The Enduring Influence of Death on Health: Insights from the Terror Management Health Model

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Word count: 11,250

Author notes: Preparation for this article was partially supported by National Cancer Institute Grant R01CA09658. We thank Melissa Spina, Jacquelyn Watson, and Burcin Cihan for their help with data collection. Correspondence should be addressed to Kasey Morris, Division of Cancer Control and Population Sciences, National Cancer Institute, 9606 Medical Center Drive, 3E530, Bethesda, MD 20892-9761, Email: kasey.morris@nih.gov

This is an Accepted Manuscript of an article published by Taylor & Francis Group in *Self and Identity* on 30 Apr 2018, available online: http://www.tandfonline.com/10.1080/15298868.2018.1458644

Abstract

The terror management health model suggests targeting sources of self-esteem or identity, in conjunction with mortality salience, offers a pathway for health behavior promotion. To date, however, experimental evidence has been limited to single time point studies. Two studies assessed whether similar processes impact behavior over time. In Study 1, mortality salience was paired with exercise (i.e., riding a recumbent bike); two weeks later, individuals primed with mortality reported more exercise than those not primed with death, and this increased fitness-contingent self-esteem and exercise intentions. In Study 2, when smokers visualized a prototypical unhealthy (vs. typical) smoker after mortality salience, they reported more attempts to quit smoking (over three weeks) than participants not primed with mortality. This facilitated continued quit attempts and decreased smoker identification three weeks later. Implications are discussed for a longitudinal process model in which mortality salience catalyzes a reinforcing relationship between behavior and esteem/identity, potentially sustaining health behavior change over time.

KEYWORDS: mortality salience; self-esteem; identity; smoking; exercise; health behavior

Every day people engage in behaviors that can benefit their health (e.g., going to an indoor cycling class after work) or harm it (e.g., smoking a cigarette with a friend at the bar). Notably, such decisions can be influenced by identity-relevant factors that may be tangential to health and occur in the context of an ongoing interplay of accessible cognitions. One particularly pressing matter posited to operate as a backdrop to a great deal of social behavior is awareness of one's own mortality (Greenberg, Pyszczynski, & Solomon, 1986). The terror management health model (TMHM; Goldenberg & Arndt, 2008; Arndt & Goldenberg, 2017) offers a framework for understanding how the accessibility of death-related cognitions motivates self and identity concerns that influence decisions to engage in behaviors with implications for health.

From the perspective of the TMHM, in the context of decisions about health, the maintenance of a valued identity is a psychological resource that people use to cope with, and that directs how people respond to, the threat posed by the awareness of mortality. Despite encouraging findings for spurring immediate positive health outcomes that have been generated by this model (see Arndt & Goldenberg, 2017; Spina, Arndt, Boyd, & Goldenberg, 2016), no research has addressed the question of whether the awareness of mortality has an enduring effect on behavior. People may be seeking to manage (experimentally elevated) concerns about mortality in health relevant ways, but what happens once these mortality concerns dissipate? The aim of the current research is to examine the dynamics through which awareness of mortality may exert an ongoing influence on health behavior.

Terror Management Health Model

According to terror management theory (TMT; Greenberg et al., 1986), a great deal of human cognition and behavior is aimed at managing the potential for anxiety engendered by the awareness of mortality. People are argued to circumvent the threat by adhering to cultural worldviews that imbue life with meaning, structure, and symbolic importance. As many have argued (e.g., Crocker & Wolfe, 2001), people develop a culturally informed identity of what it means to be a valuable person and derive self-

esteem from living up to the tenets associated with that identity. In this way, identity and self-esteem go hand in hand, and are operative in management of concerns associated with one's mortal existence. TMT thus makes the prediction that when death thoughts are active (but not in conscious awareness) behavior and decision-making are guided in large part by self-esteem striving within the context of valued identities. Substantial research fits this analysis (see Pyszczynski, Greenberg, Solomon, Arndt & Schimel, 2004).

The TMHM applies this framework to a domain in which thoughts about mortality are especially likely to arise and provides insight into health-relevant decision making by specifying distinct motivational consequences contingent on the level of consciousness of death-cognition (Goldenberg & Arndt, 2008; see Figure 1a). Specifically, the TMHM posits that conscious mortality concerns engender health decisions largely guided by the proximal motivational goal of reducing perceived vulnerability to a health threat and removing death-related thought from focal attention. Under these conditions, people may attend to or deny health risks (e.g., Arndt, Schimel, & Goldenberg, 2003; Greenberg, Arndt, Simon, Pyszczynski, & Solomon, 2000), but it is specifically concerns about vulnerability to the health risk that guides decision making (see e.g., Cooper, Goldenberg, & Arndt, 2014). In contrast, mortality concerns that are active, but outside of focal attention, invoke health relevant decisions guided by the distal motivational goal of bolstering one's self-esteem and valued cultural identity (Arndt & Goldenberg, 2011).

A number of studies support the idea that when mortality cognition is accessible, but not in conscious awareness, people are more willing to engage in behaviors that are relevant to self-esteem and identity, even at the expense of health. For example, when reminded of, and then distracted from, thoughts of death (so that they are no longer at the forefront of attention), women for whom appearance was relevant to their self-esteem, or who were exposed to an advertisement for a store featuring a tanned, attractive woman, reported greater interest in purchasing tanning products (Routledge, Arndt, &

Goldenberg, 2004). Hansen, Winzeler, and Topolinski (2010) examined similar reasoning and found when cigarette carton packaging primed death, later attitudes and intentions towards smoking were more positive. Critically, this was only the case for participants who derived self-esteem from smoking, underscoring the role of self-esteem maintenance in health behaviors. Such lines of research converge with other perspectives showing people may engage in health behaviors, sometimes despite knowledge of the (potentially fatal) consequences, because of the behavior's identity, esteem, and presentational appeal (e.g., Ginis & Leary, 2004; Hillhouse, Turrisi, & Kastner, 2000; Mahler, Kulik, Gibbons, Gerrard, & Harrell, 2003; Oyserman, Fryberg, & Yoder, 2007).

Insights derived from the TMHM have also be used to inform why people engage in healthier behaviors, and in turn, to potentially promote positive behavior change. Cox et al. (2009), for example, primed participants with thoughts of mortality and then provided them with a magazine article emphasizing the attractiveness of tanned skin, the attractiveness of pale skin, or natural-looking skin (with no mention of skin color). Under conditions of mortality salience, priming the association between tanned skin and attractiveness (i.e., "bronze is beautiful") increased tanning intentions, whereas priming pale skin as attractive decreased tanning intentions. In a second study, when reminders of mortality preceded a "pale is pretty" magazine article, beachgoers reported more interest in higher SPF products. In a further application of this analysis to sun safety, Morris, Cooper, Goldenberg, Arndt, and Gibbons (2014) presented women with a UV-filtered (vs. regular) photo of their face designed to highlight the negative implications of sun exposure on appearance (i.e., discoloration and blotchy patches depicting subsurface skin cell damage). Women (for whom appearance is typically a relevant source of self-esteem; e.g., Crocker & Wolfe, 2001) were especially likely to respond to the UV-filtered photo with greater intentions to use sun protection in the future after reminders of mortality. They also took more complementary packets of sunblock provided by the experimenter, suggesting plans to act in accordance with intentions. Conceptually similar effects have been observed in other health domains. For example,

an anti-smoking commercial emphasizing the social consequences of smoking (e.g., bad breath, poor dating appeal) was more likely to lead students who smoked for identity relevant reasons (e.g., one's image or fitting in with a group) to indicate greater interest in quitting following reminders of mortality (Arndt et al., 2009; see also Martin & Kamins, 2010; Wong, Nisbett, & Harvell, 2016).

