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Habitual exercise instigation (vs. execution) predicts healthy adults' exercise frequency

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Abstract

Objective: Habit is thought to be conducive to health behavior maintenance, because habits prompt behavior with minimal cognitive resources. The precise role of habit in determining complex behavioral sequences, such as exercise, has been underresearched. It is possible that the habit process may initiate a behavioral sequence (instigation habit) or that, after instigation, movement through the sequence is automated (execution habit). We hypothesized that exercise instigation habit can be empirically distinguished from exercise execution habit and that instigation habit strength is most predictive of future exercise and reflective of longitudinal exercise behavior change. Further, we evaluated whether patterned exercise action—that is, engaging in the same exercise actions from session to session—can be distinct from exercise execution habit. Method: Healthy adults (N = 123) rated their exercise instigation and execution habit strengths, patterned exercise actions, and exercise frequency in baseline and 1-month follow-up surveys. Participants reported exercise engagement via electronic daily diaries for 1 month. Hypotheses were tested with regression analyses and repeated-measures analyses of variance. Results: Exercise instigation habit strength was the only unique predictor of exercise frequency. Frequency profiles (change from high to low or low to high, no change high, no change low) were associated with changes in instigation habit but not with execution habit or patterned exercise action. Conclusions: Results suggest that the separable components of exercise sessions may be more or less automatic, and they point to the importance of developing instigation habit for establishing frequent exercise.

Keywords

automaticity, habit development, exercise maintenance, exercise frequency, habit strength

Disciplines

Exercise Science | Health Psychology | Other Psychology

Comments

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Habitual Exercise Instigation (versus Execution) Predicts Healthy Adults' Exercise Frequency

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Abstract

Objective. “Habit” is thought to be conducive to health behavior maintenance, since habits prompt behavior with minimal cognitive resources. The precise role of habit in determining complex behavioral sequences, such as exercise, has been under-researched. It is possible that the habit process may initiate a behavioral sequence (“instigation habit”), or that, after instigation, movement through the sequence is automated (“execution habit”). We hypothesize that exercise instigation habit can be empirically distinguished from exercise execution habit and that instigation habit strength is most predictive of future exercise and reflective of longitudinal exercise behavior change. Further, we evaluate whether patterned exercise action—i.e., engaging in the same exercise actions from session to session – can be distinct from exercise execution habit.

Method. Healthy adults (n=123) rated their exercise instigation and execution habit strengths, patterned exercise action, and exercise frequency in a baseline and a 1-month follow-up survey. Participants reported exercise engagement via electronic daily diaries for one month. Hypotheses were tested with regression analyses and repeated-measures ANOVA.

Results. Exercise instigation habit strength was the only unique predictor of exercise frequency (self-reported at follow-up, $\beta=0.38$, $p=0.002$; daily diary reports, $\beta=0.31$, $p=0.01$). Frequency profiles (change from high to low or low to high; no change high; no change low) were associated with change in instigation habit but not with execution habit or patterned exercise action.

Conclusions. Results suggest that the separable components of exercise-sessions may be more or less automatic and point to the importance of developing instigation habit for establishing frequent exercise.

Keywords. habit development; exercise maintenance; exercise frequency; habit strength; automaticity

Habitual Exercise Instigation (versus Execution) Predicts Healthy Adults' Exercise Frequency

Long-term health behavior maintenance is required for wellness (Artinian, Fletcher, Mozaffarian, et al., 2010), yet interventions rarely achieve lasting behavior change (Marcus, Forsyth, Stone, et al., 2000). The formation of “habit” – i.e., a process whereby encountering a situation in which a behavior has been consistently performed automatically generates an impulse to perform the behavior, due to learned situation-behavior associations ([Gardner, 2014](#)) – has been suggested as a mechanism for behavior maintenance (Rothman, 2000; Rothman, Sheeran & Wood, 2009). Theoretically, if interventions develop *habits*, regulation of behavior should move away from effortful, deliberative enactment and towards automatic activation and long-term maintenance (Lally, Wardle, & Gardner, 2011). A wealth of research, including longitudinal studies, has shown habit to predict behavioral frequency across health domains (Gardner, de Bruijn & Lally, 2011). Rigorous research on the precise role of habit in health behaviors, such as exercise, is required. This paper discusses current conceptualizations of exercise habit and empirically evaluates whether components of exercise performance could usefully be separated and, if so, whether habit-strength of these components are differentially predictive of future exercise behavior.

Some researchers have theorized that exercise can become habitual (i.e. automatically triggered by contextual cues), but the meaning of “habitual exercise” has been debated (Hagger, Rebar, Mullan, Lipp, & Chatzisarantis, 2014; Maddux, 1997). Aarts, Paulussen, and Schaalma (1997) conceptualized habitual exercise as specific actions (e.g., going for a run, going to the gym) that occur when the *goal* to exercise is automatically triggered by a situational cue. The exercise occurs with conscious awareness, but is “mentally efficient” and follows a specific pattern. The notion of habits being *automated* (completed without awareness or control; [Bargh, 1989, 1992](#)) also suggests instigation determines execution through a “cascade” of habitual actions, each action triggering the next. These conceptualizations of

automated behavior have not been empirically examined in health domains, but they suggest that exercise instigation may determine exercise execution rather than the two being separately determined.

