

Daily Meaning Salience and Physical Activity in Previously Inactive Exercise Initiates

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Objective: Individuals living with more experienced meaning, or meaning salience, may be more likely to engage in health behaviors including physical activity. This study examined daily meaning salience and physical activity in previously inactive exercise initiates. **Method:** Inactive adults ($N = 80$, 78% female, $M_{\text{age}} = 43$ years, $SD = 11$ years) intending to increase physical activity participated in a daily diary study. At baseline, participants completed self-report questionnaires of demographics, global meaning and purpose, depressive symptoms, and motivation. Fitness center attendance was extracted from the member database. Participants self-reported meaning salience, positive mood, negative mood, and physical activity (duration in minutes; intensity in ratings of perceived exertion) daily for the first 28 days. Multilevel and multiple regression analyses were used. **Results:** Multilevel models revealed that controlling for demographics, mood, and motivation, for every standard deviation increase in meaning salience, participants were 44% more likely to visit the fitness center, odds ratio (OR) = 1.44, 95% CI [1.24, 1.68], $p < .001$. Further, increases in meaning salience above average were positively related to physical activity duration, $\beta = .19$, $p < .001$, and intensity, $\beta = .13$, $p < .001$. Global meaning and purpose were not significantly related to physical activity duration, physical activity intensity, or fitness center visits over the 28 days. **Conclusions:** Results suggest that increased meaning salience, but not global meaning or purpose, is associated with physical activity participation in previously inactive exercise initiates, and may be a proximal predictor of physical activity behavior. Future research should use ecological momentary assessment (EMA) designs to examine the relationship within days and over longer intervals.

Keywords: purpose in life, behavior change, health behavior, daily diaries

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Regular physical activity is related to numerous benefits, including reduced risk for several chronic diseases (e.g., cardiovascular disease, diabetes, obesity, and Alzheimer's disease; Reiner, Niermann, Jekauc, & Woll, 2013) and mortality (Samitz, Egger, & Zwahlen, 2011) as well as improved mental health (Rebar et al., 2015). Although nearly everyone could benefit from being more physically active (Warburton & Bredin, 2016), objective estimates suggest that less than 10% of adults in the United States meet the national guidelines for physical activity of 150 min of moderate-vigorous physical activity per week (Tucker, Welk, & Beyler, 2011). Interventions to increase physical activity generally demonstrate short-term success but fail to report long-term maintenance (Fjeldsoe, Neuhaus, Winkler, & Eakin, 2011). This suggests that novel approaches to understanding physical activity maintenance are needed.

One psychological process likely to be related to long-term maintenance of physical activity is a sense of personal meaning (feeling that one's existence is significant) and purpose (pursuit and attainment of behavioral goals consistent with one's subjective values and life goals; Reker, Peacock, & Wong, 1987; Ryff & Singer, 1998; Steger, Frazier, Oishi, & Kaler, 2006). Purpose in life is also considered an aspect of behavioral self-regulation, providing the "why" to engage in certain behaviors (Scheier et al., 2006). Although purpose is considered the behavioral component of meaning (McKnight & Kashdan, 2009), the terms meaning in life and purpose in life are most often used interchangeably in the literature, and we will refer to them as M/P. The global sense of M/P also differs from meaning-making, which largely refers to finding meaning in the wake of stressful or traumatic events (Park, 2010) rather than individuals' perceptions of the meaningfulness of their lives in general. Several studies have demonstrated that M/P is positively related to many different dimensions of health and well-being, including increased longevity (e.g., Cohen, Bavi-shi, & Rozanski, 2016), reduced risk for cardiovascular events (Cohen et al., 2016), better self-rated health and functioning (Holahan, Holahan, & Suzuki, 2008), and better psychological and physical well-being (e.g., Steger et al., 2006). Thus, through some as yet unidentified mechanisms, M/P is associated with health and well-being.

A potential mechanism linking M/P to better health and well-being is greater engagement in healthy behaviors, and specifically,

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physical activity. Individuals who have a sense of M/P in their lives may be more likely to practice health-promoting behaviors; as noted “taking good care of oneself in terms of daily health practices presupposes a life that is worth taking care of” (Ryff & Singer, 1998, p. 22). This suggests that one reason individuals with lesser awareness of M/P may be less likely to engage in health-promoting behaviors is because they do not want to expend the effort necessary to support a life lacking M/P. Alternatively, individuals living with strong awareness of what gives their lives M/P may be more motivated to engage in healthier behaviors to support their ultimate goals and purposes.

Cross-sectional research demonstrates that M/P is related to greater engagement in physical activity (Holahan et al., 2008; Holahan & Suzuki, 2006; Homan & Boyatzis, 2010; Hooker & Masters, 2016; Ruuskanen & Ruoppila, 1995; Takkinen, Suutama, & Ruoppila, 2001). These studies show that a global sense of personal M/P (e.g., “I have a good sense of what makes my life meaningful”; Steger et al., 2006) is related to self-reported physical activity. One recent study (Hooker & Masters, 2016) demonstrated that after controlling for several possible confounds, M/P remained a significant predictor of objectively measured lifestyle movement, and to a lesser extent, moderate-to-vigorous exercise, over a period of three days. These results support the hypothesis that awareness of personal M/P is related to greater engagement in physical activity.