Potential Mechanisms for Enduring Terror Management Health Effects

The existing research demonstrates effects of (non-conscious) mortality awareness on health decisions through mechanisms of self-esteem contingencies and identity relevance, but is confined to very specific, limited time periods. Building on this work, we considered whether identity- and esteem-based processes can be used to shed light on the potential ongoing influence of mortality awareness in health behavior, and whether such mechanisms can be enlisted to promote positive health behavior change beyond the immediate time period following mortality salience. Specifically, the following longitudinal process model is proposed.

The starting premise of the model is that non-conscious death thought activation directs behavioral motivation in line with esteem or identity contingencies. The specific contingencies may vary based on existing individual differences or may be reinforced through situational association. Although existing experimental TMHM research has examined outcomes immediately following mortality salience, to the extent mortality reminders spark this association, people may be inclined to engage in such identity relevant behavior as opportunities present themselves (e.g., after a laboratory experiment). This is consistent with research demonstrating that mortality salience increases self-esteem striving (Pyszczynski et al., 2004), and that operative esteem contingencies direct and guide future behavior (Crocker & Park, 2012). This prediction also draws from insights revealing that self-referent identity labels (e.g., "I am the type of person who smokes") independently predict behavior, even when controlling for attitudes and norms (e.g., Biddle et al., 1985).

One potential implication of this idea is that engaging in a behavior previously associated with a mortality reminder, in a context where identity and esteem goals have been activated, may reinforce and further foster the esteem contingencies and identity relevance of that behavior. Both self-perception and dissonance traditions have long shown that attitudes can follow from, and be reinforced by, preceding behavior. In the present context, the specific health domain may become further relied upon as a source of self-esteem or valued identity, as a function of the proceeding behavioral engagement. Then, the more a person's esteem or identity becomes contingent on a specific health behavior, the more likely it may be that the person will act in accord with these implications. Support for this idea can be inferred from research on environmental self-identity demonstrating that reminding people of their past pro-environmental behavior strengthened the extent to which they identified as an environmentally conscious person (e.g., "Acting in environmentally friendly ways is an important part of who I am"). Moreover, this strengthened identification then predicted future pro-environmental intentions, providing evidence for the bidirectional relationship between behavior and identity (van der Werff, Steg, & Keizer, 2014).

In short, this longitudinal process model offers a viable pathway through which mortality concerns might exert a more enduring effect on health-relevant behaviors. Heightened situational mortality awareness is posited to have a potential ongoing influence on health behavior outcomes, not through an extended effect of the death prime itself, but rather, by catalyzing initial behavioral efforts aimed at bolstering esteem or identity contingencies, thus setting in motion a back-and-forth, reinforcing pattern between behavioral efforts and self-esteem/identity-relevance. That is, behavior is engaged in as a function of non-conscious death thought activation and relevance to identity and self-esteem; engaging in behavior feeds back into strengthening identity and esteem contingencies, which in turn affects subsequent behavior (see Figure 1b). The aim of the current research is to empirically evaluate this hypothesized model.

Study 1: Exercise Behavior

We began our inquiry with physical activity because it has numerous health benefits and is conducive to becoming a source of self-esteem (Sonstroem, Harlow, & Josephs, 1994). Specifically, Study 1 assessed the interplay between esteem relevance and behavioral engagement in response to mortality awareness in the domain of exercise. To prime the association between death and exercise, and thus heighten sensitivity to the esteem implications of exercise, participants were asked to ride an exercise bike following a mortality salience (or control) prime during an initial laboratory session. Two weeks later, participants completed an online questionnaire assessing their exercise behavior since the lab session, and the relevance of fitness to their self-esteem. Based on the proposed mechanisms for long-term behavioral influence, it was hypothesized that participants primed with mortality would engage in more exercise subsequent to the experiment; to the extent that they did, this was hypothesized to increase endorsement of fitness as a source of self-esteem, and also influence greater intentions to exercise in the future.

Method

Participants

Two hundred eighty-two participants (230 female, 49 male, and 3 unreported gender)[1] were recruited from a psychology department research pool and awarded extra credit for taking part in the study (M_{age} = 20.40, *SD* = 3.88). Two extreme outliers on the Time 1 measures were identified using a

[1] Given the discrepancy in sample size between male and female participants, we controlled for participant gender in all analyses. Inclusion of this covariate did not influence any of the reported results. We also tested for, and did not find, any interactions of mortality salience with participant gender. One main effect of gender was found: At the two-week follow-up, male participants (*N* = 20) reported greater intentions to exercise in the future (*M* = 483.25, *SD* = 458.06), compared to female participants (*N* = 125, *M* = 310.88, *SD* = 207.86; *p* = .03). No other gender differences were observed.

boxplot analysis and excluded from the final sample (all results are unchanged with the inclusion of these cases).[2]

Procedure

Time 1. All materials were completed in the lab at individual computer workstations. Upon arrival, participants were told the purpose of the study was to assess the link between personality and liking for various types of exercise equipment. Participants completed the first questionnaire containing the mortality salience (or control) manipulation and were then brought into a private room with a recumbent exercise bike. After adjusting the seat to the participant's height, the experimenter told the participant there was no time requirement for the task and to ride the bike for as much or as little time as they wanted. The experimenter then left the participant alone in the room to ride the bike. Once finished, participants informed the experimenter and immediately returned to the room with the computer to complete the remaining questionnaires.

Time 2. Two weeks later, participants received a link via email to take part in the online follow-up. The link was sent exactly 14 days following their participation at Time 1 and was only valid for 24 hours to ensure that responses reflected approximately the same time interval for all participants. They were asked to report their exercise behavior over the previous two weeks (following Time 1) and future intentions to exercise. Participants also completed a measure of fitness-contingent self-esteem.

Materials

Mortality Salience. The mortality salience manipulation consisted of two open-ended essay questions regarding the feelings and emotions associated with one's own death or failing an important exam in the control condition (e.g., Rosenblatt, Greenberg, Solomon, Pyszczynski, & Lyon, 1989).

[2] The first wave of data collection occurred during the fall semester; after analyzing this data and noting the unexpectedly high attrition rate (discussed below), the decision was made to continue collecting data through the spring semester. This was done to ensure that the study was not underpowered and to provide more stable estimates, but critically, the results and statistical significance of effects were unchanged as a result of the additional data collected.