Verplanken and Melkevik (2008) characterized habit as a goal-dependent sequence of behaviors that has acquired “a degree of automaticity, and is executed in stable contexts” (p.17). They authors posited that the *decision* to exercise may become habitually triggered by situational cues but that *performance* of exercise activity itself may be mindful (see too Maddux, 1997). Whereas [Aarts et al. \(1997\)](#) imply that “habitual” exercise is both automatically instigated (i.e. “chosen”) and executed (i.e. performed), Verplanken and Melkevik (2008) imply that instigation and execution can be determined by different factors (e.g., instigation becoming habitual, but execution remaining deliberative).

A recent theoretical review reasoned that behavioral instigation need not determine behavioral execution ([Gardner, 2014](#)). Gardner suggested that for simple actions, characterized by fewer behavioral sub-components, the distinction between instigation and execution may have little utility; when pressing a light switch, for example, it is hard to identify a transition from deciding to press the switch (instigation) to physically pressing the switch (execution). For more complex behaviors such as exercise, however, the distinction between habitual “deciding” (instigation) and habitual “doing” (execution) becomes meaningful. Consider a habit of “exercising in the gym”; the individual who regularly exercises and is new to a particular gym may deliberate over whether to visit the gym (no instigation habit), but once in the gym, may automatically enact a set of well-rehearsed sequences of specific activities (execution habit). Conversely, another regular exerciser may never deliberate on *whether* to visit the gym (instigation habit), but might deliberately choose specific exercise actions for each particular session (no execution habit), aiming for variability and balance in exercise for challenge or enjoyment. A third possibility is that the individual may both be automatically prompted to visit the gym and automatically enact a sequence of activities within the gym. [Gardner \(2014\)](#) argued that any of these three examples could be termed “exercise habit”, as they are all facilitated at least partly by habit.

We propose that, although they may be positively associated and both can develop through consistent behavior repetition (Kaushal & Rhodes, 2015; Lally, van Jaarsveld, Potts, & Wardle, 2010; Verplanken, 2006), exercise instigation habit is distinct from exercise execution habit, and that the presence of one need not determine the other. We define *instigation habit* as a process whereby cues automatically generate an impulse to initiate an (exercise) behavior, based on learned cue-behavior associations (see too [Gardner, 2014, 2015](#)). The cued impulse is a low-level cognitive response that, unless sufficiently opposed, generates the behavior automatically and effortlessly. While habit instigation is a cognitive process, this does not mean that it is a conscious or deliberative process requiring mental resources. People are typically unaware of habit-generated impulses, and so instigation habit is likely subjectively experienced as the direct activation of action, without conscious mediation (Gardner, 2015). In contrast, we define *execution habit* as a process whereby sub-actions within a higher-level action unit are controlled by habit, such that progression through sub-actions within the action unit (e.g. 'lift weights', 'use treadmill') is facilitated by the automatic activation of (an impulse to engage in) the sub-actions, as based on learned cue-behavior associations. Execution may be wholly or only partly determined by habit; that is, at least one, but not all, sub-actions must be habitually activated for an execution habit to be said to exist. Instigation and execution habit are conceptually separate: habitual instigation does not depend on habitual execution, and vice versa. The distinction between instigation and execution habit has important implications for understanding and changing behavior. If instigation and execution are separable, they may be differentially important for behavioral maintenance, have different developmental trajectories, and have different determinants. Such information could optimize interventions to promote long-term, regular exercise.

To evaluate whether instigation and execution are separable, habit measures must distinguish between instigation and execution of behavior. Current measures do not make this distinction. The Self-Report Habit Index (Verplanken & Orbell, 2003) and its automaticity subscale, the Self-Report Behavioral

Automaticity Index (Gardner, Abraham, Lally, & de Bruijn, 2012) measure general behavioral automaticity, through agreement with items such as “Exercising is something I do automatically”. These predict exercise behavior frequency (e.g., Rhodes, de Bruijn, & Matheson, 2010), but it is not clear whether they capture exercise instigation, execution, or both. Wood, Tam, and Witt’s (2005) ‘frequency-in-context’ measure of habit strength also fails to discern instigation from execution of behavior.

Available exercise-specific measures of habit strength have separable sub-scales, but none afford testing of the distinction between behavioral instigation and execution. The Exercise Habit Survey (EHS; Tappe & Glanz, 2013) assesses the degree to which exercise occurs at consistent times of day, in consistent locations, and with consistent partners. A final component, “exercise constancy”, regards the degree to which the same exercise actions are performed from day to day. This concept is similar to the ‘patterned action’ sub-component of Grove, Zillich, and Medic’s (2014) exercise habit strength. Exercise constancy and patterned action are distinct from what we propose as *exercise execution habit strength*, which is the degree to which exercise actions are executed habitually, i.e. without deliberation, rather than the *degree to which the same exact actions are executed in each exercise session*. For example, an individual might automatically transition from action to action during each exercise session (strong execution habit) but exercise actions may be patterned at the outset, prior to habit formation.

