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Leveraging Goals to Incentivize Healthful Behaviors Across Adulthood

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Abstract

Despite abundant evidence for the benefits of physical activity on aging trajectories, older Americans remain largely inactive. The present study was designed to examine age differences in responsiveness to financial incentives to increase walking. Grounded in socioemotional selectivity theory, we examined the effectiveness of financial incentives that varied in prosociality. Three types of incentives were presented to community-residing adults 18–92 years of age ($N = 450$). Participants were randomly assigned to one of five conditions: personal, loved one, charity, choice, or a no-incentive control group. Average daily step counts were measured using pedometers during a baseline week, during the incentivized period, and after the incentivized period ended. Overall, financial incentives significantly increased walking compared to a control group. Whereas personal incentives were effective regardless of age, incentives to earn for charities were starkly more effective in older adults than younger adults. Moreover, one week after the incentivized period ended, older participants were more likely to maintain increased step counts, whereas younger people reverted to baseline step counts. Findings suggest that financial incentives can increase walking in a wide age range and that charitable incentives may be especially effective in health interventions targeting older adults. The importance of aligning incentives with age-related goals is discussed.

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Keywords

motivation; goals; physical activity; walking; incentives; socioemotional selectivity theory

Physical activity is associated with a host of health benefits. Findings from a meta-analysis reported by Naci and Ioannidis (2013) found that exercise was at least as effective as medication in reducing mortality risk associated with cardiovascular disease and stroke. Even small increases in light activities such as walking are associated with better cognitive functioning and clinically significant reductions in mortality risk (Buchman et al., 2012; Kelly et al., 2014; Weuve et al., 2004). One study concluded that for every 2,000-step

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increase in average daily walking (approximately one mile), individuals reduce their risk of cardiovascular disease by eight percent (Yates et al., 2014).

Although most Americans know about the benefits of physical activity (Pew Research Center, 2017), they remain notoriously inactive. Only half of American adults (52%) report that they meet minimal recommendations for aerobic activity (Clarke, Norris, & Schiller, 2017). Moreover, older adults are the least likely to meet guidelines (44.9% of people aged 65–74 and 29.3% of those aged 75 or more). Estimates based on accelerometry are even more sobering: According to these objective measures, only 5–10% of adults meet activity guidelines (Troiano et al., 2008; Tucker, Welk, & Beyler, 2011). Low levels of physical activity present a major public health challenge that may be especially relevant for older adults given heightened disease risk associated with advanced age.

One relatively novel approach to increase exercise is becoming popular in workplace settings; namely, employers are offering financial incentives that encourage their employees in pursuing healthful behaviors that may benefit their long-term health (Volpp, Pauly, Loewenstein, & Bangsberg, 2009). The approach has proven effective across behaviors, including gym attendance and smoking cessation (Charness & Gneezy, 2009; Haff et al., 2015; Jeffery, Wing, Thorson, & Burton, 1998; John et al., 2011; Mantzari et al., 2015; Mitchell et al., 2013; Royer et al., 2013; Volpp et al., 2008, 2006; Volpp, Troxel, et al., 2009). However, very little is known about the utility of the approach with older adults. A handful of studies examining the effectiveness of financial incentives in older adult samples have yielded mixed results, which are further complicated by very small sample sizes and methodological limitations that render findings inconclusive (Finkelstein, Brown, Brown, & Buchner, 2008; Harkins, Kullgren, Bellamy, Karlawish, & Glanz, 2017; Kullgren et al., 2014). No studies have examined age differences in incentive effectiveness.

A large literature in psychology suggests that motivation matters for behavior change (Ajzen & Madden, 1986; Deci & Ryan, 2008; Lachman, Lipsitz, Lubben, Castaneda-Sceppa, & Jette, 2018; Locke & Latham, 2002) and a good deal of evidence suggests that low rates of physical activity are due to lack of motivation rather than lack of knowledge about benefits (see Lachman, Lipsitz, Lubben, Castaneda-Sceppa, & Jette, 2018). To date, virtually all studies on financial incentives provide personal incentives and the vast majority of these studies exclusively target young or middle-aged adults (Charness & Gneezy, 2009; John et al., 2011; Mitchell et al., 2013; Royer et al., 2013; Volpp et al., 2008). Very little is known about other types of financial incentives or their differential effectiveness as a function of age. Socioemotional selectivity theory (SST) - a life-span theory of motivation that enjoys considerable empirical support - maintains that younger people prioritize future-oriented goals (such as accumulating resources), whereas older people prioritize goals that are realized in their very pursuit (such as emotional meaning and satisfaction; Carstensen, 2006; Chang, Choi, Bazarova, & Löckenhoff, 2015; Mikels et al., 2010; Notthoff & Carstensen, 2014; Scheibe, English, Tsai, & Carstensen, 2013). Consistent with SST, other lines of research suggest that motivation (particularly prosocial motivation) changes with age (Frumkin, Fried, & Moody, 2012; Seaman et al., 2016). For example, one study using self-report, neural, and behavioral measures found that older age was positively associated with general social benevolence, or pure altruism (Hubbard, Harbaugh, Srivastava, Degras, &

Mayr, 2016). Because chronically activated goals change with age, prosocial incentives may help to increase physical activity in older adults. To our knowledge, however, there have been no theoretically informed examinations of age differences in responsiveness to different types of financial incentives to increase physical activity. In aging societies, interventions that increase healthful behaviors in older people while simultaneously helping others represent important win-win opportunities.

The present study was designed to test the effectiveness of three types of financial incentives to increase walking in a sample spanning the adult age range. We focused on walking because financial incentives are most effective when they target simple, well-defined, and objectively measured activities (Scott & Schurer, 2008). Furthermore, walking is a highly accessible, low-cost, and relatively low-risk behavioral target, and increases in walking are associated with health improvements (Buchman et al., 2012; Kelly et al., 2014; Weuve et al., 2004). We postulated that incentives framed as personal benefits would be most effective for younger adults and incentives framed as emotionally meaningful would be most effective for older adults. Two types of emotionally meaningful incentives – earning for a loved one and earning for charity – were included to represent greater and lesser personal relevance. Whereas earning for a loved one and earning for charity are both emotionally meaningful, the former represents incentives that may also entail personal (“spillover”) rewards by benefitting close loved ones whereas the latter represents more general social benevolence, which has been associated with older age and is unlikely to result in personal benefit (Hubbard et al., 2016). In addition to a control condition, we included an incentive choice condition which offered an assessment of goals independent of step counts. Because the incentives represented distinct goals, participants’ preferences offered a window into their subjective goal priorities.

