Behaviour in sustainability transitions: a systematic literature review

Stefan Kaufman[1]

Alexander Saeri[1]

Rob Raven[1]

Shirin Malekpour[1]

Liam Smith[1]

Monash Sustainable Development Institute, Monash University

Corresponding author: stefan.kaufman@monash.edu, 8 Scenic Boulevard, Monash University 3800

Abstract

Sustainability transitions require changing many behaviours embedded in production and consumption systems. Simultaneously, behavioural public policy is now a significant site of research-policy translation globally. Links between behaviour and system change are underdeveloped in both fields. Systematic review of current transitions literature found ~4% of papers focused on behaviour. Two prominent perspectives on behaviour (labelled: ‘everyday’ and ‘strategic’) are critical of a focus on individuals, preferencing broader analysis. Two additional perspectives were identified - ‘automatic’ and ‘reflective’ - which highlight immediate and local influences on behaviour but underemphasise context. All four perspectives on behaviour draw on different conceptualisations, causality, methods and disciplinary foundations, and yet all have value and application to transitions. We argue that a complimentary and flexible approach to behaviour would benefit the field, considering the diversity of phases, scales and contexts of sustainability transitions. Transitions’ own behavioural perspectives could also help address behavioural public policy’s challenges.

Keyworks: behaviour; sustainability transitions; public policy; knowledge translation; consumption

Highlights:

- Transitions require behaviour change, yet research is limited
- behavioural insights are now a major site of research-policy translation
- we review engagement with behaviour in transitions literature
- ~4% of papers focus on behaviour, often critically, in four perspectives
- complimentary perspectives benefit transitions; and, behavioural policy

1. Introduction

Mounting environmental and social pressures demand a fundamental restructuring of production and consumption systems if contemporary societies are to shift into sustainable development (Markard et al., 2012). Sustainability Transitions (ST) aims to help achieve this transformation. The Sustainability Transitions Research Network (STRN) research agenda highlights the need for better understanding the phenomena of fundamental change in socio-technical systems (i.e. research *on* ST), and simultaneously better understanding how to govern and accelerate such change (research *for* ST*)* (Köhler et al., 2019). Models such as the multi-level perspective (Geels, 2002) or innovation systems approaches (Hekkert et al., 2007) provide overarching rationales and frameworks that attempt to integrate analysis across production and consumption systems. These generic frameworks are frequently linked with additional literature to explore specific research questions: e.g. about the interaction between ST and organisational strategies (van Mossel et al., 2018), geographies of transitions (Coenen et al., 2012) political power (Avelino, 2017), and social psychology (Bögel and Upham, 2018; Upham et al., 2019).

The ST research agenda acknowledges: "A founding assumption in the literature on sustainability transitions is the importance of understanding transformation across the entire production-consumption chain. Nevertheless, interest in consumption and everyday life has remained relatively marginal in International Sustainability Transitions (IST) conferences and publications" (Köhler et al., 2019, p. 13).

We identify a significant, underdeveloped area in transitions: a focus on human behaviour in everyday life, and how the behaviour of different actors in business, government, politics and civil society influence it (Geels, 2012; Huttunen et al., 2021; Upham et al., 2020). We adopt the Cambridge English Dictionary definition of behaviour as: 'The way a person acts in a particular way in a particular situation or under particular conditions.' (McIntosh, 2013). The definition highlights behaviour as observable acts (often physical, but including decisions) by a person or persons at a time and in a place – note this is any person, in any role. This is a widely understood definition with multi-disciplinary relevance, and allows us to examine how transitions scholarship engages with a term that has increasing salience in policy circles (next section).

Facilitating demand side and consumption changes in everyday life for individuals, households and communities is an important pathway for transitions, including mobility, energy, waste, food or the built environment (Creutzig et al., 2018; Dubois et al., 2019; Markard et al., 2020; Wiedmann et al., 2020). Behaviour changes in everyday life can be a source of empowerment, innovation and experimentation, such as when individuals or households voluntarily change practices in light of environmental (or other) concerns, or when they collaborate to develop new institutional configurations for energy production and use, or when they engage in political lobbying and agenda setting, such as the climate-change strikes of school children originating in Sweden. Consumer behaviour can boost sustainable production – for example in collective community investments and use of renewable energy (Burke and Stephens, 2018; Giest and Mukherjee, 2018), or enable transformational circular and sustainable business models (Gossen et al., 2019; Meis-Harris et al., 2021; Németh, 2019; Wastling et al., 2018; Wiedmann et al., 2020, 2015).

Everyday life can be a critical source of inertia (Geels et al., 2018; Newton, 2008, 2012), perpetuating socio-technical systems that make unsustainable behaviours the 'path of least resistance' (Akenji and Huizhen, 2016; McKenzie Mohr and Smith, 2008). 'Green marketing' by incumbents often treats sustainable lifestyles as a premium niche (Groening et al., 2018; Hussain et al., 2020), which raises social equity and inclusion problems and does little to reduce overall impact (Gossen et al., 2019). Amongst other problems with simply 'greening' consumption (i.e. offshoring impacts, shifting problems to other environmental domains etc. (Parrique et al., 2019)) is the potential outcome[1] that goods with reduced individual impacts, will just be consumed in greater quantities, leading to overall higher impacts – or 'rebound' effects. A related but different issue is unconscious or explicit 'moral budgeting' and 'negative spill over' – where virtue in one area of lifestyle behaviours rationalises higher consumption in another (i.e. vegan diets and international travel, or ever larger solar-electric 'McMansions' with little electricity to export) (ComSecc, 2020; Frezza et al., 2019; Maki et al., 2019; Sorrell et al., 2020).

Everyday life can also be a site of incumbent and reactionary resistance. Grass roots movements have resisted life-style changing policies, rejecting alternative technologies or price increases, such as 'yellow-vest' protests in France, Belgium, Australia and North America (Martin and Islar, 2021). At times, genuine as well as manufactured 'astro-turf' grass roots movements are incited and amplified by incumbent interests and politicians to slow or prevent change (Robb et al., 2003), and seemingly innocuous lifestyle changes are reframed and recruited into toxic civic debates to signal identity politics or suppress civic engagement, often exploiting cognitive biases and heuristics (Hoggan, 2019). 'Individualising' sustainability has been rhetorically convenient for incumbents wishing to delegitimise critics and deflect attention from their own contributions (Akenji, 2014; Lamb et al., 2020).[2]

Given gleeful exploitation of behavioural insights on everyday change by the 'dark side' in socio-technical processes, it is understandable that some ST contributions pointedly refuse to engage with concepts and terminology regarding individuals and behaviour change. While we agree there are valid reasons for care (above, and next section), we also see this as a missed opportunity. Firstly, this paper details countervailing applications of behavioural insights already improving understanding and acceleration of transitions processes, and with the potential for much more. Secondly, behavioural insights are now a major policy discourse, relevant to many transitions topics, and a potential site of translation between research and policy to help accelerate transitions. Parts of it show increasingly critical reflection and could benefit from transitions perspectives. Our review results indicate that at present, an 'outsider' policy maker or behavioural researcher seeking to engage with ST literature on behaviour may perceive that there is overall limited attention, with the most highly cited papers adopting critical stances. We intend that this review mediates this with a more inclusive, knowledge brokering stance linking different perspectives. We also aim to show that behavioural perspectives are valuable beyond a focus on consumption. We will propose a typology of behavioural perspectives, each of which can be useful to study the behaviour of any actor in sustainability transitions.

Beyond ST, behavioural science is a diverse field of inquiry that places human behaviour as a central unit of analysis. Drawing on diverse disciplines,[3] behaviour science has been used to answer fundamental questions about how humans make decisions and maintain or change their behaviour – and applied in policy (next section). At face value, it appears aligned with positivist and pragmatist paradigms in ST (Zolfagharian et al., 2019). Less obviously, and often uncomfortably, contributions from wider research paradigms also exist (Feitsma, 2019, 2018; Hampton and Adams, 2018; OECD, 2019), aligned with critical realist

[1] Noting extensive debate as to how behaviour and context specific it is (Elf et al., 2019; Frezza et al., 2019; Nash et al., 2017; Sorrell et al., 2020)

[2] including emphasising instances of moral budgeting and rebound effects described above.

[3] psychology, cognitive sciences, economics, political science, marketing, business management, sociology and anthropology amongst others

and interpretivist paradigms in transitions research (Zolfagharian et al., 2019), including practice theory (Hampton & Adams, 2018).

Behaviour science draws on theories and methods from disciplines operating at different levels of analysis (e.g. psychology AND sociology) as well as different epistemologies and paradigms (e.g. economics AND critical theory), and is applied across the full range of policy goals, actors and sectors, including in public-private and civil society initiatives[4]. Transitions are multi-dimensional, multi-phase and multi-actor processes, which are unlikely to be captured and explained through singular theoretical perspectives and conceptual lenses (Sovacool and Hess, 2017; Zolfagharian et al., 2019). Kohler et al. (2019) note that integrating with other fields and disciplines remains a challenge for ST scholarship.

Consequently, we take a pluralistic and interdisciplinary approach to definitions of behaviour, its causes and how to change it in this paper (Bammer, 2013; Cornell et al., 2013). The task of understanding and influencing behaviour relevant to socio-technical transitions can be understood as a rich interdisciplinary problem focus (Bammer, 2013; Klein, 1996). ST could be drawing on a long tradition, since at least the 1980s (Vayda, 1996, after 1983), of recognising the theoretical, methodological and practical values of progressive exploration of human behaviour in context.

And yet, a systematic assessment of this broad range of perspectives and insights from behavioural change theories and research, and its relevance for sustainability transitions is so far missing in transitions literature. For instance, Shove critiqued the emergence of behavioural perspectives in public policy as regressive to ST, but moved on to favour sociological perspectives, in particular social practice theory (Shove, 2014, 2010; Shove and Walker, 2010). Similarly, institutional and systemic views of what shapes behaviours in transitions literature emphasises strategic solutions “that go beyond a technical fix or behaviour change” (Geels, 2012). Reviews of behavioural insights for policy provide useful contributions (discussed below) but tend to focus on transplanting selected insights and their implications, or narratively construct conceptual models (Baum and Gross, 2017; Gazheli et al., 2015, 2011), rather than adopting a systematic review approach. Other contributions focus on cognate topics, such as the role of users (Schot et al., 2016), social psychological perspectives (Bögel and Upham, 2018; Upham et al., 2020, 2019), sustainable consumption (McMeekin and Southerton, 2012) and grassroots innovations (Seyfang and Haxeltine, 2012; Seyfang and Smith, 2007).

The key research questions we address in this paper are: ‘what are the main perspectives engaging with behaviour and behaviour change in the ST literature?’ and; ‘Given the

[4] For example, a psychological view of avoiding household plastic waste may focus on a person’s attitudes towards avoidance versus recycling and whether they believe that important others also avoid plastic (after the Theory of Planned Behaviour, Ajzen 1991). A behavioural economist might emphasise interactions between internal motivations, incentives and the implicit nudges built into waste management systems (Briguglio, 2016; Gneezy et al., 2011). Some researchers recognise household plastic use as a habitual act and primarily consider an individuals’ routines and environmental cues that enable or restrict recycling behaviour (Verplanken et al., 2018), or emphasise the role of mental shortcuts (“heuristics”) or biases that systematically tip the scales of human behaviour in suboptimal directions (Ariely, 2008). Still others may emphasise that environmental behaviours involves shared meanings, competencies and materials (e.g., norms and values associated with plastic, alternatives to using it, washing and storing plastics, placing plastics in a household recycling bin) that together hold socially-defined meaning as a social practice (Briguglio, 2016; Bulkeley and Gregson, 2009). See further below in Results. The ‘thick’ layering of possibilities for insight and action provided by different perspectives on behaviour is precisely what makes it exciting as a point of entry to understanding and influencing transitions.

emergence of behavioural public policy, what are the implications for understanding and accelerating sustainability transitions?'.

The next section briefly introduces behavioural public policy, while highlighting some implications of its emergence noteworthy for ST. Section 3 presents the methodological approach to the systematic literature review. Section 4 presents the results of the review. Section 5 discusses the relevance of the results with the aim to develop a research agenda. Section 6 concludes.

2. Behavioural public policy and its relevance to sustainability transitions

Knowledge translation between behaviour science and public policy has grown significantly since the late 2000s, helped by a Nobel Memorial Prize in Economic Sciences awarded to Daniel Kahneman, a psychologist and economist, in 2002 and Richard Thaler, a behavioural economist, in 2017; and public profile, with popular books *Nudge* (Thaler and Sunstein, 2009), *Predictably Irrational* (Ariely, 2008), *Thinking, Fast and Slow* (Kahneman, 2012). It is now widely recognised as an influential, applied field of interdisciplinary inquiry, with a substantial influence on public policy, providing evidence-informed ways of influencing human behaviour for pro-social, public good goals.

This is not without criticism both within ST literature and beyond. Ten years on from Shove's 'deliberately provocative' paper, we take stock of how the transitions field is engaging with behavioural public policy. Shove's (2010, p. 1274) primary concerns regarding the growing influence of economic and psychological perspectives on behaviour in climate policy were:

1. Models of behaviour in policy, focusing primarily on the influence of internal states (i.e. attitudes, behaviours and choices – "ABC") excludes broader contextual analysis and places responsibility for change primarily on individuals.
2. Such a focus has political implications and retards transitions in that it obscures the extent to which governments and other dominant institutions of modernity sustain unsustainable economic institutions and ways of life, and the extent to which they have a hand in structuring options and possibilities for individual behaviour.
3. To the extent that this is the dominant policy model, it inoculates policy makers from broader perspectives, and robs policy, and society more broadly, of the full range of relevant, useful and insightful perspectives that could inform a more holistic and inclusive understanding of social change and its role in transitions.

For better or for worse, since 2010, at least 200 governments across the world decided to create Behavioural Insights (BI) teams (Afif et al., 2019; Ruggeri, 2019). Behavioural insights are now seen as a specific approach to the development, testing, and implementation of government policy (Ruggeri, 2019). Sustainability is not a central focus of most government BI teams (Afif et al., 2019; OECD, 2017), yet behavioural public policy is being applied in many relevant policy domains for transitions: including in energy consumption, investment in renewables, promoting efficient vehicles, water conservation, sustainable food consumption, reducing waste and encouraging resource efficiency, and firm-level environmental compliance and voluntary program participation (OECD, 2017).

Shove's concerns about the emergence of the behavioural insights in climate policy are joined by contemporary criticism from the broader Humanities and Social Sciences (HASS) disciplines in the UK in response to the broader phenomena in government (House of Lords, 2011). Further scholarship and broader debate in the last decade has further problematised the influence of behavioural science on policy, recognising a narrowing of the breadth of recognised social science evidence to experiments targeting individuals, and randomised control trials (RCTs) (Ewert, 2020), drastically narrowing comprehension of the complexity of policy contexts. Arguably this exacerbates an existing trend to favouring simplistic and narrow inputs to 'overconfident' policy decisions on complex issues (Saltelli and Giampietro, 2017; Sibony, 2020). Emphasising only internal cognitive biases and drivers over more contextual influences on behaviour, including deliberate actions by 'bad actors', is now recognised as rendering behavioural policy at best naïve, and at worst, complicit, in the manipulations of vested interests (Meder et al., 2018). Blindness to, and reproduction of, problematic and (presumably) unintended systemic consequences of policies such as inequality in health and social equality outcomes have been identified as a cumulative effect of these dynamics (MacKay and Quigley, 2018).

We introduce the term "behavioural public policy" to refer to a countervailing, emerging, contested plural perspective, in contrast to more narrow 'behavioural insights'.[5] With broadened questions asked, actors considered, lengths of time frames, and the types of outcomes desired, engagement with multiple behavioural change perspectives is both deeply insightful, and can transform how government and other actors engage with policy problems. In short, when behavioural public policy adopts inter-disciplinary approaches to behaviour change, it is better, and we suspect the same may be true for transitions research and practice.

Focusing on problems and ultimate outcomes of behaviour has seen policy makers and administrators working with behavioural economists, psychologists, sociologists, ethnographers, big data analysts, design thinkers and government innovation specialists in a wide range of policy areas (Ewert, 2020; Feitsma, 2019; Oliver, 2017). Such behaviourally informed policy emphasises the importance of context and multiple actors on everyday decision making and behaviour. It examines a wide set of influences, paying attention to the social, psychological, and economic factors, and biophysical, technical and infrastructural factors, that affect what people think and do. It addresses details in bureaucracies, technologies, and service delivery that are often overlooked in standard policy design but that dramatically influence the effectiveness of programs and projects, including the influence of business and civil society actors' behaviours. Behaviourally informed policy can provide creative solutions to difficult challenges, often at low cost. Finally, it helps policy makers themselves avoid some of the decision traps and biases that affect all individuals (Worldbank, 2015).

