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ARTICLE

Reducing touching eyes, nose and mouth ('T-zone') to reduce the spread of infectious disease: A prospective study of motivational, volitional and non-reflective predictors

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Abstract

Background: The route into the body for many pathogens is through the eyes, nose and mouth (i.e., the 'T-zone') via inhalation or fomite-based transfer during face touching. It is important to understand factors that are associated with touching the T-zone to inform preventive strategies.

Purpose: To identify theory-informed predictors of intention to reduce facial 'T-zone' touching and self-reported 'T-zone' touching.

Methods: We conducted a nationally representative prospective questionnaire study of Canadians. Respondents were randomized to answer questions about touching their eyes, nose, or mouth with a questionnaire assessing 11 factors from an augmented Health Action Process Approach at baseline: intention, outcome expectancies, risk perception, individual severity, self-efficacy, action planning, coping planning, social support, automaticity, goal facilitation and stability of context. At 2-week follow-up, we assessed HAPA-based indicators of self-regulatory activities (awareness of standards, effort, self-monitoring) and self-reported behaviour (primary dependent variable).

Results: Of 656 Canadian adults recruited, 569 responded to follow-up (87% response rate). Across all areas of the 'T-zone', outcome expectancy was the strongest predictor of intention to reduce facial 'T-zone' touching, while

self-efficacy was a significant predictor for only the eyes and mouth. Automaticity was the strongest predictor of behaviour at the 2-week follow-up. No sociodemographic or psychological factors predicted behaviour, with the exception of self-efficacy, which negatively predicted eye touching.
Conclusion: Findings suggest that focusing on reflective processes may increase intention to reduce 'T-zone' touching, while reducing actual 'T-zone' touching may require strategies that address the automatic nature of this behaviour.

KEYWORDS
automaticity, COVID-19, face touching, health action process approach, infection control, T-zone

Statement of contribution

What is already known on this subject?

- The route into the body for several viruses that pose a significant threat to public health is through the nose, eyes and mouth (i.e., the facial 'T-zone').
- People touch their face at least 50 times per hour and even more frequently within their facial 'T-zone'.
- Dual-process models of health behaviour explain motivational and volitional reflective processes alongside automatic processes.

What does this study add?

- Constructs within the Health Action Process Approach account for variability in intention to reduce touching nose, eyes and mouth.
- Automaticity was the strongest predictor of 'T-zone' touching behaviour.

Targeting motivation to reduce 'T-zone' touching may be a reflective process while reducing behaviour may require strategies addressing its automaticity.

INTRODUCTION

The route into the body for several viruses that pose a significant threat to public health is through the nose, eyes and mouth (i.e., the facial 'T-zone'); this is the case for novel viruses, such as SARS-CoV-2, as well as for recurring seasonal viruses such as influenza (Hendley et al., 1973; Wang et al., 2008). Two potential routes of infection are through inhalation of infected droplets and aerosols and transfer from fomites by physical contact between one's hands and one's eyes, nose, or mouth (Rahman, Aziz, et al., 2020; West et al., 2020). Early in the COVID-19 pandemic, concern regarding the transmission of disease centred on fomites, and public health practices such as disinfecting objects and surfaces and washing hands were emphasized, along with physical distancing (West et al., 2020). While there is an existing literature on hand hygiene behaviour, our understanding of 'T-zone' touching is comparatively small. As our knowledge about the transmission of SARS-CoV-2 grew, we learned that touching the eyes, nose or mouth was not likely to be largely implicated in transmission (Goldman, 2020; Mondelli et al., 2021; Onakpoya et al., 2021; Rahman, Aziz, et al., 2020); however, it remains a behaviour that is relevant for other seasonal viruses, such as influenza, as contact with contaminated surfaces (fomites) remains a highly relevant transmission risk for several infectious diseases. People touch their face as a whole at least 50 times per

hour, mostly within their facial 'T-zone' (Kwok et al., 2015; Nicas & Best, 2008; Rahman, Mumin, & Fakhruddin, 2020). This likely happens even without people realizing, providing constant opportunities for transmission of potentially infectious pathogens (Mueller et al., 2019).

Risk mitigation against infectious diseases is best achieved as a series of layers of protective behaviours, where no one behaviour serves as a panacea. In the case of epidemics and pandemics, as the COVID-19 pandemic has demonstrated, multiple layers of personal protective behaviours are often needed to protect oneself and to stem community transmission (Lazarus et al., 2022). Hand hygiene is among such protective behaviours; however, the frequency of facial 'T-zone' touching far outpaces the frequency of handwashing for most people. Furthermore, as mask wearing is promoted and mandated in some contexts, inadvertent 'T-zone' touching might occur with donning and doffing (and adjusting whilst wearing) of face masks and provides a potential opportunity for infection (Perez-Alba et al., 2021). Directly reducing face touching—and the facial 'T-zone' specifically—has received comparatively less research attention or public health promotion.

In the early stages of the COVID-19 pandemic, observational studies emerged to explore this behaviour. These studies quantify the frequency of face touching, highlighting its frequent occurrence, and distinguish between rates of touching both non-mucosal and mucosal areas, including the eyes, nose and mouth (Kwok et al., 2015; Nicas & Best, 2008; Rahman, Mumin, & Fakhruddin, 2020). In light of international guidelines (World Health Organisation, 2022) advocating hand hygiene and avoiding touching the face, specifically the eyes, nose and mouth, there was an investigation of a theory-based intervention to reduce this behaviour; however, intervention development in that study relied on extrapolating findings from investigations of other COVID-19 protective behaviours and there was no significant effect of the intervention, calling for further research (Smith et al., 2022). Later, when widespread mask mandates came into effect in many parts of the world, observational studies then sought to determine whether there were implications of mask wearing on the frequency of face touching; current evidence suggests a lack of or negative association between the two (Chen et al., 2020; Liebst et al., 2021; Lucas et al., 2020; Perez-Alba et al., 2021; Tao et al., 2020).

Research to date has been largely observational, providing insight into the rates of touching and some indication of how other personal protective behaviours may or may not influence behaviour (Chen et al., 2020; Liebst et al., 2021; Lucas et al., 2020; Rahman, Mumin, & Fakhruddin, 2020; Tao et al., 2020); however, these studies focus on quantifying the frequency of face touching rather than understanding its modifiable determinants. Physiological research suggests that emotional and cognitive processes have a significant role in the behaviour of self-face touching and further, that the pattern of face touching (i.e., area and duration of contact) is influenced by these demands, while maintaining that this is largely with little or no awareness (Grunwald et al., 2014; Mueller et al., 2019). Related research implicates perceived risk severity of face touching, as well as perceived barriers and self-efficacy of not touching one's face as stable predictors of face-touching mitigation behaviour, lending support to established theories of behaviour, which might also be applicable in efforts to better understand the behaviour of 'T-zone' touching itself (Yang et al., 2022).

