

## Intrinsic Rewards Predict Exercise via Behavioral Intentions for Initiators but via Habit Strength for Maintainers

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Regular exercise is thought to involve both reflective (e.g., intention) and automatic (e.g., habit) mechanisms. Intrinsic motivation is a reflective factor in exercise initiation; we propose that the experience of intrinsic exercise rewards (enjoyment; stress reduction) may come to function as a factor in exercise automaticity, or habit, and therefore of exercise maintenance. The current studies evaluate whether the relationship between intrinsic exercise rewards and exercise is mediated by behavioral intention for those newer to exercise (initiators) but mediated by behavioral habit strength for longer term exercisers (maintainers). In 2 studies, self-reported exercise stage (initiation vs. maintenance), intrinsic exercise rewards, intentions, and habit strength were measured at baseline. For outcomes, Study 1 concurrently assessed self-reported exercise in a large sample of U.S. college students ( $n = 463$ ), and Study 2 prospectively assessed objective activity using accelerometers for 1 month in a U.S. college student and staff population ( $n = 114$ ). Moderated mediation analyses resulted in support of the hypotheses: Habit strength significantly mediated the relationship between intrinsic rewards and exercise for maintainers in Studies 1 and 2 (unstandardized indirect effect = 7.66 and 0.04, respectively;  $p < .05$ ) but less strongly for initiators in Study 1 and not at all for initiators in Study 2. Intentions mediated the relationship for initiators (unstandardized indirect effect = 0.94 and 0.02, respectively;  $p < .05$ ) but not for maintainers, as expected. We concluded that intrinsic rewards may promote exercise repetition via intentional or reflective means in initiation but via habit strength in maintenance. Interventions that foster intrinsic exercise rewards may promote exercise maintenance through habitual action.

**Keywords:** intrinsic motivation, physical activity, habit, behavioral automaticity, behavioral maintenance

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As a “lifestyle factor” important for health maintenance (Hillemeier et al., 2011), regular exercise needs to be not only initiated but maintained over a lifetime (Sherwood & Jeffery, 2000). However, individuals face many barriers to initiating and sustaining exercise, and interventions to promote regular exercise have had short-lived effects (Arikawa, O’Dougherty, Kaufman, Schmitz, & Kurzer, 2012; Marcus et al., 2000). Researchers now know that behavioral initiation factors (behavioral beliefs, intentions, external goals, motivation) largely differ from maintenance factors (behavioral satisfaction, habit; Fleig, Pomp, Schwarzer, & Lippke, 2013; Rothman, Sheeran, & Wood, 2009), and interventions to date have primarily focused on the former rather than the latter (Baldwin et al., 2006; Phillips, Leventhal, & Leventhal, 2013). As stated by Rothman et al. (2009) and Rothman (2004), delineating initiation and maintenance factors and their mechanisms for behavioral promotion is required for advancing the field’s efforts to change behavior and maintain it over time. In particular, more research on behavioral maintenance factors is needed.

Although maintenance factors can be reflective or automatic, researchers have recently focused on behavioral habit (an automatic maintenance factor; Rothman et al., 2009) because habits are more likely to be maintained than are nonhabits, due to their characteristics (Kwasnicka, Dombrowski, White, & Sniehotka, 2016; Orbell & Verplanken, 2010; Phillips et al., 2013). Habits are defined as behaviors that are automatically triggered by conditioned context cues, developed through repeated behavioral performance in stable contexts (Aarts & Dijksterhuis, 2000; Wood & Neal, 2007). Habits are characterized by their *automaticity* (i.e., lack of dependence on cognitive control; Bargh, 1992), separate from frequency, of performance (Gardner, 2012; Verplanken, 2006). Because they are set off by an impulsive system (Hofmann, Friese, & Strack, 2008), habitual behaviors persist in time without relying on conscious evaluations of their outcome and thus are no longer the subject of intentional deliberation (Rothman, Baldwin, Hertel, & Fuglestad, 2011). They require little cognitive effort and self-regulation to enact (Bargh, 1992; Gardner, 2012; Verplanken, 2006). And, because people fall back on habits when they experience fatigue (Neal, Wood, & Drolet, 2013), making exercise habit-

ual creates a fail-safe means for maintenance in otherwise difficult situations.

