Intrinsic rewards predict exercise via behavioral intentions for initiators but via habit strength for maintainers

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Abstract

Purpose. 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).

Methods. In two 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 US college students (n=463), and Study 2 prospectively assessed objective activity using accelerometers for one month in a US college student/staff population (n=114).

Results. Moderated mediation analyses resulted in support of the hypotheses: habit strength significantly mediated the relationship between intrinsic rewards and exercise for maintainers in Study 1 and 2 (unstandardized indirect effect = 7.66 and 0.04, respectively; $p<0.05$) 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; $p<0.05$) but not for maintainers, as expected.

Conclusions. Intrinsic rewards may promote exercise repetition via intentional/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 not only needs to be 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 and 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 non-habits due to their characteristics (Kwasnicka, Dombrowski, White, & Sniehotta, 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). Since they are set off by an impulsive system (Hofmann,

Friese & Strack, 2009), 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, since people fall back on habits when they experience fatigue (Neal, Wood, & Drolet, 2013), making exercise habitual creates a failsafe 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 like exercise (Phillips & Gardner, 2016). Since habits can be extinguished (Martin, Haskard-Zolnierek, & 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, & Guerrero Witt, 2005), which satisfactory explains habit strength for behaviors that can be *non-consciously* activated and executed—and thereby maintained (e.g., flossing; Orbell & Verplanken, 2010; medication adherence; Phillips et al., 2013; Brooks et al., 2015). Complex behaviors, such as exercise, are not likely solely determined by *non-conscious* 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., non-deliberative, not dependent on reflective intentions; Maddux, 1997; Aarts, Paulussen, & Schaalma, 1997). In this paper, we propose a factor—the experience of intrinsic exercise rewards—as a factor that contributes to behavioral habit strength (i.e. automatic/non-deliberative 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 (Ryan & Deci, 2000; Mullan & Markland, 1997; 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. non-deliberative) engagement in exercise in response to conditioned context cues. First, research and theory support 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 & Baralou, 2015). Recent research shows 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 extrinsic rewards, and continuous rewards are less likely to be extinguished (Johnston, 2015; 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. Lastly, as Wooley and Fishbach (2015) and others (Bluemke, Brand, Scheweizer & Kahlert, 2010; Brand & Schewizer, 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 his/her 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; Stanton & Cerutti, 2003). While 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 report 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 (Staddon & Cerutti, 2003; McLachlan & Hagger, 2011). 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).

As 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: (1) Intrinsic

exercise rewards will predict exercise frequency via exercise intentions for initiators more so than for maintainers; and conversely, (2) 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

Study 1 Participants and Procedure

Participants were 500 college students in a US city (70% female; 30% minority; average age = 19.40, *SD*=1.99 years), 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 minutes 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.

Study 1 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’ (α=0.94). The response options ranged from not at all true (=1) to very true (=5).

Negative reinforcement. Two items were developed for this study to represent the degree to which an individual engages in exercise because he/she is avoiding or removing 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 're-set' button for me', strongly disagree (=1) to strongly agree (=5) (α=0.79).

Initiation vs 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" (non-initiators, 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) that 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, all with response options from strongly disagree (=1) to strongly agree (=5), are: 'Exercising for 20+minutes at moderate to vigorous intensity is something…', '…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' (α=0.91).

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: Unlikely (=1) - Likely (=7)' (Ajzen, 2006).

This item 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 participants 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-vigorous activity is used in place of minutes. The full IPAQ was not utilized, since it includes a measure of "light intensity activity", which does not fit within the definition of exercise.

Study 1 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' statistical procedure, PROCESS, for testing moderated mediation with multiple mediators (Hayes, 2015). Figure 1 illustrates the hypothesized relationships between variables and the statistical parameters that are calculated and tested for significance using PROCESS in SPSS.

Specifically, Hypothesis 1, regarding mediation by exercise intentions, is 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%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, is 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 expect the difference between these indirect effects (the conditional indirect effect) to be significantly greater than zero; this would support the hypothesis that the indirect effect through habit strength differs by stage of adoption.