Previous research has focused on self-report ratings of a global sense of M/P, or in general, how meaningful individuals believe their lives to be, in relation to physical activity. However, daily awareness of personal M/P may be a stronger predictor of day-to-day variability in behavior. This awareness, hereafter referred to as *meaning salience*, is hypothesized to be involved in the daily self-regulation of healthy behaviors (Hooker, Masters, & Park, 2017). When individuals live with daily awareness of what makes their lives meaningful and gives them purpose, they may be better able to make routine choices that support their M/P. For example, adults are frequently faced with choices that can either be healthy, and likely more effortful (e.g., engaging in exercise), or hedonically pleasurable (e.g., watching TV). Individuals with lower levels of meaning salience may be more likely to make the easier choice (i.e., watching TV). Choosing the more difficult behavior that is congruent with one’s personal values, goals, and purpose is more likely when one is aware, in the moment, of those values, goals, and purposes. Those who, at least initially when establishing a new behavior, consciously associate engaging in healthy behaviors, such as physical activity, with what gives their lives M/P, and therefore why they desire to be more physically active, may be more likely to engage in physical activity on a daily basis. Thus, meaning salience can be motivational and contribute to self-regulation of healthy behavior.

The hypothesis that meaning salience could be related to engagement in physical activity is consistent with previous theories. For example, self-determination theory (SDT; Ryan & Deci, 2001) posits that behaviors that are more internalized and consistent with the self are more likely to be maintained than behaviors that are externally regulated or extrinsically motivated. Evidence suggests that more self-determined motivations, as outlined by SDT, do predict engagement in physical activity (Teixeira, Carraça, Markland, Silva, & Ryan, 2012). Given previous hypotheses that M/P helps individuals maintain behaviors that are integrated with their

most important values and life goals (Scheier et al., 2006), it is likely that those who live with awareness of their personal M/P also have more internalized or integrated forms of behavioral regulation. In particular, meaning salience is consistent with integrated regulation (behavior motivated by consistency with the self and one’s values). Interventions to enhance integrated regulation show promise for impacting motivation and possibly exercise behavior (Duncan, Hall, Wilson, & Rodgers, 2012). Other intervention approaches, including acceptance and commitment therapy (ACT; Hayes, Strosahl, & Wilson, 1999) and the disconnected values model (Anshel, 2010), also recognize the importance of integrating values and meaning into interventions to increase the likelihood of successful behavior change.

A possible rival hypothesis would be that M/P is confounded with the improved mood that often results from activity. M/P is, therefore, viewed as somewhat unnecessary as a motivational construct. Evidence suggests that increased physical activity is related to fewer depressive symptoms (Rebar et al., 2015) and increased positive mood (Carels, Coit, Young, & Berger, 2007). Schwarz’s (2001) “Feelings as information” theory suggests that individuals use positive mood as information to make judgments about other areas of their lives. Several studies demonstrate that ratings of meaning are positively associated with positive mood (Baumeister & Vohs, 2013; Baumeister, Vohs, Aaker, & Garbinsky, 2013; Hicks, Trent, Davis, & King, 2012; King, Hicks, Krull, & Del Gaiso, 2006; for a review, see Hooker et al., 2017). For instance, inactive individuals who start exercising more will experience improved mood (Annesi, 2004). Because they are experiencing more positive mood, their improved mood may serve as the basis for informing judgments about M/P. Consequently, this study aims to examine the relationship between meaning salience and physical activity, controlling for daily mood.

The current literature in this area has two primary limitations. First, to our knowledge, all studies of M/P and physical activity are cross-sectional and no studies have specifically incorporated M/P into a longitudinal study of physical activity adoption. Second, these studies have all used global ratings of M/P (e.g., to what extent do you feel your life is meaningful?) rather than assessments of daily meaning salience, that is, daily awareness of M/P. Meaning salience is likely a dynamic process; the extent to which individuals are aware of their M/P at any given moment is hypothesized to vary. To fill the gaps in the research, this study examined the relationship between daily meaning salience and physical activity adjusting for daily mood by tracking fitness center visits and using a daily diary methodology. It was hypothesized that daily meaning salience would be positively related to greater engagement in physical activity during that same day (greater likelihood of visiting the fitness center and greater physical activity duration). As a secondary question, this study examined whether global ratings of M/P were related to average physical activity over the length of the study, also adjusting for average mood. It was hypothesized that global ratings of M/P would also be positively associated with fitness center visits and self-reported physical activity. Finally, in an exploratory analysis, we examined the relationship between meaning salience and physical activity across consecutive days, including examining whether meaning salience on one day predicted physical activity the next day, and vice versa.

Method

Participants

Participants were currently inactive adults who were joining a university-based fitness center. They were recruited from the university and surrounding communities by: (a) notifying potentially eligible individuals about the study when they joined the fitness center, (b) sending a recruitment email to potentially eligible new members within the first week of joining the fitness center, (c) advertisements on campus and in the community (e.g., flyers, email announcements to university faculty and staff, posting of the study on the university clinical trials website and the fitness center website), and (d) word of mouth. To be included, participants had to be: (a) at least 30 years of age, (b) able to read and understand English, (c) inactive (engaging in <60 min of moderate-to-vigorous exercise per week) for the last 3 months, and (d) joining the fitness center. Individuals were excluded from the study if they: (a) had medical or physical contraindications to participate in physical activity (defined as a positive Physical Activity Readiness Questionnaire; Thomas, Reading, & Shephard, 1992] score), (b) had an existing diagnosis of cardiovascular disease, or (c) were pregnant. The rationale for including adults age 30 and older was that M/P becomes more salient for adults who enter middle age (Steger, Oishi, & Kashdan, 2009) and physical activity declines for both genders and most ethnic groups at middle age (Hawkins et al., 2009). Therefore, middle to older age is a particularly important time to understand the processes that predict long-term maintenance of physical activity and is also particularly apropos for studying M/P in this context.

