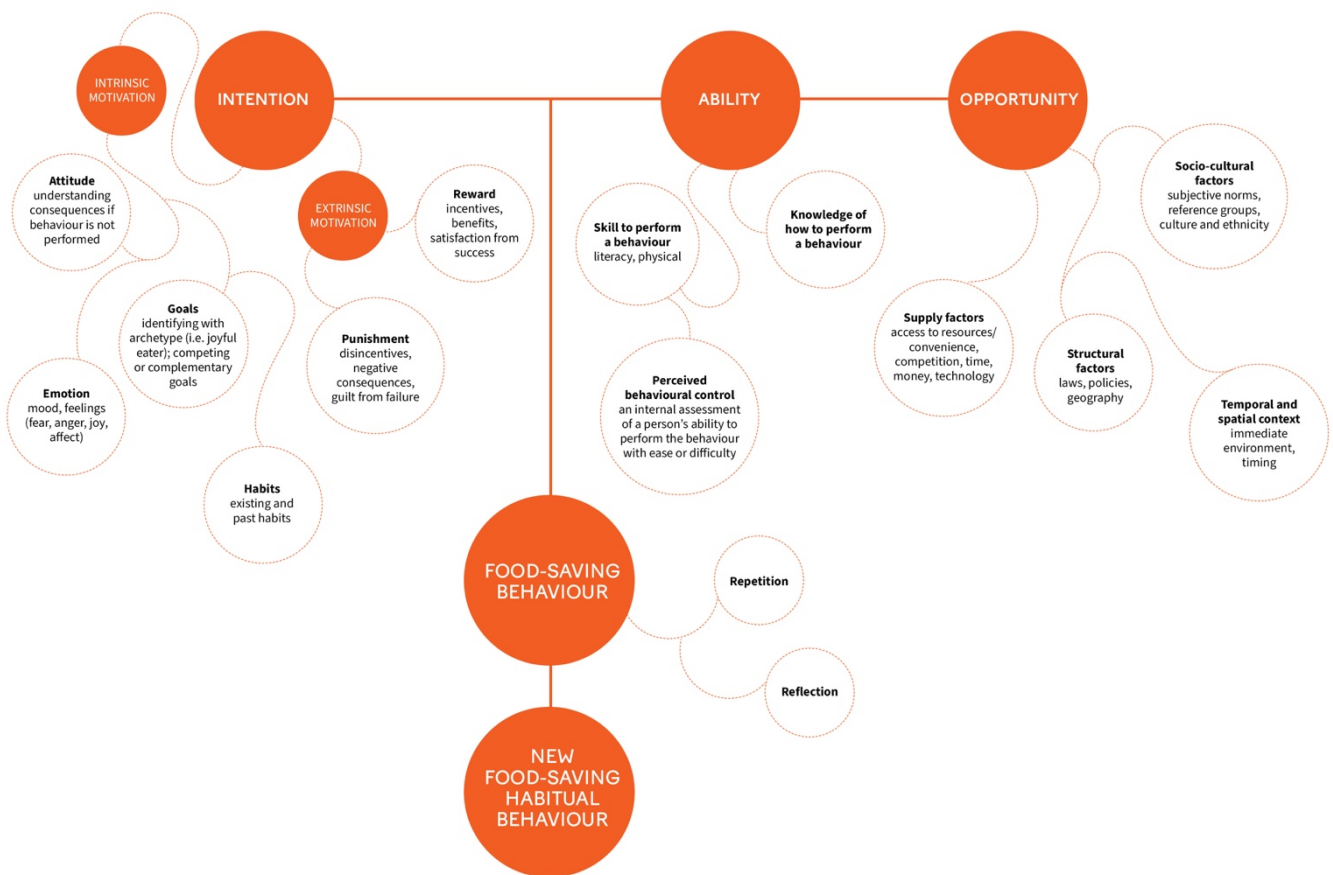


Figure 1. Framework amalgamated from the Theory of Planned Behaviour (Ajzen, 1991), the Habit Alteration Model (Pinder et al., 2018), and Motivation, Ability, and Opportunity Framework (Binney et al., 2006).