Researchers have only just begun to evaluate the factors that contribute to behavioral habit strength and maintenance over time, particularly for complex health behaviors such as exercise (Phillips & Gardner, 2016). Because habits can be extinguished (Martin, Haskard-Zolnieriek, & DiMatteo, 2010) and vary in their degree of strength, it is important for research to identify contributing factors to behavioral habit strength. The literature has evaluated context stability as a determinant of habit strength (Wood, Tam, & Witt, 2005), which satisfactorily explains habit strength for behaviors that can be *nonconsciously* activated and executed—and thereby maintained (e.g., flossing; Orbell & Verplanken, 2010; medication adherence; Brooks et al., 2014; Phillips et al., 2013). Complex behaviors, such as exercise, are not likely solely determined by nonconscious activation; an impulse to exercise may be triggered upon encountering a typical exercise context, but acting on this urge requires conscious awareness, physical exertion, and time, even if the action is relatively automatic (i.e., nondeliberative, not dependent on reflective intentions; Aarts, Paulussen, & Schaalma, 1997; Maddux, 1997). In this article, we propose that the experience of intrinsic exercise rewards is a factor that contributes to behavioral habit strength (i.e., automatic or nondeliberative enactment of behavior) and therefore to exercise frequency during maintenance.

The experience of intrinsic behavioral rewards as a factor in behavioral initiation has already been widely studied (Mullan & Markland, 1997; Ryan & Deci, 2000; Teixeira, Carraça, Markland, Silva, & Ryan, 2012). In initiation, intrinsic rewards promote behavioral intentions and therefore behavioral enactment (Biddle, Soos, & Chatzisarantis, 1999; Chatzisarantis, Biddle, & Meek, 1997)—that is, the mechanism by which intrinsic rewards promote exercise frequency in initiation is via behavioral intentions, a reflective mechanism (Rothman et al., 2009). Recent research has also highlighted the role of experiencing intrinsic rewards as a factor in *habit development*; theoretically, those who experience intrinsic behavioral rewards are more likely to *intend* to repeat behavior, actually repeat behavior, and therefore develop cue-behavior associations that characterize habits

(Gardner & Lally, 2013; Wiedemann, Gardner, Knoll, & Burkert, 2014). However, the role of intrinsic rewards and the mechanisms through which they promote exercise *maintenance* is not addressed or tested in existing research.

We propose that the experience of intrinsic rewards continues to play a role in maintenance by promoting automatic (i.e., nondeliberative) engagement in exercise in response to conditioned context cues. First, research and theory has supported the idea that habits are reinforcing: Habit development is a process by which a performance context is repeatedly associated with behavioral enactment and behavioral rewards (Gardner & Lally, 2013; Verplanken, 2006; Wood & Neal, 2007). Repeated pairing of context, action, and reward leads to conditioning of context cues as triggers for behavioral action *and as expectations for reward* (Gardner & Lally, 2013; Wood & Neal, 2007). And these cue–action–reward associations are embedded in memory, extending the activation potential of these associations (Papies & Barsalou, 2015). Recent research has shown that this distributed network can be unconsciously accessed and capable of influencing cognitions and motor responses outside of awareness (Trumpp, Traub, & Kiefer, 2013).

Second, it is the degree to which these reinforcing properties are intrinsic to the behavior that theoretically determines that habit's strength: Intrinsic rewards are more constant than are extrinsic rewards, and continuous rewards are less likely to be extinguished (Johnston, 2016; Martin et al., 2010; Watson, 1925). Further, Marien, Aarts, and Custers (2013) found that cue-elicited responses displayed much stronger intensity when paired with reward signals. Last, as Woolley and Fishbach (2015) and others (Bluemke, Brand, Schweizer, & Kahlert, 2010; Brand & Schweizer, 2015) have shown, intrinsic rewards may be cognitively devalued compared to extrinsic rewards, but they play a stronger role in determining behavioral action (e.g., an individual may report valuing the outcomes of a behavior more strongly than the enjoyment of the behavior, but it is behavioral enjoyment that more strongly predicts behavioral enactment).