In contrast to some other personal protective behaviours encouraged in the fight against COVID-19 and other infectious diseases, face touching is a pre-existing behaviour that may be operating outside of awareness in response to an itch, social cues/mimicry (Duffy & Chartrand, 2015), adjusting facial accessories (i.e., glasses, face mask, piercings), or posture (such as sitting at a desk to read a computer screen, which may provoke resting one's hand on chin to cover mouth; Mueller et al., 2019). 'T-zone' touching is likely subject to dual processes: a reflective process (decisions that we make) and an automatic process of which we are largely unaware (Strack & Deutsch, 2004; West, 2006). All else being equal, the faster-acting automatic process guides what we do unless disrupted. The degree of automaticity of 'T-zone' touching relative to other motivational and volitional processes remains uninvestigated as far as we know and to our knowledge, there are no studies yet on how to reduce this behaviour.

The Health Action Process Approach (HAPA) is a well-tested model of health behaviour change, accounting for factors linked to intention formation (pre-intentional processes in the motivational phase) and the translation of intention into action to bridge the divide between intention and action

(post-intentional processes in the volitional phase; Schwarzer, 2008; Zhang et al., 2019). HAPA proposes that during the motivational phase, individuals form Intentions based on their confidence to enact the behaviour (Self-efficacy), their expectations of what might happen should they engage in the behaviour (Outcome Expectancies) and their perceived risk of either engaging or failing to engage in the behaviour (Risk Perception). The post-intentional, volitional phase addresses the Intention-Behaviour gap. During this phase, individual Intention is translated to Behaviour through Action and Coping Planning and Action Control. Self-efficacy, Barriers and Resources, and Social Support are also factors, which may influence Intention and Behaviour included in the model (Schwarzer, 2008).

Whilst HAPA may provide insight into the modifiable factors that determine Intention and the post-intentional factors that bridge the gap between Intention and Behaviour, automaticity is likely to influence behaviour in the instance of 'T-zone' touching. The term 'habit' has been characterized as a form of automaticity (Gardner, 2015). Generally, definitions of habit describe a process whereby contextual cues stimulate behaviour based on learned associations (Gardner, 2015). These associations are learned over time such that through repetition, a shift takes place from motivational control of action to an external triggering stimulus (Wood & Tam, 2005). As such, the stability of the context cannot be negated for its potential to influence behaviour outside of the HAPA constructs (Danner et al., 2008). Further, to contextualize 'T-zone' touching within individuals' system of multiple goal pursuit, goal facilitation (how pursuit of other goals enables the performance of a target behaviour) is another important consideration, which has a demonstrated role in predicting Intention and Behaviour for health behaviours, such as physical activity (Presseau et al., 2010). In the absence of a theory-based investigation into 'T-zone' touching, theoretical constructs both within and external to HAPA must be investigated for a comprehensive understanding of the reflective and automatic processes that dictate this behaviour.

A nuanced understanding of 'T-zone' touching could provide a basis from which an additional protective strategy can be developed alongside physical distancing, hand hygiene, wearing masks and vaccination. Just as these other personal protective behaviours require their own behaviour change and maintenance strategies, reducing 'T-zone' touching will require a unique approach. This research provides a foundational understanding for this approach. We aimed to (1) understand the predictors of individual intention to reduce facial 'T-zone' touching, including exploring differences or similarities between the eyes, nose and mouth and (2) 'T-zone' touching. Descriptive statistics, stratified by sociodemographic factors, were used to first describe the measured variables. Subsequently, hierarchical multiple regression analyses tested whether sociodemographic variables, HAPA constructs and theoretical constructs external to HAPA (i.e., Goal Facilitation (Presseau et al., 2013), Stability of Context and Automaticity (Presseau et al., 2014)) predicted 'T-zone' touching intention and behaviour.

METHODS

Participants

Survey participants were recruited by a market research firm (Leger) to ensure a nationally representative sample of Canadians. A sampling strategy including participant age (18+), gender, province/territory of residence, and ethnicity was used to ensure a representative sample of Canadians based on census data from Statistics Canada. Online survey respondents were randomized to respond about their behaviour of touching one area of their facial 'T-zone' (i.e., eyes, nose, or mouth) in addition to demographic questions.

Questionnaire

The AACTT framework, which includes identification of the Action, Actor, Context, Target and Time to specify behaviour, was used to clearly describe the behaviour of interest (Presseau et al., 2019). Both the actor and the target in this case was oneself, the action was reducing touching one of the eyes, nose,

or mouth, the context was in public spaces, and the time was over the next 2 weeks. We developed questionnaire items to operationalize a dual-process model previously used by Presseau et al. (2017) that combines the motivational and volitional reflective processes of HAPA alongside automatic processes to understand factors associated with both intention and health behaviour (see Appendix S1; Presseau et al., 2014, 2017). This is consistent with the HAPA, augmented by dual-process considerations related to behavioural automaticity (Schwarzer, 2008; Zhang et al., 2019) and Goal Facilitation (Presseau et al., 2010, 2015). In this model, risk perception, outcome expectancies, and self-efficacy were motivational precursors of intention, while volitional processes included action and coping planning, action control and social support, were precursors to behaviour. The questionnaire items were piloted among the research team and colleagues, and subsequently refined to ensure clarity and focus. Unless specified, items were assessed on a 5-point Likert scale of strongly disagree to strongly agree.

Baseline questionnaire items

Intention ($a = .92$, see Appendix S2) was assessed using the shared stem, 'In the next two weeks…' followed by three standard items: '… I intend to reduce touching my [*eyes*/*nose*/*mouth*]', 'I want to reduce touching my [*eyes*/*nose*/*mouth*]', and 'I will reduce touching my [*eyes*/*nose*/*mouth*]'.

Outcome expectancies ($a = .94$) of the behaviour were assessed by 15 items following the common stem, 'If I reduce touching my [*eyes*/*nose*/*mouth*] …'. Items were adapted from Renner and Schwarzer (2005) and informed by survey piloting (Renner & Schwarzer, 2005). Items included, '…I will reduce the spread of SARS-CoV-2/COVID-19 to my family and friends'; '…I will reduce the spread of SARS-CoV-2/COVID-19 in my community'; '… I will reduce the likelihood of getting COVID-19 myself'; '…I will reduce the spread of other viruses, such as the seasonal flu'; '… I will reduce the likelihood of getting other viruses, such as the seasonal flu'; '… I will improve my health overall'; '… I will protect the health of my community'; '… I will feel better about myself'; '… People who are important to me will recognize my efforts'; '… People who are important to me will appreciate my efforts'; '… I will have no effect on the transmission of COVID-19'; '… I will be unable to manage symptoms of a common cold/allergies'; '… I will become annoyed with itches/irritations on my face'; '… I will experience more anxiety from constantly monitoring my actions', and; '… The effort required may distract me from other tasks'.