It's not clear what proportion of the world's 200+ behavioural insights teams would identify with the 'behavioural public policy' understanding we advance here, but it is present, and increasingly documented (Ewert, 2020; Feitsma, 2019; Huttunen et al., 2021; Worldbank, 2015), and is receptive to practice theory amongst other perspectives (Hampton & Adams, 2018).

Three positive trends in behavioural public policy particularly relevant to sustainability transitions are: (1) behavioural public policy has been forcing recognition in policy that human behaviour does not always or even typically reflect rational choices based on available information, and that a wide range of internal and external factors shape behaviour, so a wide range of policy tools are needed to influence it; (2) this in turn encourages people designing policy and delivering programs and services to take a far more 'real world',

[5] With apologies to the many self-identified Behavioural Insights researchers and practitioners who may identify more closely with our alternate term.

empirical and end user focused approach to public policy and administration; and (3) that this is building a norm that experimentation, user participation, research and robust measurement must be embedded into policy processes that expect to impact behaviour.

On the first trend, despite frequent critical conflation of behavioural approaches with psycho-economic perspectives on policy (Feitsma, 2018), one of the fundamental tenets of behavioural public policies is that human behaviour does not always, or even usually, reflect rational choices based on available information. This rejects the assumption that policies should be designed and implemented based on ideas derived from 'grand theories' of human nature – such as the belief that people will enact the behaviour most aligned with their rational goals, based on the information they have available. To the extent the 'ABCs' framework exists, contemporary behavioural public policy is part of the antidote (Gazheli et al., 2015). Behavioural public policy instead places behaviours, actors and their context at the centre of analysis, seeking to diagnose the internal and external factors that influence behaviour, and match policy tools and interventions to those factors (Michie et al., 2014).[6] Associated with conceptual and disciplinary plurality is also policy intervention plurality. While it is true 'nudges' are the best known tools, well beyond these, behavioural insights are being applied across the spectrum of policy intervention options of 'voluntary' through to 'coercive' approaches (Ewert, 2020; French and Gordon, 2015; Meder et al., 2018; Michie et al., 2014; Oliver, 2015).[7]

Secondly, recognition of the 'a-rationality' of behaviour is valuable because it forces those people who design and administer policy or interventions to confront the fact that individual's behaviour is influenced by diverse beliefs, experiences, and goals. We say 'a-rational', and not 'rational' behaviour, following Flyvbjerg and Sampson's (2011) distinction: while behaviour may potentially be understood using rational analytical thinking, behaviour itself is recognised as emerging from more than rational thought and decision-making alone (Flyvbjerg & Sampson, 2011, p. 22). Recognising individual behaviour as 'reasonable even if not rational' allows the design of interventions that consider the experiential reality of people, even if the aim is to fundamentally transform the outcomes and impacts of their behaviour on broader goals. Some behavioural policy teams have started recognising that problem framing, evidence gathering, and intervention design typically reflect pre-existing assumptions, personal experience, dominant policy paradigms (especially neoliberal and economic rationalism) and theoretical and disciplinary traditions of public administration (Hall, 2016; Meder et al., 2018; Worldbank, 2015), which continue to be reproduced through

[6] This view is probably most widely embedded in public health policy applications of behaviour change, which embeds policy responses to behaviour explicitly in a broader socio-ecological system (Bronfenbrenner, 2005; Damschroder et al., 2009; McManus et al., 2018). Indeed the intersection of wellbeing, environment and social equity with implications of behaviour change is emerging as a rich area of exchange (Bell et al., 2019; Van der Vliet et al., 2018). Such theoretical and methodological plurality in behavioural public policy is strikingly aligned with Vayda's proposed approach to understanding human behaviour in dynamic, complex soco-ecological systems (Vayda, 1996).

[7] A range of labels for behavioural public policy tools exist. Persuasive and encouraging interventions have been labelled 'hugs', while targeted deterrence and dis-incentives as 'smacks' (French and Gordon, 2015). Protective regulatory interventions preventing harms by private entities have been called 'budges' (Oliver, 2013), i.e. regulating cognitively exploitative payday loans and complex contracts (Oliver, 2015). More individual focused coercive interventions are labelled 'shoves' – for your own good, even if you don't want to – e.g. banning cigarettes, preventing confectionary sales from dominating optimum shelf heights in supermarkets (Oliver, 2015). Behavioural science also provides support for a distinct family of non-fiscal and non-coercive interventions: "boosts." Here the objective is to foster people's competence to make their own choices—that is, to exercise their own agency. (Hertwig and Grüne-Yanoff, 2017).

the relatively ad hoc networks of advice and knowledge available, often under significant time constraints (Cairney, 2016; Head et al., 2014; Head, 2016).

To our third trend: at its best, behavioural public policy is aligned with 'networked and negotiated' approaches to evidence based policy and its implementation (Head, 2008; Worldbank, 2015). This includes theories and methods for exploring the problem, particularly with stakeholders, developing a policy or intervention based on rigorous evidence, and testing its effectiveness before final implementation. Knowledge brokering and experimentation are front and centre (Feitsma, 2019). In contrast, a great many conventional government programs are still designed and delivered reflecting internal pressures and priorities, such as budget efficiency, organisational culture and risk appetite, political expectations, legal mandates and public value expectations (Cairney, 2016; Faulkner and Kaufman, 2018). Behaviour change perspectives are in part an antidote to public organisations relying on the ISLAGIATT principle ("it seemed like a good idea at the time") in delivering services and programs (Michie et al., 2011). Behavioural policy experimentation is an opportunity to improve policy making, facilitating adaptive management, and can facilitate learning at multiple scales towards sustainability (Althaus et al., 2018; Parson and Clark, 1995).

Behavioural public policy has also opened the door to structured, evidence-informed and participatory forms of governance such as policy co-design (Feitsma, 2019; Howlett, 2017), highlighting the value of robust experimentation, prototyping and impact measurement. Because there are many approaches to understanding and changing human behaviour, appropriate policies and interventions must address the factors ("drivers") that underpin one specific behaviour, and policy designers must be willing to question their assumptions about the behavioural audience and take an iterative approach in navigating the complexity of possible pathways through behavioural public policy. Structured processes for organising methods and tools like prioritising behaviours (Kneebone et al., 2017) identifying and synthesising pertinent evidence (SSE, 2018), rapidly developing behaviourally-informed interventions (EAST, INSPIRE (BWA, 2019; French & Gordon, 2015; McKenzie Mohr & Smith, 2008; Oliver, 2017; Ruggeri, 2019; Shafir, 2013), user participation and audience research and testing the effectiveness of interventions (test/learn/adapt) are now frequently used in behavioural public policy (BWA, 2019; French and Gordon, 2015; Oliver, 2017; Ruggeri, 2019; Shafir, 2013). A range of 'end to end' behavioural public policy frameworks and toolkits now exist covering these and other steps (Michie et al., 2014; e.g. OECD, 2019; Smith et al., 2021).

Significantly, behavioural insights teams engage with diverse challenges in bridging research and action in everyday life with wider scales of analysis, towards evidence-informed policy. They do this alongside other perspectives inside and outside of government, including those of transitions scholars and practitioners. We further anticipate that better understanding how transitions literature incorporates behaviour could also be of great value to improving behavioural public policy in the context of large-scale socio-technical change.

3. Methods

We draw on mixed review methods in this work. Firstly, to articulate the scope and focus of the review, we generated review questions using problematization methods (Alvesson and Sandberg, 2011; Sandberg and Alvesson, 2011). Secondly, to quickly identify relevant papers to our questions, we used scoping review methods (Arksey and O'Malley, 2005) and rapid systematic review methods (Dobbins, 2017; Khangura et al., 2012; Tricco et al., 2017).

Scoping reviews provide a preliminary assessment of the size and scope of an available research literature, considering elements like quantity, study types and other descriptive elements. Rapid reviews assess what is known about a policy or practice issue or question, with a focus on generating action orientated insights, generally favouring reviews and syntheses over single studies (Grant and Booth, 2009). Finally, to explore and analyse the resulting set of focal papers, we applied critical interpretive synthesis techniques (Dixon-Woods et al., 2006; Torrens et al., 2019).

3.1 Development of review questions

Problematisation helps to identify the presence and impact of key perspectives, and understand their significance (Alvesson & Sandberg, 2011; Sandberg & Alvesson, 2011). The method supports the generation of frameworks based on identifying, comparing, and synthesising assumptions in a body of work, rather than direct aggregation of findings (cf. a conventional systematic review) or to primarily map a literature and its gaps (cf. a scoping review).

We developed the following guiding questions on behaviour in sustainability transitions:

1. What are the main perspectives on human behaviour and behaviour change?
    - Disciplines, methods, problems
        - Key assumptions (unit of analysis, scale, ‘flag terms’)
    - How do these perspectives address changing behaviour?
        - Causal assumptions / theories of change
        - Applications to ‘state’ (i.e. policy and administration) and broader actors’ approaches to behaviour change
        - Metaphors
    - How is behaviour and behaviour change situated in broader socio-technical systems?
        - Extent considered
        - Useful bridging constructs and concepts
2. How does this way of looking at behaviour and changing behaviour help and/or hinder understanding and accelerating transitions?
    - Research agenda implications
    - Policy and practice implications

3.2 Search strategy, screening and coding

To identify how human behaviour and behaviour change is represented in transitions literature, we conducted a search of the Scopus academic database. Our initial search string sought to comprehensively identify peer-reviewed publications in sustainability transitions research. We used a published search string (Markard et al., 2012) defining the field of sustainability transitions as papers that cited at least one of 20 core papers. This string has subsequently been used in other studies seeking to scrutinise particular transition-field related questions, such as methods and approaches used in transitions research (Zolfagharian et al., 2019) and the concept of ‘experimentation’ (Sengers et al., 2019). In a similar way as in these publications, we combined the original search string with an additional search for behaviour (as *behav**) in title, abstracts and keywords, which enabled us to identify the cross-section of ST literature engaging with behaviour (see Appendix 1).[8]

The search was initially conducted on 20 March 2019 and had no year restrictions. However, due to how the search was constructed (i.e. papers that cited a core set of sustainability transition papers), the earliest possible record would have been published in 1991. We conducted a second update search on 14 July 2021 and followed the process below for the combined results.

Two authors screened all papers for initial inclusion or exclusion. The reviewers screened 18% (n = 70) of the abstracts in duplicate for relevance to the research questions. After discussing this initial set, the remaining abstracts were screened for inclusion by one of the two reviewers. The included abstracts were screened for eligibility through an iterative process supported by regular discussion between the reviewers. This involved coding for the extent of behaviour focus in the title, abstract and keywords (absent, implied, included, focal), the actor undertaking the behaviour, the unit of analysis (micro, meso, macro), and for article type (empirical, modelling, theoretical, or review). Appendix 2 provides more detail on each of these codes. Papers where behaviour was rated as focal were included in the critical interpretive synthesis (plus see comments on re-inclusion below, and in results).

[8] As discussed at multiple points in this paper, we acknowledge that this is likely to exclude a range of publications that intentionally avoid using variations of the term behaviour for normative or critical reasons, but may well have valuable insights relevant to the phenomena in everyday life. Noting the goals of this paper, we have included those ‘non’ or ‘anti’ behavioural scholarship perspectives that at least engage with the term and its use in practice and policy.

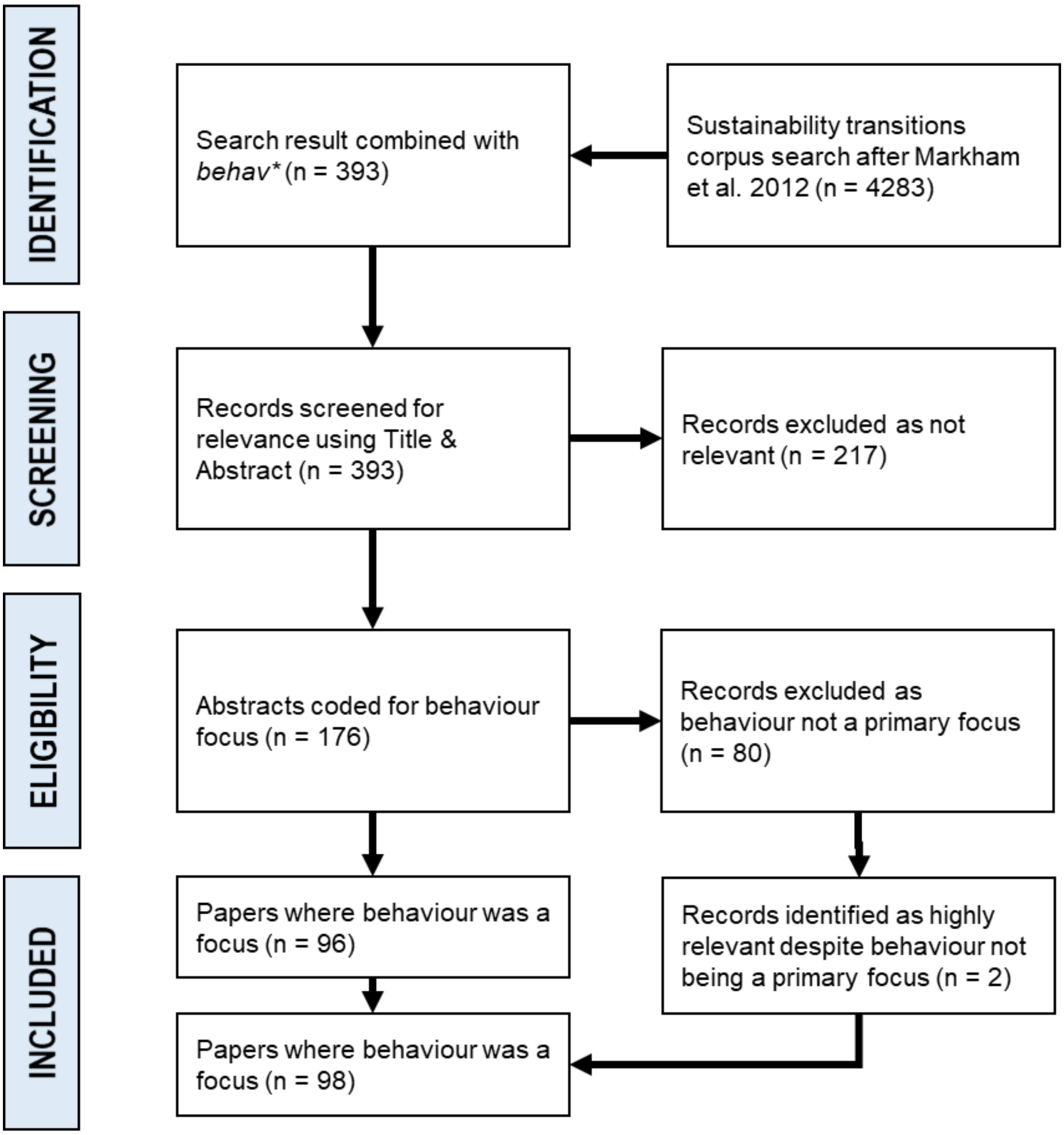

Figure 1: Review process flow diagram.

3.3 Interpretive synthesis

Finally, the authors conducted a qualitative critical interpretive synthesis (Dixon-Woods et al., 2006) of the full text of the included focal papers; through the lens of the guiding questions (after Torrens et al., 2019). The full-text analysis initially included 96 ‘behaviour focused’ papers, but rose to 98 to include two papers the authors escalated into the analysis after further reading and discussion, for instance due to their significance in initially included papers, and overall prominence in citations. The two papers are listed in Table 2, p. 13.

Typical structured reviews of the literature use narrative analysis to answer precisely specified review questions (Gough et al., 2017). Such an analysis is most appropriate when the phenomenon of interest (i.e., behaviour in sustainability transitions) is already well defined and the aim of the review is to aggregate this information into existing, converging conceptual categories (e.g., positivist behaviour science perspectives on whether sustainability transitions researchers are “correctly” applying behaviour change). This was not our objective in the current paper: in contrast, we conducted this review with the intent to reveal both consistent *and* conflicting perspectives on how behaviour was described in the sustainability transition literature.