We hypothesized that financial incentives would lead to significant step increases compared to a non-incentivized control group (H1). Furthermore, given motivational changes with age, we hypothesized that younger people would increase walking more than older people in response to incentives that produce personal benefits, and that older people would increase walking more than younger people in response to emotionally meaningful incentives that benefit another person or cause (H2). We did not have a priori hypotheses about differences in the degree of responsiveness to the loved one vs. charity conditions. However, it was important to examine differences between the two given recent empirical findings about general social benevolence increasing with age (Hubbard et al., 2016). Relatedly, we hypothesized that, when offered a choice, older people would be more likely than younger people to choose to earn incentives for others (H3). In addition to these core hypotheses, we explored whether allowing participants to choose the incentive target would lead to greater step increases than assigning a target, whether step increases would be maintained after incentives are no longer offered, and whether incentives would reduce intrinsic motivation for physical activity.

Method

Power Analysis

To estimate sample size required for this study, we conducted several power analyses using G*Power 3.1.7 (Faul, Erdfelder, Lang, & Buchner, 2007). Although effect sizes calculated from other studies of financial incentives were large (Cohen's $f^2 > .36$; e.g., Charness & Gneezy, 2009), estimated effect sizes from walking interventions targeting younger and older adults with different messages were smaller ($f^2 = .04$; Notthoff & Carstensen, 2014). Based on this effect size, a sample of 199 would be sufficient to detect evidence for our main hypothesis, an *age (continuous) x contrast (incentive vs. control)* interaction, in a regression model with 9 terms ($\alpha = 0.05$, $\beta = 0.80$, $F(1, 189) = 3.89$). However, published effect sizes are likely to be overestimates of actual effect sizes (Fanelli & Ioannidis, 2013). Therefore, to be conservative and to ensure a minimum of 30 younger, middle-aged, and older adults in each of five conditions, our total target sample size was 450 participants.

Participants

We recruited community-residing adults to participate in a study of physical activity that would require four laboratory visits and three weeks of pedometer wear. Participants were residents of the Bay Area and were recruited from a variety of sources, including flyers posted at laundromats, senior centers, and coffee shops; advertisements on Craigslist and Facebook; and emailed invitations sent to our laboratory's record of former participants or interested individuals as well as university staff. Interested individuals were screened for the presence of conditions that might make physical activity risky (such as heart or joint problems) using the Physical Activity Readiness Questionnaire (PAR-Q; Thomas, Reading, & Shephard, 1992) and for cognitive impairment using the Mini-Mental State Examination (MMSE; Newkirk et al., 2004). Participants who scored less than 23 on the MMSE were ineligible. In order to address potential confounds between younger age and student status, full-time students were not eligible to participate. We also assessed potential participants' knowledge of the study, including whether they knew earlier participants, to ensure that they were unaware of the incentive component. Study sessions were scheduled during a 3-week period wherein participants did not anticipate atypical events that might affect walking (e.g. surgery, houseguests, vacation).

We enrolled 489 participants from October 2013 through December 2016. Of these, 29 dropped out after the first session (due to scheduling constraints or pedometer issues), and data from 10 participants were excluded due to atypical life events during the study period (e.g., extreme illness, car accident), data loss, or misrepresentation of prescreen requirements. Our final sample included 450 participants (49.8% female) aged 18 to 92 uniformly distributed across the adult life span. Sixty-six percent of participants identified as White, 15% identified as Asian or Asian-American, 7% identified as Hispanic or Latino/a, 3% identified as Black or African-American, and the remaining 9% identified as another race, more than one race, or did not report their race (see Table 1 for demographic characteristics across conditions). Participants received a base payment of $50 as compensation.

Procedures

This study was approved by Stanford University's Institutional Review Board, and informed consent was obtained from all participants. Participants completed four laboratory sessions, spaced one week apart, and wore a pedometer in between sessions that automatically stored step counts (described below).

Session 1.—After providing informed consent, participants completed questionnaires using Qualtrics survey software. They were provided with a pedometer and instructed on its use.

Session 2.—Participants completed questionnaires while the previous week's pedometer steps were downloaded. They were randomly assigned within age group and gender to one of five conditions: *personal, prosocial-loved one, prosocial-charity, choice*, or *control*. After their step count data had been downloaded, participants in all four incentivized conditions were told, "During the past week, on average, you walked __ steps per day. As you may be aware, physical activity is very important for health and well-being. Walking is one of the most convenient forms of physical activity and even small changes in walking can have substantial benefits for the way you feel, both physically and mentally. In this study, we are interested in testing different ways to help people increase their physical activity, such as walking. So, for the next seven days ONLY, you will have the chance to earn extra money by increasing your daily step average." Then, participants in the *personal* condition were told, "For every step that you increase your average, you will receive 2 cents." Participants in the *prosocial-loved one* condition were told, "For every step that you increase your average, you will receive 2 cents to give to a loved one." In the *prosocial-charity* condition, participants were told, "For every step that you increase your average, you will receive 2 cents to give to a charity." Participants in the *choice* condition were told, "You have the choice to earn this money for yourself, a loved one, or a charity. For every step that you increase your average, you will receive 2 cents." Next, all incentivized participants were told, "For example, if you increase your average steps per day by 500, which is about ¼ mile, you will receive $10; if you increase your average steps by 5000, you will receive $100, and so on." Finally, they were asked if they had any questions about the incentive.

In contrast, participants in the *control* condition were not told about the opportunity to earn money by increasing their steps. They were simply told, "During the past week, on average, you walked__steps per day. As you may be aware, physical activity is very important for health and well-being. Walking is one of the most convenient forms of physical activity and even small changes in walking can have substantial benefits for the way you feel, both physically and mentally." In summary, participants in all conditions were told about the benefits of walking, but only those in the incentivized conditions were told they would earn money (for themselves or another target) for increasing their steps.

Session 3.—Participants completed questionnaires while pedometer steps were downloaded. All participants (including controls) were told their average daily steps from the previous week and how this average related to the first week's average. Incentivized participants who did not increase steps were told that they did not earn any money.

Incentivized participants who did increase steps were told how much money they earned and, depending on condition, a check was either issued to the participant directly or mailed to their chosen loved one or charity. Incentivized participants were reminded that the incentive portion of the study was complete and that they would not earn money by increasing steps during the final (post-incentive) week. Control participants were simply told to continue to wear their pedometers each day for the following week.

Session 4.—Participants completed questionnaires while pedometer steps were downloaded. Once again, all participants were told their average daily steps from the previous week and how this average related to the second week's average. At the end of this final session, all participants were fully debriefed, compensated for completing the study, and thanked for their participation. During the debriefing, participants in the control condition who increased their average daily steps over baseline were paid for these step count increases in addition to their base pay to ensure comparable remuneration across all participants and conditions. Importantly, control participants who increased their steps during the incentive week did not know they would earn money for increasing their steps and were told for the first time that they earned additional money, and the amount they earned, during the debriefing period. At this point, they chose whether to keep their earnings for themselves or give them to a loved one or charity.