Since only one predictor variable is 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 6 items was 0.90, and a factor analysis (EFA with maximum likelihood estimation and direct oblimin rotation) indicated a single factor fitting individuals' responses to the 6 items (with the eigenvalue >1 criterion for resultant factors and verified with parallel analysis; O'Connor, 2000). However, since 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 if 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 three standard deviations (SD) from the mean on each variable and evaluating Mahalanobis distance values. Only participants' reports of physical activity (moderate-vigorous exercise minutes per day) had a slight negative skew and eight outliers with activity higher than 3SD above the mean (but no multivariate outliers, indicating these univariate outliers are 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*.

Study 1 Results

Correlations between study variables and descriptive statistics are reported in the Supplemental Table 1. 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 from 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 = 0.94, boot SE = 0.45, 95% CI = 0.28, 2.07) but not for maintainers (a_1b_1 = -0.31, boot SE = 0.61, 95% CI = -1.88, 0.60). 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, -0.01). 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 = 0.57, 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 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.

Study 1 Discussion

Overall, Study 1 provided support for the hypotheses in that intrinsic exercise rewards were related to participants' concurrent reports of moderate-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

Study 2 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 (commercially available, "Fitbit Zip"; Fitbit.com; with demonstrated validity, Lee,

Kim, & Welk, 2014) on at least 75% of the days of the study. The data is 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 dollars cash; non-students with 40 dollars cash. Inclusion criteria were age of 18 years+, English proficiency, and willingness to exercise two+ times per week for the duration of the study (exercise defined as at least 20 minutes of moderate to vigorous activity) but not being active university-team athletes. The same analyses were conducted as in Study 1, but with prospectively assessed physical activity as measured via accelerometers. Nationally competitive athletes were excluded (n=9 of the students), since their physical activity is due to sport participation and is not considered leisure time activity. This left a final sample of n=114: with 73% female, 27% minority, average age = 24.84, *SD*=11.33 years.

Study 2 Measures

Intrinsic motivation. The BREQ-2 was used as in Study 1 (4 items, α=0.91).

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 from not at all true (=1) to very true (=5) (α=0.90). 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 0.68).

Exercise habit strength. The SRBAI was used, as in Study 1 (α=0.92).

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 non-leisure 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 hours per day on applicable days. Participants were told to wear the devices from waking up to going to bed, except for activities in the water (including swimming). We had no reports from participants that they went swimming for their exercise activity.

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

Study 2 Analysis Overview

The same analysis is used as in Study 1, but the outcome is accelerometer-measured proportion of days-exercised (applicable days that the participant exercised for at least 20 consecutive minutes at moderate-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 6 items was again = 0.90, and the factor analysis (EFA with maximum likelihood estimation, direct oblimin rotation, and eigen value > 1 criterion for factors after verification by parallel analysis) again resulted in a best-fitting solution of a single factor. Therefore, the composite predictor variable, "intrinsic exercise rewards" was used in analyses, although we still evaluated whether results

would change when using intrinsic motivation and negative reinforcement as predictors in separate analyses.

Study 2 Results

Correlations between study variables and descriptive statistics are reported in the Supplemental Table 2. 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 from 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 = -0.01, boot SE = 0.01, 95% CI = -0.05, 0.004) but significant for maintainers (a_2b_2 = 0.04, boot SE = 0.02, 95% CI = 0.01, 0.08). The conditional indirect effect was significant as expected (the difference in indirect effect through habit strength for maintainers compared to initiators = 0.05, boot SE = 0.02, 95% CI = 0.01, 0.10). These results support the hypothesis that the relationship between intrinsic exercise rewards and physical activity is differentially mediated by habit strength for maintainers than for 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 = 0.02, boot SE = 0.01, 95% CI = 0.001, 0.05) but not for maintainers (a_1b_1 = -0.01, boot SE = 0.01, 95% CI = -0.04, 0.004). 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 = -0.02, boot SE = 0.01, 95%CI = -0.06, -0.001).

