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Evolution of Physical Activity Habits After a Context Change: the Case of COVID-19 Lockdown

RUNNING HEAD: PHYSICAL ACTIVITY HABITS AND COVID-19

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Statement of contribution

What is already known on this subject?

- Habits can play a key role in the regulation of physical activity (PA) during the COVID-19 lockdown.
- Because of their cue-dependent nature, habits are sensitive to a context change, such as the COVID-19 lockdown.
- How PA habits evolved following a context change and the association of PA behaviours and autonomous motivation with this evolution remain largely unknown.

What this study adds?

- COVID-19 lockdown was associated with a decline in PA habits, especially among individuals with strong before-lockdown habits.
- Before-lockdown PA habits were not significantly associated with PA behaviours once the context changed, while habits developed during lockdown fostered the instigation of PA behaviours in this new context.
- Engaging in renewed PA behaviours during lockdown and exhibiting autonomous motivation was positively related to PA habits.

Abstract

Objective. Habits, defined as well-learned associations between cues and behaviours, are essential for health-related behaviours, including physical activity (PA). Despite the sensitivity of habits to context changes, little remains known about the influence of a context change on the interplay between PA habits and behaviours. Here, we investigated the evolution of PA habits amidst the Spring COVID-19 lockdown, a major context change. Moreover, we examined the association of PA behaviours and autonomous motivation with this evolution.

Design. Three-wave observational longitudinal design.

Methods. PA habits, PA behaviours, and autonomous motivation were collected through online surveys in 283 French and Swiss participants. Variables were self-reported with reference to three time points: before mid-, and end-lockdown.

Results. Mixed effect modelling revealed a decrease in PA habits from before- to mid-lockdown, especially among individuals with strong before-lockdown habits. Path analysis showed that before-lockdown PA habits were not significantly associated with mid-lockdown PA habits ($\beta = .15$, $p = .109$), while mid-lockdown PA habits were positively related to end-lockdown habits ($\beta = .44$, $p < .001$). Mid-lockdown habits were positively associated with end-lockdown PA behaviours ($\beta = .22$, $p = .004$). Autonomous motivation was directly associated with PA habits (*ps.* < .001), but neither predicted PA behaviours during lockdown, nor moderated the relations between PA behaviours and habits (*ps.* > .085).

Conclusion. PA habits were altered and their influence on PA behaviours was impeded during the COVID-19 lockdown. Engagement in PA behaviours and autonomous motivation helped in counteracting PA habits disruption.

Keywords: Physical activity; Habits; Autonomous motivation; Context change; COVID-19.

Evolution of Physical Activity Habits After a Context Change: the Case of COVID-19 Lockdown

Physical activity (PA) is associated with many beneficial outcomes relating to physical and mental health (Rebar et al., 2015; Warburton, 2006). During the Spring 2020 COVID-19 pandemic, engaging in active behaviours was particularly relevant to counteracting the detrimental effects of lockdown (Lesser & Nienhuis, 2020). Yet, a fast-growing literature reveals that individuals' PA behaviours were altered during this period: while most individuals decreased their engagement in PA, a portion of the population increased it (Cheval et al., 2020; Constandt et al., 2020; Deschasaux-Tanguy et al., 2020; Gallè et al., 2020; Sañudo et al., 2020). Among other determinants, PA habits appear as one potential factor explaining these changes (Kaushal et al., 2020; Rhodes et al., 2020).

Habits, defined as well-learned associations between cues and the enactment of a certain behaviour (Gardner, 2015), are considered a key factor for the regulation of physical activity (Gardner et al., 2011; Rebar et al., 2016). Indeed, a meta-analysis showed a medium-sized correlation between habits and PA behaviours ($r = .43$) (Gardner et al., 2011). This link is theorised to result from the fact that, once formed, habits favour a quick and efficient behavioural instigation. When contextual cues are encountered, a mental representation of the cue-behaviour association is activated, triggering an impulse to act with minimal conscious awareness (Neal et al., 2012). Contextual cues that prompt PA can stem from multiple sources, including environmental (e.g., a location in which individuals are used to exercising), temporal (e.g., jogging every Wednesday after work), or social ones (e.g., going to the gym with colleagues) (Kaushal & Rhodes, 2015; Pimm et al., 2016). For instance, one study found that 90% of regular exercisers reported that their PA behaviours were automatically prompted by a particular location or a specific time (Tappe et al., 2013).

Major Context Changes and PA Habits: The Case of COVID-19 Lockdown

Because of this cue-dependent nature (Orbell & Verplanken, 2010), the potential of habits to trigger behaviours is sensitive to a context change (i.e., discontinued exposure to regular environments) (Verplanken & Wood, 2006). According to the discontinuity hypothesis (Verplanken et al., 2008), when contextual cues are no longer available in one's environment, habits are, at least temporarily, disrupted and do not translate in behaviours anymore – an effect especially pronounced among individuals with strong initial habits. Yet, for PA habits, this hypothesis has received little empirical support (Gardner, 2015). Only two studies have provided indirect support to the discontinuity hypothesis by showing a decrease in PA behaviours after holidays (Fredslund & Leppin, 2019) or after a move to university (Wood et al., 2005). However, PA habits were not directly assessed, thereby preventing the assessment of how habits evolved following a context change. To fill this knowledge gap, the present study aimed to examine how PA habits evolved from before to during the lockdown imposed during Spring 2020.