A total of 80 participants were included in the study. On average, participants were 43.4 years old ($SD = 10.7$, range = 30–72). The sample was predominantly female (77.5%) and highly educated; 41.3% had completed a graduate or professional degree and 42.5% had completed a 4-year college degree. Additionally, most of the sample was employed (77.5% employed full-time) and reported high annual household income (50% reported an annual income of \$80,000 or more). About one third (33.8%) of the sample reported that it had been 6 months or less since they were regularly physically active, and only one person reported never having been regularly physically active.

Procedure

This study was part of a larger parent study examining whether M/P and motivation predict physical activity adoption in previously inactive exercise initiates over three months. Participants (total $N = 160$) were randomized 1:1 to complete daily surveys (see below) for the first 4 weeks (28 days total) or to participate in a no-survey control condition to determine whether self-monitoring meaning salience, mood, and physical activity in the first month significantly affected physical activity behavior. Power calculations determined that 80 participants in each group were needed to detect a small difference in physical activity between the groups. Only participants randomized to receive the daily surveys were included in this study. Of note, there were no significant differences between the intervention and control groups over the course of the larger study on self-reported physical activity ($p = .97$) or fitness center visits ($p = .46$), suggesting that self-

monitoring meaning, mood, and physical activity did not significantly increase physical activity adoption.

The study procedures were reviewed and approved by the Colorado Multiple Institutional Review Board (COMIRB) at the University of Colorado Denver. Interested individuals completed a phone or in-person screening prior to enrollment. Eligible participants were scheduled for an in-person meeting to provide written informed consent and complete baseline measurements. Participants were offered \$20 for each month they participated in the study, for a total of \$60 for 3 months (the length of the parent study). This was available either as a discounted rate off their fitness center memberships or in the form of a gift card, which they received at the end of the study. Additionally, for each completed survey, participants were given one entry into a drawing for one of eight gift cards (one for \$100, two for \$50, and five for \$20). The drawing was conducted after the study was complete.

Study data were collected and managed using Research Electronic Data Capture (REDCap) electronic data capture tools (Harris et al., 2009). REDCap is a secure, web-based application designed to support data capture for research studies, providing: (a) an intuitive interface for validated data entry, (b) audit trails for tracking data manipulation and export procedures, (c) automated export procedures for seamless data downloads to common statistical packages, and (d) procedures for importing data from external sources. Participants randomized to the self-monitoring condition were asked to complete daily measures (at 8:00 p.m. each day) of meaning salience, mood, and physical activity for four weeks after baseline. Participants received email notifications sent directly from REDCap prompting them to complete the surveys at the specified times. Surveys were sent at 8:00 p.m. because we wanted participants to recall their meaning salience, mood, and physical activity for the current day rather than waiting until the next morning to recall the day before. We surmised that most participants would have exercised for the day by 8:00 p.m. but it would not be too late for them to receive the email and answer the survey.

Measures

Baseline demographics and physical activity history. At baseline, participants reported several demographics, including age, sex, race/ethnicity, income, work status, education, and religious affiliation.

Global meaning in life. Participants completed the five-item Presence subscale of the Meaning in Life Questionnaire (MILQ; Steger et al., 2006) at baseline. The MILQ-Presence subscale measures the extent to which individuals perceive their life as meaningful (e.g., “My life has a clear sense of purpose.”). Participants rated the extent to which each statement was true for them on a 7-point Likert-type scale ranging from 1 (*absolutely untrue*) to 7 (*absolutely true*). Responses were summed for a total score. Steger and colleagues (2006) found that the Presence subscale demonstrates good internal consistency ($\alpha = .86$) and has moderate test-retest reliability over one month ($r = .70$). Evidence for convergent and discriminant validity indicated that the Presence subscale was positively associated with health and well-being indicators (i.e., life satisfaction, joy) and negatively associated with depressive symptoms and negative emotionality (Steger et al., 2006). In this study, the internal consistency was very high ($\alpha = .93$).

Global purpose in life. Participants reported on their purpose in life at baseline using the six-item Life Engagement Test (LET; Scheier et al., 2006). The LET measured the extent to which individuals believed their activities were valuable and important (e.g., “To me, the things I do are all worthwhile.”). Participants rated the extent to which they agreed with each item on a 5-point Likert-type scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Odd items were reverse-scored and the six items were summed for a total score. Scheier and colleagues (2006) examined the test-retest reliability of this measure in four different samples and found that the LET was moderately stable (*rs* ranged from .61–.76) over 4 months. Additionally, they tested the convergent and discriminant validity of the measure and found that it was positively associated with many health and well-being indicators (i.e., life satisfaction, general physical health) and negatively associated with depressive symptoms. The internal consistency for this measure was high in a previous sample of adult community members ($\alpha = .85$; Hooker & Masters, 2016). In this study, the internal consistency was high ($\alpha = .83$).

Daily meaning salience. Daily meaning salience was measured using the Thoughts of Meaning Scale (TOMS), developed for this study. The TOMS included the two-item Daily Meaning Scale (DMS; Steger, Kashdan, & Oishi, 2008). Participants rated the extent to which two statements were true for them at the moment (“How meaningful does your life feel?” and “How much do you feel your life has a purpose?”). To more directly assess meaning salience, eight additional items were developed for participants to rate the extent to which they thought about, or were aware of, meaning and purpose that day (e.g., “How much have you thought about your purpose in life today?”). Participants completed these items using Likert-type rating scales ranging from 1 (*not at all*) to 7 (*absolutely* [DMS] or *quite a bit* [TOMS]). The DMS has been shown to have very strong internal consistency reliability ($\alpha = .98$) and be positively related to daily engagement in eudaimonic behaviors (i.e., behaviors that are consistent with values; Ryan & Deci, 2001; $\gamma = .13$) in daily studies of M/P (Steger et al., 2008). In this study, the internal consistency of all 10 items over the 28 days was very high (α s = .88–.96).

