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Habits and Reflective Processes in COVID-19 Transmission-reducing Behaviors: Examining Theoretical Predictions in a Representative Sample of the Population of Scotland

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Abstract

Background Based on theory, COVID-19 transmission-reducing behaviors (TRBs) should become habitual because of their frequent performance. Habits have been hypothesized to develop through reflective processes and, to act in conjunction with them.

Purpose We investigated the existence, development, and consequences of TRB habits, for physical distancing, handwashing, and wearing face coverings.

Methods A representative sample of the Scottish population (N = 1,003) was interviewed by a commercial polling company in August–October 2020 and half were re-interviewed later. Measures included adherence, habit, personal routine tendency, reflective processes, and action control for three TRBs. Data were analyzed using general linear modeling, regression, and mediation analyses.

Results Handwashing was most habitual; only face covering became more habitual over time. Routine tendencies predicted TRB habits, and adherence to handwashing and physical distancing. Those reporting greater habits reported better adherence, for physical distancing and handwashing, and this remained true after controlling for previous adherence. Reflective and habit processes independently predicted adherence for physical distancing and handwashing; only reflective processes were independently predictive for face covering. The relationship between planning and forgetting and adherence was partly direct, and partly mediated by habit.

Conclusions The results confirm hypotheses from habit theory including the role of repetition and of personal routine tendency in developing habits. They are consistent with dual processing theory in finding that both reflective and habit processes predict adherence to TRBs. Action planning partly mediated the relation between reflective processes and adherence. The COVID-19 pandemic has enabled the testing and confirmation of several theoretical hypotheses about habit processes in the enactment of TRBs.

Lay summary

During the COVID-19 pandemic we were all asked to adopt protective behaviors, for example, keeping distance from people, wearing face masks, and handwashing. When people do the same thing repeatedly in the same situation, that behavior is likely to become a habit. As habits are generally easier to perform and maintain than planned behaviors, understanding whether the protective behaviors we adopted during COVID-19 became habitual will help us understand how best to support people to adopt infection protective behaviors in future. In this study we examined whether protective behaviors became habitual over time during the pandemic. We found that handwashing was the most habitual behavior. This is likely because hand washing was a behavior that people already regularly performed pre-pandemic. Wearing face masks was the only behavior to become more habitual over time. People with stronger habits were more likely to perform the recommendations about handwashing and physical distancing. When you want people to perform a new protective behavior this can be accomplished by making a plan to do it. Following through on these plans will eventually form habits. Habitually performed behaviors that prevent COVID-19 might also help prevent other infections and could therefore improve population health.

Keywords COVID-19 · Transmission-reducing behaviors · Habit · Personal routine tendency · Reflective processes · Adherence

Introduction

The COVID-19 pandemic has highlighted the importance of understanding how to change and maintain behavior. COVID-19 transmission-reducing behaviors (TRBs) including physical distancing, handwashing, and wearing face covering have been advised, or mandated universally during the pandemic and are crucial in controlling the spread of infection [1, 2]. Unlike TRBs that only need to be performed once or twice, such as receiving a vaccine, these TRBs must be performed frequently and consistently and would therefore theoretically benefit from being habitual rather than requiring conscious effort each time they are performed. The present study investigates five questions regarding the existence, development, and consequences of habits relating to COVID-19 TRBs.

Existence: Do All Three TRBs Become More Habitual with Time and Repetition (RQ1)?

Habits are built by frequent repetition of a behavior in response to the same cue, context, or situation, and definitions emphasize the development of automaticity over time. For example, Gardner and colleagues define habit as: "a process by which a stimulus automatically generates an impulse towards action, based on learned stimulus–response associations [3]." Similarly, Wood and Neal (2009, p. 580 [4]) define habits as "A type of automaticity characterized by a rigid contextual cuing of behavior that does not depend on people's goals and intentions. Habits develop as people respond repeatedly in a stable context and thereby form direct associations in memory between that response and cues in the performance context." Consequently, for behavior to become habitual, they must be frequently performed with similar contextual cues. For example, every time (frequent repetition) when getting on transportation (contextual cue) you put on a face covering (behavior becomes habitual).

In terms of repetition, evidence suggests that daily behaviors take about 66 days to become habitual [5], and this figure was corroborated by the finding that on average a variety of daily behaviors became habitual in 59 days [6]. Since being recommended or mandated by governments early in 2020, well over 66 days have passed since TRBs were first initiated. There is ample evidence that people have reported frequently engaging in TRBs during the pandemic [3,7–11]. A recent study found objective evidence of sustained TRB adherence for physical distancing [12], while another study found that wearing face covering increased following legislation in the USA [13]. There is some evidence, that suggests adherence between the TRBs differs, namely that adherence is greater to wearing a face covering than to physical distancing or handwashing, which could influence the frequency of the behavior and thus it becoming habitual [11]. Taken together, this suggests that all three TRBs have had the opportunity to become habitual, although each TRB may have a different pattern. Therefore, we first seek to explore the existence and level of habit in TRBs.

Development: Is Adherence to TRBs Influenced Through Dual Processing, Going Through Both Reflective and Automatic Routes in Parallel (RQ2)?

Dual process models, such as the Reflective-Impulsive Model, give insight into how habits might come about. It proposes two parallel processes governing behavior: a reflective route involving goals, reasoning, decisions and intentions, and a faster, non-reflective, associative, impulsive route exemplified by habitual, or emotional drivers of action [14]. It might be expected that once initiated, with frequent repetition behaviors would become habitual, or automatic over time and therefore require less cognitive control. Hence, after initiating behavior through reflective processes, there will likely be a time when both processes are involved. As behaviors are repeated in the same context, they become guided less by intentional, goal-directed, reflective processes and become more triggered by cues in the environment [15].