Risk perception ($a = .92$) was measured by two items following the common stem, 'In the next two weeks, if I do not reduce touching my [*eyes*/*nose*/*mouth*] …' adapted from Renner and Schwarzer (2007), including '… My risk of getting COVID-19 will…' and '… My risk of getting other viruses, such as the seasonal flu will…' using a Likert response scale of decrease greatly to increase greatly (Renner & Schwarzer, 2005).

Individual severity was assessed using the items, 'How serious a threat to your health is getting COVID-19?' and 'How serious a threat to your health is getting other viruses, such as the seasonal flu?' adapted from Renner and Schwarzer (2007) and measured on a scale of can be ignored to life-threatening (Renner & Schwarzer, 2005).

Task self-efficacy ($a = .87$) was assessed using the shared stem, 'I am confident that if I put my mind to it, over the next two weeks I could reduce touching my [*eyes*/*nose*/*mouth*] even if…' followed by 13 potential barriers specific to performance of the behaviour of interest identified by the project team and via survey piloting (Ogedegbe et al., 2003; Presseau et al., 2015). An additional assessment of task self-efficacy included a response to 'For me, reducing touching my [*eyes*] over the next two weeks will be…' on a response scale of very difficult to very easy.

Action planning ($a = .96$) was measured by four items adapted from Sniehotta, Scholz, and Schwarzer, (2005) following the shared stem, 'I have made a specific plan that details…', including 'When (i.e., at what times) to reduce touching my [*eyes*/*nose*/*mouth*] over the next two weeks', 'Where (i.e., in what places) to reduce touching my [*eyes*/*nose*/*mouth*] over the next two weeks', 'In which instances to reduce touching my [*eyes*/*nose*/*mouth*] over the next two weeks', and 'How to reduce touching my [*eyes*/*nose*/*mouth*] over the next two weeks'. (Sniehotta, Schwarzer, et al., 2005).

Coping planning (a = .96) was assessed using the shared stem, 'I have made a detailed plan regarding…', followed by the items, 'What to do if something interferes with me reducing touching my [*eyes/nose/mouth*]', 'How to cope with possible setbacks from reducing touching my [*eyes/nose/mouth*]', 'What to do in difficult situations to make sure I reduce touching my [*eyes/nose/mouth*]', and 'When I have to pay extra attention to make sure I reduce touching my [*eyes/nose/mouth*]', based on Molloy et al. (2010).

Social support (a = .91) was assessed using three items based on Molloy et al. (2010), using the shared stem, 'In the last week, I…' followed by 'Had somebody to encourage me to reduce touching my [*eyes/nose/mouth*]', 'Had somebody who was also trying to reduce touching their [*eyes/nose/mouth*] with me', and 'Felt supported in regularly trying to reduce touching my [*eyes/nose/mouth*]'.

Goal facilitation (a = .89) was assessed using the shared stem, 'I can do other things with my hands to reduce touching my [*eyes/nose/mouth*], such as…' followed by items identified during piloting representing potential alternative behaviours, including 'Put my hands in my pockets', 'Wear gloves', 'Hold an object', 'Hold onto opposite elbows (i.e., cross my arms)', 'Clasp my hands together', 'Use a sleeve/tissue', and 'Sit on my hands'.

Automaticity (a = .94) of facial 'T-zone' touching was assessed using four items based on the Self-Reported Behavioural Automaticity Index, using 'Touching my [*eyes/nose/mouth*] is something…', followed by 'I do automatically', 'I do without having to consciously remember', 'I do without thinking', and 'I start doing before I realize I'm doing it'. (Gardner & Tang, 2014; Verplanken & Orbell, 2003).

The *stability of the context* (a = .91) in which the behaviour is performed in terms of timing (i.e., time of day), place (i.e., physical location) and situation (i.e., circumstances, such as in specific weather, with other people, etc.) was measured on a 5-point Likert scale of very unstable to very stable (Danner et al., 2008).

Two-week follow-up questionnaire items

Self-reported behaviour (primary dependent variable). A 2-week self-reported follow-up survey was used to assess touching each of the eyes, nose and mouth using the following item: 'Touching my [eyes/nose/mouth] is something I do frequently'.

Additionally, measures of awareness of standards, effort and self-monitoring were incorporated, which reflect the processes of Action Control (Sniehotta, Scholz, & Schwarzer, 2005). *Action control* (a = .95) was assessed using seven items following the shared stem, 'Over the last two weeks, I have…', including, 'Often had the idea of reducing touching my [*eyes/nose/mouth*] on my mind', 'Always been aware of needing to reduce touching my [*eyes/nose/mouth*]', 'Regularly thought about my intention to reduce touching my [*eyes/nose/mouth*]', 'Really tried to reduce touching my [*eyes/nose/mouth*]', 'Tried my best to act in accordance with how often I think I should touch my [*eyes/nose/mouth*]', 'Monitored whether I have reduced touching my [*eyes/nose/mouth*]', and 'Watched carefully that I reduced touching my [*eyes/nose/mouth*]'.

Data was collected at two time points to explore whether the baseline variables predicted subsequent 'T-zone' touching; baseline and follow-up data were collected in May and June of 2021, respectively.

Sample size estimation

Using multivariable linear regression with 12 independent behaviour predictors, our power calculation showed that 561 participants would be adequate to achieve 80% power to detect the added predictive ability of a predictor assuming that the full model explains 20% of the variability compared to the reduced model explaining 18% variability using an F-test at the 5% level of significance. To account for potential loss to follow-up, we sought to recruit 650 individuals to take part in the survey at baseline.

Analysis

Anonymized survey data were provided by Leger. Analyses of survey data was first descriptive, stratified by sociodemographic factors including Canadian province or territory of residence, age, sex, gender, ethnicity, employment and other intersecting social factors.

We assessed internal consistency of multi-item theoretical constructs using Cronbach's alpha. For constructs with an alpha of .70 or less, we explored whether consistency could be improved by omitting individual items before calculating the mean of the items measuring each construct to create a summary score. We then investigated the bivariate correlations between measured variables.

Predicting Intention (outcome variable): We tested models of predictors of Intention to reduce facial 'T-zone' touching using ordinary least squares regression. Specifically, we used hierarchical multiple regression analyses to examine whether (1) sociodemographic variables (i.e., age and gender), (2) HAPA motivational predictors of Intention (Outcome Expectancies, Self-efficacy, Risk Perception, Individual Severity and Social Support) and (3) theoretical constructs external to HAPA (Goal Facilitation) predicted behavioural intentions for each area of the 'T-zone' separately. Ordinary Least Squares regressions were employed in the analysis.