Measures

Step counts.—Steps were assessed with Omron HJ-720ITC pedometers (Omron Healthcare Inc., Lake Forest, Il), which have been validated for self-paced walking in younger adults (Holbrook, Barreira, & Kang, 2009). These pedometers have a 42-day memory and reset each night at midnight; participants were not responsible for tracking steps on their own, resetting the device, or downloading step counts. To account for any age differences due to differences in stride length, each participant's stride length was calculated and entered into the pedometer settings during the first session in order to individually configure the pedometer. Participants wore the pedometer on the waistband at the hip of their dominant side. Average daily steps for baseline, incentive, and post-incentive weeks were calculated as the average number of steps across the 6 full days between study sessions.

Wealth.—Because wealth may influence the effectiveness of financial incentives, we used four items drawn from the CARDIA study's Year 25 Sociodemographic Questionnaire (Coronary Artery Risk Development in Young Adults, 2010) to assess household income, assets, and debts. We also assessed perceived wealth with an item that asked participants to describe their financial situation on a 7-point scale from "*At the end of the month, I don't have enough to make ends meet*" to "*At the end of the month, I have money left over*". To calculate a wealth score, we first created a ratio of assets to debts, then standardized this ratio and the remaining three items, and averaged across them (α = .70).

Self-rated health.—To account for the possibility that younger participants are in better health than older participants, we measured health at baseline using two items from the SF-36 (Ware & Sherbourne, 1992). One item asked participants to describe their health on a

5-point scale from "*Excellent*" to "*Poor*". The other item asked participants to rate their health compared to one year ago on a 5-point scale from "*Much better now than one year ago*" to "*Much worse now than one year ago*". We reverse-coded items and averaged across them so that higher scores indicate better health. These two items were moderately correlated, $r(448) = .18$, $p < .001$.

Exploratory dependent measures.—In addition to the primary outcomes, we explored age and incentive effects on step goals, habit strength, and intrinsic motivation. The latter was included because some researchers have raised concerns that incentives may reduce intrinsic motivation for physical activity (Mitchell et al., 2013; Promberger & Marteau, 2013). Thus, we measured intrinsic motivation and habit strength at baseline and after the final week in which the incentives were no longer available.

Step change goal.: Participants indicated their daily step change goal for the upcoming week, and incentivized participants were shown the dollar amount into which this goal would translate (e.g., "Increasing your steps by an average of 1,000 steps per day would mean you would earn $20.").

Habit strength.: To assess physical activity habit strength we used the 12-item Self- Report Habit Index (Verplanken & Orbell, 2003). Participants responded to 12 items about their engagement in physical activity (e.g., "[Physical activity is something]…I do frequently,") using a 7-point scale ("*strongly disagree*" to "*strongly agree*"). We calculated habit strength as the average of the 12 items at baseline (first session) and after the post-incentive week (final session) (αs ≥ .96).

Intrinsic motivation.: We measured intrinsic motivation for physical activity using four enjoyment and interest items from the Intrinsic Motivation Inventory (IMI) and adapting them for physical activity (Vieira et al., 2013). Participants rated these items (e.g. "I enjoy doing physical activity very much") using a 5-point scale from "*strongly disagree*" to "*strongly agree*". Intrinsic motivation scores were calculated at baseline (first session) and post-incentive week (final session) as the average of the four enjoyment items (αs ≥ .87).

Perceptions of incentive.: All incentivized participants were asked to rate how motivating the financial incentive was for increasing walking on a 5-point scale ("*not at all motivating*" to "*very motivating*").

Data Reduction and Analytic Approach

Analyses were conducted using R version 3.3.2 (R Core Team, 2016). We used the *lm* function to conduct linear regressions, the *glm* function to conduct logistic regressions, and the *multinom* function within the *nnet* package to conduct multinomial logistic regressions. Plots were produced with *ggplot2* (Wickham, 2016). Age was treated as a continuous variable in all analyses unless otherwise stated. Change scores for average daily steps and intrinsic motivation were calculated as the standardized residuals obtained by regressing post-incentive scores on raw baseline scores. To remedy outliers, values exceeding 3 standard deviations of the mean for all dependent variables were winsorized to those values.

We used orthogonal contrast coding (see Table S1 in Supplemental Materials) within a multiple regression framework to test the effects of: 1) all incentive conditions vs. no-incentive controls, 2) personal vs. prosocial incentives, 3) loved ones vs. charity incentives, and 4) chosen-vs. assigned-target incentive on change in daily average step counts and on intrinsic motivation. We tested for step changes as a function of incentive condition and age both while incentives were in place and after the incentivized period had ended.

Results

Demographic and baseline characteristics

We first examined whether demographic features and baseline behaviors differed among conditions using chi-square tests and ANOVA. Raw means and standard deviations for demographic characteristics and baseline variables are presented in Table 1. At baseline, conditions did not differ by race, wealth, self-rated health, step counts, or intrinsic motivation for physical activity, suggesting successful random assignment. We also tested for age effects on demographics and baseline behaviors. Zero-order correlations among variables are presented in Table 2. Not surprisingly given population demographics, older age was associated with a higher likelihood of being Caucasian, having greater wealth, and lower step counts at baseline. To better understand age differences in baseline average daily step counts, we calculated means by age quartile and regressed average daily step counts on age quartile, where age quartile was dummy-coded. Compared to participants aged 18–33 (M = 8,041 steps, SD = 3,360), participants aged 34–54 walked a similar number of steps (M = 7,821 steps, SD = 3,257), $b = -220.26$, SE = 450.83, $t = -0.49$, $p = .625$, as did 55–68 year-olds (M = 7,696 steps, SD = 3,513), $b = -334.69$, SE = 440.43, $t = -0.78$, $p = .434$. However, participants aged 69–92 walked fewer steps at baseline compared to those aged 18–33 (M = 6,100 steps, SD = 3,356), $b = -1{,}941.37$, SE = 447.53, $t = -4.34$, $p < .001$. Age was not associated with baseline self-rated health, intrinsic motivation for physical activity or habit strength.[1] Because age was associated with race and wealth, we analyzed our data with these two variables as covariates and results were unchanged; thus, we do not discuss these adjusted models further.

Primary Results

Effects of age and condition on step count change during the incentivized period.—Average daily step count change by condition is presented in Table 3 and regression results are reported in Table 4. Overall, incentivized participants increased average daily steps more than controls (see Figure 1). On average, incentivized participants earned $58.86 ($SD$ = $66.59) for increasing their steps over one week. A scatterplot presenting step count change by condition and age can be found in Figure 2. Participants increased daily steps more when earning personal incentives than when earning prosocial incentives, and when earning for a loved one versus earning for a charity; however, this main effect should be interpreted in light of the *age x charity vs. loved one* interaction highlighted below. Participants increased steps comparably whether the incentive target was assigned

[1]Results for effects of age and incentive condition on step change goal, intrinsic motivation, habit strength, and perceptions of the incentive are presented in the online supplement.

