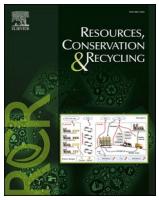
Resources, Conservation & Recycling 203 (2024) 107440

Contents lists available at ScienceDirect

Resources, Conservation & Recycling

journal homepage: www.elsevier.com/locate/resconrec



Does a holiday break disrupt pro-environmental behaviors? Using field data to test the durability of pro-environmental behaviors and the moderating effect of habit

Christoph Ratay [a,*], Thomas L. Webb [b], Wendy Wood [c], Alwine Mohnen [a]

[a] School of Management, Technical University of Munich, Germany
[b] Department of Psychology, The University of Sheffield, UK
[c] Department of Psychology and Marshall School of Business, University of Southern California, Los Angeles, USA

ARTICLE INFO

Keywords:
Pro-environmental behavior
Durability of habits
Reuse
Field data

ABSTRACT

For pro-environmental behaviors to have a meaningful impact, they need to be maintained and resilient to temporary interruptions in daily life. Yet, the effects of temporal interruptions on pro-environmental behaviors are rarely explored. The present research applied a regression discontinuity in time approach to a large field dataset from a system for reusing food containers and examined the effect of the Christmas break on 17,284 individuals' use of the system. On average, the temporal interruption was associated with a 16.7 % drop in individuals' use of reusable food containers. However, the interruption had a smaller effect on individuals for whom the behavior was more habitual, as measured by the extent to which the individuals used the system in consistent times and places before the interruption. This finding suggests that stronger habits promoted the durability of pro-environmental behaviors.

Spotlights

Temporary interruptions in daily life are common, but their effects on pro-environmental behaviors are rarely explored

A Christmas break was associated with a drop in pro-environmental behavior

The drop was smaller among individuals with more stable behavioral contexts

This finding suggests that stronger habits promote the durability of pro-environmental behaviors

Integrating pro-environmental behaviors into regular routines can foster more sustainable lifestyles

Data availability

The authors do not have permission to share data.

1. Introduction

Although it seems logical that people concerned about the environment would act on their concern, people often fail to translate their concerns into action (Sheeran and Webb, 2016; Steg and Vlek, 2009). Indeed, evidence suggests that beliefs about climate change have only small to moderate effects on pro-environmental actions (Hornsey et al., 2016), and a substantial literature investigates the gap between pro-environmental intentions and relevant behavior (Carrington et al., 2010; Kollmuss and Agyeman, 2002; Young et al., 2010). One reason why pro-environmental intentions do not necessarily translate into behavior is that many everyday behaviors that impact the environment (e.g., eating, commuting, recycling) are habitual. According to habit theory, repeating behaviors in stable contexts, for example, at particular times of day or in specific locations, creates strong associations between contextual cues and responses (Mazar and Wood, 2018; Verplanken and Wood, 2006; Wood and Neal, 2016; Wood and Rünger, 2016). As a result, many everyday actions are automatically cued by behavioral contexts rather than resulting from deliberate decision-making

* Corresponding author.
E-mail address: christoph.ratay@tum.de (C. Ratay).

https://doi.org/10.1016/j.resconrec.2024.107440
Received 20 July 2023; Received in revised form 10 January 2024; Accepted 10 January 2024

processes drawing on intentions. Thus, introducing and maintaining more sustainable lifestyles is likely to involve breaking and forming habits (Klöckner, 2013; Mazar et al., 2021; Russell et al., 2017; Verplanken and Whitmarsh, 2021) and the role of habits is increasingly acknowledged in research on pro-environmental behaviors (e.g., Dean et al., 2021; Gkargkavouzi et al., 2019; Klöckner, 2013; Russell et al., 2017; Timlett and Williams, 2009).

People's everyday routines are frequently interrupted, which means that introducing and maintaining more sustainable lifestyles is also likely to involve dealing with temporal interruptions (e.g., holidays or school breaks). Given that established habits decay slowly even when people no longer perform the response (Walker et al., 2015), habitual behaviors are likely to resume after a temporal interruption as long as behavioral contexts remain stable before and after the interruption. Thus, when pro-environmental behaviors are relatively habitual (i.e., underpinned by strong cue-response associations), they should be more durable and resilient to temporal interruptions.

The effects of contextual changes altering the cues that activate habitual responses have been investigated in a substantial body of research on 'habit discontinuity' (e.g., moving house or changing school or job location, Verplanken et al., 2008; Verplanken and Roy, 2016; Wood et al., 2005). In contrast, the effects of temporal interruptions on routine behaviors have received less attention. Temporal interruptions differ from contextual disruptions because the contextual cues that triggered responses before the disruption often remain in place after the temporal interruption. Thus, a pro-environmental habit that is established before an interruption may be reactivated when people encounter the cues that trigger the habit again after the interruption. As temporal interruptions are an integral part of people's lives and considering that many behaviors with environmental impacts are habitual, it is crucial to advance our understanding of the relationship between habits and the durability of pro-environmental behaviors.

To our knowledge, only three studies have examined the effect of temporal interruptions on routines. A semester break (Acland and Levy, 2015), Thanksgiving (Milkman et al., 2014), and Easter (Fredslund and Leppin, 2019) were found to disrupt physical exercise behaviors. Fredslund and Leppin (2019) also found a larger negative effect of an interruption on gym attendance among individuals who visited the gym more frequently (vs. less frequently) before the interruption. They argued that this finding points to the vulnerability of everyday routines to temporal interruptions. However, these findings do not necessarily indicate that habitual behavior is more susceptible to temporal interruptions than less habitual behavior as they could also be explained by regression to the mean. It is also important to note that frequency alone is a poor index of habit strength (Verplanken, 2006). According to habit theory, behaviors can be performed frequently without being habitual (e.g., in unstable contexts without clear cues), and behaviors can be habitual even if they are not performed every day (Rebar et al., 2018). Therefore, to examine whether habits moderate the effect of temporal interruptions on behavior, research needs to consider to what extent behaviors are linked to performance contexts (e.g., times, locations) that enable the formation of strong associations between specific cues and responses.

1.1. The present research

The present research evaluated whether a quasi-exogenous interruption (namely, a Christmas break) was associated with a discontinuous change in a pro-environmental behavior and whether this effect was moderated by context stability before the interruption. To do so, we examined field data from a system for reusing containers for takeaway food. Using reusable rather than single-use food containers can reduce negative environmental impacts (Gallego-Schmid et al., 2019; Greenwood et al., 2021), forms part of the current EU strategy for reducing packaging waste (European Parliament, 2023), and reuse more generally is seen as "one of the biggest opportunities to reduce plastic pollution" (Ellen MacArthur Foundation, 2023). However, reusable containers need to be used sufficiently frequently for environmental benefits to materialize. For example, depending on the underlying assumptions (e.g., material and energy used to produce containers), reusable containers must be used 2–18 times to deliver climate-related benefits compared to single-use alternatives (Gallego-Schmid et al., 2019; Greenwood et al., 2021). Thus, it is crucial that the behavior is resilient to temporal interruptions, so users maintain the behavior over time. Fortunately, reuse may become habitual, as it "could be performed on a daily or weekly basis in a stable, predictable supporting context" (Ouellette and Wood, 1998, p. 58). However, it remains unclear whether and how this influences the effects of a temporal interruption on this pro-environmental behavior.