Predicting Behaviour (outcome variable): Hierarchical multiple regression analyses, a form of ordinary least squares regression, tested whether (1) sociodemographic variables, (2) HAPA volitional predictors of behaviour (Intention, Self-efficacy, Action Planning, Coping Planning) and (3) theoretical constructs external to HAPA hypothesized to predict behaviour (Goal Facilitation, Stability of Context and Automaticity) predict 'T-zone' touching. Ordinary Least Squares regressions were employed in the analysis.

Testing indirect effects: PROCESS macro model 6, serial mediation (Hayes, 2017) analyses were used to test for indirect associations between Intention and 'T-zone' touching of the eyes, nose and mouth considered together via Action and Coping Planning and Action Control, whilst considering the direct relationship between Automaticity and Behaviour in parallel.

RESULTS

Response rates and demographics

Baseline and follow-up data were collected in May and June of 2021, respectively. A total of 656 individuals completed the initial survey and of these, 569 completed the follow-up survey (86.7% response rate). Participant characteristics are summarized in Table 1. Of those individuals who completed the follow-up survey, 49.03% (279) of the sample identified as female, 50.79% (289) as male. The mean age of respondents was 49.2 years (SD = 17.1).

Predictors of touching the eyes, nose and mouth

The construct scores for facial 'T-zone' touching and intention, considered overall and for each distinct area of the 'T-zone' (i.e., eyes, nose and mouth), are presented in Table 2.

Bivariate correlations

As shown in Table 3, reported frequency of touching eyes, nose and mouth (time 2) was associated with baseline Automaticity and with Social Support (nose) and Task Self-efficacy (eyes and mouth). Across all three areas of the T-zone, Intention was correlated with HAPA-specified motivational constructs including Task Self-efficacy, Outcome Expectancies, Risk Perception, volitional constructs including Action and Coping Planning and Action Control and the multiple behaviour construct of Goal Facilitation. Some

TABLE 1 Participant characteristics.

Characteristic	*N*	%
Gender		
Female	279	49.03
Male	289	50.79
Something else	1	.18
Province/territory of current residence		
British Columbia	78	13.71
Alberta	67	11.76
Saskatchewan	14	2.46
Manitoba	17	2.99
Ontario	218	38.31
Quebec	135	23.73
New Brunswick	9	1.58
Nova Scotia	21	3.69
Prince Edward Island	5	.88
Newfoundland & Labrador	5	.88
Language		
French	133	23.37
English	432	75.92
Other	4	.70
Ethnicity		
Caucasian	437	76.6
Aboriginal/First Nations	9	1.58
Latin American	4	.70
Arabic	8	1.41
Black	18	2.99
South Asian	17	2.99
Southeast Asian	8	1.41
West Asian	4	.70
Chinese	35	6.15
Filipino	11	1.93
Korean	4	.70
Japanese	2	.35
Other	8	1.41
I prefer not to answer	5	.88
Education		
Less than high school	51	8.96
Some college/university	74	13.00
College/Trade school	168	29.53
University certificate or diploma	27	4.75
University Bachelor's degree	158	27.77
University Master's degree	67	11.78
University Doctorate (PhD)	9	1.58
I prefer not to answer	15	2.54

TABLE 1 (Continued)

Characteristic	*N*	%
Religion		
Catholic	191	33.57
Protestant	95	16.67
Muslim	5	.88
Buddhist	6	1.05
Orthodox	6	1.05
Jewish	13	2.28
Hindu	7	1.23
Other	58	10.19
Atheist (not religious)	133	23.37
I prefer not to answer	55	9.67
Practicing religion		
Yes	46	8.08
No	390	68.54
Missing	133	23.37
Employment status		
Working part-time	69	12.13
Working full-time	226	39.72
Self-employed/freelance work	35	6.15
Student	27	4.75
Homemakers	18	3.16
Temporarily laid-off	7	1.23
Unemployed	24	4.22
Retired	154	27.07
I prefer not to answer	9	1.58
If working, leaving primary residence for work		
Yes	197	34.62
No	133	23.37
Missing	239	42.00
Total income		
$19,999 or less	30	5.27
Between $20,000 and $39,999	83	14.59
Between $40,000 and $59,999	86	15.11
Between $60,000 and $79,999	71	12.48
Between $80,000 and $99,999	80	14.06
Between $100,000 and $119,999	59	10.37
Between $120,000 and $139,999	30	5.27
Between $140,000 and $159,999	29	5.10
Between $160,000 and $199,999	28	4.92
Between $200,000 and $249,999	8	1.41
Between $250,000 and $499,999	4	.70
$500, 000 and more	2	.35

(Continues)

TABLE 1 (Continued)

Characteristic	*N*	%
I prefer not to answer	59	10.37
Occupation		
Office worker	83	14.59
Sales	23	4.04
Services	35	6.51
Manual workers	11	1.93
Skilled, semi-skilled workers	24	4.22
Science and technology workers	27	4.74
Professionals	77	13.53
Managers/Administrators	41	7.21
Homemaker	1	.18
Student	15	2.64
Retired	9	1.58
Unemployed	3	.53
Other	34	5.98
I prefer not to answer	5	.88
Missing	181	31.81

TABLE 2 Mean and standard deviation of construct scores.

	Canada			
	Overall mean (SD)	Mouth mean (SD)	Nose mean (SD)	Eyes mean (SD)
Constructs[a]	*N* = 569	*n* = 189	*n* = 186	*n* = 194
Behaviour (T2)[b]	2.83 (1.08)	2.60 (1.07)	2.96 (1.08)	2.94 (1.05)
Intention	3.64 (.99)	3.66 (.94)	3.65 (1.00)	3.62 (1.02)
Outcome expectancies	3.55 (1.04)	3.55 (1.06)	3.57 (1.03)	3.53 (1.02)
Risk perception	3.23 (.81)	3.21 (.85)	3.24 (.80)	3.24 (.77)
Individual severity	3.11 (1.21)	3.01 (1.19)	3.12 (1.23)	3.20 (1.20)
Task self-efficacy	3.47 (1.17)	3.49 (1.17)	3.52 (1.15)	3.42 (1.18)
Action planning	2.62 (1.09)	2.55 (1.10)	2.62 (1.05)	2.68 (1.12)
Coping planning	2.54 (1.06)	2.48 (1.08)	2.49 (1.04)	2.65 (1.07)
Social support	1.90 (1.00)	1.83 (1.00)	1.83 (.95)	2.04 (1.04)
Automaticity	3.30 (1.07)	3.14 (1.11)	3.40 (1.04)	3.35 (1.04)
Goal facilitation	3.30 (1.00)	3.45 (.98)	3.26 (1.00)	3.19 (1.01)
Stability of context	2.98 (.99)	3.07 (1.02)	2.88 (.93)	3.00 (1.02)
Action control	2.88 (1.10)	2.84 (1.08)	2.84 (1.10)	2.96 (1.11)

[a]Constructs were measured on a 5-point Likert scale, from 1 indicating a low or negative response to 5 indicating a high or positive response.