Intrinsic exercise rewards may be positive, such as enjoyment (Ryan & Deci, 2000), or negative, such as stress reduction (McLachlan & Hagger, 2011; Staddon & Cerutti, 2003). Although much

of the literature on exercise promotion factors and intrinsic rewards has focused on enjoyment (positive reward), stress reduction is an important benefit of physical activity (Salmon, 2001) and is often promoted as a reason for individuals to start and to continue exercising (U.S. Department of Health and Human Services, 2008; Wankel, 1993). Regular exercisers have reported exercising more when stressed (Stults-Kolehmainen & Sinha, 2014), but the mechanisms by which stress reduction promotes exercise maintenance have not been empirically evaluated. The removal of negative feelings such as stress is a form of negative reinforcement of behavior but is still a reward that is intrinsic to the behavior (McLachlan & Hagger, 2011; Staddon & Cerutti, 2003). This distinguishes it from motivation to exercise in order to avoid feeling guilt for not exercising, which is an outcome external to the behavior, as in introjected regulation (Ryan & Deci, 2000).

Because Rothman et al. (2009) have called for investigation of behavioral maintenance factors separate from initiation factors and of the relative mechanisms of these factors, the current study examines the mechanisms of intrinsic exercise rewards in both behavior initiation and maintenance. Specifically, we test the following a priori hypotheses in two studies: (a) Intrinsic exercise rewards will predict exercise frequency via exercise intentions for initiators more so than for maintainers and, conversely, (b) intrinsic exercise rewards will predict exercise frequency via exercise habit strength for maintainers more so than for initiators. These hypotheses are equivalent to hypothesizing *moderated mediation*, or conditional indirect effects of intrinsic exercise rewards on behavior (Hayes, 2015). Study 1 provides a large sample for initial hypothesis testing (larger sample sizes provide more-reliable regression estimates; Kelley & Maxwell, 2003). Study 2 provides a prospective assessment of objectively measured physical activity in order to separate the predictor(s) from the outcome in time and to address limitations of self-reported physical activity.

## Study 1

### Method

**Participants and procedure.** Participants were 500 college students in a U.S. city (70% female; 30% minority; average age = 19.40 years,  $SD = 1.99$ ), recruited and compensated

with partial course credit through an anonymous subject pool. After consent was provided online, all measures were assessed in an online questionnaire that took an average of 50 min to complete. The local human ethics board approved the project. Any students who were actively participating in a school athletics program at the time of the study ( $n = 37$ ) were excluded from participation; this decision was made to limit the data to participant reports of leisure time physical activity.

### Measures.

**Intrinsic motivation.** Participants completed the Behavioral Regulation of Exercise Questionnaire–2 (BREQ-2; Markland & Tobin, 2004). The four items specific to intrinsic motivation are: “I exercise because it’s fun,” “I enjoy my exercise sessions,” “I find exercise a pleasurable activity,” and “I get pleasure and satisfaction from participating in exercise” ( $\alpha = .94$ ). The responses were rated on a 5-point scale ranging from 1 (*not at all true*) to 5 (*very true*).

**Negative reinforcement.** Two items were developed for this study to represent the degree to which an individual engages in exercise to avoid or remove negative states (e.g., stress, bad mood) by exercising. The items were “I exercise in response to feeling stressed or anxious” and “Exercise is like a ‘reset’ button for me,” and they were rated on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*;  $\alpha = .79$ ).

**Initiation versus maintenance exercise stage.** Initiators and maintainers were identified by their response to a standard measure that assesses individuals’ exercise stage-of-change (Kuroda, Sato, Ishizaka, Yamakado, & Yamaguchi, 2012; Marcus, Rakowski, & Rossi, 1992): Participants who indicated they had been exercising regularly for at least 3 months were considered to be “maintainers”; all other participants were considered to be “initiators.” Participants who had reported being “not currently exercising and not intending to exercise” (noninitiators;  $n = 4$ ) had already been excluded from the study due to random responses.

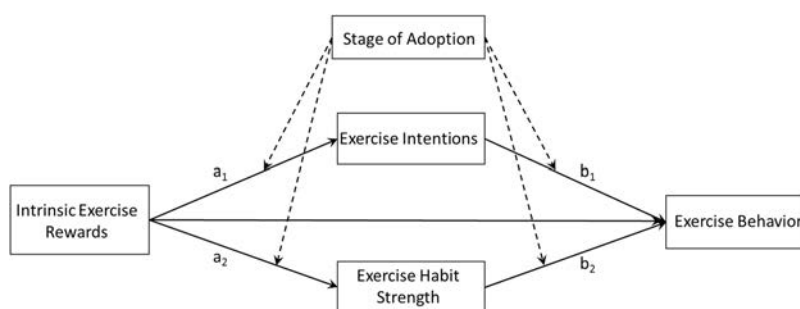
**Exercise habit strength.** Exercise habit strength was measured with the Self-Report Behavioral Automaticity Index (SRBAI; Gardner, Abraham, Lally, & de Bruijn, 2012), which has been widely utilized in recent habit-related research (de Bruijn, Gardner, van Osch, &