Indeed, this period raised an ecological contextual change which may have impacted PA habits. In France and Switzerland, the countries in which this study was conducted, restrictive measures were applied within a few days from each other and only slightly differed between these two countries (Figure 1). In France, restrictive measures included the limitation of individual outdoor activities to one hour with a proof of displacement and the closure of gym and sports clubs. In Switzerland, restrictive measures included the limitation of outdoor activities to a maximum of five persons (but no formal restriction related to outdoor movement) and the closure of gym and sports clubs. There are at least two reasons to expect that, across this period, the influence of PA habits on behaviours has changed. First, associations underpinning PA habits might have been weakened due to discontinued cue exposure (e.g., not packing one's sport bag before going to work), thus having less impact on PA behaviours.

Alternatively, PA habits might have remained intact but, because cues were no longer encountered, did not translate in PA behaviours, instead remaining dormant (Gardner, 2012). Regardless the mechanism at work, it is predicted that the association of previous habits with consecutive PA behaviours will decrease following a context change.

Association of PA Behaviours with the Evolution of PA Habits after a Context Change

Crucially, as proposed by the discontinuity hypothesis (Verplanken et al., 2008), a context change, such as the one catalysed by lockdown, can also foster a mindset of being in "the mood for change" (Verplanken & Roy, 2016). During this "window of opportunity", individuals are prone to engage in deliberative processes, leading to the renegotiation of previous behaviours (Verplanken & Roy, 2016). This discontinuity hypothesis may thus explain why some studies observed an increase of PA behaviours during lockdown (Cheval et al., 2020; Constandt et al., 2020; but see Deschasaux-Tanguy et al., 2020; Gallè et al., 2020; Sañudo et al., 2020 for contradictory findings).

In turn, engaging in PA behaviours after a context change may influence the evolution of PA habits. Indeed, one mechanism through which habits can evolve is the habit formation process, which emphasizes the crucial role of behaviours in the development of habits (Gardner & Lally, 2018; Lally & Gardner, 2013). In the first stages of this process, behavioural repetition in a stable context is the most proximal driver of the evolution of habits (Gardner & Lally, 2018; Lally & Gardner, 2013). The context-behaviour repetition fosters the establishment of strong mental cue–behaviour associations, making other alternatives less accessible (Danner et al., 2007). In this line, two studies revealed that the daily practice of the same exercise in the same context leads to a quick increase in habits (Fournier et al., 2017; Lally et al., 2010). Hence, during lockdown, the replacement of previous PA behaviours (e.g., exercising after a teleworking session rather than after a day spent in office) or the instigation of new behaviours

(e.g., cycling around home after lunch with one's children), as a response to take advantage of this window of opportunity, may have sustained – or even to strengthened – PA habits.

Furthermore, as habits develop, they acquire the capacity to prompt the engagement in behaviours in stable contexts (Gardner et al., 2011; Rebar et al., 2016). Hence, while before-lockdown habits may not translate into PA behaviours during lockdown, any replacing or newly-formed PA habits during the early stages of lockdown may drive consecutive PA behaviours. The same reasoning can be applied to the link between previous PA behaviours and consecutive PA behaviours. Indeed, previous research emphasized that past behaviours are an important predictor of consecutive behaviours (Hagger et al., 2002; McEachan et al., 2011), especially when the context remains stable (Ouellette & Wood, 1998). Hence, before-lockdown PA behaviours seem less likely to be associated with PA behaviours in the early stages of lockdown, than PA behaviours in the early stages of lockdown with PA behaviours at the later stages of lockdown. In sum, the association of previous PA habits and previous behaviours with consecutive habits and behaviours should be less pronounced when a context change occurred between two time points.

Association of Autonomous Motivation with the Evolution of PA Habits after a Context Change

Previous studies also emphasized the association of autonomous motivation with the evolution of habits, especially amidst a context change (Gardner & Lally, 2018; Lally & Gardner, 2013). Autonomous motivation, defined as the extent to which a behaviour is consistent with self-endorsed reasons for action (e.g., for pleasure or personal interest) (Ryan & Deci, 2017), fosters the development of habits through several, but not mutually exclusive, pathways: i) directly, ii) indirectly via increased behavioural repetition, and iii) interactively by strengthening the effect of behaviours on habits development. For the first pathway, previous research evidenced that autonomous motivation was positively and directly associated with PA

habits (Gardner & Lally, 2013; Radel et al., 2017), with one study reporting this direct effect within the COVID-19 lockdown context (Kaushal et al., 2020). Regarding the indirect effect, literature showed that autonomous motivation increases engagement in PA (see Ntoumanis et al., 2020 for a review), which, in turn, promotes the development of PA habits (Judah et al., 2013). Regarding the interactive pattern, two studies revealed that habits develop more quickly when PA behaviours are performed for autonomous reasons (Gardner & Lally, 2013; Radel et al., 2017).