Depressive symptoms. Baseline depressive symptoms was used as a covariate. The eight-item Patient Health Questionnaire-8 (PHQ-8; Kroenke & Spitzer, 2002) was used to measure depressive symptoms. Participants rated the extent to which they were bothered by a series of eight problems (e.g., “little interest or pleasure in doing things”) over the past 2 weeks on a scale ranging from 0 (*not at all*) to 3 (*nearly every day*). The PHQ-8 was derived from the PHQ-9, but the ninth item assessing suicidal ideation was omitted as per recommendations from the authors because this study used self-administered surveys, and depression was assessed as a secondary measure (Kroenke & Spitzer, 2002). Previous evidence for validity for this scale indicated that higher scores on the PHQ were related to greater likelihood of being diagnosed with any depressive disorder (Kroenke & Spitzer, 2002). The internal consistency of the PHQ-8 was high ($\alpha = .85$).

Behavioral regulations motivation. Motivation was used as a covariate in analyses. Motivation internalization for exercise was measured using the Behavioral Regulation in Exercise Questionnaire-2 (BREQ-2; Markland & Tobin, 2004; Mullan, Markland, & Ingledew, 1997). The 19-item BREQ-2 measured motivations for exercise on the SDT continuum. The five subscales were: Amotivation (e.g., “I

don’t see why I should have to exercise.”), External Regulation (e.g., “I exercise because other people say I should.”), Introjected Regulation (e.g., “I feel guilty when I don’t exercise.”); Identified Regulation (e.g., “It’s important to me to exercise regularly.”), and Intrinsic Motivation (e.g., “I exercise because it’s fun.”). Subsequent to the development of the BREQ-2, four items used to assess integrated regulation for exercise were developed (e.g., “I exercise because it is consistent with my life goals”; Wilson, Rodgers, Loitz, & Scime, 2006). These items were added to the existing BREQ-2. Participants rated the extent to which they engaged in exercise (or did not engage in exercise) for each of the reasons on a 5-point Likert-type scale ranging from 0 (*not true for me*) to 4 (*very true for me*). The six subscales were combined using the relative autonomy index (RAI) approach outlined by Wilson, Sabiston, Mack, and Blanchard (2012) into one score with each subscale weighted to reflect more self-determined or autonomous motivation and then combined into one score ($RAI = \Sigma([Amotivation \times -3] + [External \times -2] + [Introjected \times -1] + Identified + [Integrated \times 2] + [Intrinsic \times 3])$). The BREQ-2 has demonstrated good psychometric properties, including good internal consistency (α s range from .78–.93; Markland & Tobin, 2004; Wilson et al., 2006). Additionally, more internalized forms of regulation (identified, integrated, and intrinsic) have been shown to be positively related to psychological needs satisfaction and to self-reported physical activity (Wilson et al., 2006). In this study, the internal consistency of the individual subscales ranged from acceptable ($\alpha = .75$ for identified) to very high ($\alpha = .91$ for intrinsic).

Daily mood. Daily positive and negative mood were measured using a positive and negative mood scale previously used in a diary study of daily M/P and daily mood (Steger et al., 2008). Eight items measured positive mood (relaxed, proud, excited, appreciative, enthusiastic, happy, satisfied, and curious) and five items measured negative mood (sluggish, afraid, sad, anxious, and angry). Items were selected from the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) but more common mood items (e.g., happy, sad, angry) were added. Participants rated their affect using a 5-point Likert-type scale ranging from 1 (*very slightly or not at all*) to 5 (*extremely*). Sums of the positive and negative mood scales have been shown to be positively correlated with their respective scales on the PANAS ($r = .55$ –.57) and to have very high internal consistency ($\alpha = .97$ –.98). In this study, the internal consistency was very high for positive mood (α s = .86–.94) and acceptable to high for negative mood (α s = .70–.86) over the 28 days.

Daily physical activity. To capture physical activity, both objective measurement of attendance at the fitness center and self-report measures were utilized. First, the number of days that participants attended the fitness center was obtained from fitness center records. Participants scanned their membership cards each time they entered the fitness center; one scan per day was recorded as a visit (visit = 1, no visit = 0). Participants also reported the duration of physical activity (min/day), and intensity of engagement (using Borg’s Category-Ratio Exertion Scale, also known as the Ratings of Perceived Exertion Scale; Borg, 1998). To rate the average intensity of their activities, participants were shown a scale ranging from 6 to 20, where 6 corresponded to *no exertion at all*, 11 corresponded to *light activity*, 15 corresponded to *hard (heavy) activity*, and 20 corresponded to *maximal exertion*. This method was used in a previous daily diary study of exercise (Lutz, Stults-Kolehmainen, & Bartholomew, 2010) and allowed for anal-

ysis of different components of physical activity (duration, frequency [days/week], and intensity of physical activity). Self-report physical activity has limitations, but previous research has demonstrated medium-sized associations between daily physical activity logs and accelerometer-measured physical activity (Ainsworth et al., 2000). Ratings of perceived exertion have also been shown to be moderately and positively associated with physiological criterion measures of exertion (heart rate, blood lactate concentration, oxygen uptake [VO₂ max], and respiration rate; Chen, Fan, & Moe, 2002).

Data Analysis

Analyses were conducted in SAS (Version 9.4). SAS was used to manage the data and calculate descriptive statistics. Descriptive statistics were used to examine distributions and assess potential violations of assumptions. Minutes of physical activity was positively skewed and significantly kurtotic. Thus, following guidelines from the International Physical Activity Questionnaire (Craig et al., 2003), any values greater than 180 min were truncated to 180 min (3 hours/day). Then, physical activity minutes was transformed using a square-root transformation to normalize the data. Intraclass correlation coefficients (ICCs) were estimated to examine consistency in daily measures across the 28 days. Bivariate Pearson correlations among all study predictors, covariates, and outcomes were calculated to examine patterns in the data.