Several studies have demonstrated that, internationally, adherence to TRBs is predictable from conscious, reflective social cognition variables, especially self-efficacy (confidence in being able to perform the behaviors) [16, 17], intention [11], and risk perception [18]. Adherence has also been investigated using more comprehensive theoretical models. Protection Motivation Theory [19] was used to assess if threat appraisals (i.e., perceived vulnerability and severity) and coping appraisals (self-efficacy, response efficacy, response costs) affect protection motivation (intentions) and self-reported COVID-19 preventive behaviors (i.e., wearing face covering, wearing gloves, handwashing, mixing with other people during work) amongst health care workers in Iran. Social Cognitive Theory [11] and the Theory of Planned behavior [20] were used focusing mainly on the determinants self-efficacy and intentions, and including social norms, attitudes, and outcome expectancies. These studies looked at adherence to guidelines (e.g., physical distancing, handwashing, wearing face covering) amongst a representative sample of the general public in Scotland and the USA. Finally using the Health Belief Model [17] research assessed some overlapping determinants, including perceived threat (i.e., perceived susceptibility and severity), perceived benefits and barriers, self-efficacy, and cues to action. Handwashing and social distancing practices were compared between adults from four countries, the USA, Mexico, Hong Kong, and Taiwan. Besides behaviors being influenced by the reflective route, several studies find evidence that they are simultaneously influenced through the faster, non-reflective, impulsive route, as habits were working in parallel with social cognitive variables in predicting other behaviors [21–25].

Taking our example of wearing a face covering, when first introduced, wearing a face covering was likely to have involved reflective cognitive processing. After several months, these initial motivations may have become less important; TRBs initially controlled reflectively and involving conscious processes may have become habitual and less reflective. It is also plausible that TRBs may exhibit both parallel and sequential patterns of reflective and habitual processes simultaneously, as seen in predicting physical distancing TRBs [26]. Each TRB may have a different pattern—one may be relatively more reflective and another relatively more habitual. The current study explores whether social cognitive factors, habits, or both are associated with adherence to TRBs.

Development: Do Planning and Forgetting Influence Behavior Directly, and By Enhancing or Diminishing the Development of Habits (RQ3)?

One way the reflective route could influence behavior becoming habitual is through planning. Evidence for the interplay between intention and behaviors through planning was found in a study of doctors' clinical behaviors: doctors who intended to act in accordance with guidelines, were more likely to implement the recommended behaviors if they had made plans of how they would do it [25]. Similarly, planning partially mediated the relationship between intentions and TRBs for both physical distancing and handwashing, but not for wearing face covering [27]. For example, the intention to wear a face covering might lead to planning (i.e., taking them with you, putting on before getting on public transport) resulting in greater frequency of the behavior, and therefore a greater likelihood that the behavior would become habitual. Moreover, planning often involves cues in the environment (i.e., how, under what circumstances and when the behavior will be performed) that are important components of behavior becoming habitual. Research has already shown that habits mediated the effect of planning on clinical behaviors of guideline-recommended advising, prescribing,

and examining behaviors amongst general practitioners and practice nurses [24]. In other words, doctors' behavior became habitual through planning, leading to changed behavior 12 months later.

In addition to planning, action control may also be influenced by other conscious cognitive processes such as memory or not forgetting. Working memory is important in determining the impact of reflective and impulsive processes on behavior [28]; most obviously because intentions are more likely to be turned into action if not forgotten. Indeed, Allan et al. [29] found that an intervention providing prompts (to prompt memory and prevent forgetting) was effective in reducing unhealthy snacking behavior. In an intervention providing a poster to help students remember the behavior, the tendency to remember to act as intended predicted both behavior and habit strength in acquiring a novel health behavior (i.e., microwaving sponges or dishcloths to reduce cross-contamination risks) [22]. By remembering the intention to wear face covering, one would be more likely to wear it, the frequency of the behavior would increase, and therefore wearing of a face covering would be more likely to become habitual. Therefore, in the current study, we assess whether planning, and forgetting (or remembering, not forgetting) are associated with behavior becoming more habitual (through repetition of the behavior), which is associated with behavior becoming less effortful and therefore adherence rates to become higher. In other words, planning, and forgetting are predicted to affect adherence mediated by habits.

Consequences: Is Adherence Greater When the TRBs are Habitual (RQ4), or People Have a Personal Tendency for Routine (RQ5)?

By becoming habitual one might expect TRBs to be more reliably performed than if they were reliant upon effortful (and therefore more fallible) conscious action control. Habit formation is key in the maintenance of behaviors over time [30]. Some research indeed shows that habits are important for adherence related to physical distancing and hand hygiene [23, 31–33].

Alternatively, being habitual could be a personal tendency or trait, such that the person who is habitual about one TRB will typically be habitual about others. For example, individuals scoring high in conscientiousness, were more likely to exhibit TRB adherence [20]. It has also been proposed that being habitual goes beyond behaviors within a particular domain, and that it is possible to measure the extent to which each individual is a "creature of habit" [34]. In the current study we assess whether people with a tendency for routine also are more likely to form TRB specific habits, and whether having TRB habits are associated with more adherence.