Study 2 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 (1) mediated by behavioral intentions for initiators more so than (or not at all) for maintainers; and (2) 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 as well as 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 non-conscious 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 he/she does not exercise for a time ('negative consequences for nonperformance'). Their published evidence in support of this theory is that individuals' reports of negative consequences for non-performance 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 non-performance (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 are known to promote exercise engagement, such as planning (Lippke, Ziegelmann, & Schwarzer, 2004). The current study focused on intentions as the reflective factors in exercise, because of the sizeable extant literature that evaluates intentions and habit for predicting behavior (Conroy, Maher, Elavsky, Hyde, & Doerksen, 2013b; 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 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. While 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 if 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 argue that these assessments require validation with objective measures of automaticity (Hagger, Rebar, Mullan, Lipp, & Chatzisarantis, 2014). Research using fMRI 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. While 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, based on individual or social factors—e.g., 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 (2013a) demonstrated how intra-personal 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 day to day but have stable cues (e.g., "after work" could differ in timing but still function as the cue to exercise). Lastly, recent research in genetics indicates 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 paper 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/reflective process (Rothman et al., 2009), and/or should focus on developing stable context cues to trigger exercise initiation (Verplanken & Melkevic, 2008) or reduce sedentary behavior (Conroy et al., 2013b). The recent studies on

intrinsic motivation (Gardner & Lally, 2013) and social cognitive variables (de Bruijn et al., 2014) as a reflective processes during initiation suggest additional intervention techniques, such as having individuals exercise in contexts over which they feel in control and/or focus 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.

References

Aarts, H., & Dijksterhuis, A. (2000). Habits as knowledge structures: Automaticity in goal-directed behavior. *Journal of Personality and Social Psychology, 78,* 53-63. doi: 10.1037//0022-3514.78.1.53

Aarts, H., Paulussen, T., & Schaalma, H. (1997). Physical exercise habit: on the conceptualization and formation of habitual health behaviors. *Health Education Research*, *12*(3), 363-374. doi: 10.1093/her/12.3.363.

Abraham, C., & Sheeran, P. (2004). Deciding to exercise: The role of anticipated regret. *British Journal of Health Psychology, 9,* 269-278. doi: 10.1348/135910704773891096

Ainsworth, B. E., Haskell, W. L., Whitt, M. C., Irwin, M. L., Swartz, A. M., Strath, S. J., ... & Leon, A. S. (2000). Compendium of physical activities: an update of activity codes and MET intensities. *Medicine and Science in Sports and Exercise*, *32*(9), S498-S504.

Ajzen, I. (2006). Constructing a Theory of Planned Behavior Questionnaire, online resource: http://people.umass.edu/aizen/pdf/tpb.measurement.pdf

Arikawa, A. Y., O'Dougherty, M., Kaufman, B. C., Schmitz, K. H., & Kurzer, M. S. (2012). Attrition and adherence of young women to aerobic exercise: lessons from the WISER study. *Contemporary Clinical Trials*, *33*(2), 298-301. doi: 10.1016/j.cct.2011.11.017

Baldwin, A.S., Rothman, A.J., Hertel, A.W., Linde, J.A., Jeffery, R.W., Finch, E.A., & Lando, H.A. (2006). Specifying the determinants of the initiation and maintenance of behavior change: An examination of self-efficacy, satisfaction, and smoking cessation. *Health Psychology, 25(5),* 626-634. DOI: 10.1037/0278-6133.25.5.626

Bargh, J. (1992). The ecology of automaticity. Toward establishing the conditions needed to produce automatic processing effects. *American Journal of Psychology, 105,* 181-199. doi: 10.2307/1423027

Biddle, S., Soos, I., & Chatzisarantis, N. (1999). Predicting physical activity intentions using goal perspectives and self-determination theory approaches. European Psychologist, 4, 83–89.

Bluemke, M., Brand, R., Schweizer, G., & Kahlert, D. (2010). Exercise might be good for me, but I don't feel good about it: Do automatic associations predict exercise behavior. *Journal of Sport & Exercise Psychology*, *32*(2), 137-153.

Brand, R., & Schweizer, G. (2015). Going to the gym or to the movies?: Situated decisions as a functional link connecting automatic and reflective evaluations of exercise with exercising behavior. *Journal of Sport & Exercise Psychology*, *37*(1), 63-73. doi:10.1123/jsep.2014-0018

Brooks, T.L., Leventhal, H., Wolf, M.S.,…Federman, A. (2015). Strategies used by older adults with asthma for adherence to inhaled corticosteroids. *Journal of General Internal Medicine,* DOI: 10.1007/s11606-014-2940-8.