Sniehotta, 2014; Gardner & Lally, 2013; Rhodes & de Bruijn, 2010). The four items, which began with the stem “Exercising for 20+ minutes at moderate to vigorous intensity is something . . .,” are “. . . I do without having to consciously remember,” “. . . I do without thinking,” “. . . I start doing before I realize I’m doing it,” and “. . . I do automatically.” These were rated on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*;  $\alpha = .91$ ).

**Behavioral intention.** Intention to engage in moderate to vigorous physical activity was assessed with the item “I intend to exercise for at least 20 minutes, three times per week at a moderate to vigorous intensity for the next month” (Ajzen, 2006). This item, which was rated on a 7-point scale ranging from 1 (*Unlikely*) to 7 (*Likely*), has been used in the literature to represent reflective exercise engagement (de Bruijn et al., 2014; Gardner & Lally, 2013; Orbell & Verplanken, 2010; Rhodes & de Bruijn, 2010).

**Physical activity.** For the outcome in Study 1, participants self-reported their exercise minutes per week, using a modified version of the International Physical Activity Questionnaire (IPAQ; Ainsworth et al., 2000) in which they were asked about their days per week and minutes per day of moderate physical activity and about their days per week and minutes per day of vigorous physical activity. An average minutes per day of moderate or vigorous physical activity was created by calculating active minutes per week divided by seven. Results do not change when days per week of moderate to vigorous activity is used in place of minutes. The full IPAQ was not utilized, because it includes a measure of “light intensity activity,” which does not fit within the definition of exercise.

**Analysis overview.** The hypotheses specify two *moderated mediation* effects, or conditional indirect effects (Hayes, 2015), with exercise intentions and habit strength as the mediators and with exercise stage of adoption (initiation vs. maintenance) as the moderator. Therefore, we used A. F. Hayes’s (2015) statistical procedure PROCESS for testing moderated mediation with multiple mediators. Figure 1 illustrates the hypothesized relationships between variables and the statistical parameters that are calculated and tested for significance using PROCESS in SPSS.



*Figure 1.* The figure illustrates the hypothesized findings: The indirect effect of intrinsic exercise rewards on exercise behavior through intentions is equal to  $a_1 * b_1$ ; the indirect effect through habit strength is  $a_2 * b_2$ . The significance of these effects is hypothesized to depend on the moderator, or individuals' stage of adoption: Specifically,  $a_1 b_1$  is expected to be significantly stronger for initiators than for maintainers, and  $a_2 b_2$  is expected to be significantly stronger for maintainers than for initiators. Intrinsic exercise rewards include positive rewards (enjoyment), as represented by intrinsic motivation, as well as negative rewards (stress reduction). Exercise behavior is minutes per day of moderate to vigorous activity in Study 1 and proportion of applicable days exercising at moderate to vigorous intensity for 20+ min, as measured by the accelerometer, in Study 2.

Specifically, Hypothesis 1, regarding mediation by exercise intentions, states that there will be a significant indirect effect of intrinsic exercise rewards on exercise minutes per day through exercise intentions for initiators (indirect effect illustrated in Figure 1:  $a_1 * b_1 > 0$ ) and either no indirect effect or a weaker indirect effect of intrinsic exercise rewards on exercise minutes per day through exercise intentions for maintainers (the 95% confidence interval [CI] for  $a_1 * b_1$  for maintainers is expected to include 0). Further, that the difference between these indirect effects (i.e., the conditional indirect effect) will be significantly greater than zero; this would support the hypothesis that the indirect effect through intentions differs significantly by stage of adoption. Hypothesis 2, regarding mediation by exercise habit strength, states that there will be a significant indirect effect of intrinsic exercise rewards on exercise minutes per day through exercise habit strength for maintainers ( $a_2 * b_2$  for maintainers  $> 0$ ) and either no indirect effect or a weaker effect through habit strength for initiators. Further, we expected the difference between these indirect effects (the conditional indirect effect) would be significantly greater than zero; this would support the hypothesis that the indirect effect through habit strength differs by stage of adoption.