Further, according to the self-activation hypothesis (Verplanken et al., 2008), the impact of autonomous motivation on the evolution of PA habits could be particularly high following a context change. Indeed, this hypothesis states that values influence behaviours when they are self-endorsed and cognitively activated (Verplanken et al., 2008). Based on the habit discontinuity and self-activation hypotheses, well-integrated values are especially salient in individuals' thoughts system following a context change and, in turn, become particularly likely to guide behaviours. For instance, employees who recently moved house and held pro-environmental values were more likely to engage in sustainable commuting (Verplanken et al., 2008). Hence, because autonomous motivation reflects self-endorsed values (Ryan & Deci, 2017), it should play a key role in predicting PA behaviours and PA habits during lockdown.

The Present Study

The purpose of the present study was to investigate the association between the COVID-19 lockdown, a major context change, and the evolution of PA habits. Moreover, it aimed to examine the associations of PA behaviours and autonomous motivation with this evolution. Individuals living in France and Switzerland completed three online questionnaires in reference of three time points (i.e., before, mid-, and end-lockdown) and reported their PA habits, PA behaviours, and motivation toward PA.

Regarding the evolution of habits, we expected a decline in PA habits from before- to mid-lockdown, especially among individuals with strong before-lockdown habits (H1). Regarding the associations of PA habits with behaviours and autonomous motivation (Figure 2A), we hypothesized that, because the context change had likely deprived many individuals of the cues that usually prompt their behaviours, before-lockdown PA habits would not be significantly associated with mid-lockdown PA habits (H2a). On the contrary, because the context remains stable across lockdown, we expected that mid-lockdown PA habits would be related to end-lockdown PA habits (H2b). We predicted that PA behaviours would be concurrently and positively associated with PA habits at all three timepoints (H3). Additionally, as the context changed, we hypothesized that before-lockdown PA habits would not be significantly related to mid-lockdown PA behaviours (H4a). In contrast, as the context remained stable, we expected that mid-lockdown PA habits would be positively associated with end-lockdown PA behaviours (H4b). Following the same reasoning, we hypothesized that before-lockdown PA behaviours would be related to mid-lockdown PA behaviours (H4c), but to a lesser extent than mid-lockdown and end-lockdown PA behaviours (H4d). Regarding the role of autonomous motivation, we predicted that it would be concurrently and positively associated with PA habits at all three time points (H5a), and also indirectly through PA behaviours (H5b). Finally, we hypothesized that autonomous motivation would moderate the relationships between PA behaviours on habits, such that the association between PA behaviours and habits will be stronger when people reported strong (*vs* weak) autonomous motivation (H5c).

Methods

Participants and Procedure

Participants living in France or Switzerland were recruited through social media and word-of-mouth. They were asked to complete short online questionnaires at three time points,

spanning different phases of lockdown. To be included in the study, participants had to live either in France or Switzerland and be older than 18 years. No other exclusion criteria were specified to recruit a convenience sample as diverse as possible. Questionnaires were completed on a secured web survey hosted by the University of Geneva, Switzerland. The first questionnaire was launched on March 30, two weeks after the start of the Spring 2020 lockdown. After completing the first questionnaire, participants were asked whether they would agree to answer to a second questionnaire and, if so, they were invited to give their e-mail address. The second questionnaire was launched on April 13, corresponding to the early middle of the lockdown. The third questionnaire was launched on May 8, corresponding to the end of lockdown. In the first questionnaire, participants were asked to retrospectively report their before-lockdown PA habits, behaviours, and motivation. In the second and third questionnaires, they were invited to indicate their current mid- and end-lockdown PA habits, PA behaviours, and motivation (Figure 1). As an incentive, for each completed questionnaire, a 0.50 Euro donation was made to a foundation studying COVID-19 biomarkers. For sample size estimation, the number of participants needed for a model including up to 33 degrees of freedom, with RMSEA [0.00; 0.08], power = 90%, and α-rate = .05 was N = 150 (MacCallum et al., 2006). Given that we anticipated a loss of at least 40% from the first to the second wave (Gustavson et al., 2012), we planned to recruit around 250 participants in the first wave. It should be noted, however, that the questionnaires remained open for 8 days, regardless of the amount of collected data.

A total of 283 participants living in France or Switzerland completed the first questionnaire (age = 40 ± 18 years; Body Mass Index [BMI] = 22.8 ± 3.7 kg/m^2; 68% women; 77% French). A total of 123 participants completed the second questionnaire (age = 41 ± 19 years; BMI = 22.8 ± 3.9 kg/m^2; 70% women; 76% French). A total of 113 participants

completed the third questionnaire (age = 43 ± 18 years; BMI = 22.7 ± 3.5 kg/m^2; 68% women; 76% French).

Measures

PA Habits

PA habits were assessed using the four-item automaticity subscale of the Self-Reported Habit Index (Gardner et al., 2012; Verplanken & Orbell, 2003) before, in the middle, and at the end of lockdown. Items began with the proposition: "In general, the decision to engage in PA is something that…" and was completed by four statements (e.g., "I do automatically"). Participants answered on a Likert scale ranging from 1 (*Strongly disagree*) to 7 (*Strongly agree*). Items were averaged to create a global score (Cronbach' αs > .87, Table 1).