Chapman, G.B., & Coups, E.J. (2006). Emotions and preventive health behavior: Worry, regret, and influenza vaccination. *Health Psychology, 25(1),* 82-90. doi: 10.1037/0278-6133.25.1.82

Chatzisarantis, N. L. D., Biddle, S. J. H., & Meek, G. A. (1997). A self-determination theory approach to the study of intentions and the intention-behaviour relationship in children's physical activity. British Journal of Health Psychology, 2, 343–360. doi:10.1111/j.2044-8287.1997.tb00548.x

Conroy, D.E., Elavsky, S., Doerksen, S.E., & Maher, J.P. (2013a). A daily process analysis of intentions and physical activity in college students. *Journal of Sport and Exercise Psychology, 35(5),* 493-502.

Conroy, D.E., Maher, J.P., Elavsky, S., Hyde, A.L., & Doerksen, S.E. (2013b). Sedentary behavior as a daily process regulated by habits and intentions. *Health Psychology, 32(11),* 1149-57. DOI: 10.1037/a0031629

de Bruijn, G. J., Gardner, B., van Osch, L., & Sniehotta, F. F. (2014). Predicting automaticity in exercise behavior: the role of perceived behavioral control, affect, intention, action planning, and behavior. *International Journal of Behavioral Medicine, 21*(5), 767-774. doi: 10.1007/s12529-013-9348-4

den Hoed, M., Brage, S., Zhao, J.H., Westgate, K., Nessa, A., Ekelund, U., Spector, T., Wareham, N., & Loos, R. (2013). Heritability of objectively assessed daily physical activity and sedentary behavior. *American Journal of Clinical Nutrition,* doi: 10.3945/ajcn.113.069849

Fleig, L., Pomp, S., Schwarzer, R., & Lippke, S. (2013). Promoting exercise maintenance: How interventions with booster sessions improve long-term rehabilitation outcomes. *Rehabilitation Psychology, 58(4),* 323-333. doi: 10.1037/a0033885

Gardner, B. (2012). Habit as automaticity, not frequency. *The European Health Psychologist, 14(2),* 32-36.

Gardner, B., Abraham, C., Lally, P., & de Bruijn, G. (2012). Towards parsimony in habit measurement: Testing the convergent and predictive validity of an automaticity subscale of the self-report habit index. *International Journal of Behavioral Nutrition and Physical Activity, 9(1),* 102-114. doi: 10.1186/1479-5868-9-102

Gardner, B., & Lally, P. (2013). Does intrinsic motivation strengthen physical activity habit? Modeling relationships between self-determination, past behavior, and habit strength. *Journal of Behavioral Medicine, 36(5),* 488-497. doi: 10.1007/s10865-012-9442-0

Gardner, B., Thune-Boyle, I., Iliffe, S., Fox, K. R., Jefferis, B.J., Hamer, M., Tyler, N., & Wardle, J. (2014). 'On your feet to earn your seat', a habit-based intervention to reduce sedentary behavior in older adults: Study protocol for a randomized controlled trial. *Trials, 15,* 368. doi: 10.1186/1745-6215-15-368

Grove, J. R., Zillich, I., & Medic, N. (2014). A process-oriented measure of habit strength for moderate-to-vigorous physical activity. *Health Psychology & Behavioral Medicine, 2(1),* 379-389. doi: 10.1080/21642850.2014.896743

Hagger, M. S., Rebar, A. L., Mullan, B., Lipp, O. V., & Chatzisarantis, N.L.D. (2014). The subjective experience of habit captured by self-report indexes may lead to inaccuracies in the measurement of habitual action. *Health Psychology Review*, doi: 10.1080/17437199.2014.959728

Hayes, A. F. (2015). An index and test of linear moderated mediation. *Multivariate Behavioral Research, 50,* 1-22.

Hillemeier, M. H., Weisman, C. S., Chuang, C., Symons Downs, D., McCall-Hosenfeld, J., & Camacho, F. (2011). Transition to overweight or obesity among women of reproductive age. *Journal of Women's Health, 20(5),* 703-710. doi: 10.1089/jwh.2010.2397

Hofmann, W., Friese, M., & Wiers, R. W. (2008). Impulsive versus reflective influences on health behavior: A theoretical framework and empirical review. *Health Psychology Review*, *2*(2), 111-137. doi:10.1080/17437190802617668.