(i.e. personal, loved one, charity; *MΔsteps* = 2,420.14, *SD* = 3,235.91) or chosen (*MΔsteps* = 3,091.13, *SD* = 3,575.40)[2].

Average daily step count change by age quartile and condition (incentivized vs. controls) are presented in Table 5. Age did not impact the general effectiveness of incentives (vs. control) on average daily step counts, nor did it impact the effectiveness of personal relative to prosocial incentives (Table 4). However, the effectiveness of earning for loved ones compared to charities was moderated by age. The effectiveness of assigned incentives compared to choice of incentives on step count increases was also moderated by age.[3]

Follow-up analyses within conditions.: To better understand the *age x loved one vs. charity* interaction on change in average daily steps, we conducted follow-up analyses to test the effect of age on step count increases separately for the *charity* and *loved one* conditions. When earning for charity, older adults increased their steps significantly more than younger adults (β =.27, *SE* = .10, *p* = .008, 95% CI [.07, .47]), whereas when earning for a loved one, incentives were comparably effective across the age spectrum (β = −.14, *SE* = .10, *p* = .155, 95% CI [−.34,.06]).

To better understand the *age x choice vs. assigned* interaction, we conducted follow-up analyses to test the effect of age on step count increases separately in *choice* and *assigned-target* conditions. When participants chose the incentive target, younger adults increased their steps more than older adults (β = −.21, *SE* = .10, *p* = .048, 95% CI [−.42, −.002]), but when the incentive target was assigned, age was not associated with change in average daily step counts (β = .05, *SE* = .06, *p* = .396, 95% CI [−.07, .17]). Thus, younger adults were more responsive than older adults to incentives when they were allowed to choose the beneficiary. Older people were more responsive than younger people when incentives benefitted a charity.

Exploratory analyses.: Because there were age differences in average daily step counts at baseline and a 1,000-step increase is a larger proportion of baseline steps for older compared to younger participants, we also examined effects of incentive condition and age on *percentage* change in average daily steps. Results from the regression analyses yielded largely similar effects as regression analyses using residualized change scores discussed above. The only exception was that there was a main effect of choice vs. assigned incentives such that the choice condition led to greater percentage increase in average daily steps relative to assigned incentives, *b* = .07, *SE* = .03, *t* = 2.53, *p* = .012. Although older participants had a somewhat greater percentage increase in average daily steps compared to younger participants (38.2% increase in participants aged 55+ vs. 32.2% in those aged < 55), the main effect of age on percent change in average daily steps was not statistically significant, *b* = .04, *SE* = .04, *t* = 0.90, *p* = .370.

[2]We also tested our models using raw, winsorized average daily step change scores (*post-incentive – baseline*) as the dependent variable rather than residualized change and results were nearly identical.

[3]We also tested for evidence of quadratic effects of age (i.e., age^2) and age^2 *x condition* interactions, which we present in the online supplement. Figure S1 displays effects of age and condition on step count change using a LOESS smoothing curve.

We also explored whether the effectiveness of incentives on average daily step change was moderated by gender. We had no a priori hypotheses about interactions with gender. The only gender effect that reached significance was a 3-way *age x charity vs. loved one x gender* interaction, $b = .44$, $SE = .12$, $t = 3.54$, $p < .001$. To better understand this interaction, we examined effects of age on average daily step count change within these two conditions for each gender. In the *charity* condition, older age was associated with greater step count increases in males, $b = 0.42$, $SE = .11$, $t = 4.02$, $p < .001$, but there was no age effect in females, $b = -0.01$, $SE = .11$, $t = -0.12$, $p = .906$. In the *loved one* condition, older age was associated with smaller step count increases in males, $b = -0.38$, $SE = .12$, $t = -3.28$, $p = .002$, but no age effect in females, $b = 0.11$, $SE = .15$, $t = 0.78$, $p = .437$.[4]

Effects of age and condition on step count change when incentives were no longer offered.—We also measured step count change by condition during the final week when incentives were no longer offered. Figure 3 presents average daily step count changes after incentives were removed by condition and age. Average daily step counts for incentivized participants during the final week remained higher than baseline (average daily step count change by condition presented in Table 3; $t(359) = 5.85$, $p < .001$, 95% CI [533.79, 1,073.95]). Regression results are presented in Table 6. The only effect that reached significance was a main effect of age, such that older adults had greater increases in steps relative to younger participants during this follow-up period (see Table 5 for average daily step count change by age quartile and condition). There was a trend such that incentivized participants continued to walk more than control participants, although this did not reach significance. There was also a trend such that older people were more likely to maintain step increases when earning for charity compared to earning for a loved one, and when assigned to an incentive compared to when offered a choice of incentive, though neither reached statistical significance. There were no other effects of condition, nor were there significant *age x contrast* interactions.

Exploratory analyses.: As reported above, during this follow-up period, the *incentive vs. control x age* interaction did not reach significance. However, there was quite a bit of variability among the incentivized conditions (Figure 3). As a follow-up analysis, we examined age effects within each condition. There was a positive age effect in the personal condition ($b = 0.29$, $SE = .10$, $t = 2.87$, $p = .005$), and in the charity condition ($b = 0.27$, $SE = .10$, $t = 2.69$, $p = .008$). However, there was no age effect in the loved one ($b = 0.03$, $SE = .10$, $t = 0.26$, $p = .793$), choice ($b = -0.01$, $SE = .11$, $t = -0.11$, $p = .909$), or control conditions ($b = 0.02$, $SE = .11$, $t = 0.22$, $p = .826$). Additionally, in the loved one, choice, and control conditions, average daily step count changes compared to baseline were not significantly different from 0, ts > −1.51, ps > .134.

Because older participants had lower baseline step counts than younger participants, we also examined effects of incentive condition and age on percentage change in average daily steps when incentives were no longer offered. Results from the regression analyses yielded similar effects as regression analyses using residualized change scores discussed above. The main

[4]Full results for interactions with gender (Table S2) and plots (Figure S2) are presented in online supplementary materials.

effect of age continued to be significant, such that older participants had proportionately larger step increases than younger participants during this period when incentives were no longer offered. The only difference from results with residualized change scores was that the effectiveness of *charity vs. loved one* incentives was moderated by age, $b = -0.19$, $SE = .07$, $t = -2.63$, $p = .009$. In follow-up analyses, older age was associated with greater percentage step count increases in the *charity* condition, $b = 0.36$, $SE = .10$, $t = 3.66$, $p < .001$, but not in the *loved one* condition, $b = -0.02$, $SE = .11$, $t = -0.22$, $p = .828$.