[b]Behaviour was measured using the frequency measure of the Self-Report Habit Index 'Touching my [eyes/nose/mouth] is something I do frequently'.

T-zone specific correlations were also noted, including Social Support only correlation with Intention for touching of the mouth, and Stability of Context associated with Intention for touching of the nose and mouth but not eyes (see Table 3).

TABLE 3 Bivariate correlations.

	1	2	3	4	5	6	7	8	9	10	11
Nose (*N* = 186)											
1. Behaviour (T2)	–										
2. Intention	−.11	–									
3. Task self-efficacy	−.12	.22**	–								
4. Outcome expectancy	−.10	.62***	.29***	–							
5. Risk perception	−.09	.18*	.13	.21**	–						
6. Social Support	.27***	.10	−.02	.11	−.11	–					
7. Action planning	−.05	.38***	.21**	.37***	.06	.35***	–				
8. Coping planning	−.07	.36***	.21**	.38***	.00	.35***	.80***	–			
9. Automaticity	.41***	−.17*	−.31***	−.12	−.13	.02	−.17*	−.12	–		
10. Goal facilitation	−.07	.38***	.18*	.40***	.06	.15*	.39***	.40***	−.14	–	
11. Stable context	.03	.17*	.05	.12	.06	.12	.19**	.15*	−.21**	.14	–
12. Action control (T2)	−.10	.43***	.14	.40***	.17*	.12	.43***	.45***	−.16*	.30***	.07
Mouth (*N* = 189)											
1. Behaviour (T2)	–										
2. Intention	.00	–									
3. Task self-efficacy	−.15*	.33***	–								
4. Outcome expectancy	−.05	.61***	.25***	–							
5. Risk perception	−.03	.18*	.14	.18*	–						
6. Social Support	.05	.23**	.03	.17*	−.24***	–					
7. Action planning	−.11	.37***	.30***	.38***	−.04	.43***	–				
8. Coping planning	−.06	.37***	.25***	.37***	−.14	.48***	.72***	–			
9. Automaticity	.47***	−.14	−.18*	−.13	−.08	.06	−.14	−.12	–		
10. Goal facilitation	−.03	.19**	.31***	.23**	.02	.10	.16*	.16*	−.11	–	
11. Stable context	−.13	.17*	.15*	.14	.09	.03	.24***	.22**	−.31***	.02	–
12. Action control (T2)	.04	.49***	.19**	.34***	.04	.29***	.41***	.37***	−.15*	.12	.19*
Eyes (*n* = 194)											
1. Behaviour (T2)	–										
2. Intention	−.10	–									
3. Task self-efficacy	−.23**	.25***	–								
4. Outcome expectancy	−.02	.56***	.16*	–							
5. Risk perception	−.01	.16*	−.05	.37***	–						
6. Social support	−.05	.12	.22**	.09	.04	–					
7. Action planning	−.11	.43***	.24***	.37***	.17*	.43***	–				
8. Coping planning	−.12	.32***	.25***	.32***	−.01	.48***	.69***	–			
9. Automaticity	.50***	−.18*	−.17*	−.19**	.01	−.10	−.18*	−.18*	–		
10. Goal facilitation	−.08	.24***	.19**	.19**	.03	.14	.24***	.34***	.01	–	

(Continues)

TABLE 3 (Continued)

	1	2	3	4	5	6	7	8	9	10	11
11. Stable context	−.13	.01	.15*	.01	.04	.07	.18*	.20**	−.28***	.09	–
12. Action control (T2)	.00	.53***	.26***	.46***	.14*	.23**	.31***	.35***	−.12	.26***	−.06

*$p < .05$.
**$p < .01$.
***$p < .001$.

Testing predictors of intention to reduce facial T-zone touching

A three step Hierarchical Multiple Regression was conducted to determine predictors of Intention and 'T-zone' touching for each of the three different T-zone areas based on a dual-process model of behaviour (see Table 4). Model one included age and gender as predictors of intention to reduce facial T-zone touching and resulted in a R^2 of .01, .03 and .01 for the eyes, nose and mouth, respectively. Model two, with the addition of HAPA predictors of Intention (Self-efficacy, Risk Perception, Social Support and Outcome Expectancies), was an improvement, with R^2 values of .35 (eyes), .40 (nose) and .43 (mouth). Finally, the non-HAPA construct of Goal Facilitation was added to the third model as a predictor of Intention, accounting for an increase in the explanation of variance for the eyes (R^2 = .36) and nose (R^2 = .41) and no change for the mouth (R^2 = .43). Across all areas of the T-zone, Outcome Expectancies was the strongest predictor of intention to reduce facial T-zone touching. For only the eyes and mouth, Self-efficacy was a significant predictor of Intention.

Testing predictors of 'T-zone' touching

Hierarchical multiple regression analyses were again conducted to determine predictors of facial T-zone touching of each distinct area of the T-zone (i.e., the eyes, nose and mouth). In the first model, the sociodemographic variables of age and gender were included as predictors of behaviour, accounting for little variance in behaviour; R^2 = .02 for the eyes, R^2 = .06 for the nose and R^2 = .02 for the mouth. The addition of HAPA predictors of behaviour (Intention, Self-Efficacy, Action Planning, Coping Planning) in the second model resulted in a small improvement over the earlier model, R^2 = .09 (eyes), R^2 = .08 (nose) and R^2 = .06 (mouth). In the third model, with the addition of theoretical constructs external to HAPA hypothesized to predict behaviour (Goal Facilitation and Automaticity), the model was improved to R^2 = .31 (eyes), R^2 = .23 (nose) and R^2 = .26 (mouth), consistent with medium-large effect sizes (Cohen, 1992). Across all three areas of the T-zone, Automaticity was the strongest predictor of 'T-zone' touching at the 2-week follow-up. Sociodemographic factors, as well as HAPA constructs and Goal Facilitation were not statistically significant predictors of facial 'T-zone' touching, with the exception of Self-Efficacy, which had a negative predictive effect on T-zone touching of the eyes only (see Table 5).

The indirect effects of post-intentional volitional factors on 'T-zone' touching

The HAPA proposes that post-intentional factors, such as Action and Coping Planning and Action Control, mediate the effect of Intention on Behaviour. As Figure 1 shows, the model accounts for 22% of the variance in 'T-zone' touching when all three areas are considered together; however, there were no statistically significant indirect effects of Intention on 'T-zone' touching via any of the post-intentional volitional factors included in the model. Intention significantly predicted Action Planning, Coping Planning and Action Control, but not Behaviour of 'T-zone' touching, either directly (b = −.02, SE = .05, 95% CI [−.11, .08]) or indirectly (b = .02, SE = .03, 95% CI [−.04, .08]; see also Table 6), thus indicating no

TABLE 4 Intention hierarchical multiple regression analyses.