Johnston, M. (2016). What more can we learn from early learning theory? The contemporary relevance for behaviour change interventions. *British journal of health psychology*, *21*(1), 1-10.

Kelley, K., & Maxwell, S. E. (2003). Sample size for multiple regression: Obtaining regression coefficients that are accurate, not simply significant. *Psychological Methods, 8*(3), 305-21. doi:10.1037/1082-989X.8.3.305

Kuroda, Y., Sato, Y., Ishizaka, Y., Yamakado, M., & Yamaguchi, N. (2012). Exercise motivation, self-efficacy, and enjoyment as indicators of adult exercise behavior among the transtheoretical model stages. *Global Health Promotion, 19(1),* 14-22. doi: 10.1177/1757975911423073

Kwasnicka, D., Dombrowski, S.U., White, M., & Sniehotta F. (2016): Theoretical explanations for maintenance of behaviour change: a systematic review of behaviour theories, *Health Psychology Review*, Online first, 1-20. DOI: 10.1080/17437199.2016.1151372

Lee, J-M., Kim, Y., & Welk, G.J. (2014). Validity of consumer-based physical activity monitors. *Medicine and Science in Sports and Exercise, 46(9),* 1840-1848.

Lippke, S., Ziegelmann, J.P., & Schwarzer, R. (2004). Behavioral intentions and action plans promote physical exercise: A longitudinal study with orthopedic rehabilitation patients. *Journal of Sport & Exercise Psychology, 26*, 470-483.

Maddux, J. E. (1997). Habit, health, and happiness. *Journal of Sport & Exercise Psychology, 19(4),* 331-346.

Marcus, B. H., Forsyth, L. H., Stone, E. J., Dubbert, P. M., McKenzie, T. L., Dunn, A. L., & Blair, S. N. (2000). Physical activity behavior change: issues in adoption and maintenance. *Health Psychology, 19*(1S), 32. DOI: 1037//0278-6133.19.1

Marcus, B.H., Rakowski, W., & Rossi, J.S. (1992). Assessing motivational readiness and decision making for exercise. *Health Psychology, 11*(4), 257. doi:10.1037/0278-6133.11.4.25

Marien, H., Aarts, H., & Custers, R. (2013). Adaptive control of human action: The role of outcome representations and reward signals. *Frontiers in Psychology, 4,* 602. doi:10.3389/fpsyg.2013.00602

Markland, D. & Tobin, V. (2004). A modification of the Behavioral Regulation in Exercise Questionnaire to include an assessment of amotivation. *Journal of Sport and Exercise Psychology, 26(2),*191-196.

Martin, L.R., Haskard-Zolnierek, K.B., & DiMatteo, R. (2010). *Health Behavior Change and Treatment Adherence: Evidence-Based Guidelines for Improving Healthcare*. New York: Oxford University Press.

McLachlan, S., & Hagger, M.S. (2011). Do people differentiate between intrinsic and extrinsic goals for physical activity? *Journal of Sport and Exercise Psychology, 33(2),* 273-288.

Mullan, E., & Markland, D. (1997). Variations in self-determination across the Stages of Change for exercise in adults. *Motivation and Emotion, 21(4),* 349-362. doi: 10.1023/A:1024436423492

Neal, D. T., Wood, W., & Drolet, A. (2013). How do people adhere to goals when willpower is low? The profits (and pitfalls) of strong habits. *Journal of Personality and Social Psychology*, *104*(6), 959-75. doi:10.1037/a0032626

O'Connor, B.P. (2000). SPSS and SAS programs for determining the number of components using parallel analysis and Velicer's MAP test. *Behavior Research Methods, Instruments, & Computers*, *32,* 396-402. DOI: 10.3758/BF03200807

Orbell, S., & Verplanken, B. (2010). The automatic component of habit in health behavior: Habit as cue-contingent automaticity. *Health Psychology, 29(4),* 374-383. doi:10.1037/a0019596

Papies, E. K., & Barsalou, L. W. (2015). Grounding desire and motivated behavior: A theoretical framework and review of empirical evidence . In W. Hofman & L. F. Nordren (Eds.), *The psychology of desire* (pp. 1-21). New York: Guilford. doi:10.1037/0021-843X.109.1.106