Because only one predictor variable was evaluated in the PROCESS analysis, we did the

analysis after combining intrinsic motivation and negative reinforcement into a composite intrinsic exercise rewards predictor variable. Psychometric evaluation indicated this was justified: The internal consistency of the six items was .90, and an exploratory factor analysis (EFA) with maximum-likelihood estimation and direct oblimin rotation indicated a single factor fitting individuals' responses to the six items (with the eigenvalue  $> 1$  criterion for resultant factors and verified with parallel analysis; O'Connor, 2000). However, because the two predictors may be differentially predictive of the mediators and physical activity, we also did the analysis separately for the two predictors to see whether results changed from when they were combined.

Univariate and multivariate outliers were assessed using methods suggested by Tabachnick and Fidell (2007), including checking for values that were 3 *SDs* from the mean on each variable and evaluating Mahalanobis distance values. Only participants' reports of physical activity (moderate to vigorous exercise minutes per day) had a slight negative skew and eight outliers with activity higher than 3 *SDs* above the mean (but no multivariate outliers, indicating these univariate outliers were not errors). Tests of the hypotheses were run with and without a log 10 transformation on the outcome, which normalized the data; results did not alter with transformation, and so results using the original variable are reported in the Results section.

## Results

Correlations between study variables and descriptive statistics are reported in supplemental Table 1 in the online supplemental materials. Study 1 had 248 initiators and 215 maintainers in the final analysis. All variables were positively and significantly correlated with each other. The PROCESS analysis results did not change in interpretation when intrinsic motivation and negative reinforcement were evaluated separately as predictor variables compared with when the two were combined. Therefore, the results of the analysis with the two variables combined are reported here.

As hypothesized, the indirect effect of intrinsic exercise rewards on exercise minutes per day via *exercise intentions* was significant for initiators ( $a_1b_1 = .94$ , boot  $SE = .45$ , 95% CI [.28, 2.07]) but not for maintainers ( $a_1b_1 = -.31$ , boot  $SE = .61$ , 95% CI [-1.88, .60]). The conditional indirect effect was significant as expected (i.e., the indirect effect for initiators was significantly stronger than for maintainers: difference in indirect effect =  $-1.25$ , 95% CI [-2.98, -.01]). These results mean that intrinsic exercise rewards predicted physical activity by way of exercise intentions for initiators but not for maintainers.

The indirect effect of intrinsic exercise rewards on exercise minutes per day via exercise habit strength was significant as expected for maintainers ( $a_2b_2 = 7.66$ , boot  $SE = 2.33$ , 95% CI [3.94, 13.63]) and was also significant for initiators ( $a_2b_2 = 2.08$ , boot  $SE = .57$ , 95% CI [1.09, 3.27]). As hypothesized, the indirect effect of intrinsic exercise rewards on exercise minutes per day via exercise habit strength was significantly greater for maintainers than for initiators, as seen in the significant conditional indirect effect (difference in indirect effect =  $5.58$ , 95% CI [1.39, 11.00]). These results mean that intrinsic exercise rewards predicted physical activity by way of exercise habit strength for both initiators and maintainers, but the effect was significantly stronger in maintainers than in initiators.

## Discussion

Overall, Study 1 provided support for the hypotheses in that intrinsic exercise rewards

were related to participants' concurrent reports of moderate to vigorous exercise minutes per day, mediated by behavioral intentions for initiators and mediated by exercise habit strength for maintainers. Although the relationship between intrinsic rewards and physical activity for initiators was also significantly mediated by exercise habit strength, the indirect effect was still stronger for maintainers, as seen by the significant conditional indirect effect statistic (Hayes, 2015). Intention did not mediate the relationship between intrinsic motivation and physical activity for maintainers.

Limitations of Study 1 include the self-reported and concurrently assessed outcome variable. Objective measures of activity would provide stronger support for the theoretical hypotheses. Further, the concurrent measurement of variables is not ideal, because exercise frequency (repetition), habit strength, and intentions likely influence each other. Stronger evidence for the mediational hypotheses would be possible with prospectively measured physical activity. Hence, Study 2 was conducted with a smaller, separate sample using accelerometers to measure physical activity in the month subsequent to the baseline survey measures.