Eyes									
	Model 1			**Model 2**			**Model 3**		
Characteristic	***B***	**95% CI**	***p***	***B***	**95% CI**	***p***	***B***	**95% CI**	***p***
Age	.00	.00, .01	.39	.00	.00, .01	.40	.00	.00, .01	.30
Gender									
Male	—	—		—	—		—	—	
Female	.09	−.20, .39	.52	−.04	−.29, .21	.74	−.05	−.30, .20	.70
Task self-efficacy				.14	.03, .25	.01	.13	.02, .23	.02
Risk perception				−.05	−.21, .12	.59	−.04	−.21, .12	.61
Social support				.03	−.10, .14	.73	.01	−.11, .13	.89
Outcome expectancy				.54	.42, .67	<.01	.52	.40, .65	<.01
Goal facilitation							.12	.00, .24	.05
Note: Model 1 R^2 = .01; Model 2 R^2 = .35; Model 3 R^2 = .36									
Nose									
	Model 1			**Model 2**			**Model 3**		
Characteristic	***B***	**95% CI**	***p***	***B***	**95% CI**	***p***	***B***	**95% CI**	***p***
Age	.00	−.01, .01	.84	.00	.00, .01	.45	.00	−.01, .01	.59
Gender									
Male	—	—		—	—		—	—	
Female	.36	.07, .66	.02	.07	−.17, .31	.57	.07	−.17, .31	.57
Something else	−.45	−2.4, 1.5	.65	−.19	−1.8, 1.4	.82	−.35	−1.9, 1.2	.66
Task self-efficacy				.04	−.07, .14	.51	.02	−.08, .13	.64
Risk perception				.08	−.07, .23	.31	.08	−.07, .23	.30
Social support				.05	−.07, .18	.41	.03	−.09, .16	.61
Outcome expectancy				.57	.45, .69	<.01	.52	.39, .65	<.01
Goal facilitation							.15	.02, .27	.02
Note: Model 1 R^2 = .03; Model 2 R^2 = .40; Model 3 R^2 = .41									
Mouth									
	Model 1			**Model 2**			**Model 3**		
Characteristic	***B***	**95% CI**	***p***	***B***	**95% CI**	***p***	***B***	**95% CI**	***p***
Age	.00	−.01, .00	.25	.00	−.01, .01	.85	.00	−.01, .01	.87
Gender									
Male	—	—		—	—		—	—	
Female	.14	−.13, .41	.31	.06	−.16, .27	.61	.06	−.16, .27	.61
Task self-efficacy				.14	.04, .23	.01	.14	.04, .24	.01
Risk perception				.11	−.02, .24	.11	.11	−.02, .24	.11
Social support				.15	.04, .26	.01	.15	.04, .27	.01
Outcome expectancy				.46	.35, .57	<.01	.46	.35, .57	<.01
Goal facilitation							.01	−.11, .12	.91
Note: Model 1 R^2 = .01; Model 2 R^2 = .43; Model 3 R^2 = .43									

Note: *B* = unstandardized coefficients.

TABLE 5 'T-zone' touching behaviour hierarchical multiple regression analyses.

Eyes									
	Model 1			**Model 2**			**Model 3**		
Characteristic	***B***	**95% CI**	***p***	***B***	**95% CI**	***p***	***B***	**95% CI**	***p***
Age	−.01	−.02, .00	.13	−.01	−.01, .00	.15	−.01	−.02, .00	.05
Gender									
Male	—	—		—	—		—	—	
Female	−.21	−.51, .08	.16	−.14	−.44, .16	.36	−.1	−.36, .16	.44
Intention				−.07	−.25, .11	.44	0	−.16, .16	.97
Task self-efficacy				−.19	−.32, −.06	.01	−.15	−.26, −.03	.02
Action planning				.01	−.18, .20	.94	.02	−.15, .18	.83
Coping planning				−.09	−.28, .10	.35	−.03	−.20, .15	.78
Action control				.11	−.05, .27	.18	.13	−.02, .27	.08
Goal facilitation							−.1	−.24, .03	.14
Stable context							.07	−.06, .21	.30
Automaticity							.51	.38, .64	<.01
Note: Model 1 R^2 = .02; Model 2 R^2 = .09; Model 3 R^2 = .31									
Nose									
	Model 1			**Model 2**			**Model 3**		
Characteristic	***B***	**95% CI**	***p***	***B***	**95% CI**	***p***	***B***	**95% CI**	***p***
Age	−.01	−.02, .00	.01	−.01	−.02, .00	.01	−.01	−.02, .00	.13
Gender									
Male	—	—		—	—		—	—	
Female	−.24	−.55, .07	.13	−.18	−.50, .14	.27	−.2	−.50, .10	.18
Something else	−2.4	−4.5, −.30	.03	−2.6	−4.7, −.47	.02	−2.6	−4.6, −.63	.01
Intention				−.06	−.24, .11	.47	−.06	−.22, .11	.52
Task self-efficacy				−.09	−.23, .05	.20	.02	−.12, .15	.79
Action planning				.03	−.22, .28	.82	.07	−.16, .31	.53
Coping planning				0	−.26, .25	.97	−.06	−.29, .18	.63
Action control				−.08	−.25, .09	.33	−.04	−.19, .12	.63
Goal facilitation							.01	−.15, .17	.91
Stable context							.14	−.02, .30	.10
Automaticity							.44	.29, .59	<.01
Note: Model 1 R^2 = .06; Model 2 R^2 = .08; Model 3 R^2 = .23									
Mouth									
	Model 1			**Model 2**			**Model 3**		
Characteristic	***B***	**95% CI**	***p***	***B***	**95% CI**	***p***	***B***	**95% CI**	***p***
Age	−.01	−.02, .00	.04	−.01	−.02, .00	.11	0	−.01, .00	.26
Gender									
Male	—	—		—	—		—	—	
Female	−.08	−.39, .22	.59	−.07	−.38, .24	.67	−.06	−.34, .22	.66
Intention				.04	−.16, .24	.72	.06	−.12, .23	.54
Task self-efficacy				−.12	−.26, .02	.10	−.07	−.21, .06	.29
Action planning				−.13	−.33, .08	.23	−.11	−.30, .07	.23

TABLE 5 (Continued)

Mouth									
	Model 1			Model 2			Model 3		
Characteristic	*B*	95% CI	*p*	*B*	95% CI	*p*	*B*	95% CI	*p*
Coping planning				.03	−.18, .23	.81	.03	−.16, .21	.79
Action control				.09	−.08, .26	.30	.13	−.02, .28	.09
Goal facilitation							.02	−.13, .18	.76
Stable context							.03	−.12, .17	.70
Automaticity							.45	.32, .58	<.01
Note: Model 1 R^2 = .02; Model 2 R^2 = .06; Model 3 R^2 = .26									

Note: *B* = unstandardized coefficients.