Daily meaning salience and daily physical activity. Daily meaning salience was investigated in relation to fitness center visits, an objective indicator of a behavior associated with physical activity. A logistic multilevel model with demographics (age, sex [1 = female, 0 = male], race [1 = white, 0 = nonwhite], marital status [1 = married, 0 = not married], employment status [1 = employed full-time, 0 = not employed full time], income [1 = make \geq \$40,000 annually, 0 = make $<$ \$40,000 annually], and education [1 = bachelor's degree or higher, 0 = some college or less]), meaning salience, mood, baseline depression, baseline motivation (relative autonomy), and time as predictors was used to predict whether or not participants visited the fitness center that day (coded as a binary outcome: 1 = visit; 0 = no visit). Continuous variables were grand-mean centered. To calculate standardized regression coefficients, continuous variables were transformed to *z* scores and analyses were rerun with standardized independent and dependent variables. Multilevel regression models were also used to examine the relationship between daily meaning salience and daily self-reported physical activity (duration and intensity) controlling for the same variables, that is, demographics, mood, depressive symptoms, motivation, and clustering at the time level. For meaning salience, positive mood, and negative mood, two variables were entered into the model. The between-subjects effect was individuals' average of meaning salience, positive mood, or negative mood over the 28 days. The within-subjects effect was the deviation from individuals' average on each day. Multilevel models with compound symmetry covariance structures controlled for repeated measures within subjects to ensure that standard errors were appropriately estimated and Type I error rates were not inflated. Time (day) was entered into the model as a linear variable to control for a time trend that might artificially increase the associations.

Global meaning and purpose and average physical activity. To address the second aim of the study, that is, whether global measures of meaning and purpose were related to average physical activity over the length of the study, multiple regression models were used. Global meaning and global purpose in life at baseline were used to predict total fitness center visits, average physical activity minutes, and average physical activity intensity during the first 28 days. All available data were included in the model (up to 28 days for each person). Models controlled for demographics, average daily mood over the 28 days, depressive symptoms, and motivation.

Reciprocal relationships between daily meaning and physical activity. Finally, exploratory analyses utilized mixed logistic and regression models with meaning salience predicting visiting the fitness center the next day or the next day's minutes of physical activity and vice versa (i.e., physical activity predicting the next day's meaning salience) to determine whether a temporal pattern emerged.

Results

With 80 participants randomized to receive the daily surveys, there were 2,240 possible surveys distributed. Of these, 1,813 (80.9%) were accessed (some questions were answered), and 1,691 (75.5%) were completed (all questions were answered). Each participant completed a median of 24 of the 28 daily surveys (85.7%), with a range of 2 to 28 surveys completed. All available data were included in the analyses.

Descriptive statistics for variables are presented in Table 1, and ICCs and Pearson correlations among the variables are presented in Table 2. ICCs suggested there was greater consistency among cognitive and affective (meaning and mood) variables over the 28 days than in physical activity behavior. In the bivariate correlations, average meaning salience was not significantly associated with fitness center visits, daily minutes of physical activity, or physical activity intensity. Similarly, global meaning in life and global purpose in life at baseline were not significantly correlated with fitness center visits or average minutes of physical activity in the first 28 days. Meaning salience was strongly and positively

Table 1
Descriptive Statistics for Study Measures

Variable	<i>n</i>	<i>M (SD)</i>	Min-max	α
Global meaning	80	26.2 (5.9)	5–35	.93
Global purpose in life	80	24.6 (3.9)	12–30	.84
Meaning salience	1,762	45.2 (12.5)	10–70	.94
Positive mood	1,752	24.9 (6.7)	8–40	.91
Negative mood	1,764	8.5 (3.6)	5–23	.80
Motivation	80	40.7 (27.4)	–31–96	
Depressive symptoms	80	5.1 (3.7)	0–18	.85
Fitness center visits	80	7.7 (5.2)	0–26	
Physical activity duration	1,795	41.2 (51.6)	0–480	
Physical activity intensity	1,280	12.1 (2.6)	6–19	

Note. Meaning salience was measured using the Thoughts of Meaning Scale. Global meaning was measured using the Meaning in Life Questionnaire—Presence subscale. Global purpose in life was measured using the Life Engagement Test. Motivation was measured using the relative autonomy index of the Behavioral Regulation in Exercise Questionnaire-2.

Table 2
Intraclass Correlation Coefficients and Pearson Correlations Among the Daily Diary Variables

Variable	ICC	1	2	3	4	5	6	7	8	9
1. Global meaning										
2. Global purpose		.69**								
3. Meaning salience	.61	.43**	.54**							
4. Positive mood	.54	.35*	.50**	.70**						
5. Negative mood	.53	-.25*	-.24*	-.11**	-.30*					
6. Motivation		.22*	.27*	.16	.12	-.15				
7. Depressive symptoms		-.45*	-.33*	-.19	-.33*	.53**	-.16			
8. Fitness center visits		.03	-.03	-.07	.04	-.19	.16	-.20		
9. Physical activity duration	.28	-.17	-.15	.00	.01	-.11	.12	.25*	.30*	
10. Physical activity intensity	.28	.08	.02	-.02	-.05	-.13	.27*	-.11	.41**	-.12

Note. Meaning salience was measured using the Thoughts of Meaning Scale. Global meaning was measured using the Meaning in Life Questionnaire—Presence subscale. Global purpose in life was measured using the Life Engagement Test. Baseline measures (global meaning, global purpose in life, physical activity motivation, and depressive symptoms) were correlated with the average of the daily measures for each person over the 28 days ($N = 80$) ICC = intraclass correlation coefficient.
* $p < .05$. ** $p < .001$.

correlated with daily positive mood, and negatively correlated with negative mood.