The current study is the first to explore potential differences in the relative importance of conceptually distinct habit components for predicting exercise. Habits develop when cues in the environment are conditioned to trigger the behavior (Orbell & Verplanken, 2010; Wood & Neal, 2007). These triggers activate a mental representation of behavior (i.e. an impulse) and so *instigate* that behavior, and are therefore the necessary and likely most strongly predictive of behavioral frequency. Longitudinally, greater exercise frequency should result in a strengthening of instigation habit, more so than in a strengthening of execution habit. The long-term, regular exerciser that habitually instigates

exercise sessions on a daily basis may purposefully execute different exercise actions in order to maximize enjoyment or physical challenge, or minimize boredom (Verplanken & Melkevic, 2008).

The current study used a longitudinal design to document exercise instigation and exercise execution habit strengths as discrete predictors of exercise frequency over the subsequent 4 weeks. Three hypotheses were tested: (1) Exercise instigation and exercise execution habit strength can be empirically observed as distinct constructs. Further, both constructs will be distinct from the construct of patterned exercise-action; (2) Exercise instigation habit strength (at baseline) will more strongly predict subsequent exercise frequency than will exercise execution habit strength; (3) Change in exercise frequency over the month of the study will be associated with change in instigation habit strength and not with change in execution habit strength nor patterned exercise action.

Method

Participants

Participants were university college students ($n=87$) and staff/faculty ($n=36$). Most were female (65% of students and 89% of staff/faculty) and White/Caucasian (71% and 78%, respectively). Approximately 25% of the total sample had overweight to obese BMI values. At the study outset, 4% self-reported not previously engaging in regular exercise but being willing to exercise for the duration of the study at least twice per week for 20 minutes; 23% reported exercising some but not regularly; 15% reported exercising regularly but for less than 6 months; 9% reported exercising regularly for 6-12 months; and 49% reported exercising regularly and for longer than 12 months. The average age for students was 19.48 years ($SD=2.08$; range 18-33) and for staff/faculty, 37.61 years ($SD=13.82$; range 21-73).

Procedure

Students and faculty/staff were recruited via advertisements for a longitudinal study regarding physical activity and daily schedules. Student participants were recruited via an online web system for administering course credit for research participation; staff/faculty participants were recruited via email

advertisements, flyers, and word of mouth. Inclusion criteria, made clear in the study advertisements, were: 18 or older, currently engaging in exercise or willing to exercise for at least 20 minutes, twice per week for the duration of the study, and written and verbal English proficiency. Participants (n=123) came in to the lab, provided informed consent, and then completed baseline survey items on a computer and received instructions on completing an electronic daily diary for the subsequent month. Daily diary completion was monitored and reminder emails sent to participants non-compliant for two or more days in a row. At the end of the month, participants completed a final online survey and were compensated with partial course credit and/or cash. Students received \$20 in addition to course credit; staff/faculty participants received \$40. Measures were also taken, for unrelated studies, of body image, exercise motivation, and physical activity (via accelerometers), data for which are not reported here. Most participants were using an accelerometer in addition to filling out the daily diaries; however, accelerometer data was not used in the current analyses because accelerometers measure overall physical activity (e.g. total steps in a day) and do not reliably capture frequency of purposeful, discrete exercise sessions, which was the relevant outcome for the current hypotheses. All study procedures were approved by the human ethics committee of the relevant institution.

Measures

A pilot test was conducted in a separate sample of 124 college-aged individuals to evaluate whether an adaptation of an existing habit scale (the Self-Report Behavioral Automaticity Index; SRBAI) provided face-valid items of exercise instigation habit separately from exercise execution habit. Participants were given descriptions of instigation and execution habit and how they differ, and were asked to indicate whether modified SRBAI variants developed by the authors captured each of the two concepts. Participants were told, "With the different question wordings that you just saw in this survey, we were trying to get at the distinction between deciding to exercise ('exercise instigation habit') and the specific actions a person takes during his/her exercise routine ('exercise execution habits'). Did this distinction

between exercise instigation and exercise execution seem clear to you as you rated the questions? If not, can you describe what you thought we were asking instead or why the distinction wasn't clear?"

Most participants (109; 88.6%) reported that the distinction was clear. Of the remaining 14 participants, 9 reported that they did not even notice differences in wording, and 5 that they either disagreed with the distinction, or did not understand it. Given that the majority of participants understood the distinction, we were satisfied enough to use the items in the main analysis.

Exercise Instigation Habit Strength. The degree to which participants' exercise sessions were *instigated* without deliberation was measured using the four-item SRBAI (Gardner et al., 2012), as adapted so that the common item stem ("Exercising is something...") captured exercise instigation: "Deciding to exercise is something...". The four items were otherwise in original form: "...I do automatically", "...I do without thinking", "...I do without having to consciously remember", "...I start doing before I realize I'm doing it": strongly disagree (=1) to strongly agree (=5). Internal consistency was good ($\alpha = 0.88$ at baseline and at follow-up). *Change* in instigation habit strength was represented by the follow-up Instigation SRBAI minus the baseline Instigation SRBAI.