Our research focused on a system for reusing containers for takeaway food called *Vytal*. In the observation period (i.e., Christmas break 2021–2022), the system served an extensive network of partner restaurants primarily located in Germany. Since then, *Vytal* has expanded its network internationally (e.g., to France, Ireland, Mexico, the Netherlands, Sweden, and the United Kingdom) and is now considered the "world-leading provider of smart reusable food packaging" (Recker et al., 2023). Thus, using *Vytal*'s system reflects an increasingly relevant and popular pro-environmental behavior. To order food in reusable containers, users register on an app or purchase an offline card for €10. Afterward, users receive a personal QR code, which is scanned when food is ordered in a reusable container. App users can keep containers for up to 14 days for free. If containers are not returned within 14 days, users can extend the use period for €1 per week or automatically purchase the container for €10. Offline card users can obtain two containers at a time without a time limit. Containers can be returned at participating restaurants.

We expected the Christmas break to disrupt individuals' system use in line with findings on the vulnerability of exercise behavior to quasi-exogenous temporal interruptions (Acland and Levy, 2015; Fredslund and Leppin, 2019; Milkman et al., 2014). People in Germany typically spend the Christmas break with family and many employees are on leave. December 25–26, 2021 and January 1, 2022 were public holidays in Germany, and school children were on holiday at least from December 24, 2021 to January 1, 2022. Individuals' everyday routines were typically interrupted in this period, as many people did not go to work or school, spent time away from home, or received visitors. Accordingly, our first hypothesis was that this interruption would result in a drop in individuals' frequency of use of *Vytal*'s system (see Fig. 1).

Second, we expected context stability before the interruption to moderate the effect of the break on system use. We approximated the stability of the contexts in which users engaged with the system before the interruption by identifying (a) whether individuals typically used the system at similar times (consistent time of day) and (b) in the same restaurant(s) (consistent location). Based on these indicators, users were assigned to subgroups that used the system in more (vs. less) stable contexts before Christmas. We expected most users to find themselves in similar behavioral contexts (i.e., similar cafés, with similar people, at similar times) after Christmas as before. Therefore, our second hypothesis was that the interruption would have a smaller (negative) effect (i.e., the behavior was more durable) among users with more stable contexts of use than among users in less stable contexts before the interruption. This is illustrated by the positive moderating effect of context stability in Fig. 1.

2. Materials and methods

2.1. Participants

The dataset included individuals who joined the system at least six weeks before Christmas and used the system at least once in the six weeks before Christmas. To draw generalizable conclusions about behavior in public contexts, we excluded users of workplace and

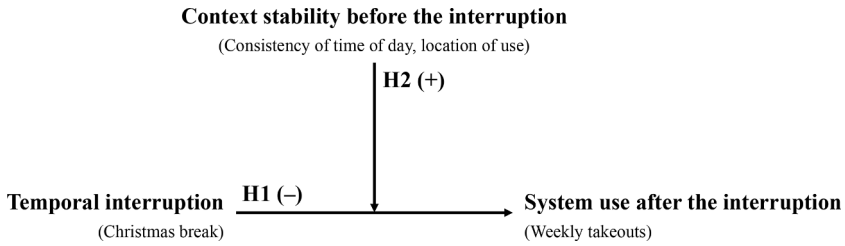


Fig. 1. *Hypotheses based on habit theory.*

university cafeterias and focused on users in noninstitutional settings (e.g., cafés, restaurants, supermarkets).[1]

2.2. Procedure

Each container transaction was recorded with an anonymized user ID, a restaurant ID, and a time stamp. If users obtained multiple containers from the same restaurant within two hours, individual transactions were considered as single "takeouts" reflecting separate instances of engaging with the system. *Vytal* mainly operated its system in Germany in the observation period. November 1, 2021 was a public holiday followed by school holidays in some German states. Therefore, the pre-Christmas interval was defined as starting the week beginning November 8, 2021 to avoid the possibility that the dataset captured multiple interruptions, which could distort estimations of discontinuities. As demonstrated by Fig. 2, individuals' system use dropped substantially over Christmas for three weeks. Thus, the final two weeks of 2021 and the first week of 2022 were defined as the Christmas break (i.e., December 20, 2021 to January 9, 2022), and the six weeks before and after were defined as pre-Christmas (i.e., November 8 to December 19, 2021) and post-Christmas intervals (i.e., January 10 to February 20, 2022).

2.3. Measures

2.3.1. Discontinuous change in frequency of use

The primary outcome variable was the change in users' average number of takeouts each week before and after the Christmas break. In addition to the absolute change in average takeouts per week, we also calculated the change as a percentage of the respective subgroup's average number of takeouts the week before Christmas. This helped to compare subgroups (i.e., users who performed the behavior in more vs. less stable contexts) and ensure that absolute effects were not driven by different baseline frequencies of use (i.e., number of takeouts) between the subgroups before Christmas. Percentages also enable comparisons with existing and future research on the durability of behaviors that are performed more or less frequently in absolute terms (e.g., household recycling, commuting, food choices).

2.3.2. Context stability: consistency of time of day and location of use

Time stamps of takeouts in the pre-Christmas interval were used to estimate the consistency of the time of day at which individuals used the system. The time of day of each takeout was converted to hours (e.g., 12:55:30 equals $12+(55/60)+(30/(60 \times 60)) = 12.925$ h) to calculate the standard deviation of each user's times of day of usage before Christmas. High standard deviations signified more variable times of day, whereas low standard deviations indicated more consistent times of day of system use.[2] Since calculating the standard deviation of times of day required at least two observations per user, this analysis was limited to users with two or more takeouts in the pre-Christmas interval (60.1 % of the sample). Finally, the number of unique restaurants at which each individual used the system in the pre-Christmas interval served as another measure of context stability.

2.4. Statistical analyses: regression discontinuity design

To test the effect of the interruption on system use, we applied a regression discontinuity design (RDD) to the weekly panel dataset of users' takeouts before and after Christmas. Similar to the approach of Fredslund and Leppin (2019), the RDD testing the main effect of the interruption was implemented with time (calendar weeks) as the running predictor, a binary interval predictor (pre-Christmas and post-Christmas), and frequency of use (number of takeouts each week) as the outcome variable. As this regression discontinuity in time approach (Hausman and Rapson, 2018) leveraged multiple observations per user, standard errors were clustered on the user level. Furthermore, following recommendations for RDDs (Cunningham, 2021; Lee and Lemieux, 2010), we allowed regression slopes to vary on either side of the interruption by including an interaction term between time (calendar weeks) and the pre-post-Christmas interval predictor. Time (calendar weeks) and interval (pre-post-Christmas) predictors were coded such that the effect of the interruption on frequency of use was measured in the final week of the Christmas break. The magnitude and significance level of the effect was assessed by inspecting the regression coefficient of the pre-post-Christmas interval predictor.