Failing an exam is frequently used as a control topic in TMT studies because it is an aversive topic that can imply different aspects of self-evaluative threat. As such, it allows one to inform whether potential mortality salience effects differ from those elicited by other self-evaluative concerns. The essay prompts stated: "Please describe the emotions that the thought of your own death (failing an important exam) arouses in you," and "Jot down, as specifically as you can, what you think will happen to you as you physically die (fail an important exam) and once you are physically dead (have failed an important exam)." Participants then completed a 60-item mood assessment (PANAS-X, Watson & Clark, 1994) to both check for positive ($\alpha = .91$), negative ($\alpha = .87$), and fear-specific ($\alpha = .83$; see Lambert et al., 2014) affective consequences of the manipulation relative to other aversive topics and to facilitate removing mortality thoughts from focal awareness (see Pyszczynski, Greenberg, & Solomon, 1999; for meta-analytic reviews see Martens, Burke, Schimel, & Faucher, 2011; Steinman & Updegraff, 2015).[3]

Exercise Behavior and Intentions. Participants indicated their past exercise behavior by reporting how many times they had exercised over the previous two weeks and the average number of minutes they exercised each time. Although this was measured after mortality salience, there was no difference on reports of prior exercise behavior between participants primed with mortality and those in the control condition ($p = .96$). Participants reported their intentions to exercise over the next two weeks in the same format. Composites were created for both past exercise behavior and future exercise intentions by multiplying the number of times participants exercised by the average number of minutes each time.

At Time 2, participants reported on their exercise behavior using the same measure; this corresponded to the time period between Time 1 and 2. Again, participants reported on their future intentions to exercise.

[3] Lambert and colleagues (2014) demonstrated that mortality salience increases fear-specific affect relative to a neutral condition. However, the issue of present interest is whether mortality salience produces affective differences compared to another aversive (but not death-related) topic, and more critically, whether affect has an influence on later processes.

Fitness-contingent Self-esteem. At Time 2, participants were asked to rate their level of agreement (from 1, *strongly disagree* to 7, *strongly agree*) with four items (α = .81) assessing self-esteem derived from fitness (e.g., "Being in good shape is an important part of who I am," "My level of fitness affects how good I feel about myself"; from Arndt et al., 2003).

Demographics. Several demographic items, including age, gender, height and weight, self-reported body type, and body satisfaction, were assessed at Time 1.

Preliminary Analyses

In test of normality, both Time 1 past exercise (skewness = 5.34, kurtosis = 51.31) and future intentions to exercise (skewness = 6.16, kurtosis = 60.97) were non-normally distributed (skewness *SE* = .145; kurtosis *SE* = .289). These variables were transformed using square root transformations prior to analysis. The resulting variables more closely approximated a normal distribution (Time 1 past exercise skewness = .688, kurtosis = 1.98; Time 1 intentions to exercise skewness = .805, kurtosis = 4.23). All other variables were normally distributed.

Approximately half of the initial sample (52.13%, *N* = 147) also completed the follow-up. The high attrition rate may have been due to the extra credit incentive not being contingent on completion of both parts of the study, and that the online follow-up link was only made available for 24 hours. We tested and found no evidence for differences in attrition by experimental condition ($p = .55$). There were also no differences between those who completed the follow-up and those who did not on the measures of BMI ($p = .32$), self-reported body type ($p = .17$), body satisfaction ($p = .38$), reports of past exercise behavior ($p = .44$), or future intentions to exercise ($p = .78$), suggesting that attrition was likely not systematic.

Based on the guidelines put forth by Fritz and Mackinnon (2007) for testing mediation using a bootstrapping approach, and assuming a small-to-medium effect size both paths in the model, the minimum required sample size would be 162 participants. To achieve adequate power, we estimated

missing values using a multiple imputation procedure. The data was first analyzed to assess patterns of missingness: Fully complete data accounted for 52% of the sample and fully missing Time 2 data accounted for approximately 48% of the sample. Less than 1% of the sample had partially missing Time 2 data. On this basis, the monotone method—in which all earlier variables (i.e., Time 1) are observed if the later variables (i.e., Time 2) are observed—was used for imputation (Yuan, 2010). In this method, earlier variables are used to predict missing values on later variables. In this case, all of the Time 1 variables were included as predictors in the model. Five sets of imputed data were generated; the analyses were conducted on each of the five data sets and the estimates were recorded and pooled.[4]

Results

Effect of Mortality Salience on Immediate Outcomes

An analysis of covariance (ANCOVA) with mortality salience (death vs. exam) as the between-subjects factor (controlling for baseline exercise) revealed a significant effect of the manipulation on intentions to exercise, F (1, 277) = 6.22, p = .01, η^2_p = .02. Participants primed with mortality reported greater intentions to exercise (M = 17.62, SD = 8.54), compared to participants in the control condition (M = 16.16, SD = 9.86).

As with most TMT research, no effects of the mortality salience prime on positive, negative, or fear-specific affect were observed (ps > .65). Further, controlling for affect did not influence any of the reported results. Data from the exercise bike (total time, total distance, total calories burned) subsequent to the mortality manipulation was also examined. There was no difference on any of the variables between participants primed with death and those in the control condition (ps > .55).

Effect of Mortality Salience on Extended Outcomes

Fitness-contingent Self-esteem

[4] Full descriptive statistics for both studies are available in the supplementary material.

The primary hypothesis concerned the indirect effect of the mortality prime on fitness-contingent self-esteem at Time 2, as a function of engagement in exercise behavior during the two-week interval. To model this relationship, we conducted a mediation analysis (PROCESS macro Model 4; Hayes, 2012) with effects derived from 5,000 bias corrected bootstrap samples. Participants' baseline exercise behavior was controlled for in all paths in the model. Participants primed with mortality (coded 0 = exam, 1 = death) reported more exercise over the two weeks after Time 1, compared to participants in the control condition, b = 47.00, SE = 20.04, p = .02, CI [7.55, 86.43], and further, exercise behavior between Time 1 and Time 2 predicted a small, but significant, increase in fitness-contingent self-esteem at Time 2, b =.001, SE = .001, p < .001, CI [.001, .002]. A test of the indirect effect was significant (effect = .062, SE = .033, CI [.013, .147]). Priming mortality at Time 1 was associated with an increase in the extent to which self-esteem became contingent on fitness at Time 2, through exercise behavior in the two weeks between time points. The full path model is presented in Figure 2.

Intentions to Exercise

The same analysis was conducted on intentions to exercise measured at Time 2. As in the previous analysis, participants primed with mortality reported more exercise than participants in the control condition. Additionally, exercise behavior over the two weeks significantly predicted an increase in future intentions to exercise, b = .727, SE = .078, p < .001, CI [.575, .877]. The test of the indirect effect was also significant (effect = 34.14, SE = 14.89, CI [5.80, 64.54]). The full path model is presented in Figure 3.[5]

Discussion

The findings of Study 1 provide preliminary evidence that mortality reminders can have an enduring effect on reports of health-relevant behavior. This is the first experimental demonstration (to

[5] All results are consistent with and without the imputed data included. Full statistics for these results on the raw (non-imputed) data are available in the supplementary material.

our knowledge) in which the elicitation of mortality cognition affected outcomes subsequent to the initial laboratory session (but see Pelham et al., 2018. Moreover, reports of actually engaging in exercise behavior in response to mortality salience were positively associated with endorsement of fitness as a source of self-esteem and also to intentions to exercise in the future. These findings provide support for the hypothesized framework in which behavior, in the context of a mortality prime, comes to take on more significance to the self, creating a reinforcing dialectic whereby behavior leads to more esteem relevance and also, potentially, to continued behavior.