### 3. Methods

In order to effectively understand and measure habitual behaviour around household food waste, this study used a longitudinal, mixed-method approach that involved triangulating three research instruments:

1. A two-part design probe (Figure 2): Part 1 consisted of playful prompts<sup>2</sup> to increase abilities, shape attitudes, and provide opportunities to enact the top three food-saving behaviours endorsed by the End Food Waste Cooperative Research Centre: eat leftovers, store food properly and prepare the right quantities of food (Ananda et al., 2021). Part 2 consisted of paper-based habit trackers deployed in participants' homes. A nine-week deployment period was chosen based on empirical evidence demonstrating that habitual behaviours take 66 days to form (Tull, 2022; Lally et al., 2010). Allowing participants to design, reflect on, and share bespoke data representations of how they used items in Part 1, the self-trackers aimed to enable social influence, reflection, and repetition of behaviours. The results were analysed through ethnographic content analysis.
2. Surveys: Distributed at three points of measurement using 5-point Likert scales, these assessed participants' frequency of performing food-saving behaviours before the probe, immediately after the probe, and one month after the probe through a paired samples frequency test.
3. Semi-structured interviews: These two online household interviews gathered qualitative data on participants' initial motivation levels, clarified survey and probe results, and explored the reasons behind the design of their chosen encoding system. Transcripts were analysed through thematic analysis.

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<sup>2</sup> This included a roll of Use it Up tape to mark a section of their fridge or pantry where food needed to be used up, googly eye stickers to mark individual items of food in the fridge, freezer, or pantry that needed to be used up, making them more visible, the Use it All book where participants could find suggestions on ingredient combinations and maximising their use, and a meal planner and shopping list that participants could share within the household. The planner also included tips on getting children involved in meal planning and preparation, information on food waste, and advice from recruited role models.



Figure 2. Items in the design probe.



All 104 participants were recruited using snowball sampling and divided into three groups:

- Group A: Over Providers<sup>3</sup> with self-trackers (N=12 households, 46 participants)
- Group B: Over providers without trackers (N=12 households, 46 participants)
- Group C: Considerate Planners<sup>4</sup> (N=6 households, 12 participants)

The participants in groups A and C posted the trackers back to the researcher via a post office box every three weeks. The trackers were then scanned, de-identified, and uploaded to a shared Miro board for each household to view. The experiment group (Group A) was given parts 1 and 2, while the control group (Group B) was given only part 1. Group C was also given parts 1 and 2 to serve as social influencers to the experiment group.

## 4. Results and Discussion

### 4.1 The Self-Tracker Led to the Formation of New Food-Saving Habitual Behaviour

The quantitative analysis of the paired samples frequency test showed that both Groups A and B increased the number of times in which they performed food-saving behaviours. However, Group A showed that they were able to sustain or increase the frequency of the behaviours a month after. Only the results for “Almost all the time (over 90%)” from the survey were considered as this points to behaviours performed regularly, which is consistent with the definition of habitual behaviour as repeated, default responses in a given context (Wood & Runger, 2016). Figure 3 shows the frequency graph of “Behaviour 1: Plan meals to be cooked for a set number of days”, illustrating that less households in Group B were able to maintain this behaviour a month after the probe was deployed.

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<sup>3</sup> Over Providers, typically represented by working parents and their children, have the highest weekly food waste (6.33kg). While they plan their food shopping, they tend to purchase and cook more than is needed and often negotiate the unpredictable tastes and appetites of their children (Karunasena & Pearson, 2022, p.7).

<sup>4</sup> Considerate Planners, best represented by older couple-based households, many with children that no longer live at home. This segment engages in waste reduction behaviours across planning, shopping and cooking practices and show pride in being organised (Karunasena & Pearson, 2022, p.7).