## Study 2

### Method

**Participants and procedure.** Participants were 87 university students and 36 university staff members recruited through the psychology department research subject pool and departmental e-mails. Participants included in the analyses had complete data on all study variables, including adherence to using an accelerometer (the commercially available Fitbit Zip, which has demonstrated validity; Lee, Kim, & Welk, 2014) on at least 75% of the days of the study. The data are from a larger study designed to investigate different psychological factors involved in regular leisure time physical activity; the measures used in the current study are not published elsewhere. Students were compensated with partial course credit and \$20 cash, and nonstudents with \$40 cash. Inclusion criteria were age of 18+ years, English proficiency, and willingness to exercise two or more times per week for the duration of the study (exercise defined as at least 20 min of moderate to vig-

orous activity) but not being active university-team athletes. The same analyses as in Study 1 were conducted but with prospectively assessed physical activity as measured via accelerometers. Nationally competitive athletes were excluded ( $n = 9$  of the students), because their physical activity was due to sport participation and was not considered leisure time activity. This left a final sample of  $n = 114$  (73% female, 27% minority, average age = 24.84 years,  $SD = 11.33$ ).

#### Measures.

**Intrinsic motivation.** The BREQ-2 was used as in Study 1 (four items;  $\alpha = .91$ ).

**Negative reinforcement.** The items in Study 2 were altered from those in Study 1 in order to better match the structure of the intrinsic motivation items from the BREQ-2. The items are "I exercise in order to feel better when I'm in a bad mood" and "I exercise in order to remove stress," with response options rated on a 5-point scale ranging from 1 (*not at all true*) to 5 (*very true*;  $\alpha = .90$ ). A third item, "I exercise to feel less physically gross," was not included in the composite for Study 2, because its inclusion decreased the internal consistency substantially (to  $\alpha = .68$ ).

**Exercise habit strength.** The SRBAI was used, as in Study 1 ( $\alpha = .92$ ).

**Exercise intentions.** The same item was used, as in Study 1.

**Physical activity.** The outcome in Study 2 was individuals' proportion of days on which they had at least one exercise session, defined as 20 or more consecutive minutes of moderate to vigorous physical activity. Although the Fitbit does not capture *intentional* exercise engagement separate from incidental or nonleisure time physical activity, it at least allows for objective identification of bouts of physical activity that would match the definition of exercise provided to participants for answering the exercise-related survey questions. The number of days with one or more such "exercise sessions" divided by the available days of Fitbit data for each individual represented the variable, which ranged from 0 to 1. Fitbit data was checked to ensure participants wore their Fitbits on at least 75% of days in the month and for at least 10 hr per day on applicable days. Participants were told to wear the devices from the time they woke until they went to bed, except for activities in the water (including swim-

ming). We had no reports from participants that they went swimming for their exercise activity.

**Initiation versus maintenance stage.** The same item and scoring was used as in Study 1.

**Analysis overview.** The same analysis as in Study 1 was used, but the outcome was accelerometer-measured proportion of days exercised (applicable days that the participant exercised for at least 20 consecutive minutes at moderate to vigorous intensity) in the month following baseline survey assessment. There were no univariate or multivariate outliers for any study variables, and the physical activity variable met normality assumptions. We again evaluated whether combining intrinsic motivation with negative reinforcement of exercise was justified for the PROCESS analysis of conditional indirect effects of intrinsic exercise rewards on physical activity through exercise intentions versus habit strength. The internal consistency of the six items was again .90, and the EFA (with maximum-likelihood estimation, direct oblimin rotation, and eigenvalue >1 criterion for factors after verification by parallel analysis) again resulted in a best fitting solution of a single factor. Therefore, the intrinsic exercise rewards composite predictor variable was used in analyses, although we still evaluated whether results would change when using intrinsic motivation and negative reinforcement as predictors in separate analyses.

## Results

Correlations between study variables and descriptive statistics are reported in supplemental Table 2 in the online supplemental materials. Study 2 had 51 initiators and 63 maintainers. The PROCESS analysis results did not change in interpretation when intrinsic motivation and negative reinforcement were evaluated separately as predictor variables compared with when the two were combined. Therefore, only the results of the analysis with the two variables combined are reported here.