Daily Meaning Salience and Daily Physical Activity

In a multilevel logistic regression model predicting fitness center attendance and controlling for demographics, positive and negative affect, depressive symptoms, and motivation, daily meaning salience was related to likelihood of visiting the fitness center (Table 3). There was a significant between-subjects association of meaning salience with fitness center visits wherein individuals with higher overall average meaning salience were less likely to visit the fitness center. For every standard deviation increase in average meaning salience, individuals were 35% less likely to visit the fitness center. However, in contrast, there was a positive and

significant within-subjects association. For every standard deviation increase in daily meaning salience above average meaning salience, participants were 44% more likely to visit the fitness center on that day. Positive and negative mood, motivation, and depressive symptoms were not significantly related to same day fitness center visits.

In a mixed model with days nested within participants and controlling for demographics, daily mood, depressive symptoms, and motivation, the between-subjects association of meaning salience was not significant with physical activity duration (see Table 3). However, there was a significant, small positive association between the within-subjects analysis of meaning salience and daily minutes of physical activity (see Table 3). Participants who reported greater daily meaning salience than average also reported

Table 3
Mixed Models Predicting Same Day Fitness Center Visits and Physical Activity

Predictor	Fitness center visit ^a		Physical activity minutes			Physical activity intensity		
	OR	[95% CI]	<i>b</i>	SE	β	<i>b</i>	SE	β
Between-subjects effects								
Age	1.43	[1.08, 1.89]*	.10	.02	.30**	-.02	.01	-.10
Female	1.06	[.61, 1.88]	.62	.55	.16	-.14	.41	-.05
White	.80	[.48, 1.35]	.61	.52	.16	.18	.38	.07
Married	1.90	[1.13, 3.24]*	.17	.52	.04	.73	.39	.28
Employed full-time	1.67	[.89, 3.22]*	-.25	.64	-.07	.71	.47	.28
Income \geq \$40,000/year	.34	[.15, .74]*	-1.37	.77	-.36	-.28	.57	-.11
Bachelor's degree or higher	3.53	[1.44, 8.61]*	.88	.81	.23	.30	.61	.11
Meaning salience	.65	[.46, .92]*	-.05	.03	-.14	.01	.02	.05
Positive mood	1.37	[.96, 1.96]	.10	.07	.13	-.06	.05	-.12
Negative mood	.88	[.66, 1.17]	-.13	.11	-.09	-.13	.08	-.14
Depressive symptoms	1.12	[.82, 1.53]	.14	.08	.14	.02	.06	.03
Motivation	1.15	[.90, 1.46]	.01	.01	.06	.01	.01	.13
Within-subjects effects								
Meaning salience	1.44	[1.24, 1.68]**	.10	.01	.19**	.05	.01	.13**
Positive mood	1.01	[.86, 1.18]	-.02	.02	-.02	.01	.02	.02
Negative mood	.97	[.84, 1.12]	-.16	.04	-.10**	-.05	.03	-.05
Time	.95	[.85, 1.08]	-.01	.01	-.02	.02	.01	.08*

Note. *b* = unstandardized regression coefficient; β = standardized regression coefficient; SE = standard error; OR = odds ratio; CI = confidence interval.
^a A mixed logistic regression model was used to predict fitness center visits.
* $p < .05$. ** $p < .001$.

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more minutes of activity on the same day. There was also a significant, small negative association between within-subjects negative mood and physical activity; on days when participants experienced more negative mood than average, they also engaged in fewer minutes of physical activity. Positive mood, depressive symptoms, and motivation were not significantly associated with daily physical activity.

The mixed model was repeated with physical activity intensity as the dependent variable (see Table 3). On days that participants reported engaging in physical activity and controlling for demographics, positive and negative affect, motivation, and depressive symptoms, there was no between-subjects association of meaning salience with intensity. There was a significant, small positive within-subjects association between meaning salience and increased intensity of physical activity. Thus, on days when individuals reported greater meaning salience than average, they also reported engaging in more intense levels of physical activity. There was also a significant, small, association with time, suggesting that intensity increased over the 28 days. Positive and negative mood were not associated with physical activity intensity.

Global Meaning and Purpose and Average Physical Activity

Multiple regression analyses revealed that controlling for demographics, average positive and negative mood over the 28 days, motivation, and depressive symptoms, global meaning in life, $\beta = -.13$, $p = .33$, and global purpose in life, $\beta = -.16$, $p = .25$, at baseline were not significantly related to fitness center visits (see Table 1 in the online supplemental materials). Similarly, global meaning in life, $\beta = -.09$, $p = .47$, and global purpose in life, $\beta = -.14$, $p = .31$, at baseline were not significantly related to average minutes of physical activity. There was also no relationship between global meaning and physical activity intensity, $\beta = .01$, $p = .92$, and global purpose and physical activity intensity, $\beta = -.07$, $p = .64$.

Reciprocal Relationships Between Daily Meaning and Physical Activity

Mixed-model analyses were repeated to determine whether meaning salience on one day predicted the next day's physical activity, controlling for demographics, the previous day's mood, depressive symptoms, and motivation. Greater than average meaning salience did not predict visiting the fitness center on the next day, $OR = 0.88$, 95% CI [0.76, 1.01], $p = .06$. Further, greater than average meaning salience did not significantly predict the next day's physical activity, $\beta = -.07$, $p = .12$. Similarly, visiting the fitness center, $\beta = -.02$, $p = .49$, or engaging in physical activity on one day did not predict meaning salience the next day, $\beta = .02$, $p = .34$.