Exercise Execution Habit Strength. The degree to which participants' exercise sessions were *executed* without deliberation was measured using the SRBAI with the following statement stem: "Once I am exercising, going through the steps of my routine is something..." ("...I do automatically", "...I do without thinking", "...I do without having to consciously remember", "...I start doing before I realize I'm doing it"; strongly disagree (=1) to strongly agree (=5)). Internal consistency was good ($\alpha = 0.85$ at baseline and follow-up). *Change* in execution habit strength was represented by the follow-up Execution SRBAI minus the baseline Execution SRBAI.

Patterned Exercise Action. Specific items from existing measures were used to represent patterned exercise action. Two items from the Exercise Habit Survey (EHS; Tappe & Glanz, 2013) represented patterned exercise action: "I varied my exercise routine by performing different exercises on different

days” (reverse scored) and “Every day that I exercised, I performed the same exercise(s)” (Never, rarely, sometimes, often, always). Two items from Grove et al (2014) were also used: “Most of my exercise sessions follow the same pattern” and “I tend to do the same activities or exercises in each session” (not true for me (=1) to very true for me (=5)). Other items from the EHS and Grove et al.’s (2014) patterned action subscale were not included as they may not be adequate measures. For example, “I exercise on the same days each week” and “I exercise for about the same amount of time in each session” could also be accurate for an individual who has varied exercise routines. Internal consistency of these 4 items was 0.70, and mean scores on the four items represented the variable.

Exercise Frequency. Exercise frequency was measured via electronic daily diary reports for four weeks post-baseline; participants would indicate each day whether they had engaged in purposeful exercise for 20 or more minutes at moderate to vigorous intensity that day (yes/no). Frequency of discrete exercise sessions were evaluated instead of total physical activity, because exercise sessions may feasibly be instigated and/or executed habitually, so this provides an opportunity for comparing the measures in a way that total physical activity duration or intensity across a given time period does not.

Daily diary exercise frequency was constructed as a proportion of applicable days on which the participant reported having exercised. Participants’ daily diary scores were not calculated if they failed to complete diaries on at least 75% of the days within a 24-hour window, as electronically verified by submission time. This allowed inclusion of 96% of the sample (n=119) in final analyses with this variable.

Participants were also asked, at baseline and 1-month follow-up: “How often do you exercise: Never, rarely (a few times a month), sometimes (1-2 times a week), quite often (3-4 times a week), frequently (5-6 times a week), or daily?” At follow-up, the participants were asked to refer to the previous month when answering the question. The follow-up item was used as one of the exercise frequency outcomes in prospective analyses. Responses to exercise frequency items at baseline and follow-up were used to create groups representing absolute exercise frequency and *change* in frequency over the study period.

Analysis Overview

To evaluate whether exercise instigation habit would be distinct from exercise execution habit (Hypothesis 1), exploratory factor analyses (maximum likelihood extraction with direct oblimin rotation, to permit inter-factor correlation) of the exercise instigation and exercise execution habit strength items were conducted with the baseline data. The baseline factor structure was verified with follow-up data.

To evaluate whether exercise instigation strength would be the strongest predictor of future exercise behavior, followed by execution habit strength and then patterned exercise action (Hypothesis 2)—bivariate correlations between the theoretical predictors (exercise instigation and execution habit, patterned exercise action) and exercise frequency outcomes (daily diary exercise frequency and self-reported frequency at follow-up) were calculated. To test the relative importance of the predictors, multiple regressions for the two exercise frequency outcomes were conducted separately, with exercise instigation habit, exercise execution habit, and patterned exercise action as simultaneous predictors. These models were tested with and without potentially important control variables (BMI, social-desirability bias, student/staff status). A minimum sample size of 82 was calculated to yield sufficient power (minimum of .80) to detect a medium effect size ($f\text{-squared}=0.15$) in a linear regression with three predictors (calculated using G-Power, version 3.1.9.2; [Faul, Erdfelder, Buchner, & Lang, 2009](#)).

To evaluate whether change in exercise over the period of the study would be most strongly associated with change in exercise instigation habit strength, followed by change in execution habit strength and then patterned exercise action (Hypothesis 3), repeated measures ANOVAs were conducted¹. Participants were categorized into one of four groups: those who exercise infrequently (i.e. <3 times per week) at baseline and remain infrequent exercisers at follow-up (low baseline frequency, low follow-up frequency [*low/low*], *no change*); those who changed from infrequent to frequent

¹ We also ran regressions to predict difference/change scores and follow-up scores when controlling for baseline scores, and the same pattern of results was found for all analyses. The results obtained here are not therefore merely a product of the analysis method. We report this analysis because it is statistically most coherent.

exercise (i.e., ≥ 3 times per week) over the month (*low/high, increased frequency*); those who changed from high to low frequency (*high/low, decreased frequency*); and those who report high frequency of exercise at both time points (*high/high, no change*). Outcomes were participants' instigation habit strength, execution habit strength, and patterned exercise action. We expected change in instigation habit strength corresponding to frequency group (i.e. low instigation habit strength and no change for the low/low group; high levels of instigation habit strength and no change for the high/high group; increased instigation habit for the low/high group; and decreased instigation habit for the high/low group). We did not expect execution habit strength or patterned exercise action from baseline to follow-up to be associated with exercise frequency groups in this way.