The moderating effect of context stability was tested by comparing subgroups of users who used the system in more (vs. less) stable contexts before Christmas.[3] Separate analyses were conducted for both variables reflecting context stability (i.e., consistency of time of day and location of use), and RDD models were separately specified for different subgroups, in line with similar analyses (Fredslund and Leppin, 2019).

To test the moderating effect of context stability measured by the times of day that individuals used the system, the variability in the timestamps associated with system use was used to define subgroups of individuals who typically used the system at similar vs. different times of day. As the consistency of time of day was calculated on a continuous scale, users were divided into two subgroups using a median split.[4] Afterward, we implemented separate RDDs for both subgroups following

[1] We also explored analyzing users in workplaces and universities as users with particularly stable contexts. System use pre-Christmas declined more steeply among workplace and university users than in public settings. This suggested that confounding factors (e.g., canteens closing pre-Christmas) influenced system use in those settings and supported the decision to focus on noninstitutional settings.

[2] This approach could lead to inconsistencies for observations close to midnight. However, this risk was ruled out as 99% of takeouts occurred between 9:28am and 9:11pm.

[3] The anticipated moderation effect of context stability relied on the assumption that users' behavioral contexts reoccurred after Christmas. 90.3% of 10,546 users who returned post-Christmas used the system at a restaurant they visited before Christmas and 99.4% visited restaurants in the same city. This supported the assumption that previous behavioral contexts reoccurred for most users.

[4] Robustness checks were implemented with cutoffs at 25% and 75% quantiles and with the standard deviation of times of day as a continuous variable (see section 3.3).

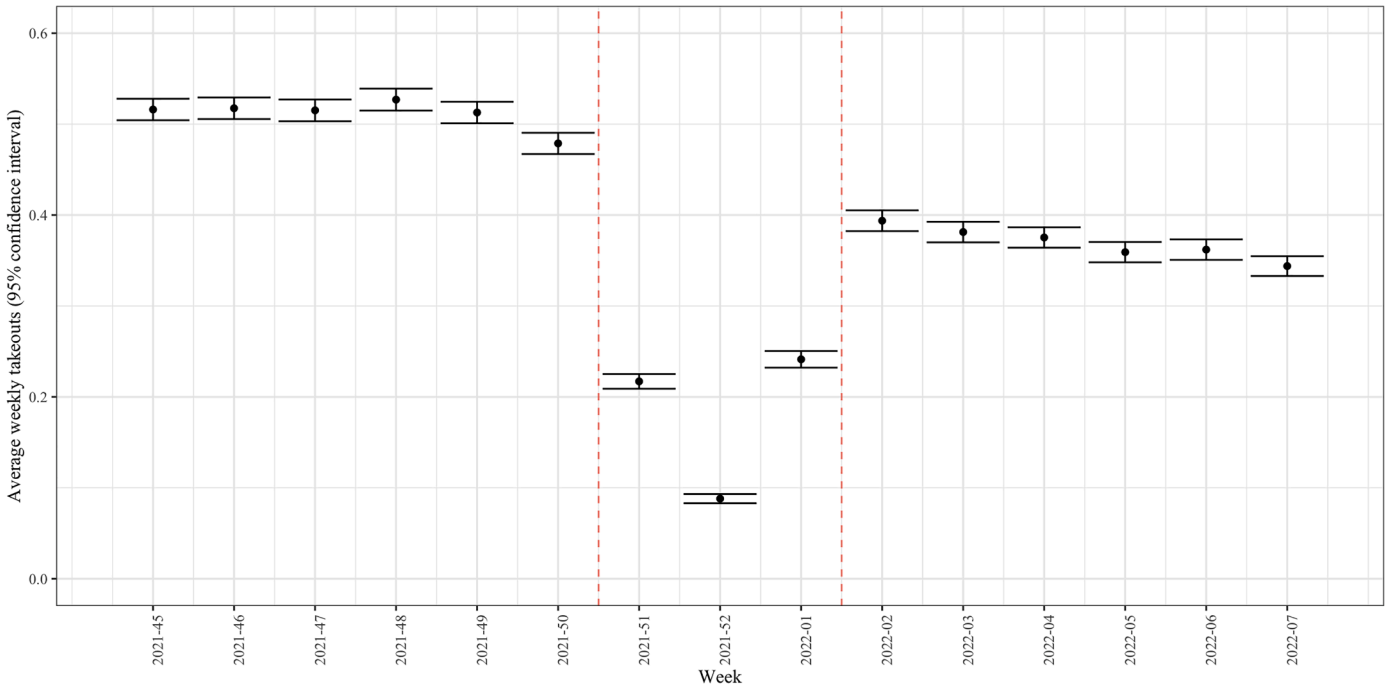


Fig. 2. *Weekly frequency of use by individuals in the sample in the weeks before, during, and after Christmas 2021.*