The Present Study

In sum, while likely to be consciously controlled at least initially, TRBs are behaviors with the potential to become habitual over time leading to the hypothesis that all TRBs are or become habitual over the course of the study (RQ1). We focused on physical distancing, handwashing, and wearing face coverings. This was assessed by exploring the self-reported behavioral automaticity index (SRBAI) amongst participants, and whether extent of habits increased in a later follow-up. Habitual processes (automaticity of behaviors and personal routine tendency) may operate in parallel with or develop sequentially from conscious processes; and action control processes, like planning and forgetting, may influence behavior directly or via their association with the development of habits. As such, we hypothesis that social cognitive factors (self-efficacy and intentions), habits (SRBAI) or both are associated with adherence to TRBs (RQ2, also see Fig. 1). We assessed whether planning and forgetting enhance or diminish habit formation and whether habits affect TRBs measured in a later follow-up (RQ3). We hypothesized that adherence would increase if behaviors were more automatic (RQ4). Finally, we hypothesized that adherence to TRBs and habits was greater if people had higher personal routine tendencies (RQ5).Consequently, the present study aimed to assess the existence, development, and consequence of habits in the context of COVID-19, after enough time went by for TRBs to become habitual.

Methods

Design and Participants

Participants were recruited as part of the larger COVID-19 Health and Adherence Research in Scotland (CHARIS) project, the protocol of which is described elsewhere [35]. Briefly, 14 cross-sectional waves explored determinants of COVID-19 TRBs through telephone interviews. Ipsos MORI, a commercial polling company, recruited ~500 adults in Scotland per wave using random digit dialing to secure a nationally representative sample on each occasion. The surveys included a core set of questions, assessing adherence to TRBs, demographics, and determinants from three behavioral theories. In addition, in each wave a changing set of questions was assessed. These questions covered non-core themes, which were based on triggers/events over time.

The habit questions used in the present study were part of these additional themes (wave 9, wave 12, and wave 14, which we have termed sample 1, sample 2, and time 2). Sample 1 (N = 503, August 13th to 26th 2020) and sample 2 (N = 500, September 24th to October 7th, 2020) were conducted at time 1. In wave 14, we collected data from participants in sample 1 and sample 2 in a longitudinal follow-up. Participants from wave 9 and 12 (the habit-themed waves) who consented to follow-up and who were contacted for a second interview. Participants were randomly re-contacted until a sample of ~500 adults was reached for wave 14 (N = 489, October 22nd to November 4th, 2020), with approximately 50% from wave 9 and wave 12. None of the other waves included habit measurements. Data collection took

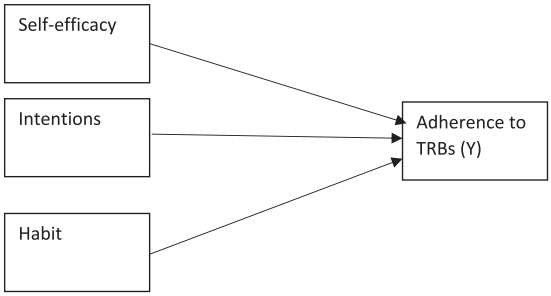

Fig. 1. Multivariate linear regression of the predictors self-efficacy, intention, and habit (self-reported behavioural automaticity, SRBAI) on adherence to transmission-reducing behaviors (TRBs).

place between 9 am–9 pm on weekdays and 10 am–7 pm on weekends.

In Scotland, the first release from lockdown was May 28th, 2020. Face covering was mandated on June 22nd in public transport and on July 10th in shops, 3 months later than handwashing, and physical distancing (21st March 2020). Ethical approval was granted by the Ethics Review Board at the University of Aberdeen (SERB/2020/5/1942).

Measures

Adherence

Adherence to three TRBs were assessed [35, 36]: physical distancing, wearing face covering, and handwashing, by asking how often participants had done each behavior in the past week using a five-point response scale, from 1 = "Never" to 5 = "Always." For example, physical distancing: "In the past week, …I stayed 2 meters (6 feet) away from other people, except those who live in my household," handwashing: "…I washed my hands as soon as I got home," and wearing face covering: "…I wore face covering when I was in a shop." Average adherence was calculated for wearing face covering (two items) and handwashing (four items), and a single item score was used for physical distancing. At time 2, only four adherence items were assessed to reduce respondent burden (meaning that handwashing was measured with one item).

Reflective processes

Self-efficacy about the three TRB was determined by asking participants to rate (on a four-point scale from not at all confident—very confident): "How confident or not are you that you can follow the government instructions, all or most of the time, on, for example, Staying 2 meters (6 feet) away from other people, except those who live in your household?" *Intentions* about each type of TRB were measured on a five-point scale, from 1 = "Never" to 5 = "Always" by asking: "Do you intend to follow the government instructions on each of the following….."

Habit

Four items from the Self-Report behavioral Automaticity Index (SRBAI) were asked for each of the three types of TRB: physical distancing: "Staying 2 meters (6 feet) away from other people, except those who live in your household…," handwashing: "Washing your hands thoroughly and frequently…," and wearing face covering: "Wearing a face covering when out shopping or on public transport…." The items for each behavior were: "… is something you do automatically," "…is something you do without having to consciously remember," "…is something you do without thinking," and "…is something you start doing before you realize you're doing it" rated on a four-point agreement scale. Cronbach's alpha was 0.88 for physical distancing, 0.89 for handwashing, and 0.91 for face covering, reflecting very good internal consistency.

Planning and forgetting

Planning and forgetting were each assessed for each type of TRB rated on four-point agreement scale. The planning item was: " …is something you have a regular plan of how you do it," the forgetting item was "…is something you sometimes forget to do."

Personal routine tendency

Creature of Habit Scale (COHS), the four items from the "routines" scale of the COHS with the highest scores on the measure of homogeneity and scalability were selected. For example, "You tend to like routine." Each item was rated on the four-point agreement scale. Cronbach's alpha was 0.76, reflecting good internal consistency.