4. Results

While 393 ST papers in our search results at least mention behaviour in their title, abstract or keywords, more than half of them we coded as only 'implicitly' engaging with behaviour. We organise the results of the review in two sections. First, we describe the characteristics of the papers we included due to having a seemingly explicit focus on behaviour and/or behaviour change in their abstract according to reviewer coding (n = 176). Second, we share insights from a critical interpretive synthesis (based on full text reviews) focusing on the 96 'behaviour focused' papers as well as two 'relevant' papers included after further reading and discussion. Table 1 provides a summary of the initial coded article types, scale of social interactions under analysis, and our assessment of the extent to which behaviour was a central element of the paper. Appendix 2 describes the codes, and Appendix 3 provides examples of papers identified for each of the categories.

Table 1: Characteristics of papers rated as relevant by reviewers (N=176).

Relevant article characteristics[1]	N	% (of 131)
Article type		
Empirical	94	53%
Models	10	6%
Theoretical and conceptual papers	40	23%
Literature review	29	16%
Other	3	2%
Level discussed		
Micro	67	38%
Meso	26	15%
Macro	-	-
Multi-level	83	47%
Centrality of behaviour		
Implied	8	5%
Included	72	41%
Focus	96	55%

1. See Appendix 2: coding used for each title / abstract.

4.1 Characteristics of relevant papers

4.1.1 Volume

The number of papers (n = 176) explicitly investigating the role of behaviour in sustainability transitions represents approximately 4% of the entire field of sustainability transitions as defined by our search string (176 / 4283). The first relevant paper was first indexed in 2004 (Vergragt, 2004).

4.1.2 Most cited

All of the relevant papers identified were published since 2004, indicating behaviour change in sustainability transitions has been present even as the field was gaining traction. The top 10 most cited papers (absolute) are shown below (Table 2). They account for 49% of all citations from the 176 relevant papers.

Table 2: Top 10 relevant papers ordered by overall citations.

Rank	Title	Author(s), year, and journal	Cites to Jul 2021	Cites / yr	B. focus (66 +)*[9]
1	Beyond the ABC: Climate change policy and theories of social change	Shove (2010) Environment and Planning A	1221	102	**Focus**
2	Strategic niche management and sustainable innovation journeys: Theory, findings, research agenda, and policy	Schot, Geels (2008) Technology Analysis and Strategic Management	900	64	Changed Incl to **Focus+**
3	Growing grassroots innovations: Exploring the role of community-based initiatives in governing sustainable energy transitions	Seyfang, Haxeltine (2012) Environment and Planning C: Government and Policy	450	45	Changed Incl to **Focus+**
4	A socio-technical analysis of low-carbon transitions: introducing the multi-level perspective into transport studies	Geels (2012) Journal of Transport Geography	417	42	Incl.
5	Business models for sustainable technologies: Exploring business model evolution in the case of electric vehicles	Bohnsack, Pinkse, Kolk (2004) Research Policy	264	33	Incl.
6	Reorienting climate change communication for effective mitigation: Forcing people to be green or fostering grass-roots engagement?	Ockwell, Whitmarsh, O'Neill (2009) Science Communication	215	17	**Focus**
7	Co-evolution of technology and society: The transition in water supply and personal hygiene in the Netherlands (1850-1930) - A case study in multi-level perspective	Geels (2005) Technology in Society	177	10	Incl.
8	Not irrational but habitual: The importance of "behavioural lock-in" in energy consumption	Marechal (2010) Ecological Economics	148	12	**Focus**
9	Keeping sustainable innovation on a leash? Exploring incumbents' institutional strategies	Smink., Hekkert, Negro (2015) Business Strategy and the Environment	140	20	**Focus**
10	A transitions model for sustainable mobility	Kohler, Whitmarsh, Nykvist, Schilperoord, Bergman, Haxeltine	111	10	Incl.

[9] * B. focus refers to whether the paper was coded as focused on behaviour and was thus included in the critical interpretive synthesis. Papers marked **Focus+** were included by the authors in the critical synthesis after initial coding, for example due to their significance in included papers.

(2009)
Ecological Economics

The most cited paper was also one we defined as behaviour focused, if critically so. It is a commentary that critiques mainstream economically and psychologically informed strategies for behaviour change in climate policy (Shove 2010). In this article, Shove argues for a more nuanced approach to the everyday implications of climate policy, informed by practice theory, in contrast to the existing simplistic and reductionist perspective she labels as the "ABCs". The paper argues the risk of assuming that attitudes (A) drive specific behaviours (B) that individuals choose (C) to adopt is that behaviours are embedded in social practices that constrain or obviate choice, that many drivers of behaviour are embedded beyond an individuals' attitude towards that behaviour, and that behaviours relevant to climate change cannot be usefully influenced in isolation; rather, complex and interdependent systems of practices are irreducible to reductionist analysis (see also introductory notes).

Other relatively highly cited papers were also critical of a rational, preference-based approach to behaviour in sustainability transitions, especially for consumers, but less directly focused on the implications for steering and governing transitions, for example focusing on implications for scholarship and conceptual developments. Consistent with Shove, some papers focused on social practice theory in everyday life in sustainability transitions (Hargreaves et al., 2013; McMeekin and Southerton, 2012). McMeekin (2012) argues in a conceptual paper for a practice-based approach to consumption rather than technology-focused or (social science) individual behaviour-focused approaches in isolation. Hargreaves (2013) presents two case studies that have used either a multilevel perspective or social practice theory to support sustainability innovation in food and farming and argues that a combined approach is necessary to foster sustainability transitions.[10] While interesting, we ultimately did not 'escalate' them after initial coding into the interpretive synthesis, as insufficiently relevant to our paper focus on intersections between behaviour and changing it via intentional public policy and administration towards ST.

Authors using multi-level perspectives or socio-technical frameworks for transitions argued that consumer behaviour change was similar to technology innovation in that neither factor alone was sufficient to foster sustainability transitions (Geels, 2012, 2005; Geels et al., 2018; Moloney et al., 2010; Schot et al., 2016). For instance, Geels 2005 presents a case study of water supply and personal hygiene transition in the Netherlands over the period 1870-1930, and notes the role of individual behaviour change alongside cultural, political and economic elements of a wider co-evolution of technology & society in improving water supply and hygiene. Smink et al (2015) describes how incumbent firms take strategic actions to influence the trajectory of sustainable innovation, such as slowing the adoption of LED lighting in the Netherlands by misrepresenting their readiness for market. Schot et al. (2016) proposes in a conceptual paper that energy consumers must be treated as part of the innovation process in transitions, rather than as subjects to be influenced or persuaded through rational incentives.

[10] Some papers sought to disentangle individual and collective behaviour in sustainability transitions (Hall, 2013; Seyfang and Haxeltine, 2012). Hall 2013 in a conceptual paper compares three lenses on behavioural approaches to sustainable tourism, arguing that a focus on individual behaviour change through nudging or rational incentives ignores the important role of structures and institutions for sustainable transitions. Seyfang 2012 in a study of UK community-based social innovation initiatives emphasises the need for a community-based, action-oriented model of social change rather than individual behaviour change to achieve sustainable energy transitions

Other approaches to sustainability transitions that discussed behaviour included: systems thinking (Williams et al., 2017), strategic niche management (Schot and Geels, 2008), circular economy (Jurgilevich et al., 2016), complexity science (Bale et al., 2015) and agent-based modelling combined with systems dynamics (Köhler et al., 2009). Williams et al. (2017) reviews the systems thinking literature in sustainability management and identifies behaviour change as a theme present in the 96 included papers. Schot & Geels (2008) reviews the field of strategic niche management, briefly mentioning how new consumer and firm practices and behaviours can be experimented within protected niches. Jurgilevich et al. (2016) presents qualitative data identifying how interrelated behaviours and practices in food production, consumption and waste management are necessary to foster in order to achieve a circular food system. Bale et al. (2015) develops a framework for understanding energy systems transitions using complexity theory, which can incorporate both technological and behavioural factors in transitions. Köhler et al (2009) used modelling to investigate sustainable mobility (especially for private vehicles). The results of the modelling were used to argue that technological change is a precondition for later consumer behaviour change, policy support, and transitions to sustainable mobility.

Although most highly cited papers focused on individual -- especially consumer -- behaviour at the micro level, some papers also considered the role of firms and regime-level actors at the meso level (Bohnsack et al., 2014; Schot and Geels, 2008; Smink et al., 2015) (Bohnsack et al., 2014; Schot & Geels, 2008; Smink et al., 2015). Smink et al. (2015) interview representatives of incumbent energy firms to understand how firm-level behaviour can influence and is influenced by sustainable innovations at the niche-regime interaction. Specifically, firms actively seek to influence policy makers and consumers, and setting technical standards that benefit current firm strategy. Bohnsack et al. (2014) provide qualitative analysis of electric vehicle projects in firms (meso-level) to try and understand how new business models evolve as a type of path-dependent firm behaviour.

A few of the highly cited papers investigated behaviour and behaviour change through a lens easily recognisable to behavioural science, and sought to unpack the role of habits (Maréchal, 2010a), effective communication (Ockwell et al., 2009), and barriers to reducing carbon footprints (Girod et al., 2014). Maréchal (2010) argues in a conceptual paper that habits, rather than rational economic decisions, are responsible for consumer behaviour in energy consumption. Ockwell et al. (2009) writes in a conceptual paper that the two current pathways for “green” individual behaviour change for climate change mitigation -- coercive regulation and persuasive communication -- could be combined such that communication is used to persuade individual consumers to demand increased regulation, which will subsequently change individual behaviour. Girod et al. (2014) analyses the carbon footprint of five consumption categories (food, shelter, travel, goods, services) relevant to achieving climate mitigation goals, as well as behavioural barriers for consumer uptake. Other relevant papers identified included those that sought to translate behavioural insights from other fields for the sustainability transitions - e.g. policy analysis, intersections of behavioural insights and big data in renewable energy policy, social psychology and behavioural economics (Baum and Gross, 2017; Bögel and Upham, 2018; Gazheli et al., 2015, 2011; Giest and Mukherjee, 2018).

4.2 Critical interpretive synthesis of papers focusing on behaviour

We analysed the papers with a particular focus on behaviour to understand how behaviour and behaviour change is conceptualised in sustainability transitions. This phase leads to one of the major findings of this paper: identifying four stylised perspectives on behaviour in sustainability transitions, each with importantly different interpretations and applications of behaviour and behaviour change (Table 3, p. 17). We will further elaborate on each of the perspectives below.

Table 3: Perspectives on behaviour in sustainability transitions literature

	Reflective Behaviour	Automatic Behaviour	Strategic Behaviour	Everyday behaviour
Behaviours are (typically) treated as…	One-off, discrete and observable	Repeated, discrete and observable	Embedded, considered, actions in socio-technical systems	Clusters of co-evolving everyday activities
Behaviours are shaped or caused by	Internal and social psychological and structural "drivers" that influence individuals' conscious deliberation, interacting with relatively static aspects of the physical and social context.	Maintenance or change in cognitive and structural cues and constraints internal to the individual, in reaction to relatively static aspects of the physical and social context.	Interactions between collective actors, and dynamic changes to the socio-technical context that affect the relative status of actors or the benefit of specific actions	Material affordances; shared, relevant meanings; skills, abilities and knowledge, with social relations, production and consumption, technologies and practices constantly co-evolving and emerging.
Relative predictability of causal relationships	Complicated, but ultimately linear from drivers, mediators and behaviours (generally predictable)	Simple to complicated, ultimately linear from contextual cues and constraints to behaviours (generally predictable)	Complicated to complex, embedded in co-evolutionary socio-technical dynamics (sometimes predictable, more often retrospectively)	Complex, non-linear, emergent and socially constructed (typically retrospective understanding of causation only)
Typical methodology of research investigating	Quantitative survey, intervention and/or policy evaluation, qualitative interviews, mixed-methods, observational	Observational or inferred from secondary data sets, can be indicated by survey scales and interviews	Longitudinal analysis, qualitative interviews, discourse analysis, historical methods, some mixed methods, modelling	Qualitative interviews, discourse analysis, historical methods, some mixed methods in evaluation, observational
Common disciplinary contributions	(Social) psychology Sociology (Social) Marketing Microeconomics Behavioural economics Anthropology	Evolutionary economics Behavioural economics Psychology Cognitive Science (Neuro) Marketing	Sociology Political science (Organisational) psychology Political economy Evolutionary economics History	Sociology Critical theory Anthropology History
Common key words	Adoption, Uptake, Diffusion, Choice, Decision-making, attitudes, identity, planned behaviour, beliefs, attitudes	Habit, heuristics, biases, unconscious, automatic, internal structures	Institutions, lobbying, advocacy networks, agency, structure, niche management	Lifestyle practices, meanings, materials, competencies, co-evolution
Scale of analysis / action	More individual action, micro to meso scale		More collective action, meso or multi-scale	
E.g. Representative papers from transitions literature	(Baum & Gross, 2017; Bögel & Upham, 2018; Ockwell et al., 2009)	(Maréchal, 2010)	(Schot & Geels, 2008; Smink et al., 2015)	(McMeekin & Southerton 2012; Moloney, Horne, & Fien, 2010; Shove, 2010)

4.2.1 Reflective behaviour

This perspective generally conceptualises behaviour as reflective, effortful and conscious. It is frequently analysed as once-off, discrete and observable actions, especially by individuals. These behaviours are causally explained by identifiable phenomena such as psychological and structural “drivers” or “barriers”. Behaviours are typically seen as boundedly rational for the individual but may ultimately be variously adaptive (i.e. beneficial) or maladaptive for the individual and/or their community, depending on the scale and nature of analysis (e.g. spatial, temporal, ecological, economic, or social). Indeed Vainio et al (2020) found that individuals’ consideration of immediate and future consequences is an important factor sustainable behaviours supporting transitions.

For policy and intervention, identifying and manipulating key “drivers” or “barriers” are understood to influence individuals’ conscious deliberation and thus produce behaviour change. Governments, NGOs and businesses all may attempt to understand and influence the knowledge, beliefs and behaviours of actors for example by experiences and social modelling, reinforcing norms, education, persuasive communication, incentives, emotional and/or moral appeals. “Drivers” and “barriers” and their link to behaviour can be thought about (“reflected on”) by individuals, and behaviour can change, if with effort and help. About two thirds of the papers in our synthesis reflected this perspective (54[11]). While numerous, they were not especially highly cited– see Table 2, above, an exception was Ockwell et al. (2009) at 215, the sixth most cited of those engaging with behaviour at all (Table 2, p. 13). Reflective contributions are growing: 22 of the papers were published in the last two years, compared to 32 between 2004 and 2019.

In transitions literature, the reflective behaviour approach is most frequently applied to mass audiences and topics such as everyday actions of consumers and households. A hypothetical example of a behaviour change intervention from this perspective is the replacement of existing water fixtures in the home with new water-efficient fixtures. A financial incentive such as a discount (intervention) would cause a home owner to schedule a tradesperson to install new water-efficient fixtures (behaviour) by increasing their capability to afford the costs of installation (driver). Baum & Gross (2017) exemplify this behaviour perspective by identifying 18 determinants of environmentally-significant behaviour including internal factors (e.g., attitudes), individual-level context (e.g., resources), socio-cultural context (e.g., geographic location), and techno-economic context (e.g., government policies). Successful ‘field’ interventions on environmental behaviour address multiple determinants. A similar logic is found in O’Brien et al. (2017), who draws on reflective behaviour theories in psychology (e.g., the theory of planned behaviour (after Azjen in Si et al., 2019) and the transtheoretical model (Prochaska et al., 1994) and sociology (diffusion of innovation, (Rogers, 2010)) to propose effective interventions for sustainable forestry. Gazheli et al. (2015) navigates both the reflective and automatic behaviour perspectives by emphasising the importance of understanding “bounded rationality” in predicting and changing the behaviours of individuals, groups and organisations to foster sustainability transitions. Other contributions link levels, e.g. Schulte et al. (2020) conduct an empirical meta-analysis of connections between individual’s social identity and collective action, within a multi-level perspective.

Feola and Binder (2011) design a formal mathematical model for use in agent-based simulation in order to predict farmer’s sustainable agricultural practices (Feola et al., 2015;

[11] Note a proportion of papers were coded as reflecting more than one perspective, meaning the total count across perspectives exceeds the actual number of papers = 98.