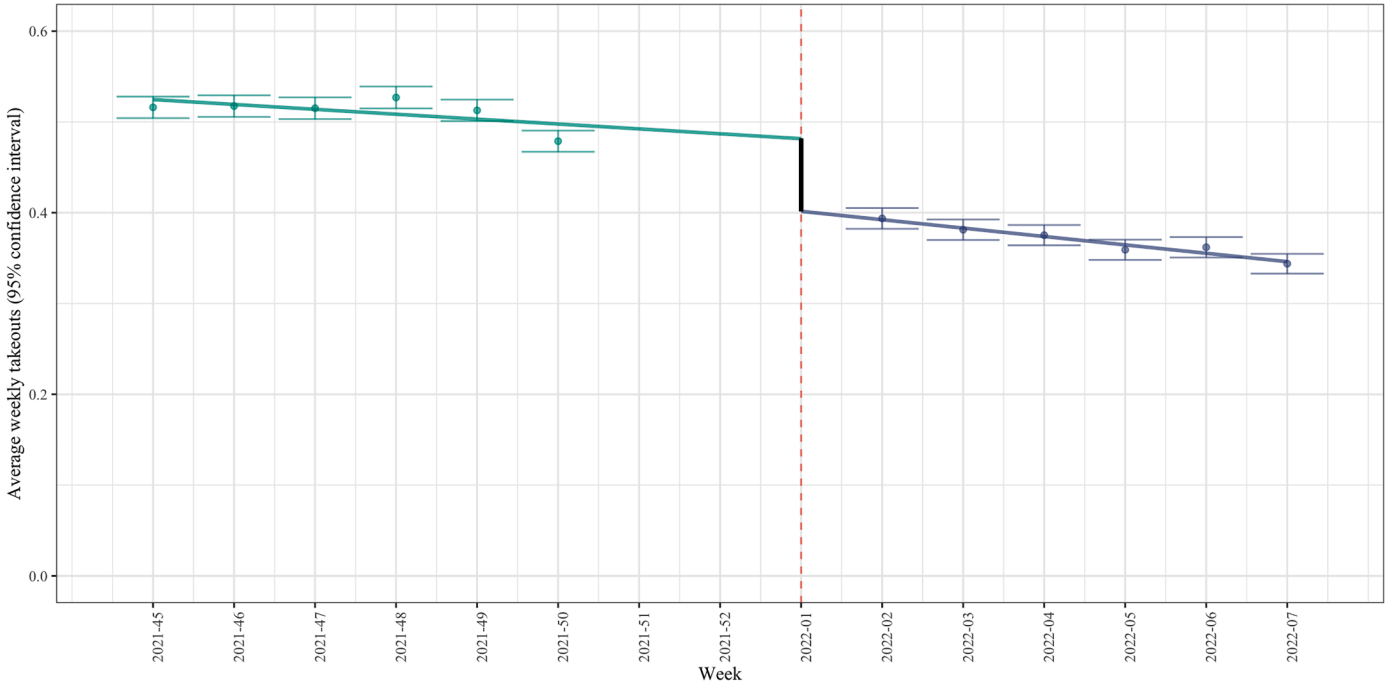


Fig. 3. *Regression discontinuity visualization of the effect of the interruption on frequency of use by all individuals in the sample.*

the logic introduced before (i.e., with calendar weeks as the running predictor, a binary pre-post-Christmas predictor, and individuals' weekly takeouts as the outcome variable). The statistical significance of the difference in effect sizes associated with the interruption among subgroups with more or less consistent times of day was assessed by estimating RDDs for both subgroups in the same regression model. To this end, a binary predictor indicating consistent (vs. inconsistent) times of day was introduced, and interaction terms were included in the RDD. Accordingly, the magnitude and statistical significance of the difference in discontinuous effects of the interruption on both subgroups (i.e., users with consistent vs. inconsistent times of day) was indicated by the interaction between the interval predictor (pre-post-Christmas) and the binary predictor indicating (in)consistent times of day before the interruption.

To test the moderating effect of context stability measured by consistent locations of use, the number of different restaurants that each individual frequented before Christmas was used to define subgroups of individuals who typically used the system in the same vs. different locations. 83.6% of users visited one restaurant in the pre-Christmas interval. Therefore, individuals were split into users who used the system

Table 1
Effect of the interruption on frequency of use by individuals who used the system at less vs. more consistent times of day in the pre-Christmas interval.

	Low context stability (i.e., users with above median standard deviation of times of day)	High context stability (i.e., users with below median standard deviation of times of day)
Estimated absolute discontinuous change (Standard error[a])	-0.17*** (0.02)	-0.10*** (0.02)
Absolute difference between the subgroups' discontinuous changes (Standard error[a])	0.07** (0.02)	
Estimated relative discontinuous change (absolute discontinuous change as a percentage of the average number of takeouts the week before Christmas)	-25.0%	-14.3%
n	5195	5195

Notes. *** $p < .001$; ** $p < .01$; * $p < .05$.
[a] Clustered on the user level.

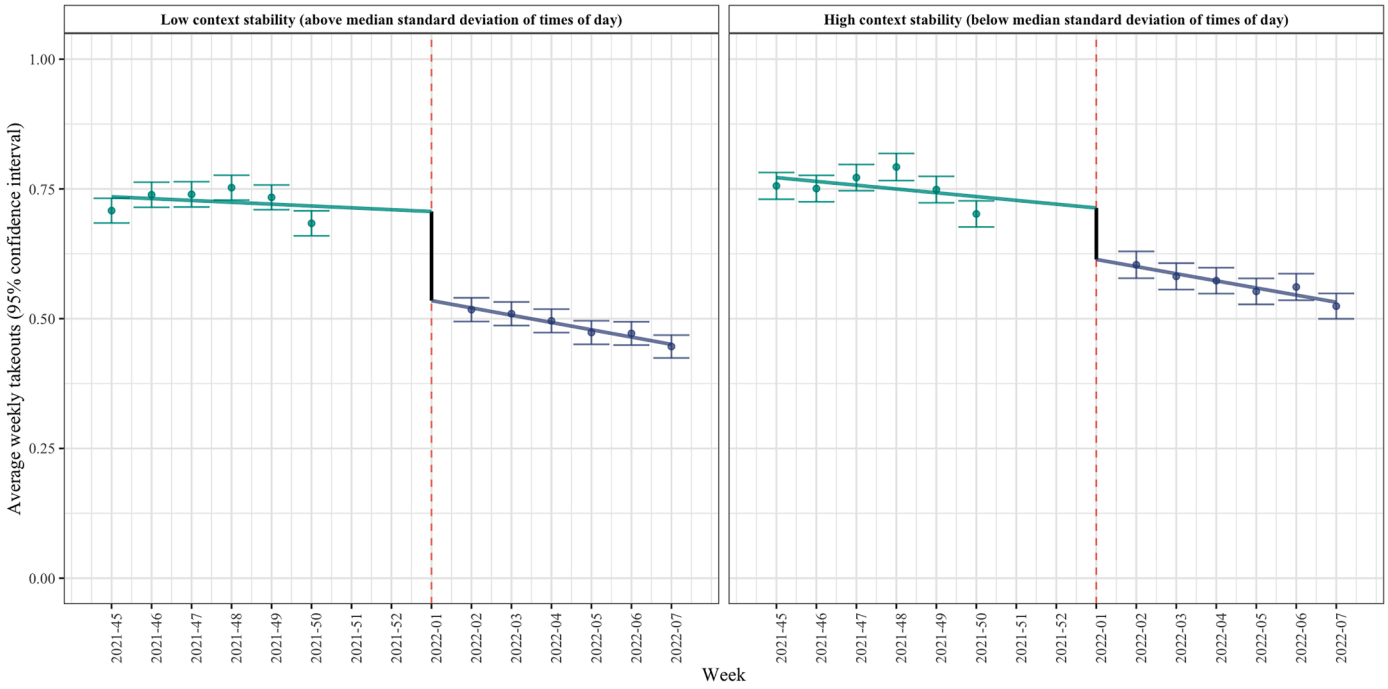


Fig. 4. *Regression discontinuity visualization of the effect of the interruption on frequency of use by individuals who used the system at less (left panel)* vs. *more consistent times of day (right panel) in the pre-Christmas interval.*

at one restaurant (more stable context) and users who visited at least two different restaurants (less stable context).[5] By definition, users who visited two or more restaurants also used the system at least twice. Thus, to ensure comparability, the subgroup of users who only visited one restaurant was limited to users who went to that restaurant at least twice (52.3% of those users who visited one restaurant). RDDs were implemented and interpreted as described above.