Sociodemographic characteristics

Sociodemographic characteristics assessed were age in years, gender, ethnicity (i.e., White; Mixed or Multiple Ethnic groups; Asian, or Asian Scottish, or Asian British; African; Caribbean, or Black, or Black Scottish, or Black British; Arab; Other ethnic group), and Scottish Index of Multiple Deprivation (SIMD) that groups 6,976 postcodes into deciles (1 = most deprived;10 = least deprived).

Analysis

Summary statistics are presented in Table 1 for each of our samples and the Scottish population, using a chi-square test to compare age, gender, ethnicity, and SIMD between the Scottish population and in turn the participants in sample 1 and sample 2, and the re-contacted sample at time 2. The data were analyzed using SPSS version 25.0. For all variables, answers "Not applicable," "I don't know" and "I prefer not to say" were treated as missing values and, therefore, excluded from the analyses. Most data only had a few missing values. Adherence had one exception to the general low numbers of missing data; wearing face covering in public transport had 76.0% missing because this behavior was only applicable to those using public transport in the previous week. The next highest level of missing adherence data was for physical distancing, which had only 5.2% missing. For the habit questions missing ranged between 0.0% and 1.6%. *p*-Values of $p < .05$ were taken as statistically significant.

We combine participants from sample 1 and 2 wherever we can, only assessing differences if relevant for the research question (RQ1), and look at the relationships of predictors to outcomes later in time. We report the theoretically weaker concurrent relationships in the Supplementary materials. (RQ1) A general linear model using habit scores as repeated-measure variables (measured for each of the three TRBs), and sample as the between-subject variable, was used to compare habit in sample 1 and 2 (recruited 6 weeks apart) to examine change over time. We compared measures from time 1 (sample 1 and sample 2) with time 2 within the same participants (the follow-up measure). Sample was added as a control to account for potential differences over time between these two cross-sectional groups. (RQ2) Multivariate linear regression assessed if TRBs are controlled by parallel, dual processing of habit, and reflective routes, with self-efficacy, intention, and habit as predictor variables, and adherence to TRBs as outcome (see Fig. 1). We report the influences of the predictor variables at time 1 on behavior at time 2, and in the supplementary we report concurrent behavior (outcome: adherence time 1 for sample 1 and 2 together). (RQ3) Mediation analyses were done between planning and forgetting and adherence with the mediator habit (see Fig. 2). We used bootstrapping (10,000 samples) and, total effects, direct effects, and indirect effects estimated by means of ordinary least squares regression, using Hayes's PROCESS macro (Model 4) [37]. We report the mediation for independent and mediator variables at time 1 on

Table 1 Summary of Sociodemographic Data for Both Samples at Time 1, for the Sample Re-contacted at Time 2 and for the Scottish Adult Population

	Sample 1 (Time 1)		Sample 2 (Time 1)		Time 2		Scottish adult population[a]
	N	%	N	%	N	%	%
Total	503	100	500	100	489	100	100
Age							
Mean (*SD*)	51.8 (18.6)		52.5 (18.2)		53.5 (18.1)		
Age							
16–24	51	10.1	43	8.6	41	8.4	14.4
25–34	73	14.5	67	13.4	58	11.9	15.2
35–44	67	13.3	66	13.2	57	11.7	16.8
45–54	66	13.1	70	14.0	72	14.7	18.0
55–64	101	20.1	104	20.8	107	21.9	15.2
65+	145	28.8	150	30.0	154	31.5	20.3
Gender							
Male	193	38.4	199	39.8	207	42.3	47.9
Female	308	61.5	301	60.2	282	57.7	52.1
Missing	2	0.4	–	–	–	–	–
Ethnicity							
White	476	94.6	484	96.8	479	98.0	96.0
Other group	17	3.4	10	2.0	9	1.8	4.0
Missing	10	2.0	6	1.2	1	0.2	–
SIMD							
1	61	12.1	58	11.6	64	13.1	19.5
2	63	12.5	64	12.8	66	13.5	20.0
3	91	18.1	83	16.6	103	21.1	20.2
4	106	21.1	105	21.0	113	23.1	20.0
5	97	19.3	111	22.2	112	22.9	20.3
Missing	85	16.9	79	15.8	31	6.3	

SIMD Scottish Index of Multiple Deprivation.
[a]Source https://www.nrscotland.gov.uk/statistics-and-data/statistics/statistics-by-theme/population/population-estimates/2011-based-special-area-population-estimates/population-estimates-by-simd-2016.

behavior at time 2, and in the supplementary we report concurrent behavior (outcome: adherence time 1 for sample 1 and 2 together). (RQ4) Univariate linear regression assessed whether adherence is greater when behaviors became more habitual. We assessed whether habit assessed at time 1 predicted adherence at time 2, in hierarchical linear regression adding previous adherence to assess whether habit predicted adherence over and above adherence at time 1. (RQ5) Univariate linear regression assessed whether adherence and habit are greater for people with higher personal routine tendency.

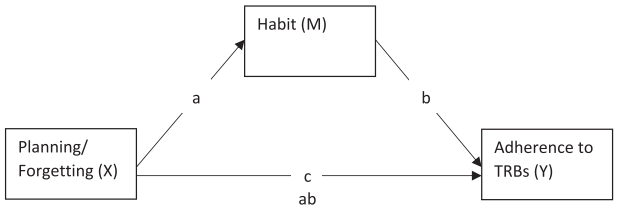

Fig. 2. Mediation analyses between planning and forgetting (X) adherence to transmission-reducing behaviors (TRBs, Y) and mediator (M) habit (self-reported behavioural automaticity, SRBAI).