## Behaviour 1: Plan meals to be cooked for a set number of days

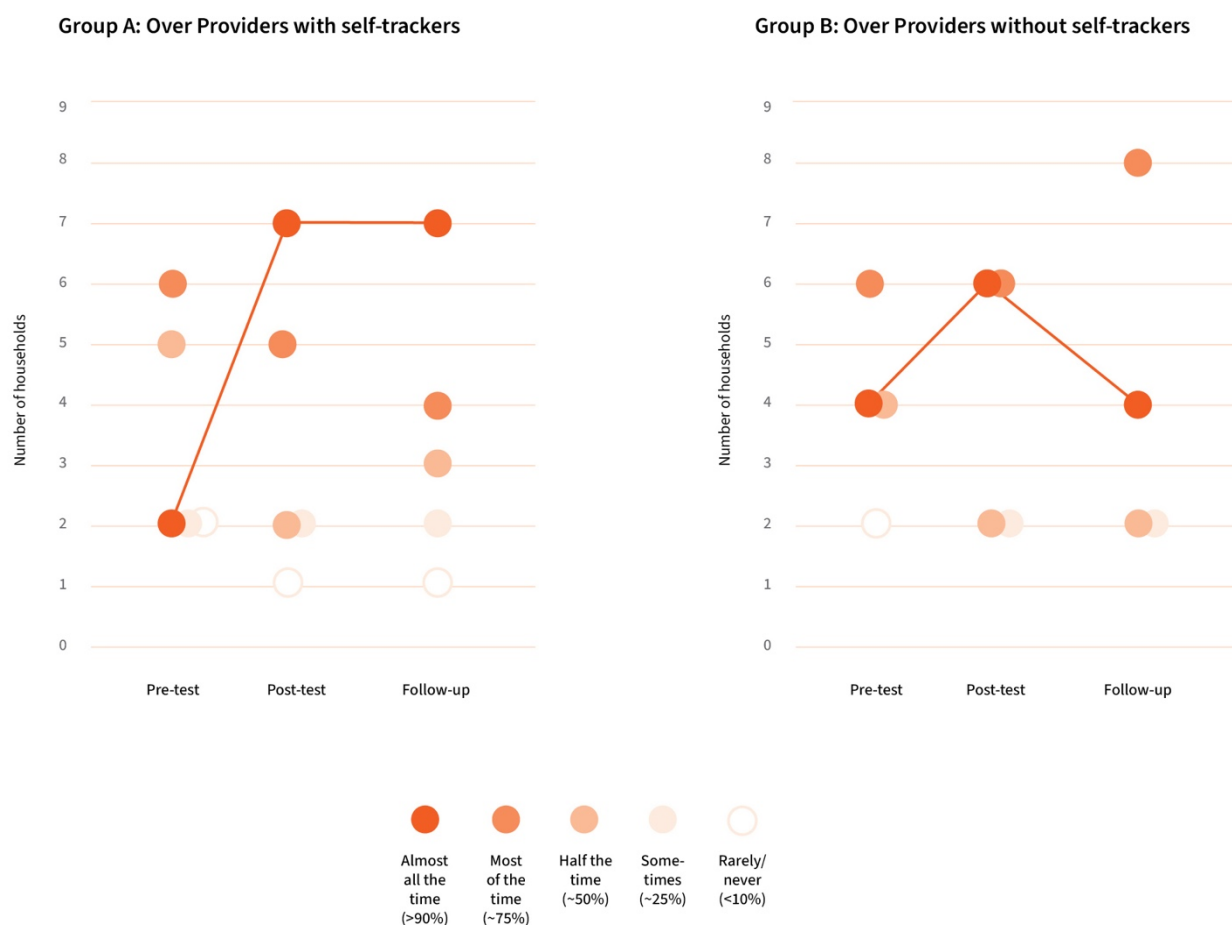


Figure 3. Paired samples frequency comparison of meal planning behaviour between Groups A and B.

## 4.2 The Self-Tracker Instilled a Sense of Autonomy and Accountability

The analysis of the probe responses showed how a vernacular approach led to having a sense of autonomy, with two-thirds of the households choosing to stray from conventional graphs and charts (Figure 4). This sense of autonomy can be attributed to the playful tracker design and the eudaimonic function of play to support agency, allowing people to choose, act, and express themselves in ways that were meaningful to them (Altarriba-Bertran et al., 2020).





Figure 4. A sample of participants' visual representations of food-saving tracking behaviours.

The thematic analysis of the semi-structured interviews revealed that using personalised visual metaphors also led to a deeper understanding the effort required by individual family members in collectively reducing food waste. Through familiar figures like cupcakes, ninjas, sheep, and rainbows, participants were able to map their own behaviours to properties of these items. For example, a ninja was chosen by one of the children in an Over Provider household because of a ninja's need to make deliberate, precise actions to

achieve a mission — an apt representation of how many seemingly small, everyday actions lead to household food waste reduction (van Geffen et al., 2020). Using one's own visual abilities is not just a performative act of reproduction but involves the construction and transformation of meaning, resulting in emotional, physical, and cognitive investment (Sanders & Stappers 2014). These bespoke representations allowed participants to see themselves as creators of their own stories and created deeper connections with the data.

Participants also felt responsible for their own actions instead of being dictated to by an institution:

“I felt more responsible and was called out more because they were our own trackers and creations.” (Over Provider 12)

Conversely, families belonging to Group B expressed that they would have liked to have more visual reminders to hold them accountable for their actions. This finding is consistent with the concept of self-determination (Binney et al., 2006), an innate human proclivity to be the agents of their own behaviour.

It is also worth noting that participants reported that emotions such as enjoyment, enthusiasm, guilt, and worry from recording their behaviours through a vernacular approach were factors that engaged them in the nine-week study. Additionally, the predominant use of anthropomorphism (i.e., smiley faces), as opposed to food-related items, implies that behaviours are largely driven by emotion and feelings rather than what the behaviour is about. This confirms Wang et al.'s (2019) argument that emotional or affective engagement is key in determining the value of physical data visualisation: affect can enable data-driven objects to rate higher in terms of user experience (more pleasurable and meaningful) and can directly influence motivations, actions, and learning.