We also explored whether the effectiveness of incentives on average daily step change during this follow-up period was moderated by gender. There was a main effect of gender on average daily step change after the incentivized period had ended such that women had smaller step count increases over baseline than men, $b = -0.19$, $SE = .09$, $t = -2.14$, $p = .033$. No interactions with gender reached significance.[5]

Secondary Results

Target choice within *choice* condition.—In addition to our primary hypotheses, we examined age differences in choice of incentive target for participants in the *choice* condition. We hypothesized that older adults would be more likely than younger adults to choose to earn for others. Using logistic regression, we regressed target choice *charity* = 1, *personal* and *loved one* = 0) on age (continuous). We present percentages by age group (< 55 and 55+) for descriptive purposes only. We found partial support for the hypothesis. Regardless of age, most participants chose to earn money for themselves (59% of participants aged 55+ and 68% of < 55). However, logistic regression analyses indicated that older age was associated with being more likely to choose to earn for charity than other options (28% of 55+ vs. 7% of < 55; $B = .81$, $SE = .33$, $p = .014$, 95% CI [.20, 1.52]). Age did not distinguish the likelihood of choosing to earn for a loved one (13% of 55+ vs. 25% of < 55) compared to other options (*loved one* = 1, *personal* and *charity* = 0; $B = -.39$, $SE = .28$, $p = .161$, 95% CI [−.96, .14]). Thus, although participants most often chose to earn for themselves, older adults were more likely than younger adults to choose to earn for a charity.

Discussion

Financial incentives targeting physical activity have emerged as a potentially effective way to increase activity. Their ease of implementation by organizations and charities and their potential scalability add to their appeal. Most research has limited the scope to personal payments made to young adults. There has been little examination of financial incentives in older adults, and no study of the relative effectiveness of incentive types, despite theoretical and empirical reason to expect that prosocial incentives may become increasingly salient with age. In the present study, we examined prosocial and personal incentives in a sample spanning a wide age range.

Overall, in this relatively active sample, incentivized participants increased step counts by an average of 2,500 steps per day – approximately one mile more per day than participants in the control condition (in support of H1). One-mile increases in walking are associated with

[5]Full results for interactions with gender (Table S3) are presented in online supplementary materials.

reductions in cardiovascular events (Yates et al., 2014), suggesting that the change we observed is both statistically and clinically meaningful.

Financial incentives were effective across the broad age range we studied, suggesting that financial incentives may be useful in increasing walking for both younger and older adults. Although older adults had lower baseline step counts, the magnitude of step increases was similar across the age range. Nonetheless, there was no evidence that older participants increased steps proportionately more than younger participants. We speculate that this could be because there was substantial variability in average percentage change within age groups. One week after the incentives were withdrawn, older adults maintained higher step counts whereas the step counts of younger adults immediately returned to baseline walking levels.

A key hypothesis, based on socioemotional selectivity theory (Carstensen, 2006), was that incentives that align with age-associated goals would be most effective. Given that the salience of emotionally meaningful goals increases with age, we expected that older adults would respond more strongly than younger adults to prosocial incentives whereas younger adults would respond more strongly than older adults to incentives with direct personal benefit (H2). We found partial support for this hypothesis. Personal incentives were most effective at increasing walking across the age range and this finding was robust. In the *choice* condition, personal incentives were the most popular choice, and older adults were as likely as younger adults to choose personal incentives, providing evidence that personal financial incentives were relatively preferred over other types of incentives. In retrospect, this makes sense because personal incentives offer the most flexibility in the ways the financial rewards are used.

Although prosocial incentives in general were not more effective at increasing walking for older (vs. younger) participants, we did observe age differences depending on the type of prosocial incentive. Incentives earned for charities were particularly potent in older adults, providing partial support for H2. In an exploratory analysis, we found that this effect was driven by men. We did not hypothesize an effect of gender and it would be important to replicate this effect. Even after the incentivized period had ended, participants aged 55+ walked an average of 1,743 more steps per day when they had previously earned incentives for charities, whereas participants aged 54 and younger did not walk more than at baseline (an average of 11 more steps per day). In contrast, charity incentives had essentially no effect on walking in younger adults. The effectiveness of incentives earned for loved ones did not differ by age. We also found partial support for H3, that older participants would choose to earn prosocial incentives relative to younger participants. Once again, personal incentives were most preferred in the choice condition. However, older participants were more likely than younger adults to choose to earn for charity and no age differences were observed in earning for a loved one. Our findings may suggest that, consistent with Hubbard et al (2016), older adults experience general benevolence as especially rewarding.

Younger adults in our study increased walking more than older adults when allowed to choose the incentive target, consistent with findings that younger adults value choice more than older adults (Reed, Mikels, & Simon, 2008). Having choice may intensify responsiveness to incentives in younger people, even controlling for incentive type. Future research should investigate the mechanisms underlying age differences in target choice on behavior. Of course, in this cross-sectional age comparison, we cannot know whether age differences represent cohort effects or developmental change.

For the first time, we also examined age differences in step counts one week after financial incentives were no longer offered. Previous findings with younger and middle-aged participants have been mixed regarding sustained behavior change after incentives are no longer available, with most studies suggesting that behaviors return to baseline levels (Charness & Gneezy, 2009; John et al., 2011; Patel et al., 2016; Volpp et al., 2008). In the present study, younger adults returned to baseline walking levels immediately after incentives were withdrawn, whereas older participants continued to walk more compared to baseline across conditions. Although the *incentive vs. control x age* interaction did not reach significance during this follow-up period, it was likely due to noise among the incentivized conditions. Older adults continued to walk more than younger adults in the personal and charity conditions during follow-up. There was no age effect in the loved one, choice, and control conditions and participants in these conditions did not have higher step counts compared to baseline. The follow-up period was relatively short, but the finding is consistent with other studies finding no evidence for maintenance in younger adults and build on these findings by showing that steps revert to baseline levels almost immediately (John et al., 2011; Patel et al., 2016; Volpp et al., 2008). Our findings are also consistent with studies showing that older people are more likely than younger people to adhere to medications (Walker et al., 2006) and exercise programs (Martin & Sinden, 2001). This finding may suggest that particular incentives may encourage adherence in older adults, although more research is necessary. Future studies should incorporate a longer follow-up period to assess the duration of maintenance in older adults to examine whether these step increases are sustained or whether returns to baseline are simply delayed.

Although some previous studies have raised concerns that incentives may reduce intrinsic motivation for physical activity (Mitchell et al., 2013; Promberger & Marteau, 2013), we found no evidence that offering and then removing financial incentives reduced intrinsic motivation in our sample. This provides additional evidence that incentives can be used to increase walking across the adult age range without harming intrinsic motivation.

Previous studies that have evaluated the effectiveness of financial incentives on physical activity have focused on gross indices, such as attendance at exercise sessions (Charness & Gneezy, 2009; Jeffery et al., 1998; Royer et al., 2013), or whether a set threshold is met (Harkins et al., 2017; Kullgren et al., 2014; Patel et al., 2016), rather than incremental behavioral changes, which substantially limits the fidelity of measurement. We improved upon these limitations by measuring individual step counts with pedometers and incentivizing participants for each step above their baseline average (rather than days a specific goal was met). This strategy allowed us to measure incremental increases in walking, regardless of initial activity level.