3. Results

3.1. Descriptive statistics and bivariate correlations

The dataset included 100,749 takeouts by 17,284 users at 1115 restaurants between November 8, 2021 and February 20, 2022. The Appendix presents descriptive statistics for pre-Christmas and post-Christmas intervals. There was a small negative correlation between the standard deviation of times of day (in the pre-Christmas interval) and weekly frequency of use before (r = -0.06, $p < .001$) and after Christmas (r = -0.08, $p < .001$), suggesting that individuals who used the system at more consistent times of day tended to use the system (slightly) more frequently. The number of different restaurants visited in the pre-Christmas interval was positively correlated with weekly frequency of use before ($r = 0.22$, $p < .001$) and after Christmas ($r = 0.13$, $p < .001$), suggesting that individuals who used the system at stable locations used the system less frequently. The different relations between frequency of use and our two indicators of context stability supports the idea that frequency alone is not a reliable indicator of habit formation. The standard deviation of times of day and the number of visited restaurants in the pre-Christmas interval were positively correlated (r = 0.31, $p < .001$). That is, using the system at more restaurants was associated with more variable times of day of use. This is an initial indication that both variables measured a similar latent variable, context stability.

3.2. Effect of the Christmas break on frequency of use

Fig. 3 visualizes the effect of the temporal interruption on the frequency of system use. The Christmas break was associated with a significant discontinuous drop in frequency of use by 0.08 takeouts per person per week ($p < 0.001$). Compared to users' average number of takeouts the week before Christmas (0.48), this amounts to a 16.7 % decrease.

[5] For robustness checks, the model was replicated with a cutoff threshold of three restaurants, and for the most frequent users. Furthermore, we compiled a model with the number of restaurants as an unmodified count variable (see section 3.3).

3.3. The moderating effect of context stability

Next, we examined whether the effect of the interruption was moderated by context stability, measured by (a) the consistency of times of day of usage and (b) the number of restaurants visited. Tests of whether the stability of the temporal context moderated the effect of the interruption on system use are presented in Table 1 and Fig. 4. As anticipated, the interruption had a smaller effect on individuals who used the system at more consistent times of day before Christmas than users who evidenced variability in the times of system use.[6] This difference was found in both absolute and relative terms: Among individuals who used the system in less stable temporal contexts before Christmas, the frequency of system use dropped by 0.17 takeouts, or 25.0 % compared to this subgroup's average number of takeouts per person in the week before Christmas. In contrast, system use among individuals who used the system in more stable temporal contexts before the holiday only dropped by 0.10 takeouts, or 14.3% compared to the week before Christmas. Taken together, these findings suggest that the interruption had a larger negative effect on individuals who used the system at more variable times of day (i.e., less stable context) before the interruption than on individuals who used the system at more consistent times of day.

Tests of whether the consistency of the locations in which users performed the behavior moderated the effect of the interruption on system use are presented in Table 2 and Fig. 5. The interruption had a smaller negative effect among users who visited a single restaurant (vs. two or more) in the pre-Christmas interval in absolute and relative terms.[7] Use of the system among individuals who only visited a single restaurant in the pre-Christmas interval (i.e., more stable context) decreased by 0.11 or 15.9% over Christmas, compared to a decrease of 0.19 or 26.8% among individuals who visited two or more different restaurants before Christmas. Taken together, these findings suggest that the interruption had a larger negative effect on individuals who used the system at a greater variety of restaurants (i.e., less stable context) before the interruption than on individuals who used the system similarly frequently but in a more stable context (i.e., at a single restaurant).

4. Discussion

The findings of the present research suggest that temporal interruptions can disrupt pro-environmental behaviors. On average, the frequency with which people used a system for reusable takeaway food containers dropped by 16.7 % over the Christmas break. The magnitude of this effect is consistent with the 12.25 % reduction in gym attendance associated with a two-week interruption over Easter reported by Fredslund and Leppin (2019). Therefore, similar to research on temporal interruptions of exercise behaviors (Acland and Levy, 2015; Fredslund and Leppin, 2019; Milkman et al., 2014), the present findings suggest that pro-environmental behaviors are vulnerable to temporal interruptions.

Nevertheless, the decrease could also be driven by regression to the mean and does not speak to the question of whether strongly habitual behaviors are less susceptible to temporal interruptions than less habitual behaviors. To answer this, the present research examined the moderating effect of context stability. The findings supported the idea that behaviors that are performed in stable contexts are more resilient to temporal interruptions. Individuals who used the *Vytal* system in more stable contexts before Christmas (i.e., more consistent times of day, fewer restaurants) were less affected by the temporal interruption than individuals whose behavior was not linked to a stable context (i.e., variable times of day, different restaurants). In line with habit theory (Mazar and Wood, 2018; Verplanken and Orbell, 2022), this suggests that context-response associations continue to trigger the respective behaviors when contextual cues reoccur after a temporal interruption.

In this way, the present research contributes to extant research on habits and pro-environmental behaviors. Specifically, it demonstrates how indicators of habit (e.g., context stability) can be estimated from observational data. It also provides field evidence that pro-environmental behaviors are more durable when repeated in stable contexts. By exploring temporal interruptions after which behavioral contexts reoccur, the present research complements research on habit discontinuity focusing on context changes (Verplanken et al., 2008; Verplanken and Roy, 2016). Furthermore, our findings support calls to consider influences of habits on pro-environmental behaviors (Gkargkavouzi et al., 2019; Klöckner, 2013; Russell et al., 2017) and complement prior findings on the positive effect of context stability on maintaining such behaviors (Dean et al., 2021).

4.1. Methodological considerations, limitations, and future research

By analyzing observational measures of behavior and properties of habits, the present research complements existing empirical research on habits that often relies on self-reported data. Our observational approach benefits from capturing actual pro-environmental behavior of a large sample and measuring behavioral frequency and context stability based on objective indicators (e.g., recorded time stamps). Furthermore, the pattern of results is directly predicted by habit theory and is not easily explained by other theoretical frameworks. Despite these strengths, it is worth noting that our analyses only examined one system for reusing containers for takeaway food. Changes in potentially related behaviors (e.g., using competing systems for reusables or single-use containers, reduced consumption of takeaway food) could not be measured. As such, the present research did not test spillover (Thøgersen and Ölander, 2003; Truelove et al., 2014) or compensatory effects (Kaklamanou et al., 2015) on other behaviors.

Furthermore, it should be noted that field data were collected during the Covid-19 pandemic and absolute levels of system use may not be comparable to times before and after the pandemic. However, the pandemic seems unlikely to have compromised our tests of the main effect of a temporal interruption and the moderating effect of context stability. Our data cover the period of late 2021 and early 2022, when the pandemic was ongoing. Thus, comparisons between intervals before and after Christmas (i.e., tests of the main effect of the interruption) are unlikely to be affected by the pandemic because system use both before and after the interruption occurred during similar stages of the pandemic. With respect to context stability, there is no reason to think that individuals who used the system in more or less stable contexts were affected by the pandemic to different extents. Taken together, the core finding that pro-environmental behaviors are more durable if they are

[6] The model was replicated with different cutoff thresholds (25% and 75% quantiles). Both models confirmed that the interruption had a larger negative effect on users with less consistent times of day of use (absolute difference in changes: 0.08, $p < 0.01$, and 0.11, $p < 0.001$, respectively).A final model including users' consistency of times of day as a continuous variable confirmed results: A one standard deviation increase of users' inconsistency of times of day in the pre-Christmas interval was associated with a 0.03 ($p < 0.05$) increase in the negative effect of the interruption.