### 4.3 The Self-Tracker Played a Role in External Motivation

Scrutinising the results against the theoretical framework revealed that socio-cultural factors and spatiotemporal environments acted as external motivators rather than macro-level social factors. Socio-cultural factors had a closer relationship to emotions associated with rewards and punishment (e.g., participants reported feelings of pride and satisfaction from using the entire vegetable because it was 'doing the right thing' according to cultural norms). The immediate environment (e.g., seeing the tracker on the fridge in the kitchen while cooking) and the tracker's physical format allowed for behaviour to happen in personal contexts, instigating conversations about the causes and consequences of food waste between parents and children and enabling children to participate without the use of digital devices.

Based on the results, the theoretical framework was modified, and a new design framework for habitual behaviour formation was presented (Figure 5).

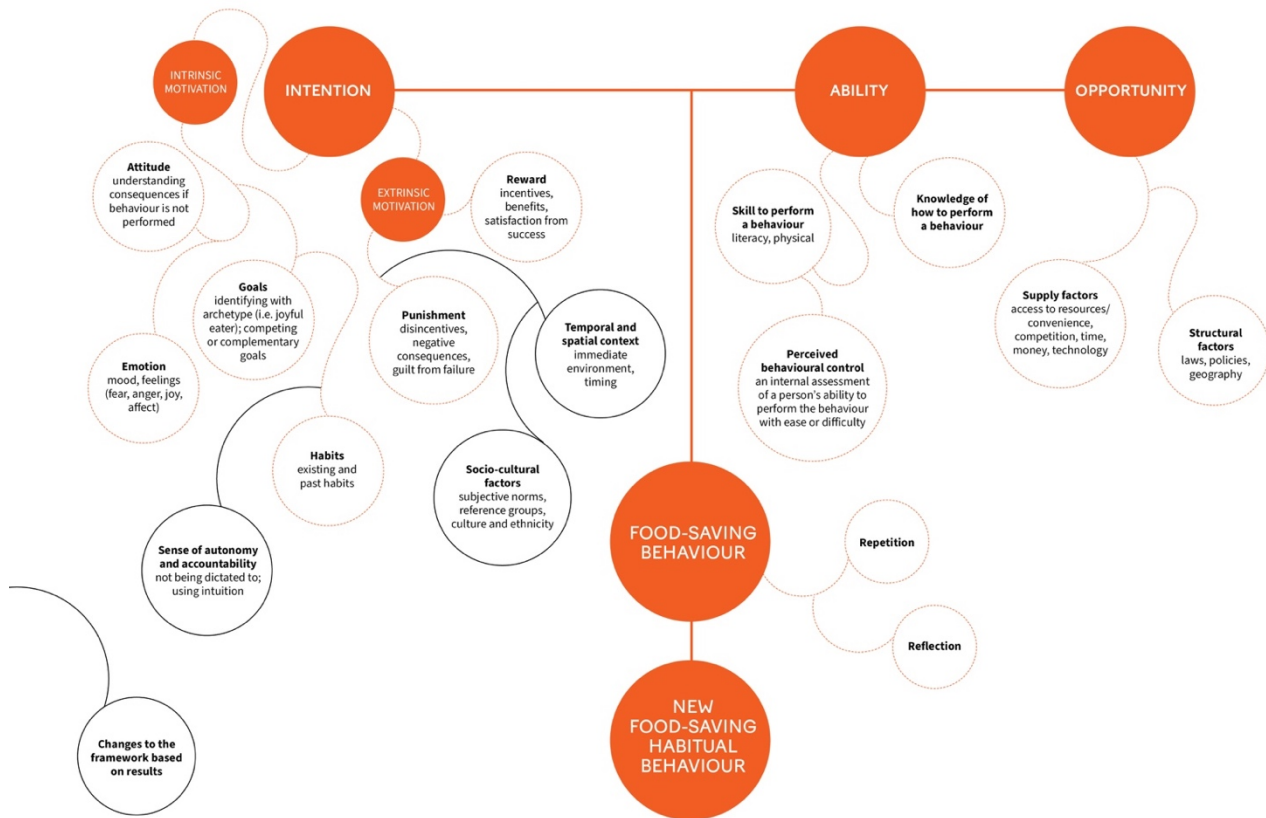


Figure 5. A new design framework for habitual behaviour formation.

## 5. Conclusion

Designing data visualisations in self-trackers using a vernacular approach had a significant capacity to influence habitual food-wasting behaviours in households. While the study could be implemented across a broader population for more robust statistical results, it strongly suggests that behaviour change theory is fundamental for designers to construct interventions, unpack active ingredients and identify common factors contributing to observed outcomes (Willmott & Rundle-Thiele, 2022). This research concludes that vernacular visualisations can augment existing frameworks and enhance the potential of data visualisation design to increase motivation, allow access to broader audiences, instigate conversation, and enable agency.

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