Another strength of the present study design is that it controlled for the effect of financial need on earnings, which is particularly important in the charity condition. Prior studies on charitable giving have found that charitable giving tends to increase with age (Bekkers &

Wiepking, 2011). However, this finding may be due to older adults having greater wealth than younger adults. In the present study, participants assigned to the charity condition could only earn for charity, meaning that any observed age differences were not due to financial need.

One limitation of this study is that participants had relatively high baseline step counts (approximately 7,500 steps per day) compared to national averages of 5,117 steps per day (Bassett, Wyatt, Thompson, Peters, & Hill, 2010). Even the oldest participants in our sample, aged 69 to 92 years, walked on average approximately 6,000 steps per day, which is higher than national averages for this age group. In some ways, the increases in walking we observed were notable given that participants were already relatively active. On the other hand, participants are not representative of Americans. More research is needed to examine whether financial incentives are effective in less active populations. Some have argued that people who need wellness programs most are the least likely to self-select into such programming (Royer et al., 2013). One strength of this study is that this sample of community-dwelling adults was recruited without awareness that they would be incentivized to walk more than they typically do.

Findings that financial incentives significantly increased walking both statistically and clinically in a sample spanning the full adult age range offer powerful support for such interventions. Findings also highlight the potential importance of aligning incentives with preexisting goals to enhance their effectiveness and suggest there may be age differences in the longer-term effects of financial incentives. Because older people are the least physically active in the population and at greatest risk for health problems, financial incentives represent an important tool for improving public health in aging societies.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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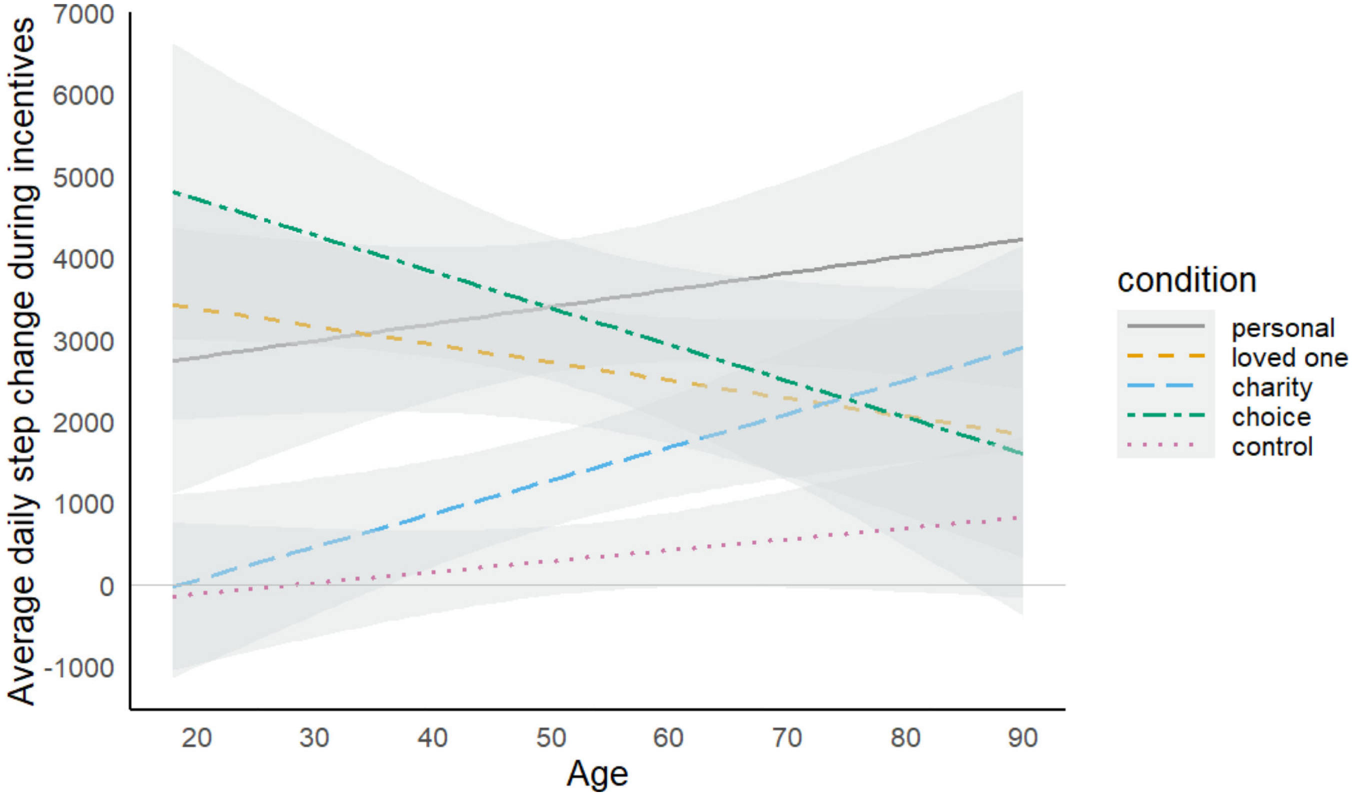

Figure 1.

Step count change while incentives were in place (vs. baseline) by incentive type and age (N = 450). For ease of interpretation, change scores were calculated by subtracting average daily step counts during the incentivized week from baseline counts. Shaded regions represent +/− 95% confidence intervals.