Feola and Binder, 2010). The model includes psychological drivers of behaviour such as expectations about consequences, perceived norms, and non-psychological "contextual factors". The most cited paper in our 2021 update search, Otto et al. (2020) similarly uses modelling to identify "Social Tipping Interventions" (STIs), situating a 'reflective' analysis in a systems transformation frame, with three of the six STIs targeting beliefs, attitudes and/or values. Köhler et al (2020) bridge qualitative case studies and agent-based modelling of multi-level pathways to identify feasible trajectories of change in both behaviour and technology for low-carbon transport.

There is an acknowledged need to also understand the drivers and barriers of behaviours and decisions of powerful actors which shape such contexts, which is increasingly being addressed (Si et al., 2019), including in transitions literature e.g. beliefs about the transition to hydrogen fuel (Upham et al., 2020). This could be a strong contribution to better understanding what we label 'strategic behaviour', below.

4.2.2 Automatic behaviour

This perspective conceptualises behaviour as often unconscious, intuitive, easy and adaptive (but hard to change once embedded). It is usually analysed as repeated, discrete and observable actions, especially by individuals, often referred to as habits. Automatic behaviours are typically maintained by recurring cues or constraints within an individuals' psychological or structural context. From a policy and intervention perspective, behaviour change results from both designed/intentional and unintentional changes in these cues or constraints, for example by governments or businesses manipulating the design and prompts of high-volume service interactions online, in supermarkets, finance, via smart meters, and in forms/letters. Actors are only understood to be able to reflect on and self-elect to change habits when they are disrupted, for example by a substantial change in context. There were 11 papers in our synthesis engaging with this perspective, and they are relatively well cited – see Table 2, above, with Marechal et al. (2010) the most highly cited at 148.

The definition of behaviour according to this perspective is very similar to that in the a-rational perspective in that behaviours are discrete and observable actions by individuals. One distinction is while the reflective perspective often treats behaviours as one-off, the automatic perspective typically incorporates habit and routine -- that is, repetition of the same action over time. A second distinction is that the automatic perspective acknowledges that a great many day to day behaviours are not driven by conscious, deliberate decisions to act. Instead, this perspective emphasises the role of heuristics and biases (cognitive and psychological "rules of thumb" or shortcuts), and habits. Habits can be deliberately formed, are often adaptively formed solutions to everyday problems, and rapidly become less or non-conscious in stable contexts. Once established, context (especially the social and physical environment) generate cues in triggering a habitual behaviour.

An example of a behaviour change intervention from this perspective is a multi-channel campaign by government for supermarket customers in Victoria, Australia, to bring their own reusable bags, after plastic bags had been banned from supermarkets. The significant change in supermarket shopping context provided an opportunity to reshape behavioural habits around bag usage. The campaign repurposed a well-known children's rhyme ("heads, shoulders, knees and toes!") to establish a new habit of bringing a bag to the supermarket as part of other items a person would typically take when they leave their house ("bag, wallet, keys and phone!").[12] As highlighted by Little et al. amongst others, in such approaches, multi-level influences on sustainable consumption and production are collapsed into 'context' (Little et al., 2019). Efforts to create smart buildings and precincts that nudge users to more sustainable behaviours align with this perspective (Giest and Mukherjee, 2018). But it's not just 'users': e.g. disrupting building owners' complacency about energy efficiency upgrades, as opposed to tenants (Gazheli et al., 2015). Ameli et al. (2020) turn the 'automatic' lens on institutional investors' decision making, theoretically and empirically, identifying the limitations of rational actor assumptions about the impact of carbon disclosures.

Maréchal and colleagues (Maréchal, 2010b, 2009; Maréchal and Holzemer, 2015) appear to be the most consistent and influential proponents of the automatic and habitual perspective on behaviour in sustainability transitions in our review. They emphasise the importance of habits being independent from or even conflicting with reflective motivations and intentions. In this view, although individuals may desire to change their behaviour (e.g., cease driving to work every day), both individual habits (e.g., transporting children to school before work) and the socio-technical system (e.g., no convenient public transport alternative) undermine this desire. Other authors seek to reconcile the techno-economic term "lock-in" with the behavioural concept of "habits" by using phrases such as "behavioural lock-in" (Gazheli et al., 2015; Han and Wu, 2019).

4.2.3 Strategic behaviour

This perspective conceptualises behaviours as strategic, intentional actions undertaken for comparative benefit in a competitive context, especially by niche innovators, established firms and government agencies and other organisational actors. Expectations of behaviour, and behaviour change, of others can be a focus – for example beliefs and assumptions about 'what works' within particular institutional and material (socio-technical) contexts to change others behaviour matters, and informs strategy by firms, policy makers, NGOs and community groups. Strategic behaviours seek to advance an actor's interest by influencing the individual or collective behaviour of others or turn others' influencing attempts to the actors' advantage. This can include exploiting insights into the motivations and predictable behaviour of others, for both selfish, and pro-social, reasons (including 'sludges' – nudges by bad actors (Thaler, 2018)). Behaviour change is recognised as an emergent and recursive property of interactions between collective actors, and/or changes to the social context that changes the status or influence of actors or the benefit of specific actions. Behaviour in everyday life is often descriptive and more deterministic in this perspective, with analyses of causes and consequences of changing it often occurring at the scale of broader processes entities, and phenomena than the individual. This noted, there is increasing recognition of changes in 'behaviour, practices and cultural models' as a force for disruptive innovation (Kivimaa et al., 2021). There were 32[13] papers reflecting this perspective in our synthesis. The most cited original inclusion based on our coding was (Smink et al., 2015) at 140 citations. Further review and discussion saw the inclusion of Schot and Geels (2008) at 900 citations and Seyfang and Haxeltine (2012) at 450, making this also a prominent perspective, by citations at least, of the four, alongside the 'everyday' perspective.

Whereas the reflective and automatic perspectives on behaviour emphasise individuals and how their behaviours are shaped by internal beliefs or their socio-technical environment, the strategic perspective attempts to recognise how actors within a system influence each other,

[12] https://www.sustainability.vic.gov.au/You-and-your-home/Live-sustainably/Single-use-items/Plastic-bags

[13] See foot note11 and Most cited summary on p.12.

in distributed networks of co-evolutionary influence. Both established and emerging actors can act strategically to try to shape the behaviours of others by deliberate engagement, interventions and communications while pursuing their instrumental interests (Smink et al., 2015). This can include niche innovators, who may seek to disrupt or destabilise an existing regime, as much as powerful incumbents (Schot & Geels, 2008).

In the reviewed literature, this perspective was typically applied to describe, characterise or explain strategic niche management, collectives, institutional influence, advocacy, and lobbying by firms and other meso-level actors in a context of sustainability transitions. For example, Mazur et al. (2013) emphasised the role of regulatory and consumer pressure to create an environment that forced German automotive manufacturers to innovate for sustainability in order to remain competitive, as well as disruption within a manufacturer (e.g., the appointment of a new CEO). de Lange et al. (2016) describe the circumstances under which corporations and non-governmental organisations' actions on environmental issues can move from adversarial to cooperative. Noonan et al. (2017) discuss the tension between espoused attitudes (support for sustainable public transport) and actual behaviours (continued use of private vehicles) among residents of Atlanta during a period in which a new public transport system was being built. A number of papers saw new methods of agent-based or network modelling as ways to explain and predict the non-linear and emergent behaviours of strategic actors in the system (Bale et al., 2015; Feola et al., 2015; Hansen et al., 2019; Otto et al., 2020).

4.2.4 Everyday behaviour

This perspective resists reducing analysis to the scale of individual behaviour, and instead conceptualises behaviour as clusters of actions (practices) that emerge from and are reinforced by relationships between individuals in context. While social practices theories are prominent, we see this perspective as potentially including other approaches with relatively 'bottom up' and 'flatter' ontologies, plus more relational and interpretivist approaches, for example including Domestication Theory and some Social Studies of Science and Technology perspectives (Sovacool and Hess, 2017; Zolfagharian et al., 2019). To expand on the more prominent social practices theory in particular: practices rely on the availability of physical affordances for the actions, relevant meanings associated with the actions, and competence (or skills and knowledge to perform the actions), with relational interaction between these elements over time and space, for example through the mediums of social relations, production and consumption, technologies and practices themselves (McMeekin and Southerton, 2012). Actors may be able to reflect on and change practices in individual and collective reflexive, transformative processes. It is not clear that external agents can effectively, nor legitimately, influence practice change, but equally, by trying to do so they also become entangled in the relevant practices and context – i.e. from this perspective, all actors are engaging with practices when they attempt to change behaviour, whether they are aware of it or not. There were 21 papers coded as 'everyday' behaviour focused in our synthesis, Shove (2010) being substantially the highest cited paper across all papers with 1221 citations.

The everyday behaviour perspective may appear to be incommensurate with other perspectives discussed in this paper. Indeed, we acknowledge Shove (2010, p. 1279) remarking, critically: "In recent writing on sustainability and climate change, words like 'behaviour' and 'practice' are often used interchangeably, or loosely as in attempts to interpret 'behaviour change' through a 'practice lens'". However, to the extent the perspective is prominent in transitions literature, and shares an interest in the same or similar phenomena of activity in ‘everyday life’, integrating it in our analysis is necessary to address the research questions of this paper.

Social practices may include the performance of observable actions, but typically do not treat actions as a unit of analysis, in contrast to some other perspectives discussed in this paper. While the other perspectives may frame as a behaviour (e.g., driving to work each day) influenced by psychological, environmental and systemic drivers (e.g., attitudes towards car travel, owning a car, routines for work travel, technologies, road congestion), social practice perspectives emphasise the interdependence of constantly reproduced capabilities, materials, and negotiated meanings of enacting that practice. The notion of instrumental intervention is less conceptually relevant and even problematic within this perspective, since social practices are maintained or changed through organic and emergent processes that perhaps can be steered and influenced, but not directed from ‘outside’. Indeed, the policy relevance of the other three perspectives is paradigmatically problematic – what is needed is not knowledge translation, but “changing dominant ways of thinking about human behaviour and lifestyle” (Shove, 2004, p. 13).

In our review, an example of an everyday behaviour perspective is the growth of a community movement for sustainable food purchasing in Italy (Fonte, 2013), describing the participation in the movement as “an integrative practice, with collective agency, the basic motivations and beliefs that make the reproduction of practice possible, interconnected with new socio-cultural understandings and norms, new physical activities and new material-functional structures” (pp. 237-238). Again, whereas other perspectives may isolate a specific “sustainable food purchasing behaviour” and identify drivers or barriers to community members enacting that behaviour, Fonte 2013 highlights how joining with others to purchase food directly from farmers, generating and reproducing their understanding of ethical and sustainable consumption, and even the intra-movement social dynamics (i.e., politics) are integral to understanding how and when people may simultaneously join and be recruited into in those practices.

This is not to preclude more systemic contributions to policy change, nor policy experimentation from this perspective – for example, a hypothetical policy maker can use it to broaden their analysis of social change to better understand problems and emerging patterns created by and sustained by the actions of policy makers themselves (Shove, 2014; Shove & Walker, 2010). Literature is emerging exploring the impact of practice theory based lifestyle interventions and experiments, for instance: deliberation in households (Grealis, 2019) and living labs in communities (Laakso et al., 2019; Sahakian et al., 2021; Sopjani et al., 2020), and collective consumption networks (Lopez et al., 2019; Pekkanen, 2021). By our reading, a valued contribution across these applications is a decentring of reflexive sensemaking for powerful actors (Latour, 2004; Lynch, 2000): i.e. helping emerging innovators and incumbent powerful actors alike to reframe their understanding of their contribution to the changing situation.

In closing this section, we note that the four perspectives all acknowledge the importance of everyday life in socio-technical systems and sustainability transitions. However, their varied focal interests and inherent blank and blinds spots also at times lead to conflict and criticism. Our labelling these as perspectives on ‘behaviour’ in transitions is not intended to frame any one as inherently more or less insightful, or more or less morally or paradigmatically preferred (Entman, 1993; Hall, 2013). We take the view that credible, peer-reviewed attention has been paid to all of them, and more importantly, all have demonstrated some contribution to transitions. The more interesting question to us is when and how are they most useful, particularly in attempting to understand, and accelerate, the process of sustainability transitions. This is the focus of the discussion section.

5. Discussion

Transitions are complex, multi-faceted and multi-actor processes. Our review identified four behavioural perspectives: reflective, automatic, strategic, and everyday. Each perspective draws on a particular configuration of disciplinary, ontological, epistemological and methodological underpinnings (Klein, 1996; Sovacool and Hess, 2017; Zolfagharian et al., 2019). Identifying and understanding where each perspective is most usefully applied, and how they relate to each other, is central to transforming the sustainability of everyday life. We believe this paper's initial mapping of their implicit and explicit domains of application, topic coverage and validity is a first in transitions literature.

A particular contribution of a behavioural focus is the opportunity to engage with relationships between individual's internal states, observable behavioural activity, and how both co-evolve with social, technical and physical contexts at different scales, including elements shaped by the behaviours of powerful actors themselves. As such, behaviour represents an interdisciplinary boundary object (Bammer, 2013; Hall, 2013; Star and Griesemer, 1989; Vayda, 1996), providing a point of interface between, for example, psychological concepts of attitudes and belief; sociological concepts of practices, agency and structure; cognitive sciences focus on un and pre conscious characterisations of behavioural influences, and broader natural science and technical analyses and disciplines (Sovacool and Hess, 2017; Zolfagharian et al., 2019).

Following from this analysis, we suggest scholars wishing to engage with human behaviour in transitions do so in a considered manner, drawing on and exploring different perspectives with attention to what interconnections between behaviour and context they highlight, and obscure.[14] This should be an explicitly interdisciplinary and complimentary exercise. Each of the four perspectives is the tip of an iceberg of scholarship and application. Rather than privileging a single perspective on behaviour in transitions, we argue it is important to apply a clear and coherent understanding of different perspectives on behaviour change: i.e. exploring the relevance of multiple perspectives in relation to the type of research question asked or the kind of impact desired. Achieving this would enable policymakers and researchers alike to draw on scholarship, analysis and tools from each perspective where it is most useful to understand and accelerate sustainable transitions, and also to understand their weaknesses and limitations, i.e. not just 'how' to change individuals behaviour, but also 'why', 'when' and whether we 'should' (Flyvbjerg and Sampson, 2011; Hampton and Adams, 2018; Lamb et al., 2020) – potentially updating mental models, and maybe beginning to change paradigms.

One important cross-cutting element is each perspective's identification of the contribution of individuals' behaviour and decisions to a variety of important and broader phenomena and processes. For example, Bögel & Upham (2018) observe in the socio-technical transitions literature, agency is analysed predominantly as social, collective and external to the individual, neglecting individual-level characteristics and processes. Three of the four perspectives we have identified at least implicitly acknowledge everyday life as a potential locus of reflexive deliberation and/or active mediation between agency and structure, particularly when disrupted (Archer, 2003, pp. 130–134; Kivimaa et al., 2021; Sovacool and Hess, 2017; Verplanken et al., 2018), and see Figure 2, p. 26. Similarly, insightful commentary from Huttenen et al. (2021), and Hall (2013) while not based on systematic review, supports our argument for pluralisation of perspectives on behaviour, and underlines our identification of everyday (practice), strategic (institutional) and reflective (social-

[14] After C. Wright Mills 'sociological imagination' (Mills, 1959)

psychological) perspectives in ST as important contributions. Conversely, ST literature only occasionally considers the internal states of the individuals and those internal states are even rarely connected to the collective, networked and institutional work that is required for system change (Bögel & Upham, 2018; Williams et al 2017). Exploring behaviour in context could link individual agency with socio-technical structures across micro, meso, and macro scales of change. Indeed, Upham et al. (2020) recently suggest a similar focus on concepts that bridge the individual and social to better advance the ST research agenda – in their example, organisational psychology and social movements.

Missing from the above contributions are biophysical influences on everyday life – most directly relevant to the automatic perspective - which we believe is easily neglected when behaviour and behaviour change are conceived of as largely reflective and socially aware ‘action’, performative ‘habitus’ or socially structured habits. A range of internal structures with probable evolutionary roots influence behaviour and broader processes. Acknowledging this valuably reconnects us to our co-evolution as one of many species on this planet (if unprecedently impactful) – and one that problematically (mal)adapts our behaviour to environments we also engineer (Boyden, 2016). Arguably, some internal structures been unconsidered or rolled up into other phenomena before scholarship in cognitive and behavioural sciences emerged in the last 50 years. In the anglo-sphere at least, such acknowledgements are a flash point for ‘culture wars’ and disjunctions between HASS and STEM fields (House of Lords, 2011; McGilchrist, 2009; Pinker, 2002). This is not to understate the frequently problematic and socially mediated nature of such ‘scientific’ understandings of evolutionary behaviour – they are contested for very good reasons (Flyvbjerg and Sampson, 2011; Latour, 2004).