Results

Participants

See Table 1 for participants' sociodemographic characteristics and the Scottish population for comparison. Participants differed significantly: in *age*, the Scottish population had more people in both the younger and older age categories [sample 1: $\chi^2(5) = 42.36$, $p < .001$, sample 2: $\chi^2(5) = 54.24$, $p < .001$, time 2: $\chi^2(5) = 70.70$, $p < .001$]; in *gender*, with more men in the Scottish population [sample 1: $\chi^2(1) = 17.72$, $p < .001$, sample 2: $\chi^2(1) = 13.20$, $p < .001$, time 2: $\chi^2(1) = 6.11$, $p = .043$]; and in SIMD, the Scottish population having more people who are more deprived [sample 1: $\chi^2(4) = 18.62$, $p < .001$, sample 2: $\chi^2(4) = 24.89$, $p < .001$, time 2: $\chi^2(4) = 24.52$, $p < .001$]. Excluding the missing *ethnicity* in our samples did not statistically differ from adults in the Scottish population. Adherence to physical distancing correlated with handwashing ($r = .25$, $p < .001$), but not with wearing face covering ($r = .01$), handwashing correlated with wearing face covering ($r = .06$, $p < .001$). See Tables 2 and 3 for descriptive data of all variables and correlations.

RQ1: Do All Three TRBs Become More Habitual with Time and Repetition?

There was a significant main effect, $F(2,994) = 54.08$, $p < .001$, ${}_p\eta^2 = .10$, showing that handwashing was more

Table 2 Summary of the Descriptive Data for All Variables for the Participants of Sample 1 and 2 Combined

Measure	TRB	Samples 1 and 2		
		Mean	SD	Range
Adherence	Physical distancing	4.3s	0.9	1–5
	Handwashing	4.6	0.5	1–5
	Face covering	4.9	0.6	1–5
Habit	Physical distancing	3.0	0.8	1–4
	Face covering	3.0	0.9	1–4
	Handwashing	3.3	0.8	1–4
Self-efficacy	Physical distancing	3.1	0.8	1–4
	Handwashing	3.7	0.5	1–4
	Face covering	3.8	0.5	1–4
Intention	Physical distancing	4.3	0.8	1–5
	Handwashing	4.7	0.6	1–5
	Face covering	4.9	0.6	1–5
Planning	Physical distancing	3.0	0.9	1–4
	Handwashing	3.2	0.9	1–4
	Face covering	3.4	0.8	1–4
Forgetting	Physical distancing	2.4	1.0	1–4
	Handwashing	1.9	1.0	1–4
	Face covering	1.7	1.0	1–4
Personal routine tendency*		12.2	2.6	4–16

*For personal routine tendency (creature of habit scale, COHS), only participants at time 2 are included (i.e., the half of sample 1 and the half of sample 2 who were re-contacted).

habitual than physical distancing and wearing face covering (p's < .001), which did not differ (p = .110, Table 2). Also, the interaction effect between behavior and time was significant, $F(2,994) = 5.19$, $p < .006$, ${}_p\eta^2 = .01$. Level of habit, physical distancing and handwashing did not change over time, but increased for wearing face covering, $F(1,995) = 9.73$, $p < .002$, ${}_p\eta^2 = .01$ (Fig. 3). No other effects reached significance. Thus, handwashing was most habitual. Only wearing face covering, last to be mandated, became more habitual.

RQ2: Is Adherence to TRBs Influenced Though Dual Processing, in Parallel Going Through Both Reflective and Automatic Routes?

Multivariate linear regression showed that the reflective processes (self-efficacy and intention), and habit were both significantly associated with adherence to later **physical distancing,** $F(3,462) = 34.56$, $p < .001$, $R^2 = 0.18$ (for concurrent analyses see Supplementary Materials). People with higher self-efficacy and intentions ($\beta = .26$, $p < .001$, and $\beta = .12$, $p = .020$ respectively), and for whom the behavior was more habitual ($\beta = .15$, $p < .003$) were more likely to adhere to physical distancing. Intention and habit were significantly associated with adherence to **handwashing,** $F(3,467) = 61.68$, $p < .001$, $R^2 = 0.28$. People with higher intentions ($\beta = .44$, $p < .001$), and for whom the behavior was more habitual ($\beta = .26$, $p < .001$) were more likely to adhere to handwashing. Self-efficacy was not associated with adherence to handwashing ($\beta = .13$, $p = .104$). Only intention was significantly associated with adherence to **wearing face covering**, self-efficacy, and habit were not, $F(3,452) = 63.49$, $p < .001$, $R^2 = 0.30$. People with higher intentions were more likely to adhere to wearing face covering ($\beta = .51$, $p < .001$), but people with high self-efficacy or for whom the behavior was more habitual were *not* more likely to adhere to wearing face covering ($\beta = .01$, $p = .857$, and $\beta = .02$, $p = .378$ respectively).

RQ3: Do Planning and Forgetting Influence Behavior Directly, and By Enhancing or Diminishing the Development of Habit?

The direct effect of the reflective process is represented in Table 4 by "c" and the indirect effect, via habit, by the path "ab." For each TRB at time 2, path "a," from planning/forgetting to habit was significant (for concurrent analyses see Supplementary Materials). Path "b," from habit to adherence, was also significant in each case except for the analysis of planning for face covering. Direct effects of planning or forgetting on adherence, path "c," was significant for each TRB. Indirect effects, via habit, path "ab," was significant in each analysis except for the effects of planning for face covering. Thus, the effect of both planning and forgetting on adherence was partly direct and partly mediated by habit, except for the effects of planning for face covering.