Although dichotomization of a continuous variable (exercise frequency) can reduce statistical power (Phillips, 2013), this analysis allows a test of the hypothesis without utilizing difference scores between time points for the predictor and the outcome. Difference scores can be statistically unreliable (but see Gollwitzer, Christ, & Lemmer, 2014), and do not allow evaluation of the effect of absolute levels of the variables (Phillips, 2013). In the current study, we expected different levels of instigation habit strength, for the four groups created to represent *change* and *level* of exercise frequency.

Results

Regression assumptions were met. Mahalanobis distance values indicated no multivariate outliers on the tested study variables (i.e., distances larger than expected by chance in 1/1000 cases, i.e. $p < 0.001$; see Tabachnik & Fidell, 2007). All variables were normally distributed around variable means.

Excluding six participants who not complete the follow-up survey, the final analytic sample was $n=118$. All analyses were conducted on available data with no imputations for missing data, except for the daily diary measure. Pairwise deletion was utilized, and so sample sizes ranged from 108 to 120.

Hypothesis 1. Factor analysis yielded two latent factors in both the baseline and follow-up data; factors corresponded to the instigation items and the execution items, respectively. In the baseline data

only, one item (“Deciding to exercise is something I do without remembering”) cross-loaded on both factors but was more strongly loaded with the other instigation items (pattern matrix loading 0.54) than with the execution items (0.31; see Table 1). At follow-up, there were no items that cross-loaded on factors (with loadings >0.29). The two factors were strongly correlated (baseline: $r(119)=0.68$; follow-up: $r(116)=0.71$). The correlation between the two subscales created from the items was $r(119)=0.67$, $p<.001$ (baseline), and $r(116)=0.64$, $p<.001$ (follow-up). Hypothesis 1 was supported.

Hypothesis 2. Exercise instigation habit strength and exercise execution habit strength were each correlated with both exercise frequency outcomes (see Table 2). Patterned exercise action was not related to either exercise frequency outcome nor to instigation and execution habit. Only instigation habit strength significantly predicted exercise frequency at follow-up. When modeling daily diary frequency, instigation habit strength was the only predictor ($\beta=0.31$, $t(3,108)=2.56$, $p=0.01$; execution habit strength: $\beta=0.06$, $t(3,108)=0.06$, $p=0.62$; patterned exercise action: $\beta=0.16$, $t(3,108)=1.79$, $p=0.08$). When modeling self-reported exercise frequency, only instigation habit strength was a predictor ($\beta=0.39$, $t(3,107)=3.16$, $p=0.002$; execution habit strength: $\beta=0.05$, $t(3,107)=0.44$, $p=0.66$; patterned exercise action: $\beta=0.06$, $t(3,107)=0.69$, $p=0.49$). No meaningful differences were found between predictors and outcomes when controlling for BMI, social-desirability bias, and student/staff status, nor were these variables significantly related to either outcome. Hypothesis 2 was supported.

Hypothesis 3. The number of individuals falling into the four exercise frequency groups was: low baseline frequency, low follow-up frequency ($n=48$); low/high ($n=13$); high/low ($n=11$); and high/high ($n=37$). Repeated measures ANOVAs showed differences between frequency groups on change and level of instigation habit strength, as the frequency group \times time interaction was significant ($F(3, 107)=2.85$, $p=0.04$, $\eta_p^2=0.08$, but no differences in change and level of execution habit strength ($F(3, 108)=0.02$, $p=0.99$, $\eta_p^2=0.001$) nor patterned exercise action ($F(3, 107)=0.25$, $p=0.86$, $\eta_p^2<0.01$). Relationships between groups for instigation habit strength as the outcome were as expected: the low/low frequency

(no change) group showed low instigation habit strength and no change in instigation habit strength over the month of the study; the high/high frequency (no change) group showed high instigation habit strength over the month; the high/low frequency group showed a decrease and the low/high frequency group showed an increase in instigation habit strength (see Figure 1). Only the simple slope (i.e. the change in instigation habit strength) of the high/low frequency group was statistically significant (slope=-0.46, $p=0.02$). The positive slope for the low/high group was not significant (slope=0.21, $p=0.22$).

As Figure 1 shows, there were no relationships between exercise frequency change and execution habit strength change, and between exercise frequency change and patterned exercise action change.

Discussion

This study evaluated whether the theorized distinction between exercise instigation habit and exercise execution habit could be empirically observed, and estimated the relative importance of the two concepts for predicting exercise frequency. Instigation and execution habit were found to be underpinned by separate latent factors. Further, both scales positively and prospectively predicted exercise frequency, assessed via daily diary and retrospectively at 1-month follow-up; however, in multivariate analyses, only instigation habit strength was a significant predictor of exercise frequency. Results also showed that patterned exercise-action was distinct from execution habit strength and did not predict exercise behavior. Change in frequency over one month was associated with change in instigation habit, but not change in execution habit nor in patterned action.