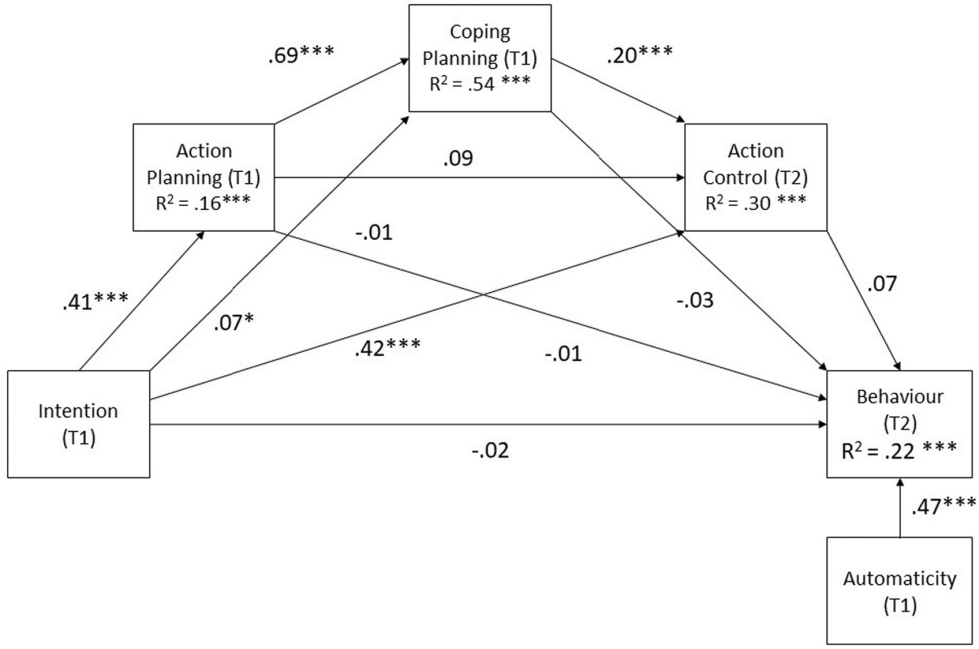

FIGURE 1 Serial multiple mediation analysis of Action Planning, Coping Planning and Action Control in the relationship between Intention and 'T-zone' touching.

mediated effect, or effect otherwise. Automaticity, however, had a statistically significant direct effect on 'T-zone' touching (*b* = .47, SE = .04, 95% CI [.40, .55]). When considering touching all of the eyes, nose and mouth in combination, these findings lend support to a dominant, if not almost exclusive, automatic nature of 'T-zone' touching.

DISCUSSION

In contrast to other personal protective behaviours during epidemics and pandemics, such as hand hygiene, physical distancing and vaccination, there is a dearth of evidence about 'T-zone' touching and interventions designed to influence it. The present research identifies differences across the three behaviours of touching each the eyes, nose and mouth. While much of public health discourse focuses on

TABLE 6 Indirect effects of Intention on 'T-zone' touching.

Indirect effects of intention on 'T-zone' touching	Indirect effect, SE [95% CI]
Intention > Action Planning > Behaviour	−.01, *SE* = .03 [−.05, .04]
Intention > Coping Planning > Behaviour	<−.01, *SE* = .01 [−.01, .01]
Intention > Action Control > Behaviour	.03, *SE* = .02 [−.02, .08]
Intention > Action Planning > Coping Planning > Behaviour	−.01, *SE* = .02 [−.04, .03]
Intention > Action Planning > Action Control > Behaviour	<.01, *SE* = <.01 [−.0019, .0097]
Intention > Coping Planning > Action Control > Behaviour	<.01, *SE* = <.01 [−.0005, .0035]
Intention > Action Planning > Coping Planning > Action Control > Behaviour	<.01, *SE* = <.01 [−.0017, .0124]

face touching as one behaviour, this research lends support to investigating touching each the eyes, nose, mouth separately and may indicate that distinct change strategies are needed to influence each of these unique behaviours.

Additional investigation into the theory-informed correlates of 'T-zone' touching which leverage social cognition models may provide the insight needed to design novel behaviour change interventions through identifying modifiable intervention targets rooted in behavioural science theory (Hagger, Cameron, et al., 2020; Hagger, Moyers, et al., 2020). To address this point, we explored the predictors of individual intention to reduce facial 'T-zone' touching and 'T-zone' touching for each distinct area using constructs within HAPA and augmented by dual-process considerations related to behavioural automaticity.

Intention was measured as an individuals' intention to *reduce* their 'T-zone' touching. Overall, the mean construct score represented a positive indication of intention to reduce facial 'T-zone' touching across all three areas, however, with room for greater intention. These findings suggest that individuals have high pre-existing intentions to reduce the touching of their eyes, nose and mouth, and public health strategies that facilitate the translation of these intentions to behaviour would be beneficial.

Outcome Expectancies was the strongest predictor of individual Intention to reduce facial 'T-zone' touching for all areas of the facial 'T-zone'. Items measuring Outcome Expectancies assessed expectations of both the individual and community health implications of reduced facial 'T-zone' touching. Mean scores for the items related to the influence of facial 'T-zone' touching on individual likelihood of contracting COVID-19 or other infectious diseases were higher when compared to those focused on the implications on disease spread to friends, family, community and items related to the perception of important others of this behaviour change (Appendix S3). These findings may suggest that Outcome Expectancies, and those with a direct effect on the individual, are key in determining Intention to reduce facial 'T-zone' touching. Additionally, similar to other COVID-19 personal protective behaviours, such as social distancing, mask wearing and hand hygiene (Derksen et al., 2020; Hagger, Smith, et al., 2020; Hamilton et al., 2020; Lao et al., 2021), Task Self-efficacy was a significant predictor of Intention; however, findings were statistically significant for only the eyes and mouth. These findings are consistent with the motivational phase of HAPA in helping to understand Intention. On the contrary, the serial multiple mediation analyses draw attention to a persisting Intention-Behaviour gap not mediated by HAPA postulated post-intentional factors, diverging from findings for face-touching mitigation behaviours and highlighting the nuance of this behaviour (Yang et al., 2022).