PA Behaviours

PA behaviours were assessed before, in the middle, and at the end of lockdown using an adapted version of the International PA Questionnaire (Craig et al., 2003), a well-validated tool among healthy adults (Hagströmer et al., 2006). Participants were asked to estimate the weekly average time (in minutes) spent in vigorous and moderate PA during leisure time. Times reported in each intensity were summed to obtain weekly time spent in moderate-to-vigorous PA.

Autonomous Motivation for PA

Autonomous motivation toward PA was assessed using a four-item scale (Brunet et al., 2015; Sheldon & Elliot, 1998) before, in the middle, and at the end of lockdown. Participants were invited to rate the degree to which the statements reflected their motivation to adopt a physically active lifestyle during leisure time. Answers were given on a Likert scale ranging from 1 (*Not at all for this reason*) to 7 (*Totally for this reason*). Autonomous motivation was calculated as the average response to the two-item intrinsic (e.g., "Because of the pleasure I feel

during PA") and two-item identified (e.g., "Because I believe it is really important to be physically active") sub-scales (Cronbach' αs > .85, Table 1).

Statistical Analyses

To examine the evolution of PA habits across time (H1), linear mixed effect models were computed. This approach handles missing data and takes into account the nested structure of the data (i.e., multiple measurement from the same individuals) (Boisgontier & Cheval, 2016; Judd et al., 2017). In the first step, the linear and quadratic effects of time on habits were entered as fixed effects to assess the evolution of PA habits over time. Then, to examine the moderating influence of before-lockdown PA habits, a two-way interaction between time (both linear and quadratic) and before-lockdown PA habits was added. Based on the data distribution, participants were categorized as having weak (i.e., a score < 2.8 on the 7-point Likert scale), moderate (a score ≥ 2.8 and ≤ 6.3 on the 7-point Likert scale), or strong (i.e., a score > 6.3 on the 7-point Likert scale) PA habits before the lockdown. Models included a random intercept for participants and a random slope for linear time. Standardized beta coefficients (β) with 95% confidence interval (95CI) are reported. Models were built using the lmerTest and lme4 packages (Bates et al., 2015; Kuznetsova et al., 2015), in R software ® (R Core Team, 2016),

Second, the associations between PA habits, PA behaviours, and autonomous motivation across time were investigated using path analysis (Brown, 2006). Based on previous work (Judah et al., 2018), a longitudinal model was computed and included all hypothetical pathways (see Figure 2A). Regarding missing data, after conducting a Hawkins' test, there was no sufficient evidence to reject that values were missing at complete random (p = .452) (Jamshidian et al., 2014). Hence, a full information maximum likelihood (FIML) approach was used in subsequent analysis to include participants who did not answer all the three waves of measurement. Multiple indices were computed to examine the goodness of the model fit: the Root Mean Square Error of Approximation (RMSEA), the Standardized Root Mean Squared

Residual (SRMR), the Comparative Fit Index (CFI), and the Tucker-Lewis Index (TLI) (Brown, 2006; MacCallum & Austin, 2000). A reasonable model fit is indicated by RMSEA, SRMR < .08, and TLI, CFI > .90. Given the complexity of the hypothesized model, we planned to adopt a backward strategy (Kline, 2015), whereby variables that do not improve the fit of the model are removed, based on inspection of the *z* Wald-test statistic. β and 95CI were computed to examine the strength of the associations between variables. All analyses were conducted using the lavaan package (Rosseel, 2012). To compare the strength of the associations, the overlapping of β and 95CI were examined. When coefficient intervals overlapped by less than 50%, β coefficients could be considered significantly different from each other, with $p < .05$ (Cumming, 2009) (Figure S1).

Results

Descriptive statistics are reported in Table 1. Mixed effect modeling revealed a significant effect of quadratic time on PA habits ($p < .001$), with PA habits decreasing from before to mid-lockdown (β = -.16, 95CI [-.25; -.07], $p < .001$), but not significantly evolving from mid- to end-lockdown (β = .13, 95CI [-.00; 0.27], p = .058). A significant interaction between time and before-lockdown PA habits was observed (Figure 1). Simple effects revealed that participants with strong before-lockdown PA habits exhibited a decline in PA habits from before- to mid-lockdown (β = -.29, 95CI [-.44; -.13], $p < .001$), but PA habits did not significantly evolve from mid- to end-lockdown (β = 24; 95CI [-.05; .55], p = .11). On the contrary, participants with weak before-lockdown PA habits exhibited an increase in PA habits from before- to mid-lockdown (β = .34, 95CI [.15; .55], $p < .001$), but this increase was significantly decelerated from mid- to end-lockdown (β = -.41, 95CI [-.79; -.03], p = .032). Evolution of PA behaviours and autonomous motivation across time is presented in supplementary material (Figure S2 and S3).

In the path analysis, when all the hypothetical pathways were included, the model demonstrated inadequate fit to the data (CFI = 0.815; TLI = 0.715, RMSEA = .136, SRMR = 0.061). Interactive terms between PA behaviours and autonomous motivation at the three timepoints did not improve model fit and were non-significant (*zs.* < 1.857, *ps.* > .603). When these associations were removed, the adjusted model showed good fit to the data (CFI = 1.000; TLI = 1.030, RMSEA = .000, 90CI [0.000; 0.068], SRMR = 0.029) and was thus retained (Figure 2B). The model explained 31, 39, and 63% of variance in PA habits before, in the middle, and at the end of lockdown, respectively, and 16, 15 and 39% of PA behaviours before, in the middle, and at the end of lockdown.