Results suggest that instigation habits are empirically discernable from execution habits in the exercise domain. Findings support Verplanken and Melkevic's (2008) proposition that *deciding* to exercise, or instigating exercise, is the mechanism underpinning commonly observed habit-exercise behavior associations (see Gardner et al., 2011). Further, exercise habit need not be scripted or automated, once the "goal" or decision to exercise is triggered (as posited by [Aarts et al., 1997](#)). Our instigation and execution habit items were adapted from the Self-Report Habit Index, which is the most

commonly used habit measure ([Gardner, 2014](#)), but in its original form (e.g. “Exercise is something I do automatically”) does not distinguish between instigation and execution. Our findings do not reveal whether previously observed associations between exercise habit and behavior reflect instigation or execution habit. Empirical assessment of whether non-specific measures of habit better represent instigation or execution would help researchers interpret more precisely the role(s) played by habit in previous studies. For example, if non-specific measures of habit are found to measure execution habit, or a combination of instigation and execution habits, then previously observed exercise habit-frequency relationships may have underestimated the true relationship between individuals’ exercise habit strength and behavioral frequency. Moreover, work is needed to replicate the present findings in other behavioral domains. We expect that the distinction will be less relevant, or less observable, for simpler actions characterized by fewer sub-actions (e.g. pulling a light switch, taking medication), for which initiating is less easily separable from executing the sequence. For complex behaviors such as exercise, however, we believe the distinction is important. Empirical evidence is required to evaluate the relative importance of instigation and execution habit in other complex behaviors, such as dietary intake.

Patterned exercise action was unrelated to execution habit and exercise outcomes. This may be due to the measures used. Following Grove et al (2014) and Tappe & Glanz (2013), items assessed whether *exactly the same actions* are done *every time* a participant exercises. If patterned action is defined more broadly, however, to recognize that people can have more than one exercise routine, and may engage in patterned action each time one of their routines is ‘chosen’, then patterned action may correlate more strongly with execution habit. Even if patterned action is shown to be equivalent to exercise execution habit strength, however, our results suggest having set routine(s) and execution habits does not predict exercise maintenance. Inclusion of patterned action in existing habit measures may be unfounded.

Our results have important implications for intervention design and evaluation. For behaviors that have separable instigation and execution components, interventions may differentially target these

habits. Our findings call for greater specification of the intended outcomes of purported habit-formation interventions; that is, are participants being encouraged to learn to habitually select one health behavior over alternative options, or to automate rigid sequences of health-promoting actions? Our results suggest that the former habit type (instigation habit) may better promote frequent action, at least in the exercise domain. While further experimental studies or intervention trials are needed to empirically establish the extent to which modifying instigation habits changes behavior frequency, our findings tentatively suggest that setting cues for exercise performance instigation, but not necessarily encouraging adherence to an exercise routine, may be optimal. This resolves a tension in the habit literature, in that it appears possible to promote exercise habit formation in a manner conducive to behavior maintenance while also allowing individuals to vary the exercise activities they perform, so preventing boredom that may arise from repeating the same routine (Gardner, Lally & Wardle, 2012; Verplanken & Melkevik, 2008). This need not mean that patterned exercise action is unhelpful for initiating exercise; reducing the complexity of exercise may make people more likely to intend to exercise and more confident to exercise, which are known determinants of behavior repetition and so habit formation (Bandura, 1986; Lally & Gardner, 2013). Patterned execution may therefore foster development of instigation habits. Alternatively, it may be that focusing on instigation habit but promoting *non*-habitual execution of the behavior to avoid boredom may better maintain intrinsic motivation for the behavior, which has been shown to predict generic exercise habit strength (Gardner & Lally, 2013). Exploring the effect of execution habit on enjoyment could inform interventions designed to optimize maintenance of healthy behaviors through habitual and non-habitual means. Longitudinal studies of individuals new to a behavior, and evaluation of change in both types of habit strength, may address these questions.

Limitations of this study must be acknowledged. Whereas change in frequency was more closely associated with change in instigation habit strength than in execution habit strength or patterned

exercise action, the trend of increasing instigation habit strength with increasing exercise frequency was not significant, as the simple slope for instigation habit change over time for the low-to-high frequency group was no greater than zero. The size of this frequency group likely reduced power to detect an effect. The percentage of individuals who fell into each frequency-change group in this study may be used to determine a sample size large enough to achieve sufficient power in future analyses. Further, since we were analyzing *change* in habit as a *cause* of change in frequency, our two-panel data is equivalent to a cross-sectional view of change, so instigation habit change could be argued to cause exercise frequency change instead, or a bidirectional relationship may exist between the two variables. Three time points of data would allow investigation of cross-lagged *change* in both variables, and detection of whether and to what extent habit change precedes behavior change, and vice versa. Notably, however, using regression as an alternative (albeit statistically suboptimal) method of probing differences in exercise frequency on habit strength, based either on modeling change in frequency over the study period, or follow-up frequency when controlling for baseline frequency, instigation habit emerged as a significant predictor and execution habit did not, thus corroborating our main findings.