Phillips, L. A., & Gardner, B. (2016). Habitual Exercise Instigation (versus Execution) Predicts Healthy Adults' Exercise Frequency. *Health Psychology, 35(1),* 69-77. doi: 10.1037/hea0000249

Phillips, L. A., Leventhal, H., & Leventhal, E. A. (2013). Assessing theoretical predictors of long-term medication adherence: Patients' treatment-related beliefs, experiential feedback, and habit development. *Psychology and Health, 28(10),* 1135-1151. doi: 10.1080/08870446.2013.793798

Rhodes, R. E., & De Bruijn, G. J. (2010). Automatic and motivational correlates of physical activity: does intensity moderate the relationship? *Behavioral Medicine*, *36*(2), 44-52.

Roberts, M.D., Toedebusch, R.G., Wells, K.D., … & Booth, F.W. (2014). Nucleus accumbens neuronal maturation differences in young rats bred for low versus high voluntary running behavior. *Journal of Physiology, 592(10),* 2119-35. doi: 10.1113/jphysiol.2013.268805

Rothman, A. (2004). Is there nothing more practical than a good theory? International Journal of Behavioral Nutrition and Physical Activity, 1(11). doi: 10.1186/1479-5868-1-11

Rothman, A. J., Baldwin, A. S., Hertel, A. W., & Fuglestad, P. T. (2011). Self-regulation and behavior change: Disentangling behavioral initiation and behavioral maintenance. In K. D. Vohs & R. F. Baumeister (Eds.), *Handbook of self-regulation: Research, theory, and applications* (pp. 106-122). New York: Guilford Press.

Rothman, A. J., Sheeran, P., & Wood, W. (2009). Reflective and automatic processes in the initiation and maintenance of dietary change. *Annals of Behavioral Medicine, 38(1 Suppl),* 4–17. doi: 10.1007/s12160-009-9118-3

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55(1),* 68-78. doi: 10.1037/0003-066X.55.1.68

Ryan, R. M., Williams, G. C., Patrick, H., & Deci, E. L. (2009). Self-determination theory and physical activity: The dynamics of motivation in development and wellness. *Hellenic Journal of Psychology, 6,* 107 - 124.

Salmon, P. (2001). Effects of physical exercise on anxiety, depression, and sensitivity to stress: A unifying theory. *Clinical Psychology Review, 21(1),* 33-61.

Sherwood, N. E., & Jeffery, R. W. (2000). The behavioral determinants of exercise: Implications for physical activity interventions. *Annual Review of Nutrition, 20,* 21-44. doi: 10.1146/annurev.nutr.20.1.21

Smith, K., & Graybiel, A. M. (2014). Investigating habits: Strategies, technologies, and models. *Frontiers in Behavioral Neuroscience, 8(39),* 1-17. doi: 10.3389/fnbeh.2014.00039

Staddon, J.E.R, & Cerutti, D.T. (2003). Operant Conditioning. *Annual Review of Psychology,* 54, 115-144. doi: 10.1146/annurev.psych.54.101601.145124

Stults-Kolehmainen, M.A., & Sinha, R. (2014). The effects of stress on physical activity and exercise. *Sports Med, 44(1),* 81-121. DOI: 10.1007/s40279-013-0090-5.

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics.* Boston: Allyn & Bacon.

Teixeira, P. J., Carraça, E. V., Markland, D., Silva, M. N., & Ryan, R. M. (2012). Exercise, physical activity, and self-determination theory: A systematic review. *The International Journal of Behavioral Nutrition and Physical Activity, 9.*

Trumpp, N. M., Traub, F., & Kiefer, M. (2013). Masked priming of conceptual features reveals differential brain activation during unconscious access to conceptual action and sound information. *PloS One, 8*(5), e65910. doi:10.1371/journal.pone.0065910

U.S. Department of Health and Human Services. (2008). Chapter 2: Physical activity has many health benefits. *In Physical Activity Guidelines for Americans.* http://www.health.gov/paguidelines/guidelines/chapter2.aspx

Verplanken, B. (2006). Beyond frequency: Habit as mental construct. *British Journal of Social Psychology, 45,* 639-656. doi: 10.1348/014466605X49122

Verplanken, B., & Melkevik, O. (2008). Predicting habit: The case of physical exercise. *Psychology of Sport and Exercise, 9,* 15-26. doi: 10.1016/j.psychsport.2007.01.002

Verplanken, B. & Orbell, S. (2003). Reflections on past behavior: A self-report index of habit strength. *Journal of Applied Social Psychology, 33(6),* 1313-1330.