Despite the encouraging finding of differences in exercise behavior between the mortality salience and control conditions in the two weeks following the experimental manipulation, it should be noted that exercise did not actually increase from baseline for these participants. In both conditions, participants reported roughly equal estimates of exercise prior to the experiment (Mortality: M = 269.29, SD = 289.04; Control: M = 268.63, SD = 293.05). Subsequent to the experiment, participants in the mortality condition reported exercising 270.93 minutes (SD = 230.18) over the previous two weeks, compared to the 225.66 minutes (SD = 199.70) in the control condition. One possibility is that, given the college student sample, exercise behavior decreases naturally as the semester progresses (and students become more burdened with academic and extracurricular commitments). Consistent with this, Small, Davis, Morgan and Maggs (2012) found that college students' physical activity consistently declined across semesters from freshman to senior year, perhaps in part due to increasing workloads as a barrier to exercise (Silliman, Rodas-Fortier, & Neyman, 2004). It may be that this pattern in the control condition reflects the typical change in physical activity in the absence of behavioral interventions, and the mortality salience manipulation helped to combat this naturally occurring decline. Going forward, it will be important to consider temporal patterns of physical activity changes (across multiple populations) and how these motivational mechanisms might intervene.

A limitation of the study design is that the role the exercise bike played in these processes remains ambiguous. First, the TMHM would predict behavioral effects on exercising immediately after the prime, but no differences were observed on intensity or time spent riding the bike. It may be that the situation of biking in a laboratory added further influences that obscured such tendencies. For example, participants might not have been dressed appropriately for exercise or might have had later engagements that prevented them from wanting to become sweaty. They could have already exercised or had plans to exercise later. Additionally, the presence of a research assistant waiting outside of the room could have influenced behavior.

Because all participants rode the bike after the mortality or control primes, it is not possible to conclude whether the temporal association of mortality salience with behavioral engagement in exercise was critical—or not—to the effect on behavior and esteem contingencies. As noted above, the specific contingencies of a behavior can be on account of experimental procedures or individual differences. At the outset, we reasoned that pairing the exercising bike with mortality salience would strengthen physical activity as a viable route to self-esteem maintenance; however, consistent with prior research (Hansen et al., 2010; Tam, 2013; Wong et al., 2016), this might be especially true for people who already derive self-esteem from fitness. To that end, we assessed whether baselines levels of fitness contingent self-esteem, collected during a mass testing time period before participants came to the research lab, moderated these effects. Due to an administration error, the measure was only collected for those participants who took part in the study during the spring semester (N = 62 at the follow-up). Given this small subset of participants, the analyses were exploratory, and thus not included in our primary results. This data does, however, provide some additional insight.[6]

[6] We also imputed missing values for the baseline fitness-contingent self-esteem measure for the full sample (N = 282) and found consistent results.

There was a significant interaction between the death prime (coded 0 = control, 1 = mortality) and baseline fitness-contingent self-esteem on exercise behavior in the two weeks after the lab session, F (1, 57) =13.20, $p < .001$, $\Delta R^2 = .14$. Participants primed with death exercised more than those in the control condition if they were at the mean ($b = 153.14$, $p < .01$) or one SD above the mean ($b = 543.84$, $p < .001$) on baseline fitness esteem. In contrast, participants low on baseline fitness esteem (one SD below the mean) and primed with death reported exercising less, compared to those in the control condition ($b = -212.20$, $p = .03$). Further, baseline fitness esteem moderated the indirect effect of mortality salience on Time 2 fitness-contingent self-esteem and future intentions to exercise, through initial exercise behavior. Those high (or moderately high) on baseline fitness esteem responded to the priming of mortality with more exercise behavior in the two weeks after the lab session; this, in turn, was associated with greater endorsement of fitness as a source of self-esteem and increased intentions to exercise in the future, measured at the follow-up. Conversely, participants who were low on fitness esteem at baseline responded in an opposite manner: priming mortality decreased exercise behavior over the subsequent two weeks, which in turn further was associated with reduced esteem contingencies of fitness and intentions to engage in exercise behavior. These conditional indirect effects are presented in Table 1.

This analysis is consistent with the idea that engaging in a behavior that is a relevant source of self-esteem is key to this process. Riding the exercise bike likely reinforced the esteem relevance of the behavior, particularly for those individuals who placed even a moderate amount of self-worth in their fitness level. Still, it is not possible to ascertain the role of the exercise bike without a true control condition, and the small sample size of this subset of participants makes any conclusions tentative at best.

This exploratory data also provides additional evidence for the back-and-forth, reinforcing nature of these hypothesized mechanisms. The relevance of fitness to self-esteem may have functioned first to

direct initial behavior in response to mortality salience, and then, through engagement in the behavior, become further relied on as a source of self-esteem. Relatedly, these results highlight the complex nature of self-oriented motivations, indicating that those who did not derive self-esteem from fitness to begin with actually responded to mortality salience with less exercise. This is conceptually congruent with past work showing the ironic health effects of mortality salience (e.g., Hansen et al., 2010), and underscores the importance of matching, or manipulating, esteem contingencies in line with desired health outcomes. Study 2 specifically addresses these issues by experimentally manipulating identity-relevance of a behavior in conjunction with mortality salience.

Study 2: Smoking Cessation

The aim of Study 2 was to further examine the potential for awareness of mortality to exert an enduring influence on health-relevant behavior. In doing so, Study 2 extended Study 1 in a number of ways. First, the basic conceptual analysis shifted to assess smoking cessation in light smokers, allowing for examination of how the hypothesized processes operate in a different health domain. It also positions the work to address a critical health behavior. We focus on light smokers, in part, because they provided a convenient opportunity sample, but also because this is an increasingly represented subset of smokers and a vital population to study (Shiffman, 2009).

Study 2 also featured changes to allow for greater insight into the temporal sequence of effects. The first time interval was extended from two to three weeks to assess an even longer-term impact of the manipulations on reports of health behavior, and a third wave was added, three weeks after Time 2 (six weeks after the original session). It follows from the proposed model, and the findings on behavioral intentions from Study 1, that a change in behavior at Time 2 might continue to exert an influence on behavior and identity at Time 3.

Rather than inferring that the temporal association between mortality salience and a health behavior would position the behavior to be identity relevant (as in Study 1), in Study 2 we manipulated

the salience of prototypical representations of smokers as a means to heighten identity relevance. The prototype willingness model (PWM; Gibbons, Gerrard, & Lane, 2003) builds from a social comparison tradition to articulate how prototypes of people who engage in health-relevant behaviors can subsequently guide a person's actions. Integrating insights from the PWM and the TMHM, it follows that if death-related cognition (outside of conscious awareness) directs attention towards cultural benchmarks, and prototypes are culturally informed images and valuable in their capacity to signal cultural worth (or not), when thoughts of death are activated, behavior associated with the prototype should be pursued. Existing studies offer some support for this. For example, Arndt and colleagues (2009) found that visualizing someone who exercises in the context of accessible mortality concerns led to increased endorsement of exercise as a basis of self-worth, especially when participants tended to derive self-esteem from extrinsic sources. In another study, having grocery store patrons visualize a prototype of a healthy eater following a mortality prime led shoppers to purchase more nutritious foods (McCabe et al., 2015). This research suggests that, in the context of accessible thoughts of death, prototypes are well positioned to set the stage for a viable health-relevant pathway to self-esteem/identity and corresponding health behavior.