All four behavioural perspectives can help answer research, governance, or practice questions, depending on “what needs to change, by who, how, where and when”. Equally, blind favouring of one perspective over another could also undermine or miss opportunities posed by others, for example when prioritising paradigmatic change neglects its emergent nature from more tractable socio-technical leverage points (including behaviour) (Fischer and Riechers, 2019; Newton, 2008); or ‘nudges’ crowd out support for more ambitious policy transformation (Hagmann et al., 2019; Shove, 2014); omission of individual motivations and agency leads to missed chances for change (Bögel & Upham, 2018); or oversimplifying emergent practices, institutions and structures misidentifies problems and the contribution of powerful actors (Lamb et al., 2020; Meder et al., 2018; Shove, 2010). Without an a-theoretical perspective on behaviour, ST research, policy and practice will miss chances for both interdisciplinary understanding and actionable insights.

Our review findings may help to explain where transitions literature appears to have become a little ‘stuck’ on everyday life and behaviour change, and how to resolve it. Individual, cognitive models of change such as the reflective and automatic perspectives are conflated with top down, neo-liberal policies that take an instrumental and narrow view of how to change behaviours in the context of particular policy aims, without taking note of complex institutional realities and everyday life (Geels, 2012; Hall, 2016; O’Rourke and Lollo, 2015; Shove, 2010), let alone broader biophysical and socio-technical processes framing these elements (including their manipulation by vested interests) . However, contemporary practices of behavioural public policy *can* be much more nuanced, and interdisciplinary. As we have outlined in this paper’s introduction: by necessity, it is embedded both in everyday life and strategic institutional realities.

Meanwhile, within the ST discourse, what we would call ‘everyday’ and ‘strategic’ perspectives have become prominent narratives on behaviour and are associated with a systemic view of what shapes behaviours and emphasising things “that go beyond a technical fix or behaviour change" (Geels, 2012) in transitions literature. This is to their detriment, in terms of better understanding the contributions and influence of individuals and their behaviour (Huttunen et al., 2021; Upham et al., 2020). Less obviously, we believe insufficient integration between the perspectives also robs the emerging policy discourse of behavioural public policy of important insights from ST.

As a thought experiment, consider if the insights of the four perspectives might be nested and related (see Figure 2, p. 26). For example, consider brown coal mining communities in Australia's Gippsland (Veldhuizen, 2020) or Germany's Lusatia (Staemmler, 2020) as they transition into new socio-technical regimes. Open ended, emergent and interpretive methods and frameworks such the 'Everyday' perspective may be useful as disruption becomes apparent, revealing challenges or opportunities as experienced in the community. Insights from this analysis may identify particular problems bridging micro and meso scales that need addressing, unintended consequences of policies, or grassroots innovations such as local networks turning technical skills to community needs or reskilling. But what is to be done about it?

To understand the origins and context of the situation, and who wins and loses from it, a different but complementary 'Strategic' approach might be useful, embedded in institutional analyses, innovation studies, political science or political economics. Insights from this approach could assist a local activist or politician to advocate effectively to win funding to deliver a re-skilling program for their community, or to motivate regulators to require the departing industry provide remediation and transition funding. Such efforts could benefit from understanding how behaviours are embedded, enabled or constrained by strategic political or corporate agendas and their preferred frames for everyday life. Reflective and Automatic perspectives could help understand the motivations, action and inaction of key players in context, as well as maximise the uptake of transitions services and support in larger populations - e.g., to enrol local workers and residents in career re-training. Or, mainstreaming 'easier' and contagious niche grassroots innovations using marketing and behaviour change approaches (Seyfang & Smith, 2007) such as boosting efforts to re-integrate alienated unemployed workers creating backyard brick art in Lusatia by celebrating them in a local capital's gallery (Staemmler, 2020).

Throughout this process, there are numerous opportunities where reflexive deliberation, linked to purposeful action, may support broader policy and systemic change (Axsen and Kurani, 2014, 2012; Baum and Gross, 2017; Shove, 2014). Simultaneously, as system shocks and efforts to drive change influence micro and meso level everyday experience, they may fuel innovation by disrupting unconsidered behaviours, habitual recruitment into practices and unreflective reproduction of social processes and structures (Kivimaa et al., 2021; Otto et al., 2020). Reframing stronger links between climate adaptation, mitigation and socio-technical change might build support for more interventionist policies in both coal regions and wider society (Ockwell et al., 2009), for example connecting local and global public health agendas (Maibach et al., 2021) or highlighting the risks of social conflict and extremism in neglecting such regions (Martin and Islar, 2021; Staemmler, 2020).

Our brief example illustrates how the lenses of the four perspectives could help the transition to new socio-technical futures (Figure 2). Like the phenomena they analyse, each perspective can be thought of as dynamically and hierarchically linked to the others. Anchored in the behaviour of key individuals and groups, this suggests different perspectives can usefully come to the fore, combine, and/or recede in efforts to understand and/or accelerate transitions as we apply the lens progressively to different challenges within the broader transition.

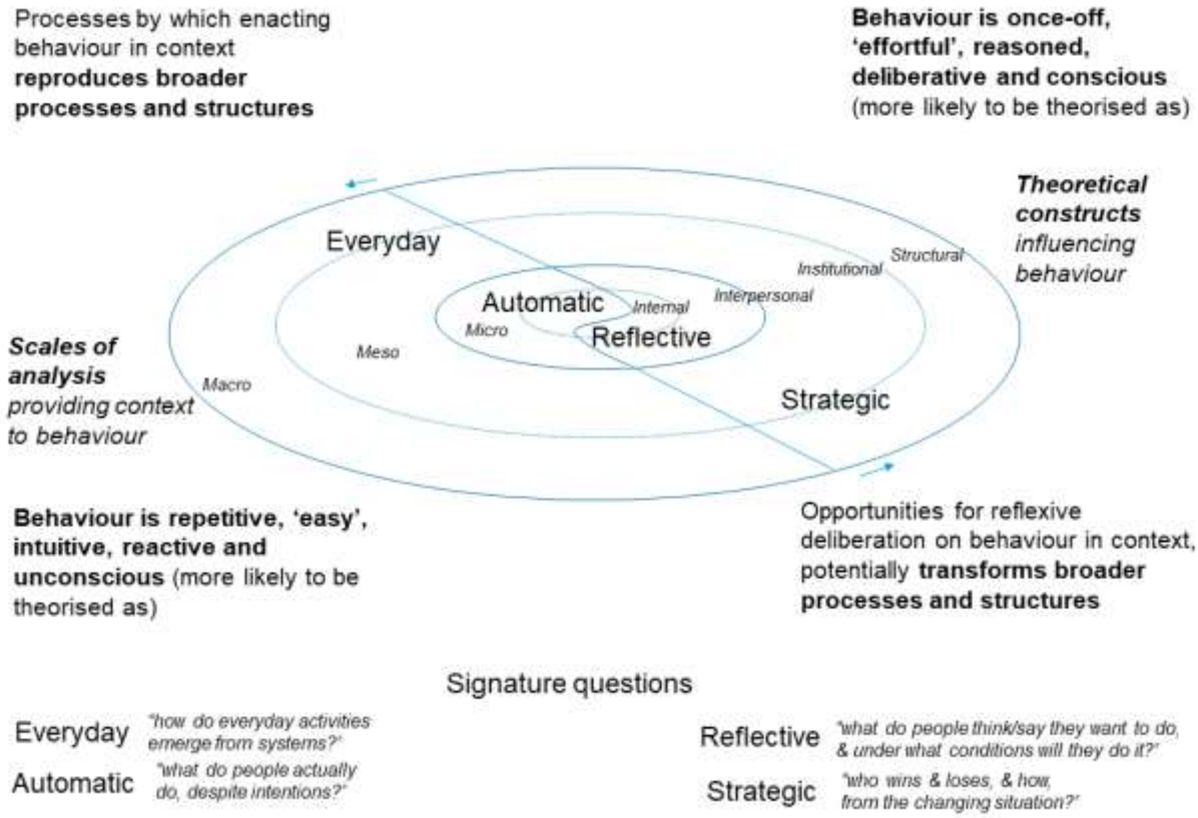

Figure 2: Initial sketch of a complimentary and dynamic model of behaviour in context, suggesting complementarities between the four perspectives.

A critical next step for a behaviour in transitions research agenda is to explore when, where and how each behavioural perspective is appropriate and useful to analyse or govern sustainability transitions, considering the diverse time-horizons and degrees of socio-technical change (Newton, 2008; Newton and Meyer, 2012). We encourage future research exploring more systematically how, when, where and why each perspective may offer most benefit in various phases, scales or contexts of sustainability transitions.

Similarly, future research could include a systemic review of contemporary behavioural public policy challenges indicated but not limited to those raised in section 2, from a ST perspective. Public policy constantly works with socio-technical transitions challenges, even if not by that name. ST scholarship and practice can help behavioural public policy researchers and practitioners better link multiple levels of change and innovation. In particular, a broader, multi-level analysis of dynamics, structures and processes relevant to behaviour change beyond those examined at the individual and social group scale, and how innovations translate across scales, would be valuable. Similarly, better integration of the 'technical' change insights of socio-technical systems, and broader biophysical dynamics and processes encompassing all of them, would also be helpful. As before, sustainability is not a central theme in mainstream behavioural insights teams, but it needs to be.

Working research and practice examples of how to constructively relate the disparate disciplinary and subject matter foci of the four perspectives – avoiding both superficial integration, and critical deadlock are also much needed. We suggest a focus on 'place based' and 'problem focused' boundary work, attempting to change behaviour in context, presents such opportunities (Bögel et al., 2019; Hisschemöller and Sioziou, 2013; Klein, 1996). A range of grey literature frameworks could prompt such consideration and could be further theorised, validated and critiqued into ST (Akenji and Huizhen, 2016; Darnton et al., 2013b, 2013a; McManus et al., 2018). Further expicating contributions from perspectives interested in everyday life and implicitly, the phenomena of behaviour, but which won't use the term would be difficult, but valuable.

To the extent that that elments of the four perspectives are also reflected in ST modelling efforts (Halbe and Pahl-Wostl, 2019; Köhler et al., 2009; Otto et al., 2020), system modellers outside of ST have reflected that building and manipulating models can transform mental models and paradigmatic perspectives (Meadows, 1999; Meadows and Wright, 2008, p. 164), however evidence for this as promising intervention is not clear (Angheloiu and Tennant, 2020; Fischer and Riechers, 2019). Most likely, this is another important arena of knowledge translation, presenting both opportunities, and challenges (Sibony, 2020). Robust evaluation of integrating behavioural perspectives into applied ST modelling for policy, in terms of what mental models they disrupt, or reinforce for participants, and how they translate into implementation, would be valuable.

The following limitations in our study should be considered. As previously raised, we note that our research question and resulting review strategy probably under-represents papers that implicitly discuss behaviour in everyday life, or resisted using the term. This noted, our goal was to explore the implications of representations of behaviour in ST in light of the emergence of behavioural public policy. We are satisfied that perspectives that were explicitly critical of the term are at least included. Similarly, as ST is an emerging and open-edged field, it is possible that our review has missed important publications where transitions scholars may have engaged with behaviour change perspectives in other disciplinary publications, and so for example may not have cited one of the defined 20 seminal papers. Finally, we acknowledge that the four perspectives identified are by no means entirely discrete or exhaustive, nor do we believe that our labels and brief descriptions in this paper adequately describe them in full. We present them as propositional ideas to facilitate further discussion and refinement, and hope they serve the development of a more satisfactory, flexible and complementary perspective on behaviour change in transitions.

6. Conclusion

This paper asked the questions "What are the main perspectives on human behaviour in the sustainability transitions literature?" and "What the research and policy implications are that follow from this analysis given the emergence of behavioural public policy?".

- We argue that progressively exploring behaviour in context, especially in everyday life, is an important lens for both understanding 'of' and action 'for' sustainability transitions. We also argue that the ST agenda could both learn from, and contribute to, the 'behavioural public policy' revolution occurring across world governments.
- Our research has identified four perspectives on behaviour present in transitions literature, which we labelled reflective, automatic, strategic and everyday behaviour. Each behavioural perspective rests in an identifiable combination of concepts, causal assumptions, methods and disciplinary foundations. Our analysis suggests that, while all four perspectives are present and relevant, the 'everyday' and 'strategic' perspectives are the most prominent in ST.
- We argue that future research in the transitions community could be more relaxed about particular perspectives and, instead, embrace a more pluralistic and ultimately, complimentary approach, as indeed the broader behavioural public policy discourse is striving to do also.

- The key implication that should drive future research in this area, through empirical and conceptual development, is to explore when and where each of these perspectives are most helpful in understanding behaviour change in socio-technical transitions.

Finally, a more pluralistic approach to behaviour change in sustainability transitions generates opportunities for the transitions community to better connect the community's valuable systemic approach to transitions with the approaches applied by contemporary behavioural policy units globally. We hope and expect that such an exchange would improve research, policy and practice in behavioural public policy also, while accelerating critically important sustainability transitions themselves.

References

Afif, Z., Islan, W.W., Calvo-Gonzalez, O., Dalton, A.G., 2019. Behavioral Science Around the World: Profiles of 10 Countries (an eMBeD brief). World Bank Group, Washington, D.C.

Akenji, L., 2014. Consumer scapegoatism and limits to green consumerism. Journal of Cleaner Production 63, 13–23. https://doi.org/10.1016/j.jclepro.2013.05.022

Akenji, L., Huizhen, C., 2016. A framework for sustainable lifestyles: Determinants and strategies (No. DTI/1717/PA). United Nations Environment Programme.

Althaus, C., Bridgman, P., Davis, G., 2018. The Australian policy handbook: a practical guide to the policy-making process, 6th edition. ed. Allen & Unwin, Sydney Melbourne Auckland London.

Alvesson, M., Sandberg, J., 2011. Generating research questions through problematization. Academy of management review. Academy of Management 36, 247–271.

Ameli, N., Drummond, P., Bisaro, A., Grubb, M., Chenet, H., 2020. Climate finance and disclosure for institutional investors: why transparency is not enough. Climatic Change 160, 565–589. https://doi.org/10.1007/s10584-019-02542-2

Angheloiu, C., Tennant, M., 2020. Urban futures: Systemic or system changing interventions? A literature review using Meadows' leverage points as analytical framework. Cities 104, 102808. https://doi.org/10.1016/j.cities.2020.102808

Archer, M.S., 2003. Structure, Agency and the Internal Conversation, 1st ed. Cambridge University Press. https://doi.org/10.1017/CBO9781139087315

Ariely, D., 2008. Predictably irrational: the hidden forces that shape our decisions, 1st ed. ed. Harper, New York, NY.