The primary analysis of interest, regarding the role of intrinsic exercise rewards in predicting proportion of applicable days of exercise via exercise habit strength for initiators versus maintainers, was in support of the hypothesis: The indirect effect of intrinsic exercise rewards on proportion of exercise days via exercise habit strength was not significant for initiators

( $a_2b_2 = -.01$ , boot  $SE = .01$ , 95% CI  $[-.05, .004]$ ) but was significant for maintainers ( $a_2b_2 = .04$ , boot  $SE = .02$ , 95% CI  $[.01, .08]$ ). The conditional indirect effect was significant as expected (the difference in indirect effect through habit strength for maintainers compared to initiators =  $.05$ , boot  $SE = .02$ , 95% CI  $[.01, .10]$ ). These results support the hypothesis that the relationship between intrinsic exercise rewards and physical activity is differentially mediated by habit strength for maintainers compared to initiators.

Support was also found for the expected mediation by exercise intentions for initiators: The indirect effect of intrinsic exercise rewards on proportion of exercise days via exercise intentions was significantly different from 0 for initiators ( $a_1b_1 = .02$ , boot  $SE = .01$ , 95% CI  $[.001, .05]$ ) but not for maintainers ( $a_1b_1 = -.01$ , boot  $SE = .01$ , 95% CI  $[-.04, .004]$ ). The conditional indirect effect was significant, as expected, indicating that the mediation by intentions depended on the moderator, or stage of adoption (the difference in indirect effect through intentions for maintainers compared to initiators =  $-.02$ , boot  $SE = .01$ , 95% CI  $[-.06, -.001]$ ).

## Discussion

As in Study 1, Study 2 showed support for the hypotheses in that intrinsic exercise rewards significantly predicted exercise frequency, mediated by exercise intentions for initiators and by habit strength for maintainers. Further, intrinsic exercise rewards did *not* predict exercise frequency via habit strength for initiators (unlike in Study 1) or via intentions for maintainers (as in Study 1).

### General Discussion

In both studies, hypotheses were supported in that intrinsic exercise rewards predicted physical activity (a) mediated by behavioral intentions for initiators more so than (or not at all) for maintainers and (b) mediated by exercise habit strength for maintainers but not for initiators. This research furthers the field's knowledge regarding the role of intrinsic behavioral rewards for promoting both behavioral initiation and maintenance, via different mechanisms. The current findings suggest that determinants of

habit strength for complex behaviors, such as exercise, may include intrinsic exercise rewards, in addition to context stability. Simple, purely nonconscious habits theoretically do not require intrinsic behavioral rewards (Wood & Neal, 2007). For complex behaviors, such as exercising, it may be the presence of intrinsic rewards in maintenance that keep the behavior automatic.

This study indicates that negative reinforcement of exercise may be useful in promoting exercise habit, although future research into optimal measurement of the construct is required. Among maintainers, the stress-reducing properties of exercise may function to ensure automatic engagement in exercise, particularly for those who routinely experience stress and experienced stress reduction from exercising in initial stages of adoption. Stults-Kolehmainen and Sinha (2014) recently determined in a review of the literature on stress and physical activity that higher levels of experienced stress predicted greater engagement in physical activity for those who reported stronger exercise habits but lesser engagement in activity for those who reported weak exercise habits. We posit that this moderation of the effect of stress on activity may be due to a changing nature of the relationship between intrinsic exercise rewards and physical activity as habits develop and individuals enter a maintenance stage of adoption; if individuals get direct rewards from physical activity in the form of stress reduction, then physical activity is more rewarding among those who experience greater levels of stress and their behavior can be more strongly habitual than if individuals do not experience this direct reward from physical activity (and for whom stress is a barrier to activity).

The role of other factors in exercise maintenance is warranted. For example, operant conditioning recognizes conditioning factors beyond positive and negative reinforcement. Punishment also drives behavior and may be important in considering determinants of exercise maintenance. In fact, Grove, Zillich, and Medic (2014) recently theorized that exercise habit is partially determined by the degree to which an individual experiences negative consequences when not exercising for a time (negative consequences for nonperformance). Their published evidence in support of this theory is that individuals' reports of negative conse-



quences for nonperformance is related to their exercise frequency. However, punishment involves consequences that are external to the behavior (occurring separately in time from the behavior; e.g., feeling bad at the end of the day if one has not exercised). Therefore, we anticipate that punishment may be a reflective determinant of exercise maintenance rather than an automatic one. Experiencing negative consequences for nonperformance (punishment) may foster anticipation of negative states, such as regret, which is known to predict behavior in other domains (e.g., flu vaccination: Chapman & Coups, 2006; exercise: Abraham & Sheeran, 2004).