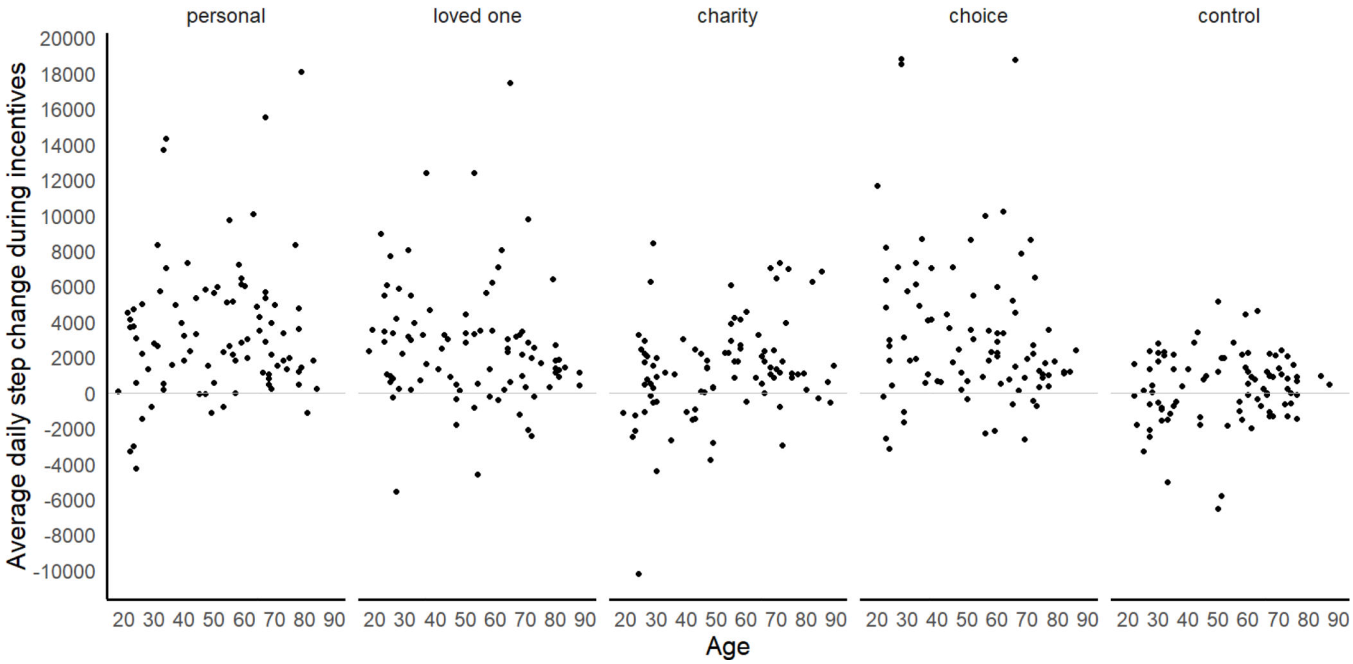

Figure 2.

Scatterplot depicting effects of age and condition on step count change while incentives were in place (N = 450). Each point represents one participant. For ease of interpretation, change scores were calculated by subtracting average daily step counts during the incentivized week from baseline counts.

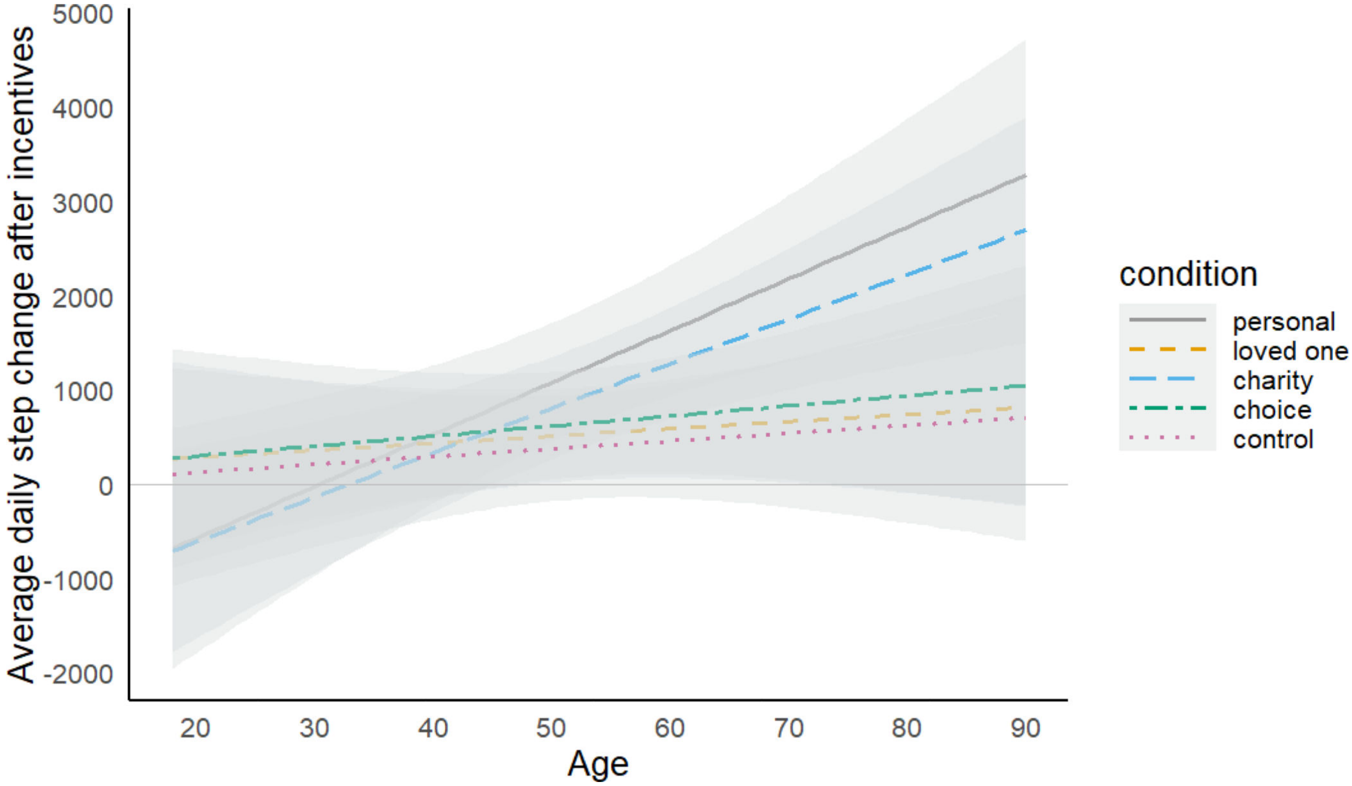

Figure 3.
Step count change when incentives were no longer offered (vs. baseline) by incentive type and age ($N = 450$). For ease of interpretation, change scores were calculated by subtracting average daily step counts during the post-incentive period from baseline counts. Shaded regions represent +/− 95% confidence intervals.

Table 1.

Demographic and baseline characteristics of participants by condition

Variable	Personal (n = 90)	Loved One (n = 90)	Charity (n = 90)	Choice (n = 90)	Control (n = 90)	Statistic	*df*	*p*
Age	51.77 (19.34)	52.26 (20.40)	51.37 (19.71)	52.29 (19.30)	52.34 (18.37)	$F = 0.04$	4, 445	.996
18–33 years (quartile 1)	23	25	26	22	23			
34–54 years (quartile 2)	22	22	20	22	20			
55–68 years (quartile 3)	25	18	22	23	28			
69–92 years (quartile 4)	20	25	22	23	19			
Gender (% female)	50.0	50.0	48.9	50.0	50.0	$\chi^2 = 0.04$	4	.999
Race (% White)	67.8	63.3	64.4	65.6	67.8	$\chi^2 = 0.63$	4	.960
Wealth	0.06 (0.71)	−0.08 (0.78)	0.00 (0.77)	−0.03 (0.72)	0.08 (0.65)	$F = 0.71$	4, 444	.586
Self-rated Health	3.44 (0.67)	3.38 (0.61)	3.51 (0.57)	3.46 (0.69)	3.41 (0.58)	$F = 0.57$	4, 445	.684
Baseline Average Daily Step Counts	7,875 (3,496)	7,250 (3,395)	7,396 (3,345)	7,444 (4,198)	7,455 (3,875)	$F = 0.36$	4, 445	.836
Baseline Intrinsic Motivation	3.84 (0.94)	3.71 (0.91)	3.82 (0.90)	3.75 (1.00)	3.66 (0.93)	$F = 0.56$	4, 445	.695

Note. Data presented are means with standard deviations in parentheses, unless otherwise noted. Values presented for steps and intrinsic motivation are raw, untransformed values.