Arksey, H., O'Malley, L., 2005. Scoping studies: towards a methodological framework. International Journal of Social Research Methodology 8, 19–32. https://doi.org/10.1080/1364557032000119616

Avelino, F., 2017. Power in Sustainability Transitions: Analysing power and (dis)empowerment in transformative change towards sustainability. Environmental Policy and Governance 27, 505–520. https://doi.org/10.1002/eet.1777

Axsen, J., Kurani, K.S., 2014. Social Influence and Proenvironmental Behavior: The Reflexive Layers of Influence Framework. Environ Plann B Plann Des 41, 847–862. https://doi.org/10.1068/b38101

Axsen, J., Kurani, K.S., 2012. Social Influence, Consumer Behavior, and Low-Carbon Energy Transitions. Annu. Rev. Environ. Resour. 37, 311–340. https://doi.org/10.1146/annurev-environ-062111-145049

Bale, C.S.E., Varga, L., Foxon, T.J., 2015. Energy and complexity: New ways forward. Applied Energy 138, 150–159. https://doi.org/10.1016/j.apenergy.2014.10.057

Bammer, G., 2013. Disciplining Interdisciplinarity. ANU Press. https://doi.org/10.22459/DI.01.2013

Baum, C.M., Gross, C., 2017. Sustainability policy as if people mattered: developing a framework for environmentally significant behavioral change. J Bioecon 19, 53–95. https://doi.org/10.1007/s10818-016-9238-3

Bell, R., Khan, M., Romeo-Velilla, M., Stegeman, I., Godfrey, A., Taylor, T., Morris, G., Staatsen, B., van der Vliet, N., Kruize, H., Anthun, K.S., Lillefjell, M., Espnes, G.A., Chiabai, A., García de Jalón, S., Quiroga, S., Martinez-Juarez, P., Máca, V., Zvěřinová, I., Ščasný, M., Marques, S., Craveiro, D., Westerink, J., Spelt, H., Karnaki, P., Strube, R., Merritt, A.-S., Friberg, M., Bélorgey, N., Vos, M., Gjorgjev, D., Upelniece, I., Costongs, C., 2019. Ten Lessons for Good Practice for the INHERIT Triple Win: Health, Equity, and Environmental Sustainability. International Journal of Environmental Research and Public Health 16, 4546. https://doi.org/10.3390/ijerph16224546

Bögel, P., Pereverza, K., Upham, P., Kordas, O., 2019. Linking socio-technical transition studies and organisational change management: Steps towards an integrative, multi-

scale heuristic. Journal of Cleaner Production 232, 359–368. https://doi.org/10.1016/j.jclepro.2019.05.286
Bögel, P., Upham, P., 2018. Role of psychology in sociotechnical transitions studies: Review in relation to consumption and technology acceptance. Environmental Innovation and Societal Transitions 28, 122–136. https://doi.org/10.1016/j.eist.2018.01.002
Bohnsack, R., Pinkse, J., Kolk, A., 2014. Business models for sustainable technologies: Exploring business model evolution in the case of electric vehicles. Research Policy 43, 284–300. https://doi.org/10.1016/j.respol.2013.10.014
Boyden, S., 2016. The Bionarrative, 1st ed. ANU Press. https://doi.org/10.22459/B.08.2016
Briguglio, M., 2016. Household Cooperation in Waste Management: Initial Conditions and Intervention. Journal of Economic Surveys 30, 497–525. https://doi.org/10.1111/joes.12156
Bronfenbrenner, U. (Ed.), 2005. Making human beings human: bioecological perspectives on human development, The Sage program on applied developmental science. Sage Publications, Thousand Oaks.
Bulkeley, H., Gregson, N., 2009. Crossing the threshold: Municipal waste policy and household waste generation. Environment and Planning A 41, 929–945. https://doi.org/10.1068/a40261
Burke, M.J., Stephens, J.C., 2018. Political power and renewable energy futures: A critical review. Energy Research & Social Science, Energy and the Future 35, 78–93. https://doi.org/10.1016/j.erss.2017.10.018
BWA, 2019. The BehaviourWorks Method: A tried and tested approach to behaviour change. BehaviourWorks Australia, Monash Sustainable Development Institute, Monash University, Melbourne, Australia.
Cairney, P., 2016. The Politics of Evidence-Based Policy Making. Palgrave Macmillan UK, London.
Coenen, L., Benneworth, P., Truffer, B., 2012. Toward a spatial perspective on sustainability transitions. Research Policy 41, 968–979. https://doi.org/10.1016/j.respol.2012.02.014
ComSecc, 2020. Australian houses are again the world's biggest: Home Size Trends Report (Economic Insights). Commonwealth Securities Limited (CommSec).
Cornell, S., Berkhout, F., Tuinstra, W., Tàbara, J.D., Jäger, J., Chabay, I., de Wit, B., Langlais, R., Mills, D., Moll, P., Otto, I.M., Petersen, A., Pohl, C., van Kerkhoff, L., 2013. Opening up knowledge systems for better responses to global environmental change. Environmental Science & Policy, Special Issue: Responding to the Challenges of our Unstable Earth (RESCUE) 28, 60–70. https://doi.org/10.1016/j.envsci.2012.11.008
Creutzig, F., Roy, J., Lamb, W.F., Azevedo, I.M.L., Bruin, W.B. de, Dalkmann, H., Edelenbosch, O.Y., Geels, F.W., Grubler, A., Hepburn, C., Hertwich, E.G., Khosla, R., Mattauch, L., Minx, J.C., Ramakrishnan, A., Rao, N.D., Steinberger, J.K., Tavoni, M., Ürge-Vorsatz, D., Weber, E.U., 2018. Towards demand-side solutions for mitigating climate change. Nature Climate Change 8, 260–263. https://doi.org/10.1038/s41558-018-0121-1
Damschroder, L.J., Aron, D.C., Keith, R.E., Kirsh, S.R., Alexander, J.A., Lowery, J.C., 2009. Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science. Implementation Sci 4, 50. https://doi.org/10.1186/1748-5908-4-50
Darnton, A., Evans, D., Scotland, Scottish Government, 2013a. Influencing behaviours: a technical guide to the ISM tool. Scottish Government, Edinburgh.
Darnton, A., Horne, J., Scotland, Scottish Government, 2013b. Influencing behaviours: moving beyond the individual : a user guide to the ISM tool.
de Lange, D.E., Armanios, D., Delgado-Ceballos, J., Sandhu, S., 2016. From Foe to Friend: Complex Mutual Adaptation of Multinational Corporations and Nongovernmental Organizations. Business & Society 55, 1197–1228. https://doi.org/10.1177/0007650314568537

Dixon-Woods, M., Cavers, D., Agarwal, S., Annandale, E., Arthur, A., Harvey, J., Hsu, R., Katbamna, S., Olsen, R., Smith, L., Riley, R., Sutton, A.J., 2006. Conducting a critical interpretive synthesis of the literature on access to healthcare by vulnerable groups. BMC Medical Research Methodology 6, 35. https://doi.org/10.1186/1471-2288-6-35
Dobbins, M., 2017. Rapid Review Guidebook | National Collaborating Centre for Methods and Tools. National Collaborating Centre for Methods and Tools, Hamilton, Ontario, Canada.
Dubois, G., Sovacool, B., Aall, C., Nilsson, M., Barbier, C., Herrmann, A., Bruyère, S., Andersson, C., Skold, B., Nadaud, F., Dorner, F., Moberg, K.R., Ceron, J.P., Fischer, H., Amelung, D., Baltruszewicz, M., Fischer, J., Benevise, F., Louis, V.R., Sauerborn, R., 2019. It starts at home? Climate policies targeting household consumption and behavioral decisions are key to low-carbon futures. Energy Research & Social Science 52, 144–158. https://doi.org/10.1016/j.erss.2019.02.001
Elf, P., Gatersleben, B., Christie, I., 2019. Facilitating Positive Spillover Effects: New Insights From a Mixed-Methods Approach Exploring Factors Enabling People to Live More Sustainable Lifestyles. Front. Psychol. 9. https://doi.org/10.3389/fpsyg.2018.02699
Entman, R.M., 1993. Framing: Toward Clarification of a Fractured Paradigm. Journal of Communication 43, 51–58. https://doi.org/10.1111/j.1460-2466.1993.tb01304.x
Ewert, B., 2020. Moving beyond the obsession with nudging individual behaviour: Towards a broader understanding of Behavioural Public Policy. Public Policy and Administration 35, 337–360. https://doi.org/10.1177/0952076719889090
Faulkner, N., Kaufman, S., 2018. Avoiding Theoretical Stagnation: A Systematic Review and Framework for Measuring Public Value. Australian Journal of Public Administration 77, 69–86. https://doi.org/10.1111/1467-8500.12251
Feitsma, J., 2019. Brokering behaviour change: the work of behavioural insights experts in government. policy polit 47, 37–56. https://doi.org/10.1332/030557318X15174915040678
Feitsma, J., 2018. The behavioural state: critical observations on technocracy and psychocracy. Policy Sci 51, 387–410. https://doi.org/10.1007/s11077-018-9325-5
Feola, G., Binder, C.R., 2010. Towards an improved understanding of farmers' behaviour: The integrative agent-centred (IAC) framework. Ecological Economics 69, 2323–2333. https://doi.org/10.1016/j.ecolecon.2010.07.023
Feola, G., Lerner, A.M., Jain, M., Montefrio, M.J.F., Nicholas, K.A., 2015. Researching farmer behaviour in climate change adaptation and sustainable agriculture: Lessons learned from five case studies. Journal of Rural Studies 39, 74–84. https://doi.org/10.1016/j.jrurstud.2015.03.009
Fischer, J., Riechers, M., 2019. A leverage points perspective on sustainability. People and Nature 1, 115–120. https://doi.org/10.1002/pan3.13
Flyvbjerg, B., Sampson, S., 2011. Making social science matter: why social inquiry fails and how it can succeed again, 13. printing. ed. Cambridge Univ. Press, Cambridge.
Fonte, M., 2013. Food consumption as social practice: Solidarity Purchasing Groups in Rome, Italy. Journal of Rural Studies 32, 230–239. https://doi.org/10.1016/j.jrurstud.2013.07.003
French, J., Gordon, R., 2015. Strategic social marketing. SAGE Publications Ltd, London.
Frezza, M., Whitmarsh, L., Schäfer, M., Schrader, U., 2019. Spillover effects of sustainable consumption: combining identity process theory and theories of practice. Sustainability: Science, Practice, and Policy 15, 15–30. https://doi.org/10.1080/15487733.2019.1567215
Gazheli, A., Antal, M., van den Bergh, J., 2015. The behavioral basis of policies fostering long-run transitions: Stakeholders, limited rationality and social context. Futures 69, 14–30. https://doi.org/10.1016/j.futures.2015.03.008
Gazheli, A., van den Bergh, J., Antal, M., 2011. Behavioral Foundations of Sustainability Transitions (Working paper No. 3), Work Package 203 MS31 "Literature review on behavioural perspectives on transitions". Socio-economic Sciences and Humanities

Europe moving towards a new path of economic growth and social development - Collaborative project. Welfare, Wealth and Work for Europe.
Geels, F.W., 2012. A socio-technical analysis of low-carbon transitions: introducing the multi-level perspective into transport studies. Journal of Transport Geography, Special Section on Theoretical Perspectives on Climate Change Mitigation in Transport 24, 471–482. https://doi.org/10.1016/j.jtrangeo.2012.01.021
Geels, F.W., 2005. Co-evolution of technology and society: The transition in water supply and personal hygiene in the Netherlands (1850–1930)—a case study in multi-level perspective. Technology in Society 27, 363–397. https://doi.org/10.1016/j.techsoc.2005.04.008
Geels, F.W., 2002. Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. Research Policy, NELSON + WINTER + 20 31, 1257–1274. https://doi.org/10.1016/S0048-7333(02)00062-8
Geels, F.W., Schwanen, T., Sorrell, S., Jenkins, K., Sovacool, B.K., 2018. Reducing energy demand through low carbon innovation: A sociotechnical transitions perspective and thirteen research debates. Energy Research & Social Science 40, 23–35. https://doi.org/10.1016/j.erss.2017.11.003
Giest, S., Mukherjee, I., 2018. Behavioral instruments in renewable energy and the role of big data: A policy perspective. Energy Policy 123, 360–366. https://doi.org/10.1016/j.enpol.2018.09.006
Girod, B., van Vuuren, D.P., Hertwich, E.G., 2014. Climate policy through changing consumption choices: Options and obstacles for reducing greenhouse gas emissions. Global Environmental Change 25, 5–15. https://doi.org/10.1016/j.gloenvcha.2014.01.004
Gneezy, U., Meier, S., Rey-Biel, P., 2011. When and Why Incentives (Don't) Work to Modify Behavior. Journal of Economic Perspectives 25, 191–210. https://doi.org/10.1257/jep.25.4.191
Gossen, M., Ziesemer, F., Schrader, U., 2019. Why and How Commercial Marketing Should Promote Sufficient Consumption: A Systematic Literature Review. Journal of Macromarketing 39, 252–269. https://doi.org/10.1177/0276146719866238
Grant, M.J., Booth, A., 2009. A typology of reviews: an analysis of 14 review types and associated methodologies. Health Information & Libraries Journal 26, 91–108. https://doi.org/10.1111/j.1471-1842.2009.00848.x
Grealis, E., 2019. Temperature Rising: Capturing the long-term effects of a living lab initiative to change domestic heating practices, in: Segalàs, J., Lazzarini, B. (Eds.), Circular Europe for Sustainability: Design, Production and Consumption, Proceedings of the 19th European Roundtable for Sustainable Consumption and Production. Barcelona, Spain, p. 262.
Groening, C., Sarkis, J., Zhu, Q., 2018. Green marketing consumer-level theory review: A compendium of applied theories and further research directions. Journal of Cleaner Production 172, 1848–1866. https://doi.org/10.1016/j.jclepro.2017.12.002
Hagmann, D., Ho, E.H., Loewenstein, G., 2019. Nudging out support for a carbon tax. Nature Climate Change 9, 484–489. https://doi.org/10.1038/s41558-019-0474-0
Halbe, J., Pahl-Wostl, C., 2019. A Methodological Framework to Initiate and Design Transition Governance Processes. Sustainability 11, 844. https://doi.org/10.3390/su11030844
Hall, C., 2013. Framing behavioural approaches to understanding and governing sustainable tourism consumption: beyond neoliberalism, "nudging" and "green growth"? Journal of Sustainable Tourism 21, 1091–1109. https://doi.org/10.1080/09669582.2013.815764
Hall, M.C., 2016. Intervening in academic interventions: framing social marketing's potential for successful sustainable tourism behavioural change. Journal of Sustainable Tourism 24, 350–375. https://doi.org/10.1080/09669582.2015.1088861

Hampton, S., Adams, R., 2018. Behavioural economics vs social practice theory: Perspectives from inside the United Kingdom government. Energy Research & Social Science 46, 214–224. https://doi.org/10.1016/j.erss.2018.07.023
Han, H., Wu, S., 2019. Determinants of the Behavioral Lock-in of Rural Residents' Direct Biomass Energy Consumption in China. Sustainability 11, 469. https://doi.org/10.3390/su11020469
Hansen, P., Liu, X., Morrison, G.M., 2019. Agent-based modelling and socio-technical energy transitions: A systematic literature review. Energy Research & Social Science 49, 41–52. https://doi.org/10.1016/j.erss.2018.10.021
Hargreaves, T., Longhurst, N., Seyfang, G., 2013. Up, Down, round and round: Connecting Regimes and Practices in Innovation for Sustainability. Environ Plan A 45, 402–420. https://doi.org/10.1068/a45124
Head, B., Ferguson, M., Cherney, A., Boreham, P., 2014. Are policy-makers interested in social research? Exploring the sources and uses of valued information among public servants in Australia. Policy and Society 33, 89–101. https://doi.org/10.1016/j.polsoc.2014.04.004
Head, B.W., 2016. Toward More "Evidence-Informed" Policy Making? Public Administration Review 76, 472–484. https://doi.org/10.1111/puar.12475
Head, B.W., 2008. Three Lenses of Evidence-Based Policy. Australian Journal of Public Administration 67, 1–11. https://doi.org/10.1111/j.1467-8500.2007.00564.x
Hekkert, M.P., Suurs, R.A.A., Negro, S.O., Kuhlmann, S., Smits, R.E.H.M., 2007. Functions of innovation systems: A new approach for analysing technological change. Technological Forecasting and Social Change 74, 413–432. https://doi.org/10.1016/j.techfore.2006.03.002
Hertwig, R., Grüne-Yanoff, T., 2017. Nudging and Boosting: Steering or Empowering Good Decisions. Perspect Psychol Sci 12, 973–986. https://doi.org/10.1177/1745691617702496
Hisschemöller, M., Sioziou, I., 2013. Boundary organisations for resource mobilisation: enhancing citizens' involvement in the Dutch energy transition. Environmental Politics 22, 792–810. https://doi.org/10.1080/09644016.2013.775724
Hoggan, J., 2019. I'm right and you're an idiot: the toxic state of public discourse and how to clean it up. New Society Publishers, S.l., United States.
House of Lords, 2011. Behaviour Change (HL Paper No. 179). House of Lords - Science and Technology Committee, London, United Kingdom.
Howlett, M., 2017. Matching policy tools and their targets: beyond nudges and utility maximisation in policy design. Policy & Politics. https://doi.org/10.1332/030557317X15053060139376
Hussain, S.A., Ul Haq, M.A., Soomro, Y.A., 2020. Factors influencing consumer's green purchasing behaviour: green advertising as as moderator. Marketing and Management of Innovations 144–153. https://doi.org/10.21272/mmi.2020.4-11
Huttunen, S., Kaljonen, M., Lonkila, A., Rantala, S., Rekola, A., Paloniemi, R., 2021. Pluralising agency to understand behaviour change in sustainability transitions. Energy Research & Social Science 76, 102067. https://doi.org/10.1016/j.erss.2021.102067
Jurgilevich, A., Birge, T., Kentala-Lehtonen, J., Korhonen-Kurki, K., Pietikäinen, J., Saikku, L., Schösler, H., 2016. Transition towards Circular Economy in the Food System. Sustainability 8, 69. https://doi.org/10.3390/su8010069
Kahneman, D., 2012. Thinking, fast and slow. Penguin Books, London.
Khangura, S., Konnyu, K., Cushman, R., Grimshaw, J., Moher, D., 2012. Evidence summaries: the evolution of a rapid review approach. Systematic Reviews 1. https://doi.org/10.1186/2046-4053-1-10
Kivimaa, P., Laakso, S., Lonkila, A., Kaljonen, M., 2021. Moving beyond disruptive innovation: A review of disruption in sustainability transitions. Environmental Innovation and Societal Transitions 38, 110–126. https://doi.org/10.1016/j.eist.2020.12.001