The lack of a relationship between execution habit and exercise frequency in multivariate analyses may be a methodological artifact, as execution items were less compatible with frequency scores than were instigation items. The compatibility principle proposes that items that specify the same behavioral target are likely to correlate more strongly (and truly; [Ajzen, 1988](#)). Instigation items referred to 'deciding to exercise', which corresponded more closely with the exercise frequency measure than did execution items, which referred to 'going through the steps of my routine'. However, bivariate relationships between execution habit strength and exercise frequency were significant, and the execution habit items loaded on a separate factor from the instigation habit items, which provides some confidence in the validity of the execution habit items relative to the instigation habit items. Similarly, habit items related to 'exercising' and so were not directly compatible with behavior frequency

measures, which referred to 'purposeful exercise'. Behavior wording was chosen to differentiate exercise from instrumental physical activity, and habit wording to minimize ambiguity that may have arisen from framing the behavior as 'deciding to exercise purposefully'. Nonetheless, it is possible that incompatibility may have reduced the magnitude of observed habit-behavior relationships. Also, we measured exercise as frequency, rather than duration or intensity, which may have inflated instigation habit-behavior effects, or suppressed execution habit-behavior effects. Findings require replication using alternative exercise and habit measures. However, we have no reason to expect execution habit to correlate more closely with other exercise measures: two people could, for example, have identical execution habits, yet one may do each sub-action within their routine for longer or at a higher intensity. Conversely, two people could perform the same routine for the same duration and intensity but rate their execution habits differently, one performing the routine mindfully and the other automatically.

Moreover, both habit types were measured by self-report. Concerns have been raised around the validity of assessing habit via self-report; people may have little insight into unconscious processes, which can limit the accuracy of self-reported habit strength (Hagger et al., 2015). Some have argued that habit can be inferred from its consequences (e.g. 'I can't remember actively deciding to go to the gym, yet I am now walking towards the gym, so I must have made the decision habitually'), thus providing an adequate proxy measure of habit (e.g. [Gardner, 2014](#); Sniehotta & Penseau, 2012), but such inferences can lack precision (Hagger et al, 2015; but see Orbell & Verplanken, 2015). This problem may have been compounded in our study. People often fail to recognize actions within a higher-level behavior sequence as discrete, instead perceptually organizing them into a single unit (e.g. 'putting on sneakers' and 'leaving the house' are clustered together as part of 'going for a run'; see Vallacher & Wegner, 1987). It is therefore possible that respondents may have less insight into the role of habit within a sequence (execution habit) than at the outset of the sequence (instigation habit). Alternatively, given research indicating that people can be environmentally cued to behave in certain ways without awareness of the

cues (Nisbett & Wilson, 1977), it may be that people have less insight into habitual activation of a sequence (instigation habit) than enactment (execution habit).

More fundamentally, respondents often misinterpret self-report habit items (Gardner & Tang, 2014). This may have been exacerbated here, given the subtlety of the distinction between instigation and execution, and ostensibly similar instigation and execution item wording. Instigation habit item stems in particular may have been misinterpreted. These were intended to capture unconsciously 'choosing' to engage in exercise in response to conditioned contextual cues. Items were worded in relation to "deciding" instead of "instigating" to articulate, in lay terms, the instigation habit concept and its distinction from execution. It is possible, however, that respondents interpreted these items to refer to deciding to exercise *at a later time* (e.g. deciding *before* going to work to exercise *after* work). Instigation habit refers to the activation of behavior immediately prior to its execution, and is not synonymous with habitual planning. Had respondents misinterpreted instigation items however, the relationship between instigation habit and frequency would likely have been attenuated, due to the possibility of internal or external forces (e.g., preference reversals, structural barriers; Tversky & Thaler, 1990) obstructing translation into action. Moderate-to-strong correlations between instigation habit and exercise frequency suggest this was not the case. Indeed, pilot study data suggested most participants recognized the distinction between habit types and items. Nonetheless, empirical validation is needed of instigation and execution habit items against more objective measures of decision-making automaticity and procedural automaticity respectively (Keatley, Chan, Caudwell, Chatzisarantis & Hagger, 2015).

While self-report measures may be imperfect for tapping habit (Hagger et al, 2015), one means of improving them is to better specify the concept being measured, as we have done here. The current study demonstrates that exercise behavior has separable components that can develop into habits and predict behavior differentially. Specifically, the extent to which individuals habitually decide to engage in exercise, rather than the automaticity of their exercise routines, better predicts exercise frequency.

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Figure 1.

Results of the repeated measures ANOVA for test of Hypothesis 3. The interaction between time and exercise frequency groups in predicting the outcome was only significant for instigation habit strength as the outcome. The exercise frequency groups are identified in the legend: “Low T1-Low T2 Frequency” represents those who reported low frequency exercise at both baseline and at follow-up, etc.

Table 1.

Item-factor loadings (pattern matrix) for instigation habit strength and execution habit strength items, from baseline data and follow-up data. Items are listed in the order from greatest to lowest factor loading in the baseline analysis.