Wankel, L.M. (1993). The importance of enjoyment to adherence and psychological benefits from physical activity. *International Journal of Sport Psychology, 24(2),* 151-169.

Watson, J.B. (1925). *Behaviorism*. New York: Norton.

Wiedemann, A., Gardner, B., Knoll, N., & Burkert, S. (2014). Intrinsic rewards, fruit and vegetable consumption, and habit strength: A three-wave study testing the Associative-Cybernetic Model. *Applied Psychology: Health and Well-Being, 6(1),* 119-134.

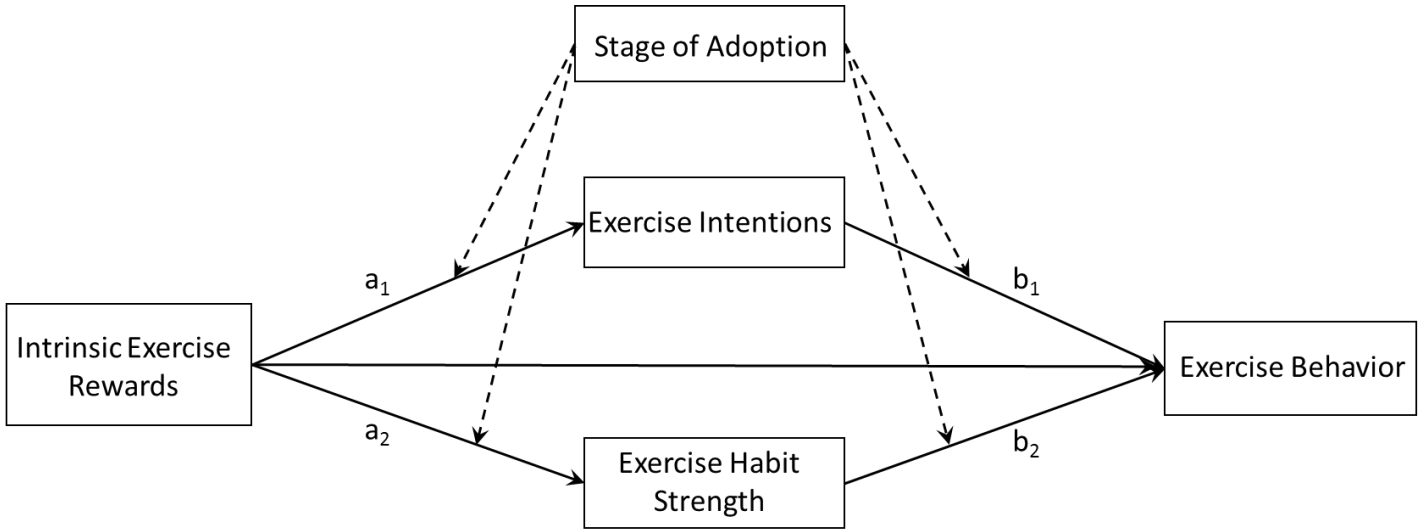
Wood, W., & Neal, D. T. (2007). A new look at habits and the habit-goal interface. *Psychological Review, 114(4),* 843-863. DOI: 10.1037/0033-295X.114.4.843

Wood, E., Tam, L., & Guerrero Witt, M. (2005). Changing circumstances, disrupting habits. *Journal of Personality and Social Psychology, 88,* 918-933.

Woolley, K., & Fishbach, A. (2015). The experience matters more than you think: People value intrinsic incentives more inside than outside an activity. *JPSP, 109(6),* 968-982.

Figure 1.

*The Figure can be used to illustrate 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 are hypothesized to depend on the moderator, or individuals' stage of adoption: specifically a_1b_1 is expected to be significantly stronger for initiators than for maintainers, and a_2b_2 is expected to be significantly stronger for maintainers than for initiators.*



Note. 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-vigorous activity in Study 1 and proportion of applicable days exercising at moderate-vigorous intensity for 20+ minutes, as measured by the accelerometer, in Study 2.