Discussion

The purpose of this study was to examine whether M/P, conceptualized as daily meaning salience and global ratings of M/P, was related to physical activity in the first 4 weeks of starting an exercise program. As hypothesized, on days when participants were more aware of M/P than average, they were more likely to

visit the fitness center and engaged in more minutes of physical activity and more intense physical activity. This relationship existed even after controlling for demographics, positive and negative mood, depressive symptoms, and physical activity motivation, suggesting that meaning salience is a potentially important correlate of physical activity. However, contrary to the hypotheses, baseline global ratings of M/P were not related to fitness center attendance or average physical activity over the 4-week daily diary study. This suggests that in previously inactive exercise initiates, global M/P ratings are not strong predictors of physical activity during the first month of an exercise program.

This is the first study to demonstrate that on days when individuals experienced greater meaning salience than average, they also engaged in more physical activity; supporting the hypothesis that awareness of what makes life personally meaningful, on a daily basis, is related to greater engagement in healthy behaviors: in this case, physical activity. Daily meaning salience appears to be a stronger predictor of physical activity than global ratings of M/P. Previous research has examined global ratings of M/P with cross sectional designs and found that M/P is positively associated with physical activity (Holahan et al., 2008; Holahan & Suzuki, 2006; Homan & Boyatzis, 2010; Hooker & Masters, 2016; Ruuskanen & Ruoppila, 1995; Takkinen et al., 2001). Though it is not clear why global ratings were not significant correlates of physical activity in this sample, in contrast with previous research, we nevertheless provide a few possible reasons. First, ours is the first study to examine this relationship in a group of previously inactive exercise initiates. The variability in physical activity behavior was likely restricted at baseline (individuals were inactive) and then became much more variable over time. In contrast, global evaluations of meaning in life tend to be relatively stable. A second reason is that the relationship between a global sense of meaning in life and physical activity may not be perfectly linear. For example, Ryff and Singer's (1998) supposition that engaging in health behaviors requires a necessary level of M/P in life may be true, but having much more global meaning above and beyond the necessary level may not translate to increased engagement in healthy behaviors. Finally, it is possible that we were underpowered to detect a significant relationship between global meaning or purpose and physical activity. In this study, daily meaning salience was a stronger predictor of physical activity than global ratings of M/P, suggesting that the extent to which M/P is salient for an individual, on a daily basis, may be an important factor in predicting engagement in physical activity.

One particularly noteworthy finding was that deviations in meaning salience from average, or increased awareness of meaning, was related to physical activity on the same day, but there was no relationship between physical activity and meaning salience across days. That is, meaning salience one day did not predict physical activity the next day, and physical activity one day did not predict meaning salience the next day. This finding lends support to the postulate that meaning salience is a proximal, rather than distal, predictor of physical activity behavior. As thoughts can be fleeting, the closer that the thoughts about meaning are to the desired time to execute the behavior, the stronger the relationship between meaning salience and the behavior is likely to be. Indeed, Frankl states this nicely:

For the meaning of life differs from man to man (sic), from day to day and from hour to hour. What matters, therefore, is not the meaning of life in general but rather the specific meaning of a person's life at a given moment. (Frankl, 1985, p. 108)

Meaning salience may be more malleable than global ratings of M/P because peoples' attention is constantly being pulled in different directions and they may not attend to what gives their lives meaning on a daily or momentary basis.

Interestingly, there was a small and negative association found in the between-subjects analysis of meaning salience (i.e., average) and fitness center visits, but not for self-reported physical activity duration or intensity, suggesting that individuals with lower overall average meaning salience were more likely to attend the fitness center. This association was in the opposite direction of what was hypothesized, and at this time, it is not clear what may account for this finding. One possible explanation is that meaning salience is, on average, very high for some individuals, but they are engaging in other behaviors (e.g., working, caring for family) that support their sense of meaning rather than exercise (Emmons, 2003; Gebhardt & Maes, 1998). Understanding these competing values may help discern whether individuals will be more likely to engage in physical activity or other behaviors to support their sense of meaning.

Meaning salience was also associated with greater physical activity intensity on days in which participants reported engaging in physical activity. This is surprising because previous findings suggested that purpose in life was more strongly associated with overall lifestyle physical activity than moderate-vigorous physical activity (Hooker & Masters, 2016). To date, little attention has been paid to the psychological predictors of whether someone generally engages in more intense or less intense physical activity (Scott, Rhodes, & Downs, 2009), which is surprising, given the evidence that engaging in more intense physical activity is particularly helpful in maintaining a healthy weight (Bailey, Borup, LeCheminant, Tucker, & Bromley, 2015). The finding that daily meaning salience is associated with daily engagement in more intense physical activity is worthy of greater scrutiny in order to better understand the nature of this relationship.

The mechanisms linking M/P and meaning salience to physical activity and other health outcomes remain to be explored. Our primary hypothesis is that M/P can be used as motivation to engage in health behaviors, especially when individuals connect their ultimate reasons to be healthy to the behavior at hand. Research from SDT supports this hypothesis, as individuals who are motivated by more internalized sources (i.e., because the behavior is consistent with their values or their sense of identity) are more likely to maintain the behavior (e.g., Teixeira et al., 2012). There are also other possible mechanisms. For example, individuals who think about their personal M/P more frequently may have a future-oriented and long-term time perspective (Baumeister, 1991; Hicks et al., 2012), which would make them more likely to engage in healthy behaviors that have long-term benefits even in the face of limited short-term reward. Further, thinking about meaning may also invoke thoughts of one's own mortality (Taubman-Ben-Ari, 2011), which could motivate individuals to engage in health behaviors as a coping mechanism to delay one's death. These mechanisms offer possible pathways linking meaning salience to health-promoting behaviors.