Study 2 was guided by the following hypotheses. First, it was hypothesized that reminders of mortality in conjunction with a negative prototype of a smoker would increase immediate smoking cessation intentions. The next prediction was that the pairing of mortality salience and the negative smoker prototype would promote more engagement in behaviors aimed at smoking cessation between Time 1 and Time 2. Finally, to the extent that participants engaged in behaviors aimed at quitting smoking as a function of the experimental manipulations, it was hypothesized that this would, in turn, facilitate continued smoking cessation efforts and decreased identity relevance of smoking at Time 3.

Method

Participants

Two hundred sixty-one introductory psychology students indicating they were occasional or daily smokers on an earlier screening survey took part in the study in exchange for course credit. Participants who did not take part in Time 1 (N = 4) or had missing Time 1 data (N = 1) were removed, leaving a final sample of 256 (116 female, 139 male, 1 unreported gender; M_{age} = 18.92, SD = 1.50).

Materials and Procedure [7]

Overview. The study took place over three phases with approximately three weeks between time points. Participants were compensated with course credit for each phase and, as an added incentive to complete all phases, had their name entered into a drawing to receive a $100 gift card to the university bookstore.

Time 1. The purpose of the first laboratory session was to introduce the experimental manipulations. During this phase, participants completed paper and pencil materials in the lab at private workstations. The following measures were administered.

Nicotine Dependence. Participants first completed the Fagerstrom Test for Nicotine Dependence (FTND; Heatherton, Kozlowski, Frecker, & Fagerström, 1991; α = .61; M = 1.00, SD = 1.41) so baseline nicotine dependence could be examined and statistically controlled for. The measure consists of six items, and includes questions such as "How soon after waking up do you smoke your first cigarette?" and "Do you find it difficult to refrain from smoking in places where it is forbidden (e.g., church, at the library, etc.)?" The mean (.12) and modal (0) response to the FTND item assessing number of cigarettes smoked per day (0 = 10 or fewer, 1 = 11 to 20, 2 = 21 to 30, 3 = 31 or more) indicated participants typically smoked 10 or fewer per day.

Mortality Salience. Participants completed the same mortality salience manipulation and delay measure (i.e., PANAS-X, Watson & Clark, 1994) used in Study 1. Again, the positive (α = .67),

[7] A description of other measures in Study 2, included as part of a separate study or intended to capture different facets of smoking attitudes and perceptions, is available in the supplementary material.

negative (α =. 51) and fear-specific (α = .80) subscales of the PANAS-X were computed to assess whether the mortality influenced affect differently than an aversive topic. This study used dental pain as the control topic, as is commonly done in TMT research, because it presumably focuses on aversive cognitions pertaining to pain and informs generalizability of the effect. This study also included a short reading passage as a secondary delay (see Martens et al., 2011).

Smoker Prototype Prime. The smoker prototype prime, adapted from previous studies (Gibbons & Gerrard, 1995; McCabe et al., 2015), instructed participants to "…think about the image that you have of an unhealthy [typical] person who is a smoker of your age for a moment…" The unhealthy prime reflects the negative social framing of being a smoker and the typical smoker prime served as the control condition. Participants were then asked to list characteristics of the prototype and rate the prototype on a number of trait pairs (e.g., *Lazy-Active, Unattractive-Attractive)* on 10-point scales to reinforce their visualization. Participants in the unhealthy smoker condition rated the target more negatively (M = 4.70, SD = 1.00) compared to participants in the typical smoker condition (M = 5.34, SD = 0.84), F (1, 254) = 30.06, $p < .001$, $\eta^2_p = .11$. Evaluations of the target did not differ as a function of the mortality salience prime ($p = .95$), nor did mortality salience interact with the prototype condition to influence ratings of the target ($p = .81$).

Intentions to Quit. Two items assessed intentions to quit smoking in the future (e.g., "I plan to quit smoking in the next three months"). Responses ranged from 1, *not at all* to 10, *very much* and were averaged to create a composite score (α = .86).

Smoker Identity. Four items, adapted from Van de Putte et al. (2009), measured self-identity related to smoking. Two items assessed the extent to which participants identified with being a smoker (e.g., "Smoking fits with the kind of person I want to be"). Similarly, two items assessed the extent to which participants identified with being someone who quits smoking (e.g., "Quitting smoking within the next 3 months fits with the kind of person I want to be;" from, 1, *strongly disagree* to 10, *strongly*

agree). The latter two items were reverse scored and the items were averaged to create a composite of smoker identification (α = .85).

Demographics. Participants completed a demographic questionnaire assessing age, gender, and ethnicity.

Time 2. Participants returned to the research lab three to four weeks after completing the first phase of the study. All materials were completed on a computer in a private workstation. Participants were presented with the following measures.[8]

Attempts to Quit. Two items were used to measure behavior related to smoking cessation (Shadel & Shiffman, 2005). The first item assessed the number of quit attempts ("Since your last visit to the Social Health Lab, how many times have you abstained from smoking in an effort to quit?"). The second item assessed smoking reduction efforts ("…how many times have you made a serious effort to reduce smoking?") Responses ranged from 1, *zero attempts* to 7, *six or more attempts* and were averaged to create an index of quitting behavior (α = .75).[9]

Smoker Status. Participants indicated their status as a smoker by responding to the yes/no item, "Do you currently smoke cigarettes?" Those who reported still smoking cigarettes (*N* = 158) were presented with two additional measures.

Smoking Frequency. Current smokers indicated how frequently they smoked cigarettes (from 1, *less than once a month* to 7, *daily*) and how many cigarettes they smoked in a typical week (from 1, *5 or*

[8] A second subliminal mortality manipulation was administered at Time 2; due to a methodological error, the data is not included in this analysis. There was no evidence that the manipulation influenced any of the reported results (see supplementary material for a detailed discussion).

[9] The smoking cessation measure also asked participants to report how recent their last quit/reduction attempt was and the length of these attempt. However, some response choices corresponded to a time prior to taking part in the study (e.g., "More than one month ago"). Because the items assessing number of quit attempts unambiguously reflected the duration of time between laboratory sessions, and most clearly indicated behavior, we focused on this outcome as our primary index of smoking cessation efforts.

fewer to 7, *100 or more*; Scragg, Wellman, Laugesen, & DiFranza, 2008). Both items were averaged to create a composite of smoking frequency (α = .79).

Time 3. The third phase of the study took place online. Three weeks after completing Time 2, participants were emailed a link to an online study with a five-day window to complete the survey. The response window was increased from Study 1 to reduce attrition. Participants completed the following measures.

Attempts to Quit. Participants responded to the same two items used at Time 2 to assess the number of attempts to quit smoking (α = .82).