Associations between PA habits across time (H1a & H1b)

Before lockdown PA habits were not significantly associated with mid-lockdown PA habits (β = .15, CI = [-.03; .34], p = .109). In contrast, mid-lockdown PA habits were positively associated with end-lockdown PA habits (β = .44, CI = [.29; .58], p < .001). The association of PA habits from before-lockdown to mid-lockdown was significantly lower than that from mid-lockdown to end-lockdown (percentage of CIs' overlapping < 50%).

Associations between PA behaviours and PA habits across time (H2)

Before-lockdown PA behaviours were not significantly associated with before-lockdown PA habits (β = .18, 95CI [-.02; .37], p = .078). In both the middle and the end of lockdown, PA behaviours were associated with PA habits (β = .38, 95CI [.21; .55], p < .001 for mid-lockdown, β = .20, 95CI [.03; .28], p = .012 for end-lockdown). No significant difference in the magnitude of these associations was found (percentage of CIs' overlapping > 50%).

Associations between previous PA habits and behaviours with consecutive PA behaviours across time (H3a, H3b, H3c, H3d)

Before-lockdown PA habits were not significantly associated with mid-lockdown PA behaviours (β = .04, 95CI [-.16; .25], p = .696). Mid-lockdown PA habits were positively

associated with end-lockdown PA behaviours (β = .22, 95CI [.04; .37], p = .004). The association between mid-lockdown PA habits and end-lockdown PA behaviours was significantly stronger than that of before-lockdown PA habits and mid-lockdown PA behaviours (percentage of CIs' overlapping < 50%).

Before-lockdown PA behaviours were positively associated with mid-lockdown PA behaviours (β = .21, 95CI [.01; .42], p = .039). Mid-lockdown PA behaviours were positively associated with end-lockdown PA behaviours (β = .49, 95CI [.24; .74] p < .001). The association between mid-lockdown PA behaviours and end-lockdown PA behaviours was significantly stronger than that of before-lockdown PA behaviours and mid-lockdown PA behaviours (percentage of CIs' overlapping < 50%).

Associations of autonomous motivation with PA habits across time (H4a, H4b, H4c)

Autonomous motivation was directly and positively related to PA habits at the three timepoints (β = .49, 95CI [.29; .73], p < .001 for before-lockdown; β = .30, 95CI [.12; .48], p = .001 for mid-lockdown; β = .40, 95CI [.26; .52], p < .001 for the end- lockdown). No significant differences in the magnitude of these three associations were found (percentage of CIs' overlapping > 50%).

Autonomous motivation was significantly related to before-lockdown PA behaviours (β = .40, 95CI [.25; .71], p < .001), but not to mid- and end-lockdown PA behaviours (β = .21, 95CI [-.03; .45], p = .085 for mid-lockdown, β = .07, 95CI [-.10; .25], p = .383 for end-lockdown).

Discussion

Main Findings

The present study investigated the association between the COVID-19 lockdown, a major context change, and the evolution of PA habits. Moreover, it aimed to examine the association of PA behaviours and autonomous motivation with this evolution. Findings

revealed a global decrease in PA habits across the COVID-19 lockdown, but this evolution was depended on before-lockdown PA habits. Individuals with strong before-lockdown PA habits exhibited a sharp decrease, while individuals with weak before-lockdown PA habits demonstrated the reverse pattern (i.e., a short increase in habit strength, then followed by a quick deceleration). These findings, in addition to the non-significant relation between before-lockdown and mid-lockdown habits, support the assumption that habits are sensitive to a context change. In addition, results showed that before-lockdown PA habits were not significantly associated with PA behaviours once the context changed. However, engaging in renewed PA behaviours during lockdown and exhibiting autonomous motivation counteracted such disruption of PA habits.

Comparisons with Other Studies

Findings showed that PA habits decreased following a context change – especially among individuals with strong before-lockdown habits. These results are in line with the idea that a context change can disrupt existing habits (Verplanken & Wood, 2006). Nevertheless, while previous studies only indirectly inferred PA habits' disruption through changes in behaviours (Fredslund & Leppin, 2019; Wood et al., 2005), our study is the first to provide a formal test of this assumption by assessing habits both before and after a context change. By contrast, an increase in PA habits was observed among individuals with weak before-lockdown habits. As proposed by the discontinuity hypothesis (Verplanken et al., 2008), this finding may result from the fact that a context change can also foster the development of habits. One possible adjuvant of this development may rely on the disruption of other habits, such as the ones related to sedentary behaviours. Indeed, while sedentary opportunities act as temptations, distracting individuals from their intention to be physically active (Cheval et al., 2015, 2017, 2018), lockdown settings may have reduced individuals' exposure to some of these cues. For example, someone who was used to have a drink in a bar or to go to the cinema after work was deprived

of such opportunities during lockdown, thereby opening new perspectives on the adoption of more physically active behaviours. Nevertheless, this reasoning only applies for outside-home sedentary behaviours as, on the opposite, individuals were particularly exposed to sedentary opportunities at home during lockdown (e.g., watching TV).