RQ4: Is Adherence Greater When the TRB is Habitual?

Univariate regression showed that time 2 adherence to **physical distancing** was predicted by its level of habit, $F(1,466) = 43.90$, $p < .001$, $R^2 = 0.09$ (for the same analyses using concurrent adherence see Supplementary Materials). People for whom physical distancing was more habitual at time 1, had higher adherence to physical distancing at time 2. In hierarchical regression analysis, previous adherence was added in a second step; both habit and previous adherence were significantly associated with adherence to physical

Table 3 Correlations Between Variables for Combined Samples 1 and 2 (Data for each sample separately are presented in Supplementary File, Table S1)

	Physical distancing						Handwashing						Face covering					
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
1. Adherence																		
2. SE	.48***						.49***						.54***					
3. Intention	.51***	.54***					.59***	.56***					.73***	.60***				
4. Habit	.41***	.46***	.42***				.54***	.43***	.46***				.22***	.22***	.28***			
5. Planning	.40***	.43***	.41***	.55***			.46***	.31***	.37***	.52***			.29***	.26***	.35***	.45***		
6.Forgetting	−.26***	−.23***	−.23***	−.37***	−.31***		−.45***	−.36***	−.35***	−.54***	−.36***		−.15***	−.15***	−.17***	−.34***	−.25***	
7. Personal routine tendency	.18***	.19***	.14***	.30***	.25***	−.13**	.22***	.16***	.18***	.21***	.17***	−.04	.17***	.05	.15***	.28***	.12*	−.04

Significant p-values are indicated by * (<.05), ** (<.01), and *** (<.001)

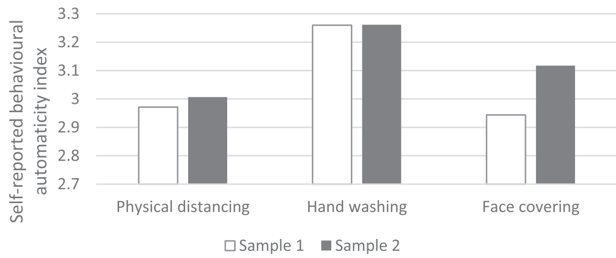

Fig. 3. Habit scores (self-reported behavioural automaticity index, SRBAI) for the three behaviors comparing sample 1 and sample 2, who were recruited 6 weeks apart.

distancing, $F(2,462) = 43.73$, $p < .001$, $R^2 = 0.17$, $\Delta R^2 = .08$ (Beta habit = 0.18, $p < .001$, Beta Time 1 Adherence = .28, $p < .001$).

Time 2 adherence to **handwashing** was associated with its level of habit, $F(1,469) = 112.33$, $p < .001$, $R^2 = 0.19$. People for whom handwashing was more habitual at time 1, had higher adherence to handwashing at time 2. In hierarchical regression analysis, time 1 adherence measured using four handwashing items was added in a second step; both habit and previous adherence were significantly associated with time 2 adherence to handwashing, $F(2,468) = 118.17$, $p < .001$, $R^2 = 0.36$, $\Delta R^2 = .16$ (Beta habit = 0.16, $p < .001$, Beta Time 1 Adherence = .79, $p < .001$). This analysis was repeated using only the first handwashing item (rather than all 4); both habit and time 1 adherence were significantly associated with adherence to handwashing, $F(2,468) = 139.40$, $p < .001$, $R^2 = 0.38$, $\Delta R^2 = .19$ (Beta habit = 0.21, $p < .001$, Beta Time 1 Adherence = .52, $p < .001$).

Time 2 adherence to wearing **face covering** was associated with its level of habit, $F(1,455) = 12.29$, $p < .001$, $R^2 = 0.03$. People for whom wearing face covering was more habitual at time 1, had higher adherence to wearing face covering at time 2. In hierarchical regression analysis, time 1 adherence was added in a second step; habit was no longer associated with time 2 wearing face covering, $F(2,442) = 78.04$, $p < .001$, $R^2 = 0.26$, $\Delta R^2 = .23$ (Beta habit = 0.03, $p = .139$, Beta time 2 Adherence = .45, $p < .001$). In sum, across all three TRBs, those who reported being more habitual reported higher adherence, for physical distancing, and handwashing; this was still the case controlling for past adherence.

RQ5: Is Adherence Greater When People Have a Personal Tendency for Routine?

Univariate regression showed that adherence to **physical distancing** was associated with personal routine tendency, $F(1,465) = 7.28$, $p = .007$, $R^2 = 0.02$. People scoring higher on personal routine tendency had higher adherence to physical distancing. Adherence to **handwashing** was associated with personal routine tendency, $F(1,468) = 8.18$, $p = .004$, $R^2 = 0.02$. People scoring higher on personal routine tendency had higher adherence to handwashing. Finally, adherence to **wearing a face covering** was *not* associated with personal routine tendency, $F(1,454) = 1.73$, $p = .189$. In sum, personal routine tendency predicted physical distancing and handwashing but not face covering.