Smoker Identity. The same four items administered at Time 1 were used to assess identification with being a smoker (α = .76).

Smoker Status. Participants reported (on a yes/no scale) whether they currently smoked cigarettes. Current smokers (*N* = 108) were again presented with two additional measures.

Smoking Frequency. Current smokers reported the frequency of their smoking over the previous three weeks using the same items as Time 2 (α = .81).

Intentions to Quit. Current smokers also responded to the same two items administered at Time 1 and Time 2 assessing intentions to quit smoking in the future (α = .91).

Preliminary Analyses

Sixty-five percent of the initial sample (*N* = 165) completed all three phases of the study. Fifty-three participants did not take part in Time 2, and an additional 38 participants did not take part in Time 3. We tested and found no difference in attrition status by experimental condition (*p*s > .43). To further test for biases in dropout rate, we examined nicotine dependence and smoking motives (e.g., "I smoke in order to feel a part of the crowd," "Smoking is part of my self-image"; Arndt et al., 2009; see supplementary material for a detailed description of this measure) assessed at Time 1. There were no

differences on these measures between participants who completed all three sessions and participants who dropped out from any portion of the study (*p*s > .16).

In order to have an appropriate sample size for testing the hypothesized models (given the sample size guidelines indicated by Fritz and Mackinnon, 2007), missing data was estimated for participants who did not return for Time 2 and/or Time 3. The data was first assessed for patterns of missingness. Fully complete cases accounted for approximately 64% of the sample, and fully missing cases (all Time 2 and Time 3 variables) accounted for 16% of the sample. Approximately 15% of the cases had complete data for Time 2 variables but missing data for Time 3. Roughly 5% of cases were missing Time 2 data only, and less than one percent were missing only half of the Time 3 variables. On this basis, a fully conditional specification method was used (Van Buuren, 2007). Fully conditional specification is an iterative Markov chain Monte Carlo (MCMC) method that can be used when the pattern of missing data is arbitrary. For each iteration, a univariate model is fit using all other available variables as predictors. This process continues until the maximum number of iterations is reached. The imputation model was based on all Time 1 variables as predictors. Because the survey contained skip patterns based on current smoker status, we estimated values only for the variables completed by all participants (attempts to quit, smoking-relevant identity). Five sets of imputed data were generated and the analyses were conducted on each of the five data sets. The estimates were recorded and pooled.

Results

Effects of Mortality Salience and Prototype on Immediate Outcomes

To examine the effects of the mortality salience and smoker prototype manipulations on smoking-related attitudes measured at Time 1, we conducted a 2 (mortality salience: death vs. pain) X 2 (smoker prototype: unhealthy vs. typical) ANCOVA on participants' intentions to quit smoking, controlling for baseline nicotine dependence (to ascertain the influence of the situational factors independent of pre-existing differences in dependence). There was no main effect of mortality salience,

F (1, 251) = 0.06, p = .81, η^2_p < .001, or the smoker prototype, F (1, 251) = 0.25, p = .62, η^2_p < .001, and the hypothesized interaction was not significant, F (1, 251) = 2.00, p = .16, η^2_p = .01. We conducted the same analysis on the relevance of smoking to identity. The effect of mortality salience was not significant, F (1, 251) = 0.14, p = .71, η^2_p < .001, nor was the effect of the smoker prototype, F (1, 251) = 1.29, p = .26, η^2_p = .01. The interaction was also not significant, F (1, 251) = 0.41, p = .52, η^2_p < .001.

We examined the positive, negative, and fear-specific subscales of the PANAS-X (Watson & Clark, 1994) following the mortality prime and no effects were observed (ps > .50).

Effect of Mortality Salience and Prototype on Quitting Behavior at Time 2

To test the hypothesis that the mortality reminder and smoker prototype visualization at Time 1 would impact quitting behavior in the weeks after the lab session, we conducted a 2 (mortality salience: death vs. pain) X 2 (smoker prototype: unhealthy vs. typical) ANCOVA on participants reports of attempts to quit between sessions, controlling for baseline nicotine dependence. There was no main effect of mortality salience, F (1, 251) = 1.27, p = .26, η^2_p = .01, or the smoker prototype, F (1, 251) = 2.53, p = .11, η^2_p = .01. However, the mortality salience X smoker prototype interaction was significant, F (1, 251) = 4.97, p = .03, η^2_p = .02. Among participants given the unhealthy smoker prototype manipulation, those primed with mortality reported more attempts to quit in the time between lab sessions (M = 3.95, SD = 2.12) compared to those in the control condition (M = 3.06, SD = 2.04), F (1, 251) = 5.19, p = .02, η^2_p = .02. For participants in the typical smoker condition, there was no difference in reported attempts to quit between the mortality salience (M = 3.85, SD = 2.25) and control condition (M = 4.15, SD = 2.33), F (1, 251) = 1.08, p = .30, η^2_p < .001. Unexpectedly, within the control condition, individuals given the unhealthy smoker prototype reported fewer attempts to quit (M = 3.06, SD = 2.04) than those given the typical smoker prototype (M = 4.15, SD = 2.33), F (1, 251) = 7.12, p < .01, η^2_p = .03. This comparison was not significant for participants primed with mortality salience (p = .53).

The second behavioral measure, frequency of smoking, was also examined for the subset of participants who reported being a current smoker at Time 2 (N = 158) using the same analysis. Neither of the predictors, nor their interaction term, was significant (ps > .68).

Effect of Mortality Salience and Prototype on Time 3 Outcomes Through Initial Behavior

Next, we assessed whether initial quitting behavior, as a function of the experimental manipulations, would impact continued attempts to quit and smoking-relevant identity at Time 3. To model this, we used a moderated mediation approach (Model 7; Hayes, 2012) with effects derived from 5,000 bootstrap samples. The percentile corrected bootstrapping method was used to provide more stringent control of Type 1 errors (Preacher & Hayes, 2008). Time 1 mortality salience (0 = pain, 1 = death) was the predictor variable and Time 2 attempts to quit was the mediator variable, with smoker prototype (0 = typical, 1 = unhealthy) moderating the path from Time 1 mortality salience to Time 2 attempts to quit. Baseline nicotine dependence was controlled for in all paths in the model.

Smoking Cessation

We first examined quitting behavior between Time 2 and Time 3. As noted above, the mortality X smoker prototype interaction significantly predicted initial attempts to quit smoking. Additionally, initial quit attempts predicted further quit attempts, b = .560, SE = .052, p < .001, CI [.459, .661]. The test of the conditional indirect effect was significant for participants in the unhealthy smoker prototype condition (effect = .486, SE = .207, CI [.090, .900]), but not for participants in the typical smoker condition. For participants given the unhealthy smoker prototype at Time 1, mortality salience led to more initial behavior aimed at quitting smoking (compared to those not primed with mortality); in turn, this increased continued smoking cessation efforts over the next three weeks.