Further, results revealed that before-lockdown PA habits were not significantly related with mid-lockdown PA behaviours. Although a previous study found a significant association between previous habits and PA behaviours during lockdown (Rhodes et al., 2020), the strength of the association (r = .24) was weaker than the commonly reported relationship between habits and behaviours (r = .43) (Gardner et al., 2011). These results can be explained by the fact that, during lockdown, some contextual cues were no longer encountered during lockdown (e.g., going to the gym club on Wednesdays after work with colleagues), which, in turn, made habits dormant and impeded their influence on behaviours (Gardner, 2012). Likewise, the discontinuity to cues exposure is also likely to decrease PA habits, which in turn became too weak to instigate behaviours.

By contrast, mid-lockdown PA habits were positively associated with end-lockdown PA behaviours. This result suggests that people may have quickly adjusted existing habits (e.g., exercising after a teleworking session rather than after a day spent in office) or developed new habits (e.g., cycling around home with one's children) that could effectively guide PA behaviours in the new context. Nevertheless, other mechanisms such as the re-activation of old habits (e.g., coming back to one's parents' home and walking around the neighbourhood as one used to before leaving parental home) might also explain this pattern. Moreover, the association between previous and consecutive PA behaviours was more salient from mid- to end-lockdown, than from the before- to end-lockdown. In other words, similarly to the influence of habits on behaviours, past behaviours seem especially likely to drive consecutive behaviours when the context remains stable (Ouellette & Wood, 1998).

Autonomous motivation was directly and positively associated with PA habits before and during lockdown. These results align with the idea that autonomous motivation can foster the development of PA habits (Gardner & Lally, 2018; Lally & Gardner, 2013). However, while a positive association between autonomous motivation and before-lockdown PA behaviours was found, our study did not support the mediating or the interactive association of autonomous motivation with PA habits during lockdown. Though these results diverge with previous literature (Gardner & Lally, 2013; Radel et al., 2017) and stand in contrast with the self-activation hypothesis (Verplanken et al., 2008), at least two factors can explain this discrepancy. First, autonomous motivation can only foster PA behaviours when individuals have control over the considered behaviour (Hagger & Chatzisarantis, 2014). Hence, during lockdown, behaviours for which people were autonomously motivated might have been disallowed by restrictive measures (e.g., swimming, playing football in a club). A second explanation lies in the fact that the COVID-19 lockdown represents a unique period, which cannot be compared with other context changes, such as moving house (Verplanken et al., 2008). In particular, the COVID-19 lockdown was imposed on individuals and transitory (at the time of the study, it was expected to last for about 3 months in France and Switzerland). Hence, at odds with the self-activation hypothesis (Verplanken et al., 2008), this context change might not have triggered the activation of any particular self-endorsed values for action.

Strengths and Limitations

The present study has several strengths. At the theoretical level, the present study advances existing literature on PA habits by providing direct evidence about the association between a context change and the evolution of PA habits. Further, it sheds light on the role of behaviours and autonomous motivation in this evolution, in particular by testing the self-activation hypothesis on PA habits. Moreover, the use of a longitudinal design with repeated measurements of PA habits, behaviours, and autonomous motivation were also strengths.

However, this study includes at least four limitations. First, the Self-Reported Habit Index enables the measurement of global habit strength – i.e., an overall perception of the automaticity of a category of actions, such as physical activity, across multiple contexts – but does not provide information about any specific cue-responses (Gardner et al., 2012). Hence, this scale does not allow for disentanglement of whether the evolution of habits and of their associations with behaviours result from dormant habits, a degradation of before-lockdown habits, or to the development of new PA habits. Future studies assessing specific PA habits and the cues on which they are based upon should seek to unravel these different mechanisms. Second, the reliance on self-reported measures has been criticized for the assessment of PA habits (Hagger et al., 2015; Rebar et al., 2018) and behaviours (Dyrstad et al., 2014). This limitation was exacerbated by the fact that PA habits and behaviours before lockdown were assessed retrospectively. Third, recruitment procedure was done online because of the COVID-19 restrictions, which may have resulted in an over-recruitment of participants with high self-reported levels of PA behaviours. Fourth, this longitudinal design did not enable to infer causality in the associations between the variables.

Conclusion

This study drew on the COVID-19 lockdown to examine how PA habits evolved following a major context change. Our findings suggest that, although such disruptive settings can weaken existing habits, individuals can quickly renegotiate or develop new PA habits. Encouraging the instigation of PA behaviours and developing an autonomous motivation toward PA may be important in interventions aiming at sustaining PA habits after a context change.