[7] A model with a cutoff threshold of three restaurants confirmed that the interruption had a larger negative effect on individuals who used the system in less stable contexts (i.e., visited at least three restaurants) compared to those in more stable contexts (i.e., visited at most two restaurants; absolute difference in changes: 0.19, $p < 0.01$).Additionally, the original model was replicated for users with at least four takeouts pre-Christmas (top 26.6% most frequent users). Results confirmed that the interruption had a larger negative effect on frequent users in less stable contexts (i.e., visited two or more restaurants) compared to frequent users in more stable contexts (i.e., visited one restaurant; absolute difference in changes: 0.11, $p < 0.05$).Finally, the model was replicated with the number of visited restaurants as an unmodified count variable and all 17,284 users. This model also confirmed our finding: Each additional restaurant visited in the pre-Christmas interval was associated with a 0.11 ($p < 0.001$) increase in the negative effect of the interruption.

Table 2
Effect of the interruption on frequency of use by individuals who visited two or more vs. a single restaurant in the pre-Christmas interval.

	Low context stability (i.e., users who visited two or more different restaurants)	High context stability (i.e., users who visited a single restaurant)
Estimated absolute discontinuous change (Standard error[a])	-0.19*** (0.02)	-0.11*** (0.01)
Absolute difference between the subgroups' discontinuous changes (Standard error[a])	0.08** (0.03)	
Estimated relative discontinuous change (absolute discontinuous change as a percentage of the average number of takeouts the week before Christmas)	-26.8%	-15.9%
n[b]	2832	7558

Notes. *** $p < .001$; ** $p < .01$; * $p < .05$.
[a] Clustered on the user level.
[b] Users who visited at least two restaurants in the pre-Christmas interval ($n = 2832$) were compared to users with at least two takeouts at one restaurant in the pre-Christmas interval ($n = 7558$).

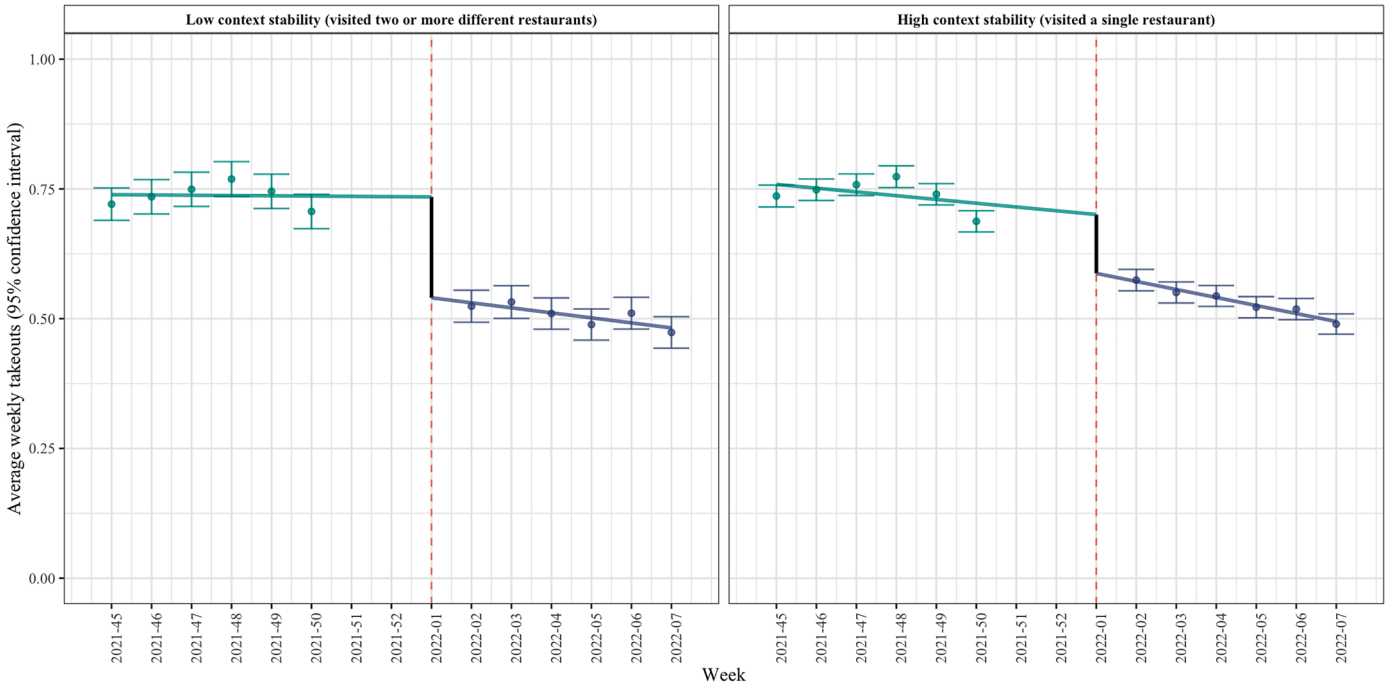


Fig. 5. *Regression discontinuity visualization of the effect of the interruption on frequency of use by individuals who visited two or more (left panel)* vs. *a single restaurant (right panel) in the pre-Christmas interval.*

performed in stable contexts is unlikely to be compromised by the fact that the data were collected during the pandemic.

Additionally, although our findings on the moderating effect of context stability are supported by habit theory, we did not obtain self-reported measures of habit automaticity as additional evidence of users' habit strength (e.g., Self-Report Habit Index, Self-Report Behavioral Automaticity Index, Rebar et al., 2018). Matching observational data with self-reported data is a promising approach for future research. Furthermore, similar analyses could be replicated with contextual factors other than time and location (e.g., whether people typically perform the behavior alone or in social groups, Wood et al., 2005; or whether the behavior is associated with a specific type of food), which were not captured by the data used for this research. Future research may benefit from datasets with more detailed information on individuals, allowing for additional analyses of the circumstances that promote context stability and, as a result, the durability of behaviors.

4.2. Implications for promoting pro-environmental behavior

Understanding the effects of temporal interruptions on everyday behavior is crucial to maintain pro-environmental behaviors. One of the key findings of the present research is that pro-environmental behaviors that are performed in stable contexts are more durable than those not supported by stable cues. This implies that strategies to integrate behaviors into people's regular routines can foster the longevity of pro-environmental behaviors. For instance, regulators and operators of systems for reusable containers could seek to standardize systems so that customers are always exposed to the same cues (e.g., similar signage and messaging). This may even allow different restaurants to be construed as similar and thus stable environmental contexts. Additionally, system operators could seek to tie the behavior to specific temporal and geographical contexts; for example, by encouraging people to have lunch at regular times and establishing the system at locations where food-related choices are made regularly (e.g., around offices, train stations). Furthermore, operators of app-based systems could benefit from automatic notifications prompting system use around typical times and locations of use.