Klein, J.T., 1996. Crossing Boundaries: Knowledge, Disciplinarities, and Interdisciplinarities. University of Virginia Press.
Kneebone, S., Smith, L., Fielding, K., 2017. The Impact-Likelihood Matrix: A policy tool for behaviour prioritisation. Environmental Science & Policy 70, 9–20. https://doi.org/10.1016/j.envsci.2016.11.013
Köhler, J., Geels, F.W., Kern, F., Markard, J., Onsongo, E., Wieczorek, A., Alkemade, F., Avelino, F., Bergek, A., Boons, F., Fünfschilling, L., Hess, D., Holtz, G., Hyysalo, S., Jenkins, K., Kivimaa, P., Martiskainen, M., McMeekin, A., Mühlemeier, M.S., Nykvist, B., Pel, B., Raven, R., Rohracher, H., Sandén, B., Schot, J., Sovacool, B., Turnheim, B., Welch, D., Wells, P., 2019. An agenda for sustainability transitions research: State of the art and future directions. Environmental Innovation and Societal Transitions 31, 1–32. https://doi.org/10.1016/j.eist.2019.01.004
Köhler, J., Turnheim, B., Hodson, M., 2020. Low carbon transitions pathways in mobility: Applying the MLP in a combined case study and simulation bridging analysis of passenger transport in the Netherlands. Technological Forecasting and Social Change 151, 119314. https://doi.org/10.1016/j.techfore.2018.06.003
Köhler, J., Whitmarsh, L., Nykvist, B., Schilperoord, M., Bergman, N., Haxeltine, A., 2009. A transitions model for sustainable mobility. Ecological Economics 68, 2985–2995. https://doi.org/10.1016/j.ecolecon.2009.06.027
Laakso, S., Heiskanen, E., Matschoss, K., Eeva-Lotta, A., Frances, F., 2019. The role of practice-based living labs in redesigning socio-technical systems toward sustainability, in: Segalàs, J., Lazzarini, B. (Eds.), Circular Europe for Sustainability: Design, Production and Consumption, PROCEEDINGS of the 19th European Roundtable for Sustainable Consumption and Production. Barcelona, Spain, pp. 94–109.
Lamb, W.F., Mattioli, G., Levi, S., Roberts, J.T., Capstick, S., Creutzig, F., Minx, J.C., Müller-Hansen, F., Culhane, T., Steinberger, J.K., 2020. Discourses of climate delay. Global Sustainability 3. https://doi.org/10.1017/sus.2020.13
Latour, B., 2004. Politics of nature: how to bring the sciences into democracy. Harvard University Press, Cambridge, Mass.
Little, V.J., Lee, C.K.C., Nair, S., 2019. Macro-demarketing: The Key to Unlocking Unsustainable Production and Consumption Systems? Journal of Macromarketing 39, 166–187. https://doi.org/10.1177/0276146718823885
Lopez, V., Teufel, J., Gensch, C.-O., 2019. How a Transformation towards Sustainable Community Catering Can Succeed. Sustainability 12, 101. https://doi.org/10.3390/su12010101
Lynch, M., 2000. Against Reflexivity as an Academic Virtue and Source of Privileged Knowledge. Theory, Culture & Society 17, 26–54. https://doi.org/10.1177/02632760022051202
MacKay, K., Quigley, M., 2018. Exacerbating Inequalities? Health Policy and the Behavioural Sciences. Health Care Anal 26, 380–397. https://doi.org/10.1007/s10728-018-0357-y
Maibach, E., Miller, J., Armstrong, F., El Omrani, O., Zhang, Y., Philpott, N., Atkinson, S., Rudoph, L., Karliner, J., Wang, J., Petrin-Desrosiers, C., Stauffer, A., Jensen, G., 2021. Health professionals, the Paris agreement, and the fierce urgency of now. The Journal of Climate Change and Health 1, 100002. https://doi.org/10.1016/j.joclim.2020.100002
Maki, A., Carrico, A.R., Raimi, K.T., Truelove, H.B., Araujo, B., Yeung, K.L., 2019. Meta-analysis of pro-environmental behaviour spillover. Nature Sustainability 2, 307–315. https://doi.org/10.1038/s41893-019-0263-9
Maréchal, K., 2010a. Not irrational but habitual: The importance of “behavioural lock-in” in energy consumption. Ecological Economics 69, 1104–1114. https://doi.org/10.1016/j.ecolecon.2009.12.004

Maréchal, K., 2010b. Not irrational but habitual: The importance of "behavioural lock-in" in energy consumption. Ecological Economics 69, 1104–1114. https://doi.org/10.1016/j.ecolecon.2009.12.004
Maréchal, K., 2009. An Evolutionary Perspective on the Economics of Energy Consumption: The Crucial Role of Habits. Journal of Economic Issues 43, 69–88. https://doi.org/10.2753/JEI0021-3624430104
Maréchal, K., Holzemer, L., 2015. Getting a (sustainable) grip on energy consumption: The importance of household dynamics and 'habitual practices.' Energy Research & Social Science 10, 228–239. https://doi.org/10.1016/j.erss.2015.06.013
Markard, J., Geels, F.W., Raven, R., 2020. Challenges in the acceleration of sustainability transitions. Environ. Res. Lett. https://doi.org/10.1088/1748-9326/ab9468
Markard, J., Raven, R., Truffer, B., 2012. Sustainability transitions: An emerging field of research and its prospects. Research Policy, Special Section on Sustainability Transitions 41, 955–967. https://doi.org/10.1016/j.respol.2012.02.013
Martin, M., Islar, M., 2021. The 'end of the world' vs. the 'end of the month': understanding social resistance to sustainability transition agendas, a lesson from the Yellow Vests in France. Sustain Sci 16, 601–614. https://doi.org/10.1007/s11625-020-00877-9
Mazur, C., Contestabile, M., Offer, G.J., Brandon, N.P., 2013. Understanding the automotive industry: German OEM behaviour during the last 20 years and its implications, in: 2013 World Electric Vehicle Symposium and Exhibition (EVS27). Presented at the 2013 World Electric Vehicle Symposium and Exhibition (EVS27), IEEE, Barcelona, Spain, pp. 1–14. https://doi.org/10.1109/EVS.2013.6914996
McGilchrist, I., 2009. The Master and His Emissary: The Divided Brain and the Making of the Western World. Yale University Press.
McIntosh, C. (Ed.), 2013. Cambridge advanced learner's dictionary, Fourth edition. ed. Cambridge University Press, Cambridge.
McKenzie Mohr, D., Smith, W., 2008. Fostering sustainable behavior: an introduction to community-based social marketing, Education for sustainability. New Society Publishers, Gabriola Island.
McManus, J., Constable, M., Bunten, A., Chadborne, T., 2018. Improving people's health: applying behavioural and social sciences (No. 2018478). Public Health England.
McMeekin, A., Southerton, D., 2012. Sustainability transitions and final consumption: practices and socio-technical systems. Technology Analysis & Strategic Management 24, 345–361. https://doi.org/10.1080/09537325.2012.663960
Meadows, D., 1999. Leverage Points: Places to Intervene in a System. The Academy for Systems Change. URL http://donellameadows.org/archives/leverage-points-places-to-intervene-in-a-system/ (accessed 7.13.18).
Meadows, D.H., Wright, D., 2008. Thinking in systems: a primer. Chelsea Green Pub, White River Junction, Vt.
Meder, B., Fleischhut, N., Osman, M., 2018. Beyond the confines of choice architecture: A critical analysis. Journal of Economic Psychology 68, 36–44. https://doi.org/10.1016/j.joep.2018.08.004
Meis-Harris, D.J., Klemm, Dr.C., Kaufman, D.S., Curtis, D.J., Borg, Ms.K., Bragge, D.P., 2021. What is the role of eco-labels for a circular economy? A rapid review of the literature. Journal of Cleaner Production 127134. https://doi.org/10.1016/j.jclepro.2021.127134
Michie, S., Atkins, L., West, R., 2014. The behaviour change wheel: a guide to designing interventions. Silverback publishing, London.
Michie, S., van Stralen, M.M., West, R., 2011. The behaviour change wheel: A new method for characterising and designing behaviour change interventions. Implementation Science 6. https://doi.org/10.1186/1748-5908-6-42
Mills, C.W., 1959. The sociological imagination. Oxford University Press, Oxford [England] New York.
Moloney, S., Horne, R.E., Fien, J., 2010. Transitioning to low carbon communities—from behaviour change to systemic change: Lessons from Australia. Energy Policy,

Special Section: Carbon Reduction at Community Scale 38, 7614–7623. https://doi.org/10.1016/j.enpol.2009.06.058
Nash, N., Whitmarsh, L., Capstick, S., Hargreaves, T., Poortinga, W., Thomas, G., Sautkina, E., Xenias, D., 2017. Climate-relevant behavioral spillover and the potential contribution of social practice theory. Wiley Interdisciplinary Reviews: Climate Change 8, e481. https://doi.org/10.1002/wcc.481
Németh, A., 2019. Innovative behaviour aspects within the circular economy. pp. 708–715. https://doi.org/10.34190/ECIE.19.210
Newton, P., 2008. Transitions: pathways towards sustainable urban development in Australia. CSIRO Pub., Collingwood, VIC.
Newton, P., Meyer, D., 2012. The Determinants of Urban Resource Consumption. Environment and Behavior 44, 107–135. https://doi.org/10.1177/0013916510390494
Newton, P.W., 2012. Liveable and Sustainable? Socio-Technical Challenges for Twenty-First-Century Cities. Journal of Urban Technology 19, 81–102. https://doi.org/10.1080/10630732.2012.626703
Noonan, D., Zhou, S., Kirkman, R., 2017. Making Smart and Sustainable Infrastructure Projects Viable: Private Choices, Public Support, and Systems Constraints. UP 2, 18–32. https://doi.org/10.17645/up.v2i3.999
O'Brien, L., Morris, J., Marzano, M., Dandy, N., 2017. Promoting sustainability behaviours through forestry. Forestry 90, 88–98. https://doi.org/10.1093/forestry/cpw030
Ockwell, D., Whitmarsh, L., O'Neill, S., 2009. Reorienting Climate Change Communication for Effective Mitigation: Forcing People to be Green or Fostering Grass-Roots Engagement? Science Communication 30, 305–327. https://doi.org/10.1177/1075547008328969
OECD, 2019. Tools and ethics for applied behavioural insights: the BASIC toolkit. Organisation for Economic Co-operation and Development.
Oliver, A., 2017. The Origins of Behavioural Public Policy. Cambridge University Press, Cambridge. https://doi.org/10.1017/9781108225120
Oliver, A., 2015. Nudging, Shoving, and Budging: Behavioural Economic-Informed Policy. Public Administration 93, 700–714. https://doi.org/10.1111/padm.12165
Oliver, A., 2013. From Nudging to Budging: Using Behavioural Economics to Inform Public Sector Policy. J. Soc. Pol. 42, 685–700. https://doi.org/10.1017/S0047279413000299
O'Rourke, D., Lollo, N., 2015. Transforming Consumption: From Decoupling, to Behavior Change, to System Changes for Sustainable Consumption. Annu. Rev. Environ. Resour. 40, 233–259. https://doi.org/10.1146/annurev-environ-102014-021224
Otto, I.M., Donges, J.F., Cremades, R., Bhowmik, A., Hewitt, R.J., Lucht, W., Rockström, J., Allerberger, F., McCaffrey, M., Doe, S.S.P., Lenferna, A., Morán, N., van Vuuren, D.P., Schellnhuber, H.J., 2020. Social tipping dynamics for stabilizing Earth's climate by 2050. Proc Natl Acad Sci USA 117, 2354–2365. https://doi.org/10.1073/pnas.1900577117
Parrique, T., Barth, J., Briens, F., Kerschner, C., Kraus-Polk, A., Kuokkanen, A., Spangenberg, J.H., 2019. Decoupling debunked – Evidence and arguments against green growth as a sole strategy for sustainability. EEB - The European Environmental Bureau.
Parson, E.A., Clark, W.C., 1995. Sustainable development as social learning: theoretical perspectives and practical challenges in the design of a research program, in: Gunderson, L.H., Holling, C.S., Light, S.S. (Eds.), Barriers and Bridges to the Renewal of Ecosystems and Institutions. Columbia University Press, New York, pp. 428–460.
Pekkanen, T.-L., 2021. Institutions and Agency in the Sustainability of Day-to-Day Consumption Practices: An Institutional Ethnographic Study. J Bus Ethics 168, 241–260. https://doi.org/10.1007/s10551-019-04419-x
Pinker, S., 2002. The blank slate: the modern denial of human nature. Viking, New York.
Prochaska, J.O., Velicer, W.F., Rossi, J.S., Goldstein, M.G., Marcus, B.H., Rakowski, W., Fiore, C., Harlow, L.L., Redding, C.A., Rosenbloom, D., Rossi, S.R., 1994. Stages of

change and decisional balance for 12 problem behaviors. Health Psychology 13, 39–46. https://doi.org/10.1037/0278-6133.13.1.39
Robb, M., Goodman, A., Media Education Foundation, 2003. Toxic sludge is good for you: the public relations industry unspun. Media Education Foundation, Northampton, MA.
Rogers, E.M., 2010. Diffusion of innovations. Simon and Schuster.
Ruggeri, K., 2019. Behavioral insights for public policy: concepts and cases.
Sahakian, M., Rau, H., Grealis, E., Godin, L., Wallenborn, G., Backhaus, J., Friis, F., Genus, A.T., Goggins, G., Heaslip, E., Heiskanen, E., Iskandarova, M., Louise Jensen, C., Laakso, S., Musch, A.-K., Scholl, C., Vadovics, E., Vadovics, K., Vasseur, V., Fahy, F., 2021. Challenging social norms to recraft practices: A Living Lab approach to reducing household energy use in eight European countries. Energy Research & Social Science 72, 101881. https://doi.org/10.1016/j.erss.2020.101881
Saltelli, A., Giampietro, M., 2017. What is wrong with evidence based policy, and how can it be improved? Futures, Post-Normal science in practice 91, 62–71. https://doi.org/10.1016/j.futures.2016.11.012
Sandberg, J., Alvesson, M., 2011. Ways of constructing research questions: gap-spotting or problematization? Organization 18, 23–44. https://doi.org/10.1177/1350508410372151
Schot, J., Geels, F.W., 2008. Strategic niche management and sustainable innovation journeys: theory, findings, research agenda, and policy. Technology Analysis & Strategic Management 20, 537–554. https://doi.org/10.1080/09537320802292651
Schot, J., Kanger, L., Verbong, G., 2016. The roles of users in shaping transitions to new energy systems. Nature Energy 1, 1–7. https://doi.org/10.1038/nenergy.2016.54
Schulte, M., Bamberg, S., Rees, J., Rollin, P., 2020. Social identity as a key concept for connecting transformative societal change with individual environmental activism. Journal of Environmental Psychology 72, 101525. https://doi.org/10.1016/j.jenvp.2020.101525
Sengers, F., Wieczorek, A.J., Raven, R., 2019. Experimenting for sustainability transitions: A systematic literature review. Technological Forecasting and Social Change 145, 153–164. https://doi.org/10.1016/j.techfore.2016.08.031
Seyfang, G., Haxeltine, A., 2012. Growing Grassroots Innovations: Exploring the Role of Community-Based Initiatives in Governing Sustainable Energy Transitions. Environ Plann C Gov Policy 30, 381–400. https://doi.org/10.1068/c10222
Seyfang, G., Smith, A., 2007. Grassroots innovations for sustainable development: Towards a new research and policy agenda. Environmental Politics 16, 584–603. https://doi.org/10.1080/09644010701419121
Shafir, E., 2013. The behavioral foundations of public policy. Princeton University Press, Princeton.
Shove, E., 2014. Putting practice into policy: reconfiguring questions of consumption and climate change. Contemporary Social Science 9, 415–429. https://doi.org/10.1080/21582041.2012.692484
Shove, E., 2010. Beyond the ABC: Climate Change Policy and Theories of Social Change. Environment and Planning A 42, 1273–1285. https://doi.org/10.1068/a42282
Shove, E., 2004. Changing human behaviour and lifestyle: A challenge for sustainable consumption?, in: The Ecological Economics of Consumption. Edward Elgar Publishing, p. 3205. https://doi.org/10.4337/9781845423568.00014
Shove, E., Walker, G., 2010. Governing transitions in the sustainability of everyday life. Research Policy 39, 471–476. https://doi.org/10.1016/j.respol.2010.01.019
Si, H., Shi, J., Tang, D., Wen, S., Miao, W., Duan, K., 2019. Application of the Theory of Planned Behavior in Environmental Science: A Comprehensive Bibliometric Analysis. IJERPH 16, 2788. https://doi.org/10.3390/ijerph16152788
Sibony, A.-L., 2020. The UK COVID-19 Response: A Behavioural Irony? Eur J Risk Regul 1–8. https://doi.org/10.1017/err.2020.22