Identity Relevance of Smoking

We conducted the same analysis on smoking-relevant identity measured at Time 3. Again, the Time 1 manipulations impacted initial quit attempts, and initial quit attempts decreased smoking

relevant identity at Time 3, b = -.114, SE = .030, p < .001, CI [-.173, -.055]. The test of the conditional indirect effect was significant for participants in the unhealthy smoker prototype condition (effect = -.100, SE = .050, CI [-.210, -.020]), but not for participants in the typical smoker condition. For participants in the unhealthy smoker prototype condition, the mortality reminder at Time 1 led to more initial behavior aimed at quitting smoking (compared to those not primed with mortality); in turn, this reduced the extent to which smoking was relevant to identity at Time 3.

The full statistical models and estimates of conditional effects for both of the previously reported analyses are presented in Figure 4.

Smoking Frequency and Intentions

We also examined the other outcomes measured at Time 3 (smoking frequency and intentions to quit) in the subset of current smokers. Though the small sample size (N = 108) precludes any definitive conclusions, we found a consistent pattern of results. For smoking frequency, the conditional indirect effect was significant for participants in the unhealthy smoker prototype condition (effect = -.230, SE = .129, CI [-.526, -.010]), but not the typical smoker condition (effect = -.106, SE = .153, CI [-.473, .143). Similarly, for intentions to quit at Time 3 the conditional indirect effect was significant for participants in the unhealthy smoker prototype condition (effect = .358, SE = .194, CI [.008, .778]), but not the typical smoker condition (effect = .165, SE = .230, CI [-.271, .642). This suggests that for participants given the unhealthy smoker prototype prime, mortality salience decreased the frequency of smoking, and increased intentions to quit smoking six weeks later (compared to those not primed with mortality), through initial quitting behavior.

<u>Supplemental Analysis: Mediation by Identity Relevance</u>

Though our hypotheses at the outset specified initial behavioral engagement as the primary catalyst in the effects, we have also suggested that once esteem or identity relevance becomes wrapped up in a particular behavior, people should be even more inclined to engage with the behavior, and

identity should become even more contingent upon doing so. The third wave of measurement afforded the opportunity to test this. We conducted the same analysis with identity relevance of smoking at Time 2 mediating outcomes at Time 3. The interaction of mortality salience and the smoker prototype did not directly affect identity at Time 2; however, the test of the conditional indirect effects revealed that, compared to the control condition, participants primed with mortality at Time 1 reported more attempts to quit at Time 3, through decreased smoking-relevant identity at Time 2, but only for those in the unhealthy smoker prototype condition (effect = .273, *SE* = .153, CI [.002, .613]). Similarly, participants primed with mortality at Time 1 reported decreased identification with being a smoker at Time 3, through decreased smoking-relevant identity at Time 2, but only for those in the unhealthy smoker prototype condition (effect = -.210, *SE* = .108, CI [-.429, -.001]). However, in both analyses, the index of moderated mediation, which compares the equality of the two conditional indirect effects, was not statistically significant. The full statistical models and estimates of conditional effects are available in the supplementary material.[10]

Discussion

The results of Study 2 provide further insight into how the mechanisms involved in mortality cognitions and identity maintenance might unfold over time to affect health behavior. When participants were primed with mortality and visualized a prototype of an unhealthy smoker, they reported more attempts to quit smoking in the following three weeks, compared to participants not primed with mortality. In support of the hypothesized enduring effects process, the increase in attempts to quit at Time 2 mediated continued attempts to quit and decreased smoking relevant identity three weeks later.

[10] The results are consistent without the missing data included with one exception: in the full model, the interaction effect of the mortality and prototype primes on Time 2 attempts to quit is no longer statistically significant; this may be due, in part, to reduced power given the smaller sample size. All conditional indirect effects are statistically significant, and thus, the conclusions drawn from the analyses remain the same.

Together, these findings raise the possibility of instrumental effects of cognitions about death and identity relevance in sustained health behavior outcomes.

There were no effects on immediate intentions to quit smoking following the mortality prime. One aspect of Study 2 that may have obscured the ability to detect an immediate effect on intentions is that, given the extensive questions about smoking, participants might have been especially aware that smoking cessation is difficult and at the mercy of smoking urges (Allen, Bade, Hatsukami & Center, 2008). Previous research indicates that the immediate impact of mortality salience on smoking behavior is moderated by current level of nicotine craving (Arndt et al., 2013). Perhaps if craving had been measured, an effect on intentions may have been observed among people scoring low on this variable. Another possibility stems from the idea that prototypes do not generally have a direct effect on intentions, but rather, influence behavior through perceptions of willingness (Gerrard, Gibbons, Houlihan, Stock, & Pomery, 2008). When McCabe et al. (2015) manipulated mortality salience and exposure to prototypes about healthy eaters, they similarly found no effect on initial intentions but did find effects on actual grocery purchases. Additionally, it is possible that the unhealthy prototype had the unintended effect of reinforcing thoughts of death. To the extent that contemplating the unhealthy aspects of smoking conjures ideas about cancer or other smoking-related diseases, thoughts of death might have temporarily resurfaced into proximal awareness. This could explain the lack of effects on immediate outcomes. These are speculative suggestions and the lack of initial effects is an ambiguity that will need to be more fully addressed in future research.

Of course, another likely possibility—at least to some degree—is that mortality reminders do not *always* influence health judgments. While a number of studies have found initial effects of mortality salience on health judgment and behavior (examples noted in the introduction; also Study 1's intention measure), as with most if not all social behaviors, such processes are surely complex and influenced by

various factors. The point of TMHM research is not that mortality awareness invariably influences health judgment and behavior, but that it has the potential to do so.

Although there was an increase in quit attempts between the mortality salience and control conditions among those participants given the unhealthy smoker prototype prime, participants who were not primed with mortality actually reported less attempts in the unhealthy smoker condition than in the typical smoker condition. This finding is unexpected and makes it difficult to conclude whether mortality salience promoted quit attempts among those reminded of the negative social consequences of smoking, or if being reminded of a negative prototype of a smoker, in the absence of accessible death thought, led to *decreased* interest in and behavior aimed at quitting. Still, it was only in the unhealthy prototype condition that mortality reminders were associated with subsequent identity and behavioral outcomes. Thus, the contribution of this study is not in demonstrating the efficacy of a particular intervention, but in specifying a novel theoretical framework through which existential concerns and self-oriented motives have the potential to impact health-relevant outcomes over time.

Study 2 also afforded the opportunity to examine the reinforcing dialectic between identity and behavior through an assessment of the mediating influence of identity. Though the difference in the indirect effect of mortality salience between the unhealthy and typical smoker prototype condition was not statistically significant (as it was with behavior operating as a mediator), there was at least some evidence that the identity implication of these manipulations can influence behavior, in addition to behavior influencing identity implications. Additional research is necessary to examine this directional relationship, and ideally, the bidirectional relationship over time.

The study was limited to light and intermittent (LIT) smokers for two reasons: first, they are a readily accessible population in a college university setting, and second, LIT smokers have become an increasingly substantial portion of the smoking population (Shiffman, 2009), and thus are an important group to study. Identifying the potential mechanisms underlying the motivation to smoke for this

population is critical because light smoking may eventually lead to more habitual use (Colder et al., 2006; National Cancer Institute, 2008). Going forward, it will be important to determine whether the processes identified here operate in the same way for heavy smokers and non-student populations.