Although the present research focused on the durability of a pro-environmental behavior, these findings might also extend to more unsustainable everyday behaviors. Just like pro-environmental behaviors, unsustainable behaviors are also more likely to survive temporal interruptions if they are anchored in stable contexts. For example, contexts in which single-use packaging is the norm likely continue to be associated with single-use after an interruption. Thus, although our results are promising regarding the durability of habitual pro-environmental behaviors, they also highlight the challenges of breaking environmentally

harmful habits. Having said this, the present research suggests that temporal interruptions might present opportunities to disrupt habits by changing the cues that support such habits (Wood et al., 2005). That is, the habit discontinuity hypothesis suggests that individuals are more receptive to new information and more likely to reconsider their habitual behaviors following changes to behavioral contexts (e.g., moving house or starting a family, Verplanken and Wood, 2006). Our research provides some initial indication that regulators and businesses could leverage temporal interruptions in a similar way, for example by changing contexts (e.g., signage) associated with less sustainable behaviors when users are naturally taking a break.

5. Conclusions

The present research contributes to evidence on how habits affect the durability of pro-environmental behaviors. We analyzed a large field dataset describing individuals' use of reusable containers for takeaway food. Christmas, a quasi-exogenous interruption of routines, was associated with a discontinuous drop in behavioral frequency. The weekly frequency with which users performed the behavior dropped by an average of 16.7% over Christmas. Notably, measures of the extent to which behavior is habitual (namely, performed repeatedly in a stable context) moderated the effect of the temporal interruption on use: Users who typically performed the behavior at more consistent times of day and in fewer restaurants were less affected by the temporal interruption. Thus, this research provides empirical support for recent propositions to consider the habit strength of everyday behaviors in attempts to promote sustainable lifestyles (Mazar et al., 2021; Verplanken and Whitmarsh, 2021). We encourage future research to explore the effects of context stability beyond time and location and how these can be leveraged to maintain pro-environmental behaviors.

CRediT authorship contribution statement

Christoph Ratay: Conceptualization, Methodology, Formal analysis, Data curation, Writing – original draft, Writing – review & editing, Visualization. **Thomas L. Webb:** Methodology, Writing – review & editing. **Wendy Wood:** Methodology, Writing – review & editing. **Alwine Mohnen:** Conceptualization, Methodology.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

Acknowledgments

We thank *Vytal* for providing field data on the use of their system for reusing food containers and the German Federal Environmental Foundation (Deutsche Bundesstiftung Umwelt, DBU) and the Smart Sustainable Plastics Packaging Challenge (SSPP), delivered via the Natural Environment Research Council (NERC; NE/V010638/1), for supporting this work.

Appendix: Descriptive statistics

Variable	pre-Christmas interval	post-Christmas interval
Frequency of use		
No takeouts	$n = 0$ (0.0 %)	$n = 6738$ (39.0 %)
1 takeout	$n = 6894$ (39.9 %)	$n = 3396$ (19.6 %)
2 takeouts	$n = 3662$ (21.2 %)	$n = 2096$ (12.1 %)
3 takeouts	$n = 2128$ (12.3 %)	$n = 1478$ (8.6 %)
4 takeouts	$n = 1354$ (7.8 %)	$n = 963$ (5.6 %)
5 takeouts	$n = 905$ (5.2 %)	$n = 716$ (4.1 %)
6 or more takeouts	$n = 2341$ (13.5 %)	$n = 1897$ (11.0 %)
Consistency of time of day (measured by the standard deviation of times of day in hours)[a]	$M = 1.1$ ($SD = 1.3$)	$M = 1.1$ ($SD = 1.2$)
Consistency of location of use		
No restaurants visited	$n = 0$ (0.0 %)	$n = 6738$ (39.0 %)
1 restaurant visited	$n = 14{,}452$ (83.6 %)	$n = 8430$ (48.8 %)
2 restaurants visited	$n = 2203$ (12.7 %)	$n = 1599$ (9.3 %)
3 restaurants visited	$n = 471$ (2.7 %)	$n = 366$ (2.1 %)
4 or more restaurants visited	$n = 158$ (0.9 %)	$n = 151$ (0.9 %)

[a] Calculated for the subsample of users with at least two takeouts in the pre-Christmas ($n = 10{,}390$) and post-Christmas interval ($n = 7150$), respectively.

References

Acland, D., Levy, M.R., 2015. Naiveté, projection bias, and habit formation in gym attendance. Manage. Sci. 61, 146–160. https://doi.org/10.1287/mnsc.2014.2091.

Carrington, M.J., Neville, B.A., Whitwell, G.J., 2010. Why Ethical Consumers Don't Walk Their Talk: towards a Framework for Understanding the Gap Between the Ethical Purchase Intentions and Actual Buying Behaviour of Ethically Minded Consumers. J. Bus. Ethics 97, 139–158. https://doi.org/10.1007/s10551-010-0501-6.

Cunningham, S., 2021. Regression Discontinuity, in: Causal Inference: The Mixtape. Yale University Press, Yale, pp. 241–314.

Dean, A.J., Kneebone, S., Tull, F., Lauren, N., Smith, L.D.G., 2021. 'Stickiness' of water-saving behaviours: what factors influence whether behaviours are maintained or given up? Resour. Conserv. Recycl. 169, 105531 https://doi.org/10.1016/j.resconrec.2021.105531.

Ellen MacArthur Foundation, 2023. Unlocking a reuse revolution: scaling returnable packaging. https://www.ellenmacarthurfoundation.org/scaling-returnable-packaging/downloads (accessed 9 January 2024).

European Parliament, 2023. Parliament adopts revamped rules to reduce, reuse and recycle packaging. https://www.europarl.europa.eu/news/en/press-room/20231117IPR12213/parliament-adopts-revamped-rules-to-reduce-reuse-and-recycle-packaging (accessed 9 January 2024).

Fredslund, E.K., Leppin, A., 2019. Can the easter break induce a long-term break of exercise routines? an analysis of danish gym data using a regression discontinuity design. BMJ Open 9, e024043. https://doi.org/10.1136/bmjopen-2018-024043.

Gallego-Schmid, A., Mendoza, J.M.F., Azapagic, A., 2019. Environmental impacts of takeaway food containers. J. Clean Prod. 211, 417–427. https://doi.org/10.1016/j.jclepro.2018.11.220.

Gkargkavouzi, A., Halkos, G., Matsiori, S., 2019. Environmental behavior in a private-sphere context: integrating theories of planned behavior and value belief norm, self-identity and habit. Resour. Conserv. Recycl. 148, 145–156. https://doi.org/10.1016/j.resconrec.2019.01.039.