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Table 1

Descriptive Statistics

Variables	Mean ± SD	Range	α	ICC
PA habits				
Before-lockdown	4.60 ± 1.79	1 – 7	.88	
Mid-lockdown	4.06 ± 1.75	1 – 7	.89	.71
End-lockdown	4.07 ± 1.79	1 – 7	.91	
Moderate-to-vigorous PA (min/week)				
Before- lockdown	232 ± 195	0 – 960	-	
Mid-lockdown	224 ± 187	0 – 945	-	.56
End-lockdown	224 ± 199	0 – 1260	-	
Autonomous motivation				
Before-lockdown	6.01 ± 1.18	1 – 7	.86	
Mid-lockdown	6.07 ± 1.22	1 – 7	.87	.89
End-lockdown	5.97 ± 1.19	1 – 7	89	

Note: SD: standard-deviation. PA: Physical Activity; ICC: intra-class correlations coefficient. ICC reflects stability in the construct at the participant-level across time.

Figure 1

Evolution of PA Habits Across Time, as a Function of Before-Lockdown PA Habits

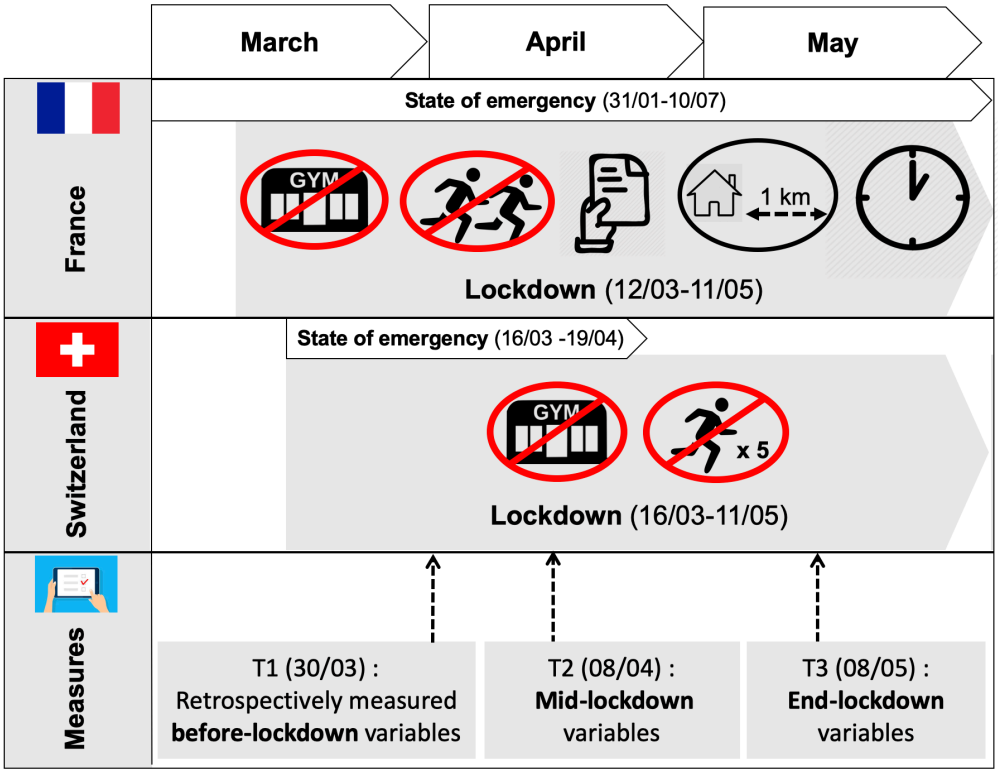
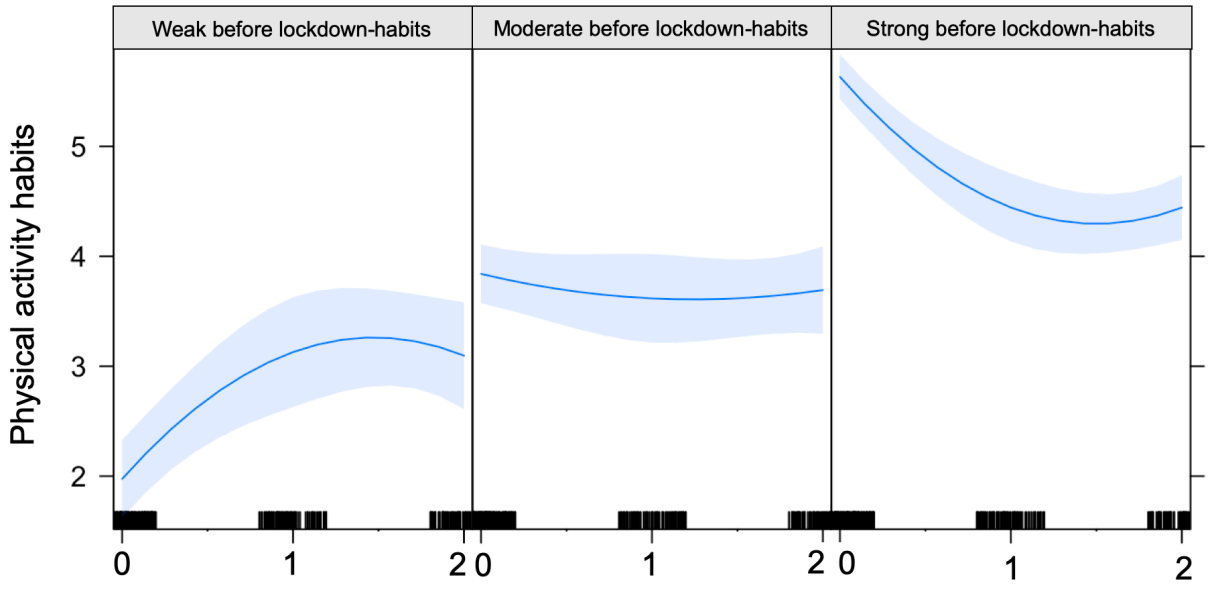