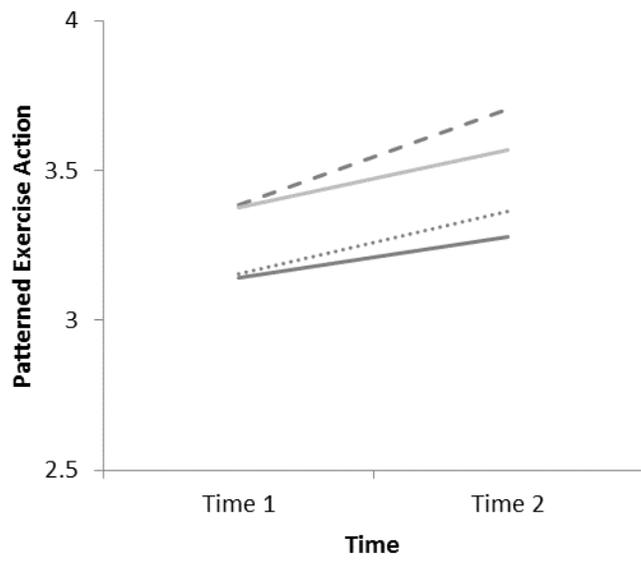
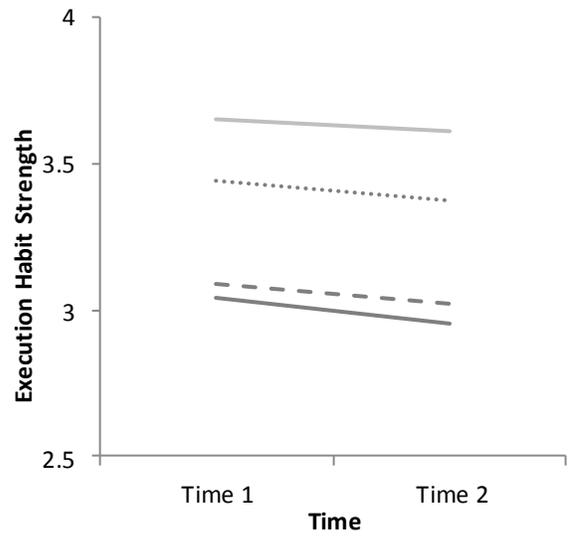
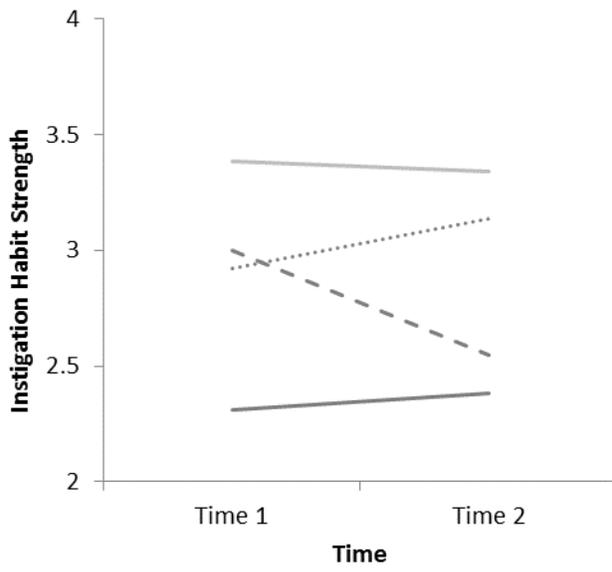
Item	Baseline Data		Follow-Up Data	
	Factor 1	Factor 2	Factor 1	Factor 2
Instigation Habit Strength:				
“Deciding to exercise is something...”				
“...I do without thinking”	0.99		0.95	
“...I do automatically”	0.82		0.78	
“...I start doing before I realize I’m doing it”	0.67		0.66	
“...I do without having to consciously remember”	0.54	0.31	0.81	
Execution Habit Strength:				
“Once I am exercising, going through the steps of my routine is something...”				
“...I do without thinking”		0.81		0.79
“...I start doing before I realize I’m doing it”		0.80		0.65
“...I do automatically”		0.68		0.85
“...I do without having to consciously remember”		0.61		0.72

Table 2.

Descriptive statistics and correlations among study variables, with scale internal consistency alpha values in diagonal cells, where applicable.

Variable	Mean (SD)	1	2	3	4	5	6	7	8
1 Instigation Habit Strength, T1	2.84 (0.99)	0.88							
2 Execution Habit Strength, T1	3.28 (0.87)	0.67	0.85						
3 Patterned Exercise Action, T1	3.21 (0.77)	-0.11	-0.02	0.70					
4 Instigation Habit Strength, T2	2.83 (0.98)	0.79	0.62	-0.14	0.88				
5 Execution Habit Strength, T2	3.24 (0.92)	0.49	0.56	-0.02	0.64	0.85			
6 Patterned Exercise Action, T2	3.43 (0.78)	-0.02	-0.02	0.65	-0.04	0.06	0.72		
7 Exercise Frequency, Self-Report, T1	3.02 (1.16)	0.56	0.41	0.04	0.44	0.30	0.08	--	
8 Exercise Frequency, Self-Report, T2	2.92 (1.13)	0.42	0.29	0.02	0.46	0.33	0.02	0.69	--
9 Exercise Frequency, Daily Diary Measure	0.61 (0.24)	0.33	0.22	0.13	0.32	0.30	0.06	0.45	0.67

Note. Mean value for exercise frequency from the daily diary measure is a proportion of days on which individuals reported exercising out of the total days they filled out daily diaries. Variables 1-4 had a possible range of 1 to 5. All correlations were calculated with pairwise deletion, and sample sizes ranged from 108 to 120; correlations of magnitude 0.22 or greater were statistically significant at $p < 0.05$; correlations of magnitude 0.28 or greater were statistically significant at $p < 0.01$.



- Low T1-Low T2 Frequency
- Low T1-High T2 Frequency
- - - High T1-Low T2 Frequency
- High T1-High T2 Frequency