Univariate regression showed that the extent to which each TRB was habitual was associated with personal routine tendency. People scoring higher on personal routine tendency, scored higher on habit for **physical distancing** $F(1,486) =$

Table 4 Results of Mediation Analyses (RQ3)

TRB	On Habit	Habit on adherence	Indirect via Habit	Direct
Pathway	a	b	ab	c
Planning				
Physical distancing	.48* *(.42,.54)*	.20* *(.09,.31)*	.10* *(.04,.16)*	.15* *(.06,.25)*
Handwashing	.47* *(.40,.53)*	.33* *(.23,.43)*	.15* *(.09,.22)*	.19* *(.11,.28)*
Face covering	.47* *(.38,.56)*	.04 *(–.00,.09)*	.02 *(–0.00,.05)*	.08* *(.03,.13)*
Forgetting				
Physical distancing	–.37* *(–.43, –.30)*	.25* *(.15,.35)*	–.09* *(–.14, –.05)*	–.07* *(–.15, –.01)*
Handwashing	–.46* *(–.53, –.40)*	.36* *(.26,.47)*	–.17* *(–.24, –.11)*	–.13* *(–.22, –.05)*
Face covering	–.38* *(–.46, –.30)*	.07* *(.02,.11)*	–.03* *(–.06, –.00)*	–.02* *(–.06, –.03)*

[a]Letters a, b, c indicate the paths of the mediation analysis.
*$p < .05$; Figures in brackets are 95% confidence intervals.

46.82, $p < .001$, $R^2 = 0.09$. People scoring higher on personal routine tendency, scored higher on habit for **handwashing** $F(1,486) = 23.11$, $p < .001$, $R^2 = 0.05$. People scoring higher on personal routine tendency, scored higher on habit **for wearing a face covering**, $F(1,484) = 40.42$, $p < .001$, $R^2 = 0.08$. In sum, personal routine tendency predicted habitualness for each TRB.

Discussion

The present study examined habit and adherence to three types of COVID-19 TRBs, namely physical distancing, handwashing and wearing a face covering, in the Scottish population approximately 3 and 5 months after release from the first government mandated lockdown. There was some evidence for the existence of habit for all three behaviors, with handwashing being more habitual than the other two behaviors. Only wearing face coverings became more habitual with time between the two sampling occasions.

The three TRBs differed in the likely frequency of daily repetition and in weeks since pandemic onset and being mandated. Handwashing behaviors incur several repetitions per day and were likely to have been at least somewhat habitual prior to the pandemic; for example, adults in Korea were washing their hands an average of 4.8 times per day in 2006 prior to pandemics and prior to public health campaigns [38] and in 2009 in the USA the average was 8.6 times [39]. Handwashing behaviors could be carried out frequently and regularly even during lockdown, whereas opportunities and necessity for physical distancing and wearing face covering were restricted when the population was being asked to stay at home. Taking into account previous studies of the time taken to acquire a daily habitual behavior [3, 8] it is likely that handwashing had reached a stable level of habit by the time of the current study as several months had passed from the point at which it was recommended to the public.

Keeping a safe distance from others who could have an illness is something that participants have likely performed many times throughout their lives. However, physical distancing to the extent people were asked to perform it during the pandemic was new behavior. Physical distancing only began to be practiced regularly (but perhaps not daily) after release from lockdown, 73 days before the first respondents were interviewed. There was no increase over time in the extent to which this behavior was habitual and the current results may represent the limits of habit and the need for other explanations of this behavior. Importantly, this behavior may have had less opportunity to become habitual as the context in which it is performed is unlikely to be stable (e.g., required at busy times but not others, required flexibly in contexts with people from other households, etc.), unlike the performance of the other two behaviors. Handwashing is invariably carried out in a similar context (at a sink) and mask wearing was enforced in all shops and public transport settings so reliably occurred each time such a setting was visited. In addition, physical distancing may be more likely to be disrupted by the behavior of other people and, as suggested by Verplanken and Orbell [40], this disruption may bring the behavior back under reflective control. Wearing a face covering was probably a near-daily behavior required to be performed in well-defined contexts (public transport and shops) which became more habitual between approximately 6 weeks and 12 weeks of being mandated (22nd June and 10th July respectively), fitting the 59–66 day habit pattern [3, 8].

In addition, the findings gave some insights into the development of habits. The results support the joint functioning of dual reflective (self-efficacy, intention) and automatic (habit) processes in predicting adherence for physical distancing and handwashing but not for wearing of face covering. This may be due to face covering habits still being developed, as this is the newest behavior in the TRB repertoire, and thus being under more reflective control. Another possible explanation is that, unlike the other two TRBs, wearing of face coverings may be externally motivated by being legally mandated, resulting in different reflective processes. Indeed, also looking at the correlations, interventions for changing adherence to wearing of a face covering might focus on social cognitive predictors such as self-efficacy and intentions. As Verplanken and Orbell [40] propose, reflective processes are likely to be important in habit formation as well as when habitual behaviors are disrupted.

It is therefore important to investigate the process by which reflective processes become habitual. We have already shown in previous papers that cognitive processes (planning and forgetting) mediate the impact of intentions on TRBs [29] emulating the findings in studies of doctors' clinical behaviors [28]. The current study goes further and finds that the relationships between planning and forgetting and each TRB were partly mediated by habit. The only exception was that the habit of face covering at time 1 did not predict, nor

mediate between planning and adherence at time 2, perhaps due to the increase in the habitual state of face covering between the two occasions.

Replication of these patterns of mediation are important both because they confirm the theorizing of several authors [17,40] that reflective processes can be consolidated in habitual, automatic processes and because it offers opportunities for interventions. Basic learning theory proposes that habits are only developed by frequent repetition of the behaviors in association with rewards or context and this is the method adopted in many experimental studies [41]. By contrast, social cognitive approaches allow that behavior change techniques that develop motivation or that increase action control may affect behavior change that can then be supported by environmental prompts [42]. The effectiveness of action planning or implementation intention interventions in changing behavior has been attributed to their success in functioning like habits but without the burden of habit development by repeated performance [43]. On the other hand, the breaking of an undesirable habit may require some habit disruption such as a change of environmental context before social cognitive factors can be influential [40].