Table 2.

Summary of zero-order correlations for demographic characteristics and baseline variables

Variable	1	2	3	4	5	6	7
1. Age	1.00						
2. Gender	−.02	1.00					
3. Race	−.33***	−.04	1.00				
4. Wealth[a]	.34***	.05	−.16***	1.00			
5. Self-rated health	−.03	.03	−.12*	.08	1.00		
6. Baseline average daily step counts[b]	−.20***	−.04	.01	.02	.24***	1.00	
7. Baseline intrinsic motivation	−.07	−.01	.04	−.03	.29***	.21***	1.00
8. Baseline habit strength	.07	−.10*	−.03	.12**	.37***	.30***	.67***

Note. $N = 450$. Gender coded as 0 = male, 1 = female; race coded as 0 = white, 1 = non-white.

[a] $n = 449$

[b] To account for outliers, values exceeding 3 standard deviations of the mean were winsorized to equal +/− 3 standard deviations of the mean.

* $p < .05$,

** $p < .01$,

*** $p < .001$

Table 3.

Average daily step count increase by condition

Condition	*N*	Δ Steps During Incentivized Period (Week 2–Baseline)	Δ Steps After Incentives Ended (Week 3–Baseline)
Control	90	326.70 (1,984.98)	362.90 (2,473.05)
Incentivized	360	2,587.89 (3,331.64)	803.87 (2,605.75)
Personal	90	3,289.87 (3,426.30)	1,187.37 (2,866.29)
Prosocial	180	1,985.27 (3,054.25)	695.22 (2,500.17)
Loved one	90	2,618.83 (3,243.23)	532.61 (2,338.45)
Charity	90	1,351.71 (2,726.04)	857.83 (2,655.19)
Choice	90	3,091.13 (3,575.40)	637.66 (2,529.92

Note. Data presented are means, with standard deviations in parentheses. Average daily step counts were winsorized to equal +/− 3 standard deviations of the mean. 'Incentivized' mean was averaged across all 4 incentive conditions (personal, loved one, charity, and choice). 'Prosocial' mean was averaged across the loved one and charity conditions.

Table 4.

Age and incentive effects on step count change while incentives were in place

Variable	*B*	*SE B*	*p*	95% CI	
Intercept	.002	.04	.955	−0.08	0.09
Age	.002	.04	.964	−0.08	0.09
Incentive vs. control	.14	.02	< **.001**	0.10	0.18
Personal vs. prosocial	.13	.04	< **.001**	0.06	0.21
Loved one vs. charity	.19	.07	**.006**	0.06	0.33
Choice vs. assigned	.05	.03	.070	0.00	0.11
Incentive type x age					
Incentives vs. control x age	−.02	.02	.382	−0.07	0.03
Personal vs. prosocial x age	.01	.04	.793	−0.07	0.09
Loved one vs. charity x age	−.19	.07	**.006**	−0.32	−0.05
Choice vs. assigned x age	−.07	.03	**.013**	−0.13	−0.02
Adjusted R^2	.13				

Note. $N = 450$. Step count change was calculated as the standardized residuals obtained by regressing incentive week steps on baseline steps, and winsorized to +/− 3 standard deviations to account for outliers. Age was standardized (i.e., $M = 0$, $SD = 1$) to increase interpretability of condition effects. Conditions were compared using orthogonal contrasts, see Table S1. Bold values indicate $p < .05$.

Table 5.

Baseline average daily steps and average daily step change by age quartile and condition (incentives vs. controls)

	Incentivized groups				Control group			
Age Quartile	**N**	**Baseline**	**During Incentivized Period (average daily step change)**	**After Incentives Ended (average daily step change)**	**N**	**Baseline**	**During Incentivized Period (average daily step change)**	**After Incentives Ended (average daily step change)**
18–33 years (Q1)	96	8,092 (3,462)	2446 (3,896)	50 (2,898)	23	7,830 (2,960)	−161 (2,047)	396 (2,370)
34–54 years (Q2)	86	7,872 (3,059)	2,442 (3,287)	580 (2,393)	20	7,602 (4,088)	184 (2,824)	−635 (2,619)
55–68 years (Q3)	88	7,736 (3,341)	3,425 (3,222)	1,255 (2,432)	28	7,570 (4,069)	625 (1,663)	836 (2,912)
69–92 years (Q4)	90	6,046 (3,391)	2,059 (2,661)	1,381 (2,444)	19	6,354 (3,261)	627 (1,113)	676 (1,363)

Note. Data presented are average daily step counts, or change in average daily steps, with standard deviations in parentheses. Means for "Incentivized groups" are aggregated across all 4 incentivized conditions (personal, loved one, charity, choice). To account for outliers, values exceeding 3 standard deviations of the mean were winsorized to equal +/− 3 standard deviations of the mean. Average daily step count change during incentives and after incentives calculated as the difference between post-test steps during that week and baseline steps.

Table 6.

Age and incentive effects on step count change after the incentivized period ended

Variable	*B*	*SE B*	*p*	95% CI	
Intercept	.003	.05	.956	−0.09	0.09
Age	.13	.05	**.006**	0.04	0.22
Incentive vs. control	.04	.02	.119	−0.01	0.08
Personal vs. prosocial	.08	.04	.065	−0.01	0.16
Loved one vs. charity	−.07	.07	.318	−0.22	0.07
Choice vs. assigned	−.03	.03	.395	−0.08	0.03
Incentive type (contrast) x age					
Incentives vs. control x age	.03	.02	.273	−0.02	0.07
Personal vs. prosocial x age	.06	.04	.150	−0.02	0.14
Loved one vs. charity x age	−.13	.07	.078	−0.27	0.01
Choice vs. assigned x age	−.06	.03	.063	−0.11	0.00
Adjusted R^2	.03				

Note. N = 450. Step count change was calculated as the standardized residuals obtained by regressing post-incentive week steps on baseline steps, and winsorized to +/− 3 standard deviations to account for outliers. Age was standardized (i.e., M = 0, SD = 1) to increase interpretability of condition effects. Conditions were compared using orthogonal contrasts, see Table S1. Bold values indicate $p < .05$.