Previous research has highlighted the importance of mood for predicting physical activity (Carels et al., 2007), but this study demonstrates that, after controlling for mood, meaning salience still related to physical activity. Indeed, on days individuals experienced greater meaning salience, they also experienced greater positive mood and less negative mood. Meaning in life is not a purely cognitive construct but also has a significant affective component, which may be why meaning is strongly associated with positive mood. Baumeister (1991) refers to this affective component as feeling a sense of fulfillment. Positive mood is a part of feeling a sense of fulfillment, but fulfillment has the additional element of reaching goals and feeling pride or a sense of accomplishment that is associated with purpose (Baumeister, 1991). Physical activity, especially as individuals are in the process of becoming more physically active, is likely to invoke a sense of fulfillment as individuals make steps toward their goals. This is consistent with the idea of eudaimonia, or well-being associated with engagement in valued activities (Ryan & Deci, 2001).

Strengths and Limitations

This study has several strengths. Perhaps most notable is the examination of meaning salience, in addition to global ratings of M/P, as a predictor of physical activity. This represents an innovative contribution, one that might have intervention implications. Second, this was the first study of previously inactive exercise initiators that examined M/P in the context of behavior change. And finally, fitness center visits were used as an objective behavior that likely correlates with physical activity.

The primary limitation of this study is, apart from the fitness center attendance measure, reliance on self-report measures of physical activity. Self-report physical activity measures are susceptible to reporting error and may not strongly associate with objective physical activity measures (Troiano, Pettee Gabriel, Welk, Owen, & Sternfeld, 2011), but are considered reliable for rank ordering physical activity behavior (Masse & de Niet, 2012). Thus, the self-reported physical activity measures should be reliable in distinguishing those who engage in more activity from those who perform less activity, but the absolute levels of physical activity may not be representative of actual behavior. Further, participants rated their perceived exertion during exercise at the end of the day, and it is not clear whether the delay in reporting may have affected their ratings. A second limitation is that the sample was predominantly female, highly educated, and able to afford a membership to a fitness center. Thus, these results may not generalize to less educated and less affluent samples, although they may be representative of those who join private fitness centers. As with all longitudinal studies, missing data are of concern. In particular, participants may be less likely to report days in which they did not engage in physical activity. However, the sheer number of available days for each participant, the relatively good retention rates (75% completed surveys), and the use of all available data in the data analysis may minimize the influence of missing data in this study.

Of note, participants reported their daily meaning salience and physical activity at the end of the day. Thus, this study cannot determine the within-day time order of meaning salience and physical activity. It could be that participants engaged in physical activity, which increased their meaning salience, rather than mean-

ing salience increasing the likelihood of engaging in physical activity. Sense of meaning in life is not amenable to random assignment and experimental manipulation is difficult, but interventions to increase meaning salience may be an appropriate strategy to test for causal relationships.

Future Directions

There are several possible future directions for this research. Expanding to different samples is an important future step. For example, utilization of larger general community samples, with wider age ranges, are indicated. Similarly, samples lacking the requirement that they be joining a fitness center or intending to increase physical activity, would provide a wider range of tests for these constructs. Recruiting from several different fitness centers would increase the generalizability of the findings and replicate the results. Second, an EMA design with multiple within-day measurements and objective monitoring of physical activity would improve the assessment of time-ordering of meaning salience and physical activity behavior. For example, the objective physical activity monitor could capture bouts of physical activity and then examine whether there was a stronger relationship between meaning salience prior to a bout of physical activity behavior or between physical activity and meaning salience after a bout of activity.

Finally, interventions incorporating meaning salience to increase physical activity in inactive adults with intention to be more active would be a logical experimental step. To initiate a behavior change, individuals could engage in the conscious process of thinking about what is meaningful to them when faced with everyday decisions, such as the decision about whether or not to engage in physical activity that day. Researchers could tap into methods to enhance meaning salience, such as using a brief writing prompt (Burrow & Hill, 2013; Taubman-Ben-Ari, 2011), reading meaning-related passages (King et al., 2006), or using mobile technologies to deliver meaning-related messages (Masters, Ross, Hooker, & Wooldridge, 2018), and examine whether these experimental interventions enhance engagement in physical activity. Recent interventions incorporating SDT (Duncan et al., 2012), ACT (Forman, Butryn, Hoffman, & Herbert, 2009), and values (Anshel, 2010) may provide techniques to increase meaning salience. Just-in-time behavioral interventions could be uniquely applied in this context to increase engagement in physical activity. Indeed, the advent of mobile technology allows researchers to design investigations that can tap into these dynamic processes to: (a) increase knowledge of proximal predictors of behavior in context, and (b) intervene at apropos times to improve health behavior adoption and maintenance (Basen-Engquist et al., 2013; Spruijt-Metz et al., 2015). Sending prompts to individuals that increase meaning salience at particularly important or opportune times may increase the likelihood that individuals engage in physical activity.

Conclusions

Physical activity is an important health behavior for preventing many chronic illnesses, as well as for increasing mental health, vitality, and longevity (Rebar et al., 2015; Reiner et al., 2013; Samitz et al., 2011). Most adults do not engage in regular physical

activity, and determining factors related to physical activity maintenance in previously inactive exercise initiates is vital to our understanding of behavior change. This study provides evidence that meaning salience is related to daily engagement in physical activity in adults attempting to become more physically active. Future research should continue to explore these variables among exercise initiates as well as those who maintain regular activity and exercise. M/P and meaning salience ought to also be considered more carefully within the context of health behavior change theories. By building both empirical and theoretical foundations, M/P may well advance health behavior theory and lead to the design of better interventions to improve physical activity adoption and maintenance.

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