Greenwood, S.C., Walker, S., Baird, H.M., Parsons, R., Mehl, S., Webb, T.L., Slark, A.T., Ryan, A.J., Rothman, R.H., 2021. Many happy returns: combining insights from the environmental and behavioural sciences to understand what is required to make

reusable packaging mainstream. Sustain. Prod. Consum. 27, 1688–1702. https://doi.org/10.1016/j.spc.2021.03.022.
Hausman, C., Rapson, D.S., 2018. Regression discontinuity in time: considerations for empirical applications. Annu. Rev. Resour. Econ. 10, 533–552. https://doi.org/10.1146/annurev-resource-121517-033306.
Hornsey, M.J., Harris, E.A., Bain, P.G., Fielding, K.S., 2016. Meta-analyses of the determinants and outcomes of belief in climate change. Nat. Clim. Chang. 6, 622–626. https://doi.org/10.1038/nclimate2943.
Kaklamanou, D., Jones, C.R., Webb, T.L., Walker, S.R., 2015. Using Public Transport Can Make Up for Flying Abroad on Holiday: compensatory Green Beliefs and Environmentally Significant Behavior. Environ. Behav. 47, 184–204. https://doi.org/10.1177/0013916513488784.
Klöckner, C.A., 2013. A Comprehensive Model of the Psychology of Environmental Behaviour - A Meta-analysis. Global Environ. Change 23, 1028–1038. https://doi.org/10.1016/j.gloenvcha.2013.05.014.
Kollmuss, A., Agyeman, J., 2002. Mind the Gap: why Do People Act Environmentally and What Are the Barriers to Pro-environmental Behavior? Environ. Educ. Res. 8, 239–260. https://doi.org/10.1080/13504620220145401.
Lee, D.S., Lemieux, T., 2010. Regression Discontinuity designs in economics. J. Econ. Lit. 48, 281–355. https://doi.org/10.1257/jel.48.2.281.
Mazar, A., Tomaino, G., Carmon, Z., Wood, W., 2021. Habits to Save Our Habitat: using the Psychology of Habits to Promote Sustainability. Behav. Sci. Policy 7, 75–89. https://doi.org/10.1353/bsp.2021.0014.
Mazar, A., Wood, W., 2018. Defining Habit in Psychology. In: Verplanken, B. (Ed.), The Psychology of Habit: Theory, Mechanisms, Change, and Contexts. Springer International Publishing, Cham, pp. 13–29. https://doi.org/10.1007/978-3-319-97529-0_2.
Milkman, K.L., Minson, J.A., Volpp, K.G.M., 2014. Holding the hunger games hostage at the Gym: an evaluation of temptation bundling. Manage. Sci. 60, 283–299. https://doi.org/10.1287/mnsc.2013.1784.
Ouellette, J.A., Wood, W., 1998. Psychological Bulletin Habit and Intention in Everyday Life: the Multiple Processes by Which Past Behavior Predicts Future Behavior. Psychol. Bull. 124, 54–74. https://doi.org/10.1037/0033-2909.124.1.54.
Rebar, A.L., Gardner, B., Rhodes, R.E., Verplanken, B., 2018. The Measurement of Habit. In: Verplanken, B. (Ed.), The Psychology of Habit. Springer International Publishing, Cham, pp. 31–49. https://doi.org/10.1007/978-3-319-97529-0_3.
Recker, J., Bockelmann, T., Barthel, F., 2023. Growing online-to-offline platform businesses: how Vytal became the world-leading provider of smart reusable food packaging. Inf. Syst. J. 1–22. https://doi.org/10.1111/isj.12474.
Russell, S.V., Young, C.W., Unsworth, K.L., Robinson, C., 2017. Bringing Habits and Emotions into Food Waste Behaviour. Resour. Conserv. Recycl. 125, 107–114. https://doi.org/10.1016/j.resconrec.2017.06.007.
Sheeran, P., Webb, T.L., 2016. The Intention-Behavior Gap. Soc. Personal Psychol. Compass 10, 503–518. https://doi.org/10.1111/spc3.12265.
Steg, L., Vlek, C., 2009. Encouraging Pro-Environmental Behaviour: an Integrative Review and Research Agenda. J. Environ. Psychol. 29, 309–317. https://doi.org/10.1016/j.jenvp.2008.10.004.
Thøgersen, J., Ölander, F., 2003. Spillover of environment-friendly consumer behaviour. J. Environ. Psychol. 23, 225–236. https://doi.org/10.1016/S0272-4944(03)00018-5.
Timlett, R.E., Williams, I.D., 2009. The impact of transient populations on recycling behaviour in a densely populated urban environment. Resour. Conserv. Recycl 53, 498–506. https://doi.org/10.1016/j.resconrec.2009.03.010.
Truelove, H.B., Carrico, A.R., Weber, E.U., Raimi, K.T., Vandenbergh, M.P., 2014. Positive and negative spillover of pro-environmental behavior: an integrative review and theoretical framework. Global Environ. Change 29, 127–138. https://doi.org/10.1016/j.gloenvcha.2014.09.004.
Verplanken, B., 2006. Beyond frequency: habit as mental construct. British J. Soci. Psychol. 45, 639–656. https://doi.org/10.1348/014466605X49122.
Verplanken, B., Orbell, S., 2022. Attitudes, Habits, and Behavior Change. Annu. Rev. Psychol. 73, 327–352. https://doi.org/10.1146/annurev-psych-020821-011744.
Verplanken, B., Roy, D., 2016. Empowering interventions to promote sustainable lifestyles: testing the habit discontinuity hypothesis in a field experiment. J. Environ. Psychol. 45, 127–134. https://doi.org/10.1016/j.jenvp.2015.11.008.
Verplanken, B., Walker, I., Davis, A., Jurasek, M., 2008. Context change and travel mode choice: combining the habit discontinuity and self-activation hypotheses. J. Environ. Psychol. 28, 121–127. https://doi.org/10.1016/j.jenvp.2007.10.005.
Verplanken, B., Whitmarsh, L., 2021. Habit and climate change. Curr. Opin. Behav. Sci. 42, 42–46. https://doi.org/10.1016/j.cobeha.2021.02.020.
Verplanken, B., Wood, W., 2006. Interventions to break and create consumer habits. J. Public Policy & Marketing 25, 90–103. https://doi.org/10.1509/jppm.25.1.90.
Walker, I., Thomas, G.O., Verplanken, B., 2015. Old habits die hard: travel habit formation and decay during an office relocation. Environ. Behav. 47, 1089–1106. https://doi.org/10.1177/0013916514549619.
Wood, W., Neal, D.T., 2016. Healthy through habit: interventions for initiating & maintaining health behavior change. Behav. Sci. Policy 2, 71–83. https://doi.org/10.1353/bsp.2016.0008.
Wood, W., Rünger, D., 2016. Psychology of Habit. Annu. Rev. Psychol. 67, 289–314. https://doi.org/10.1146/annurev-psych-122414-033417.
Wood, W., Tam, L., Witt, M.G., 2005. Changing circumstances, disrupting habits. J. Pers. Soc. Psychol. 88, 918–933. https://doi.org/10.1037/0022-3514.88.6.918.
Young, W., Hwang, K., McDonald, S., Oates, C.J., 2010. Sustainable Consumption: green Consumer Behaviour When Purchasing Products. Sustain. Development 18, 20–31. https://doi.org/10.1002/sd.394.