Figure 2

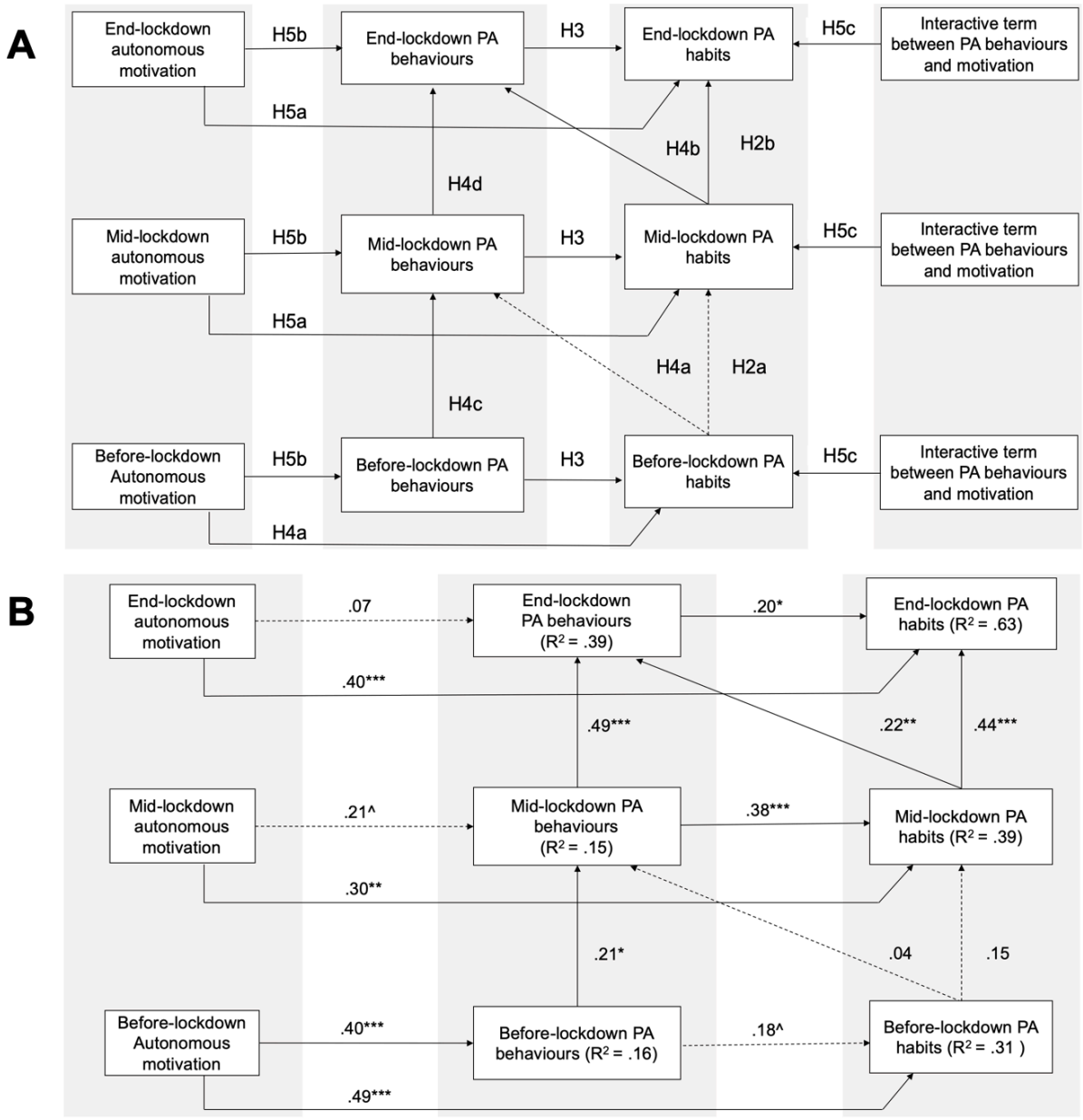
Evolution of PA Habits Across Time, as a Function of Before-Lockdown PA Habits



Note. Evolution of PA habits was plotted as a function of the quadratic effect of time. PA: Physical activity; Time 0: before-lockdown; Time 1: mid-lockdown; Time 2: end-lockdown.

Figure 3

Path Diagrams Illustrating the hypothetical (A) and evidenced associations (B) of PA Behaviours and Autonomous Motivation for PA with PA Habits.



Note. Significant and non-significant associations are represented with solid and dashed lines, respectively. Standardized beta coefficients (β) and R-squared (R^2) are reported. ***: $p < .001$; **: $p < .01$; *: $p < .05$; ^: $p < .10$. PA: Physical activity. The influence of the interactive terms between PA behaviours and autonomous motivation on habits is not represented in Figure 3B as these variables were not included in the final model.