Habitual processes had consequences for behavior in the present study. Adherence to all three TRBs was greater if it was reported to be habitual. Causality might work in both directions: more frequent adherence is likely to build habits, while the formation of a habit likely prompts greater adherence. However, for both physical distancing and handwashing, habit was predictive of adherence allowing for earlier performance of the behavior, supporting the hypothesis of a causal role for habit. Furthermore, a personal tendency of towards being habitual [34] or past adherence predicted the extent to which each TRB became habitual, suggesting that habit development may depend on individual characteristics. Personal routine tendency predicted adherence to physical distancing and handwashing but not face covering, which suggests it may be controlled more by external factors such as legislation or social disapproval.

While the evidence presented supports the theoretical underpinnings of the study, it says little about how to intervene to enhance habits relevant to COVID-19 prevention. One implication is that social cognitive factors could increase behavior and therefore lead to habit formation. Results from the CHARIS project have been reported regularly to Scottish Government to assist in their understanding of TRBs [44]. The results confirm that the behaviors studied were becoming automatic and that this assisted adherence to guidelines. Further, messages which enhance motivation or self-efficacy may, by enhancing planning and reducing forgetting, serve to develop these valuable habits.

Strengths and Limitations

Many of the strengths and limitations arise from the timely conduct of this study in the context of a pandemic: strengths in the opportunity to investigate habit development for behaviors that were either new or required to be performed in new contexts, and limitations in the need to establish the study with limited resources and to minimize respondent burden. Participants were recruited using random selection procedures resulting in more representative samples than via opportunistic or online recruitment, although there was some deviation from the national population. To reduce respondent burden, abbreviated versions of measures were used. Because the power was determined in relation to another study, we conducted a post hoc power analysis using G*Power and simulation analysis [45]. These analyses show that none of the studies are underpowered, some of the studies might be a little overpowered, therefore in all studies r-squares or confidence intervals are presented to assist in interpreting the data. In addition, correlations below 0.20 may be statistically significant in our study but may not be of practical significance. This was only the case for the association between forgetting and adherence, self-efficacy, and intentions for wearing face covering and for some of the associations with personal tendency for routine. Since this is a more general habit measure not directly linked to specific TRBs, we would expect a weaker correlation especially with the social cognitive factors.

The study has allowed us to examine theoretical proposals about the development of habit and the consequences of habit for three behaviors. However, these investigations were limited to observational rather than experimental designs, and so, positive findings for a hypothesis only offer support rather than a test of the hypothesis; null or negative findings tend to disconfirm the hypotheses. In a separate study, we have experimentally manipulated self-efficacy and found increased intention to engage in physical distancing [46] providing more support for the involvement of causal processes. The assessment of the behaviors was exclusively by self-report, a limitation common to virtually all studies of TRBs during COVID-19. In addition to the usual problems of bias in self-report, reporting of adherence to TRBs may have been distorted by inaccurate knowledge or assessment of how the TRBs should be performed, resulting in the high levels of adherence reported. Apart from wearing of a face covering (before becoming mandated) adherence to all behaviors was high in the Scottish population. The distribution of behaviors was high and therefore variance was limited. This could have made it more difficult to see relationships between habit and adherence to TRBs prospectively, as behavior rates were already high, but we still found that people who reported planning and not forgetting, and thus were more likely to have habits, also showed more adherence later in time.

Conclusions

The COVID-19 pandemic has presented the opportunity and necessity to gain further understanding of habit formation and the establishment of TRBs over time. Our evidence suggests that these behaviors do become habitual, especially in individuals with a "habitual" personal tendency, and that automaticity may contribute to improved adherence. Nevertheless, both reflective and automatic processes are involved in TRB adherence and intentional goal-direction may enhance adherence both directly via action control, by planning and remembering, and indirectly by planning resulting in habit development. If established TRBs persisted as habits beyond the immediate threat of COVID-19, these same TRBs might usefully prevent the transmission of other infections, including flu and the common cold [47], improving general population health.

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Compliance with Ethical Standards

Conflict of Interest All authors declare no conflict of interest.

Authors' Contributions Chantal den Daas (Conceptualization: Equal; Formal analysis: Lead; Funding acquisition: Equal; Investigation: Lead; Methodology: Lead; Project administration: Lead; Writing – original draft: Lead), Diane Dixon (Conceptualization: Lead; Funding acquisition: Lead; Methodology: Supporting; Project administration: Supporting; Writing – review & editing: Supporting), Gill Hubbard (Conceptualization: Supporting; Funding acquisition: Equal; Methodology: Supporting; Writing – review & editing: Supporting), Julia Allan (Conceptualization: Supporting; Writing – review & editing: Supporting), Marie Johnston (Conceptualization: Lead; Funding acquisition: Equal; Methodology: Lead; Writing – review & editing: Lead)

Statement Regarding Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study. Ethical approval was granted by the Life Sciences and Medicine College Ethics Review Board (CERB) at the University of Aberdeen (CERB/2020/5/1942).

Statement Regarding Informed Consent All participants were asked to provide verbal informed consent prior to starting the survey, for sharing their information with researchers, and for follow-up research related to the study. In addition, specific verbal consent was requested for the postcode information, used to code region information and Scottish Index of Multiple Deprivation.

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Supplementary Material

Supplementary material is available at *Annals of Behavioral Medicine* online.

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