Smink, M.M., Hekkert, M.P., Negro, S.O., 2015. Keeping sustainable innovation on a leash? Exploring incumbents' institutional strategies [WWW Document]. Business Strategy and the Environment. https://doi.org/10.1002/bse.1808
Smith, L., Curtis, J., Bragge, P. (Eds.), 2021. The Method Book: a practical toolkit for behaviour change for policy., 1st Edition. ed. Monash University (Open Access E-book), Melbourne, Australia.
Sopjani, L., Stier, J.J., Hesselgren, M., Ritzén, S., 2020. Shared mobility services versus private car: Implications of changes in everyday life. Journal of Cleaner Production 259, 120845. https://doi.org/10.1016/j.jclepro.2020.120845
Sorrell, S., Gatersleben, B., Druckman, A., 2020. The limits of energy sufficiency: A review of the evidence for rebound effects and negative spillovers from behavioural change. Energy Research and Social Science 64. https://doi.org/10.1016/j.erss.2020.101439
Sovacool, B.K., Hess, D.J., 2017. Ordering theories: Typologies and conceptual frameworks for sociotechnical change. Soc Stud Sci 47, 703–750. https://doi.org/10.1177/0306312717709363
SSE, 2018. Social Systems Evidence [WWW Document]. URL https://www.socialsystemsevidence.org/?lang=en (accessed 11.9.18).
Staemmler, J., 2020. Social Transformation and Policy Advice in Lusatia | Institute for Advanced Sustainability Studies [WWW Document]. URL https://www.iass-potsdam.de/en/research-group/lusatia (accessed 8.19.20).
Star, S.L., Griesemer, J.R., 1989. Institutional Ecology, `Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. Soc Stud Sci 19, 387–420. https://doi.org/10.1177/030631289019003001
Thaler, R.H., 2018. Nudge, not sludge. Science 361, 431–431. https://doi.org/10.1126/science.aau9241
Thaler, R.H., Sunstein, C.R., 2009. Nudge: improving decisions about health, wealth, and happiness, rev. and expanded ed., with a new afterword and a new chapter. ed. Penguin, New York, NY.
Torrens, J., Schot, J., Raven, R., Johnstone, P., 2019. Seedbeds, harbours, and battlegrounds: On the origins of favourable environments for urban experimentation with sustainability. Environmental Innovation and Societal Transitions 31, 211–232. https://doi.org/10.1016/j.eist.2018.11.003
Tricco, A.C., Langlois, E.V., Straus, S.E., World Health Organization, Alliance for Health Policy and Systems Research, 2017. Rapid reviews to strengthen health policy and systems: a practical guide.
Upham, P., Bögel, P., Dütschke, E., 2020. Thinking about individual actor-level perspectives in sociotechnical transitions: A comment on the transitions research agenda. Environmental Innovation and Societal Transitions 34, 341–343. https://doi.org/10.1016/j.eist.2019.10.005
Upham, P., Bögel, P., Johansen, K., 2019. Energy transitions and social psychology: a sociotechnical perspective, Routledge studies in energy transitions. Routledge, Abingdon, Oxon ; New York, NY.
Vainio, A., Pulkka, A., Paloniemi, R., Varho, V., Tapio, P., 2020. Citizens' sustainable, future-oriented energy behaviours in energy transition. Journal of Cleaner Production 245, 118801. https://doi.org/10.1016/j.jclepro.2019.118801
Van der Vliet, N., Staatsen, B., Kruize, H., Morris, G., Costongs, C., Bell, R., Marques, S., Taylor, T., Quiroga, S., Martinez Juarez, P., Máca, V., Ščasný, M., Zvěřinová, I., Tozija, F., Gjorgjev, D., Espnes, G.A., Schuit, J., 2018. The INHERIT Model: A Tool to Jointly Improve Health, Environmental Sustainability and Health Equity through Behavior and Lifestyle Change. International Journal of Environmental Research and Public Health 15, 1435. https://doi.org/10.3390/ijerph15071435
van Mossel, A., van Rijnsoever, F.J., Hekkert, M.P., 2018. Navigators through the storm: A review of organization theories and the behavior of incumbent firms during transitions. Environmental Innovation and Societal Transitions 26, 44–63. https://doi.org/10.1016/j.eist.2017.07.001

Vayda, A.P., 1996. Methods and Explanations in the Study of Human Actions and their Environmental Effects. Centre for International Forestry Research and World Wide Fund for Nature, Jakarta, Indonesia.
Vayda, A.P., 1983. Progressive contextualization: Methods for research in human ecology. Hum Ecol 11, 265–281. https://doi.org/10.1007/BF00891376
Veldhuizen, C., 2020. Smart Specialisation as a transition management framework: Driving sustainability-focused regional innovation policy? Research Policy 49, 103982. https://doi.org/10.1016/j.respol.2020.103982
Vergragt, P., 2004. Transition management for sustainable personal mobility. IEEE Eng. Manag. Rev. 34, 27–27. https://doi.org/10.1109/EMR.2006.261400
Verplanken, B., Roy, D., Whitmarsh, L., 2018. Cracks in the Wall: Habit Discontinuities as Vehicles for Behaviour Change, in: Verplanken, B. (Ed.), The Psychology of Habit. Springer International Publishing, Cham, pp. 189–205. https://doi.org/10.1007/978-3-319-97529-0_11
Wastling, T., Charnley, F., Moreno, M., 2018. Design for Circular Behaviour: Considering Users in a Circular Economy. Sustainability; Basel 10, 1743. http://dx.doi.org.ezproxy.lib.monash.edu.au/10.3390/su10061743
Wiedmann, T., Lenzen, M., Keyßer, L.T., Steinberger, J.K., 2020. Scientists' warning on affluence. Nat Commun 11, 3107. https://doi.org/10.1038/s41467-020-16941-y
Wiedmann, T., Schandl, H., Lenzen, M., Moran, D., Suh, S., West, J., Kanemoto, K., 2015. The material footprint of nations. PNAS 112, 6271–6276. https://doi.org/10.1073/pnas.1220362110
Williams, A., Kennedy, S., Philipp, F., Whiteman, G., 2017. Systems thinking: A review of sustainability management research. Journal of Cleaner Production 148, 866–881. https://doi.org/10.1016/j.jclepro.2017.02.002
Worldbank (Ed.), 2015. Mind, society, and behavior, World development report. World Bank, Washington, DC.
Zolfagharian, M., Walrave, B., Raven, R., Romme, A.G.L., 2019. Studying transitions: Past, present, and future. Research Policy 103788. https://doi.org/10.1016/j.respol.2019.04.012

Appendix 1: search string

((REFTITLE ({Regime shifts to sustainability through processes of niche formation: The approach of strategic niche management}) AND REFPUBYEAR = 1998) OR (REFTITLE ({Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case-study}) AND REFPUBYEAR = 2002) OR (REFTITLE ({On the nature, function and composition of technological systems}) AND REFPUBYEAR = 1991) OR (REFTITLE ({Understanding carbon lock-in}) AND REFPUBYEAR = 2000) OR (REFTITLE ({More evolution than revolution: Transition management in public policy}) AND REFPUBYEAR = 2001) OR (REFTITLE ({From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory}) AND REFPUBYEAR = 2004) OR (REFTITLE ({The governance of sustainable socio-technical transitions}) AND REFPUBYEAR = 2005) OR (REFTITLE ({Typology of sociotechnical transition pathways}) AND REFPUBYEAR = 2007) OR (REFTITLE ({The diffusion of renewable energy technology: An analytical framework and key issues for research}) AND REFPUBYEAR = 2000) OR (REFTITLE ({Bricolage versus breakthrough: Distributed and embedded agency in technology entrepreneurship }) AND REFPUBYEAR = 2000) OR (REFTITLE ({The past and future of constructive technology assessment }) AND REFPUBYEAR = 1997) OR (REFTITLE ({Functions of innovation systems: A new approach for analysing technological change}) AND REFPUBYEAR = 2007) OR (REFTITLE ({Transforming the energy sector: the evolution of technological systems in renewable energy technology}) AND REFPUBYEAR = 2004) OR (REFTITLE ({Strategies for Shifting Technological Systems: The Case of the Automobile System}) AND REFPUBYEAR = 1994) OR (REFTITLE ({The politics and policy of energy system transformation - Explaining the German diffusion of renewable energy technology}) AND REFPUBYEAR = 2006) OR (REFTITLE ({Analyzing the functional dynamics of technological innovation systems: A scheme of analysis}) AND REFPUBYEAR = 2008) OR (REFTITLE ({Technological innovation systems and the multi-level perspective: towards an integrated framework}) AND REFPUBYEAR = 2008) OR (REFTITLE ({CAUTION! Transitions ahead: politics, practice and sustainable transition management}) AND REFPUBYEAR = 2007) OR (REFTITLE ({Processes and patterns in transitions and system innovations: Refining the co-evolutionary multi-level perspective}) AND REFPUBYEAR = 2005)) AND (TITLE-ABS-KEY ((sustainab* OR environmental* OR bio* OR renewable OR socio-technical) AND (transition OR transform* OR "system innovation" OR "radical innovation" OR shift OR change) AND (behav*)))

Appendix 2: coding used for each title / abstract.

Descriptive coding theme / interest	Codes
Type of paper:	- Primary: study where primary data were collected (e.g., survey, experiment, interview) and study was interpreting that data - Modelling: study where no primary data were collected; instead simulations or models were constructed to explore systems or actor behaviours (e.g., modelling adoption of solar PV) - Theoretical: study where primary aim was to propose a theory or framework for understanding primary data or to make progress in some area - Review: study where primary aim was to review + synthesise existing literature on a research question
Extent of focus on behaviour	- Focus - the abstract specifically sought to measure or investigate behaviour (especially as an outcome or a concept/artefact of study) - Included - the abstract described measured/investigated behaviour in a list of other variables (e.g., "behaviour, attitudes, cost, policy") - Implied - the abstract measured something that was probably a behaviour but the specific term wasn't used (e.g., decision-making, choice), but also where those other terms were not a focus of the paper
Scale of analysis	- Micro - at the level of individuals and their interactions in different social contexts e.g. households, firms, communities, etc. - Meso - at the level of interactions between social contexts listed above - Macro - at the level of aggregations of many social contexts, often over longer time frames.

Appendix 3: examples of empirical, modelling, theoretical and review papers

Type of relevant paper	Examples
Empirical	The prevalence of primary studies underlines the long-acknowledged point that behaviour makes a useful empirical ground for understanding systemic intersections between people, environment and technology (Vayda, 1983). The most common type of primary study was case studies. Examples included consumer food buying networks in Italy (Brunori et al., 2012; Fonte, 2013), uptake of renewable energy in New Zealand (Ford et al., 2017), and telework in Ireland (Hynes, 2016). Other study designs included qualitative interviews, including to investigate sustainable mobility behaviours in young New Zealand citizens (Hopkins, 2017) 2017), business model innovation by vehicle manufacturers (Bohnsack et al., 2014), and householders and installers' behaviours for energy efficiency retrofitting of residential properties in England (Owen & Mitchell, 2015); quantitative surveys, including of Chinese e-bike users (Lin et al., 2017), of Japanese high school and college students' pro-environmental behaviour (Mori & Tasaki, 2019), and Swiss householders' support for sustainable energy policies (Ingold et al., 2019); and living labs (Cellina et al., 2013; Cottafava et al., 2019).
Modelling	Eight papers proposed and tested modelling and simulation approaches to investigate consumer and firm behaviour in a transitions context. Agent-based modelling was used in Colombian farmers' behaviour in agricultural systems (Feola & Binder, 2010), transitions in UK private vehicle use (Köhler et al., 2009), effectiveness of carbon taxes in changing consumer behaviour (Patriarca & Vona, 2012), and firm behaviours in energy markets (Wu et al., 2018).
Theoretical	Many of the relevant papers advanced a theoretical argument or proposed a new framework that incorporated behaviour into sustainability transitions. Papers typically (1) advanced a novel method for tackling sustainability transitions that made reference to behaviour (e.g., (O'Rourke & Lollo, 2015; Safarzyńska, 2013), (2) compared different existing approaches to sustainability transitions as part of developing a framework (Bale et al., 2015; Seyfang & Haxeltine, 2012; Seyfang & Smith, 2007), or (3) critiqued a particular approach to sustainability transitions (Hall, 2013; Shove, 2010; Shove & Walker, 2010; Whitmarsh, 2012).
Review	The review papers generally took a non-systematic, narrative mode of review (Baethge et al., 2019). There were a number of reviews that explicitly and constructively translated ideas between behaviour science and sustainability transitions. Newton in particular suggested that transitions have three horizons, each with different implications for interactions between behaviour, resource consumption and the socio-technical system (Newton, 2008; Newton & Meyer, 2012). Other examples include Axsen and Kurani (2012), who reviewed the literature on social influence on consumer behaviour in adopting low-carbon products and practices; Iyer (2015) who reviewed the constraints on

	the diffusion of low-carbon technologies (including behaviour) for global climate stabilisation; and Scrieciu (2013) who critically reviewed the cost-benefit assumptions in climate policy that do not account for other influences on human behaviour and socio-technical responses.

Appendix 4. Examples of papers on different levels of analysis

Level of analysis	Examples
Multiple levels	The majority of relevant papers described the behaviour of actors at multiple levels of analysis, such as modelling policy decisions and householder behaviours in residential heating costs (Knobloch et al., 2019), acceptance and uptake of telework in Ireland among employees, firms and sectors (Hynes, 2016), mapping stakeholders influence on behaviour at different levels in sustainable UK forestry management (O'Brien et al., 2017), and policy makers, firms, and consumer behaviours in an (ultimately unsuccessful) implementation of a single use plastic bag tax (Little et al., 2019).
Micro	Other relevant papers tended to focus on individual (micro level) behaviour, especially in consumer uptake of new sustainable products - e.g., solar energy use in Yemen, (Baharoon et al., 2016) or curtailment of unsustainable behaviours - e.g., switching from private car ownership to using car sharing services (Firnkorn & Shaheen, 2016).
Meso	Finally, a minority of papers focused exclusively on firm or institutional (meso level) behaviour. Examples of these papers include green entrepreneurs in the UK (O'Neill & Gibbs, 2014), Chinese construction firms' sustainability practices (Chang et al., 2016) and factors influencing cooperation between multinational corporations and non-government organisations on social and environmental issues (de Lange et al., 2016).
Macro	None

Appendix 5: Examples of papers on different levels of analysis

Behavioural focus	**Examples**
Implied / included	In papers where behaviour was implied or included but not a focus, behaviour was listed as one of several elements of change (such as cultural, political, and economic change). For example, in Geels' (Geels, 2005) case study of Netherlands' water supply and personal hygiene transitions, behaviour was one type of innovation amongst other dimensions such as economic and technological.
Focus	Papers where behaviour was a focus were included in the subsequent critical interpretive synthesis, reported below. Examples included a review of individual and contextual factors relevant to policy makers' promotion of public pro-environmental behaviour (Baum & Gross, 2017), and the challenges of measuring user behaviour to evaluate the success of a living lab for electric mobility in Sweden (Cellina et al., 2013).