Further, other volitional factors, such as planning, are known to promote exercise engagement (Lippke, Ziegelmann, & Schwarzer, 2004). The current study focused on intentions as the reflective factors in exercise because of the sizable extant literature that has evaluated intentions and habit for predicting behavior (Conroy, Maher, Elavsky, Hyde, & Doerksen, 2013; de Bruijn et al., 2014; Gardner & Lally, 2013; Orbell & Verplanken, 2010; Rhodes & de Bruijn, 2010). Future research could evaluate the role of planning in promoting habit development or exercise engagement in juxtaposition to or in combination with behavioral intentions and experience of intrinsic rewards.

There are limitations of the current studies that should be discussed. Study 1 limitations include the concurrent assessment of the variables. Although Study 2 addressed this limitation, a more-difficult but a valuable next step would be to conduct a longitudinal study or experiment that tests the developmental relationships of the motivational factors, conditioned context cues, and exercise habit strength. Whether exercise habits *require* intrinsic rewards to be maintained requires more resource-intensive research: An ideal test of the necessity of intrinsic exercise rewards in addition to context stability for habit maintenance would be a longitudinal study that evaluates the role of these factors in promoting habit strength through repetition in those with no habit at all and then following them to see whether the experience of intrinsic rewards predicts who maintains habit over time, above and beyond context stability.

A more-controversial issue is the degree to which behavioral automaticity can be validly

measured via self-report: Some researchers have argued that individuals can reflect on behaviors that have occurred automatically (Gardner et al., 2012; Verplanken & Orbell, 2003); others have argued that these assessments require validation with objective measures of automaticity (Hagger, Rebar, Mullan, Lipp, & Chatzisarantis, 2015). Research using functional magnetic resonance imaging holds promise for measures of automaticity (Smith & Graybiel, 2014). The results of the current study use a theoretically appropriate measure of habit strength, but the results can indicate the importance of intrinsic rewards for habit only insofar as individuals are aware of their exercise automaticity.

The current samples consisted of healthy, well-educated individuals. Although they comprise a target population for intervening to maintain or promote new exercise habits, future research should evaluate the theoretical hypotheses in older adult populations, including chronically ill adults. Individuals' motivations for engaging in exercise over the long term may change as the reasons for exercising change; however, experience of intrinsic rewards may remain similar across ages, even if exercise-related goals shift. Future research could also evaluate under what circumstances each factor may play a more or less important role, on the basis of individual or social factors—for example, whether an individual lives in a highly varied life context versus has a highly regular schedule, or during developmental times of transition, such as for young adults or those entering retirement. Conroy, Elavsky, Doerksen, and Maher (2013) demonstrated how intrapersonal context variation influences exercise intentions and behavior—such context analysis may be beneficial in characterizing and promoting health-related habits and help to overcome the difficulty in defining *context stability* for a behavior whose performance context may vary from day to day but have stable cues (e.g., “after work” could differ in timing but still function as the cue to exercise). Last, recent research in genetics has indicated that physical enjoyment of exercise is heritable (den Hoed, et al., 2013; Roberts et al., 2014); therefore, promoting negative reinforcement of exercise instead of enjoyment may lead to greater success in maintenance.

This article may inform interventions to promote exercise maintenance. Existing research has suggested that interventions should promote exercise maintenance by promoting satisfaction with exercise (Fleig et al., 2013), a deliberative or reflective process (Rothman et al., 2009), and/or a focus on developing stable context cues to trigger exercise initiation (Verplanken & Melkevik, 2008) or reduce sedentary behavior (Conroy, Maher, et al., 2013). The recent studies on intrinsic motivation (Gardner & Lally, 2013) and social-cognitive variables (de Bruijn et al., 2014) as reflective processes during initiation have suggested additional intervention techniques, such as having individuals exercise in contexts over which they feel in control and/or focusing on promoting positive rewards from exercise. However, relying on continued satisfaction with exercise may be difficult and less effective in the long term (external goals change over time; Ryan, Williams, Patrick, & Deci, 2009), and focusing only on stable context cues for behavior (e.g., Gardner et al., 2014) may not be sufficient or optimal for long-term maintenance of regular physical activity.

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