Automaticity was the strongest predictor of 'T-zone' touching at the 2-week follow-up. Sociodemographic factors, as well as HAPA constructs and Goal Facilitation were not statistically significant predictors of facial 'T-zone' touching, with the exception of Task Self-efficacy, which had a significant relationship with 'T-zone' touching of the eyes only. The study took place during widespread masking mandates across Canada, which could have contributed to this differential, as a mask creates a physical barrier to mouth and nose touching but leaves the eyes susceptible to touch. Conducting a similar study in the absence of a mask mandate could provide an opportunity to test whether self-efficacy's role may be more prominent for the nose and mouth when mask use is much less prevalent. In studies of other

COVID-19 protective behaviours, such as social distancing, Self-efficacy had a prominent role in predicting Intention, and only indirectly on Behaviour mediated by Intention (Hamilton et al., 2020). Research on social distancing also points to the influence of previous behaviour on subsequent behaviour and indicates the possible effects of behavioural constructs that bypass intention and which are rooted in non-conscious processes (Hagger, Smith, et al., 2020; Hamilton et al., 2020). The absence of an effect of Intention on Behaviour suggest that facial 'T-zone' touching should not be conceptualized as a reasoned action, but rather as an automatic behaviour, as is evidenced in the significant predictive effect of Automaticity on Behaviour.

The identification of predictors of Intention and Behaviour have important implications for the development of interventions designed to influence behaviour. These findings suggest targeting constructs within HAPA may have a limited effect on facial 'T-zone' touching. Indeed, this was the case with the theory-based intervention developed by Smith et al. (2022), where avoiding touching one's face increased over time independent of the intervention. While risk perceptions moderated the effect of the intervention in their study, we did not find a significant relationship between risk perceptions and intention to reduce 'T-zone' touching. Whereas Outcome Expectancies and Task Self-efficacy are likely to influence individual Intention, this is unlikely to translate to changes in facial 'T-zone' touching. Despite the Intention-Behaviour gap, these findings provide insight into the predictors of wanting to reduce 'T-zone' touching, which public health interventions could leverage to increase intention to reduce 'T-zone' touching and subsequently employ automaticity-enhancing strategies to enact this intention.

This research suggests that targeting Automaticity may be most effective in reducing facial 'T-zone' touching across all three areas. Significant research exists for promoting the formation of habits for exercise and healthy eating, using strategies that create environments conducive to the desired behaviour (e.g., reminders or environmental restructuring) and context-dependent repetition of alternative behaviours (e.g., response substitution) in public health interventions (Gardner, 2015). Implementation intentions, specifications of the when, where and how of goal-directed behaviour, are another way of tapping into impulsive processes to facilitate behaviour change (Gollwitzer, 1999; Hagger et al., 2016; Hagger & Luszczynska, 2014; Presseau et al., 2021). In the case of facial 'T-zone' touching, the disruption of habit may reap the most benefit. This may involve change strategies, such as reminders to not touch one's facial 'T-zone' in public areas, scented or sound cues (i.e., bracelets or gloves) to alert individuals to their facial 'T-zone' touching, or having tissues readily accessible as an alternative to direct facial 'T-zone' touching. Though, future research seeking to evaluate the effectiveness of the reduction of 'T-zone' touching via implementation intentions should be mindful of the likely lower effectiveness of reducing a behaviour relative to increasing a behaviour (Adriaanse et al., 2011).

Changes in the environment that manipulate the specific cues central to performance provide the greatest opportunity to disrupt habit (Wood & Tam, 2005). In order to develop effective public health interventions aimed to reduce facial 'T-zone' touching, identifying the prominent cues that trigger the behaviour will be an essential avenue for future research. Substantiating the physiological evidence, behavioural science research lends support to the potential of mood and other internal states to act as cues for behaviour (Ji & Wood, 2007). Investigating both external, environmental cues and internal states should be included in future investigation of the contextual cues that trigger facial 'T-zone' touching and as potential targets for behaviour change intervention. Further, it is possible the relationship between Automaticity and 'T-zone' touching is in part (though not entirely) dependent on the stability of the context, and future research should seek to investigate such interactions. Investigating the predictive effects of the HAPA constructs on Automaticity represents another area of potential focus that could enhance our theoretical understanding of this behavioural construct.

While providing novel insight into the theory-informed predictors of 'T-zone' touching, there are some key limitations to note. First, the theoretical constructs of Outcome Expectancies and Self-efficacy did not meet the Cronbach's alpha threshold of .7; five items for the construct of Outcome Expectancies (Q9r11–15) and one for the Task Self-efficacy construct (Q14) were omitted to improve the alpha value. Secondly, Behaviour was self-reported, which could contribute to inaccuracies in reporting. Additionally, the automatic nature of this behaviour may contribute further to potential response bias. Thirdly, it is

possible that the degree of T-zone touching and its predictors may be especially context-dependent. The present study sought to provide a broad assessment across non-home contexts applicable across a national sample, and future studies should seek investigate these perspectives in more specific contexts and settings. Finally, Intention was measured as an individual's intention to *reduce* touching their 'T-zone'. So, while this provides insight into the theory-informed correlates of this pro-health intention, this may too have contributed to a lack of coherence in measures and the absence of an effect of Intention on Behaviour. Future research should explore whether intention to touch one's 'T-zone' is associated with 'T-zone' touching.

CONCLUSION

Reducing facial 'T-zone' touching is an understudied personal protective behaviour. The identification of theory-informed correlates of 'T-zone' touching herein provides a basis for designing behaviour change interventions; namely, the use of strategies that aim to disrupt the habit of 'T-zone' touching. The limited predictive value of constructs other than automaticity solidifies 'T-zone' touching as an automatic behaviour, highlights shortcomings in our contemporary theories and is indicative of an opportunity to strengthen our theoretical understanding of Automaticity.

AUTHOR CONTRIBUTIONS

Mackenzie Wilson: Conceptualization; data curation; methodology; investigation; formal analysis; visualization; writing – original draft; writing – review and editing. **Zachary M. van Allen:** Conceptualization; methodology; visualization; formal analysis; writing – review and editing. **Jeremy M. Grimshaw:** Conceptualization; methodology; writing – review and editing. **Jamie C. Brehaut:** Conceptualization; methodology; writing – review and editing. **Audrey Durand:** Conceptualization; methodology; writing – review and editing. **Jean-François Lalonde:** Conceptualization; methodology; writing – review and editing. **Douglas G. Manuel:** Conceptualization; methodology; writing – review and editing. **Susan Michie:** Conceptualization; methodology; writing – review and editing. **Robert West:** Conceptualization; methodology; writing – review and editing. **Justin Presseau:** Conceptualization; funding acquisition; methodology; writing – original draft; writing – review and editing; supervision.

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CONFLICT OF INTEREST STATEMENT

None declared.

DATA AVAILABILITY STATEMENT

Data availability. De-identified data from this study are not available in a public archive. De-identified data from this study will be made available (as allowable according to institutional research ethics board standards) by emailing the corresponding author.

Analytic code availability. Analytic code used to conduct the analyses presented in this study are available in a public archive: http://www.processmacro.org/download.html. The study R-code will be made publicly available prior to manuscript publication.

Materials availability. The surveys used to conduct the study are included as electronic supplementary materials.

ETHICAL APPROVAL

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ottawa Health Science Network Research Ethics Board (20200285-01H).

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