General Discussion

Together, findings from two experiments, in two health domains, provide preliminary evidence of enduring effects of death reminders on health. The studies suggest the possibility that a combination of a behavior (or visualizing a prototype of persons who engage in that behavior) with accessible death thoughts can help set the stage for a health behavior to become integrated into one's self and identity, and this association is fostered as a result of ongoing behavioral engagement. In each study, pairing a health behavior with a mortality prime promoted behavioral engagement over the ensuing weeks, which in turn impacted the esteem (Study 1) and identity relevance (Study 2) of the behavior, as well as intentions (Study 1) and reported continued behavioral efforts (Study 2).

Mechanisms for Effects Over Time

The present studies raise the possibility that there are at least two important ingredients for reminders of mortality to engage enduring health-relevant effects: esteem/identity relevance and behavioral engagement. In Study 1, it was presumed that pairing exercise behavior with an induction of mortality salience fostered the association of death cognition with the self-esteem relevance of exercise. This possibility is tentatively supported by the additional analyses showing that the effects of mortality salience on exercise outcomes were only observed for those who initially derived at least a moderate level of self-esteem from fitness. Study 2 explicitly manipulated the identity-relevance of smoking by having people visualize a negative image of a smoker to highlight the identity-relevance of smoking (and quitting), and showed that reminders of mortality (compared to a control topic) promoted health-relevant behavior, but only when participants were also primed with a prototype depicting smokers in a negative light.

Further, in both studies, behavioral engagement was pivotal in fostering esteem contingencies and identity relevance. After mortality salience, the more participants reported engaging in the behavior (i.e., exercising or trying to quit smoking), the more the behavior became relevant to their sense of esteem and identity. Moreover, behavior not only promoted greater identity contingency, but also sustained behavior engagement (Study 2, and behavioral intentions in Study 1), which may reflect the influence of self-perceptual processes strengthening these interrelationships.

Implications for Esteem Contingencies and Identity-Relevance

These findings provide additional evidence for a critical insight offered by the TMHM, and other research on self-oriented motivations (e.g., Leary, Tchividjian, & Kraxberger, 1994; Sherman, Nelson, & Steele, 2000): Health decisions are sometimes less about health than they are about the self (see Arndt & Goldenberg, 2011). This suggests that in certain contexts health promotion efforts can be more effective by attending to self-related processes, in conjunction with accessible death thought. It also highlights the multi-faceted nature of the behaviors under investigation. People exercise or not, and smoke or not, for a multitude of reasons; but to the extent these behaviors become relevant to esteem and identity, this may offer an effective route to enduring behavioral change.

The prototype manipulation in Study 2, compared to the actual opportunity for behavioral engagement (for all participants) in Study 1, was implemented, in part, for practical reasons. Whereas we were able to easily pair exercise behavior and mortality salience in the laboratory in Study 1, we could not feasibly pair the behavior of quitting smoking with the mortality prime in the confines of the lab in Study 2. But this manipulation also provided a test of the proposition that identity relevance plays a role in the cycle of existential threat, behavior, and self-esteem. By pairing a visualization of an unhealthy smoker with the mortality prime we reasoned that attention to the esteem and social identity relevance of smoking should be heightened; this should, in turn, impact behavior aimed at quitting smoking, which should subsequently function to inform one's own self-concept. This theorizing is partly

grounded in the premise that, for people who smoke, the behavior can be a central aspect of their identity, and identity relevance predicts resistance to cessation efforts (Tombor, Shahab, Brown & West, 2013). Interestingly, however, the social disapproval of smoking that has emerged over the years has not only contributed to reduced smoking behavior (Alamar & Glantz, 2006), but also helps to position a non-smoker identity as a potentially important catalyst of successful cessation (Tombor, Shahab, Brown, Notley, & West, 2015). Going forward, additional insights may be garnered from considering different contingencies for self-esteem and identity that can be tapped into so as to inform how mortality awareness affects enduring health behavior.

In addition, though the current research targeted positive behavior and intentions concerning exercise and smoking, the process theorized to underlie such change, at least conceptually, also accommodates negative health outcomes. The model suggests that behaviors tethered to self-esteem or identity can be fostered and relied upon as resources to combat existential threat. This may include unhealthy behaviors, like substance use. Ironically, this may lead to further death concerns emerging from the destructive health behavior, motivating further the negative behavior, and further inclusion of the identity into the self, forming an unfortunate spiral of health-defeating behavior (McCabe & Arndt, 2016). Although the primary analyses did not provide evidence for negative health change, there was at least some evidence in the ancillary analysis for Study 1 suggestive of this possibility (i.e., decreased exercise in response to mortality salience among those low on baseline fitness-contingent self-esteem). Going forward, it may prove important to investigate this aspect of the theoretical model, so as to not only encourage positive health behavior over time, but also, to stymie the same processes with respect to negative health behavior.

Finally, we have described a model in which cognitions about death are proposed to influence health through a back-and-forth, reinforcing pattern between esteem/identity contingencies and behavior. However, these processes do not occur in a vacuum, and mortality concerns are managed with

behavior and esteem contingencies in a variety of domains, not just health. For instance, people often cling more to standards for an attractive body than a healthy one, and mortality awareness exacerbates these tendencies (e.g., Routledge et al., 2004; Tam, 2013). More generally, various individual differences and situational factors can alter the trajectory of terror management responses. For example, affirming an important self-value reduces defensiveness (unrelated to that self-value) in response to mortality awareness (Schmeichel & Martens, 2005). This suggests that other psychological processes unrelated specifically to the health context might be able to disrupt the back-and-forth pattern of esteem contingencies and potentially redirect, or undermine, health behavior. Going forward, an intervention informed by this model may benefit from strategies aimed at reinforcing the esteem contingencies catalyzing the heath behavior.

Death and Health Beyond the Research Lab

These studies utilized experimental primes to increase (initial) thoughts of death; an interesting question to consider is how naturally occurring thoughts of death might function in the hypothesized processes. The theoretical tradition behind the TMHM, as well as relevant data in non health-oriented contexts (e.g., Du & Chi, 2016; see Hayes, Schimel, Arndt, & Faucher, 2010), suggests that non-conscious concerns about inevitable mortality are an ever-present condition with which people must contend. People are reminded of mortality—sometimes blatantly and sometimes subtly—on a routine basis, and this is especially true in the context of health behavior (e.g., anti-smoking ads; a routine physical). Likewise, just as thoughts about death are likely to be naturally activated, there is ample opportunity for the esteem and identity relevance of health-relevant behaviors to be highlighted during the course of one's day (e.g., fitness marketing; social disapproval and stigma of smoking, Alamar & Glantz, 2006). New measures and methodologies, such as ecological momentary assessment, might prove especially beneficial in this line of work by allowing for observation of the naturally occurring ebbs and flows of mortality awareness and self-esteem/identity maintenance over time. One recent

example of work in this area utilized data on Google search term volume to assess the temporal relationship between information-seeking of life-threatening (i.e., death-thought provoking) illnesses and seeking information about religion (Pelham et al., 2018). Paying attention to the real world experiences that function to solidify the bases of self-esteem and identity relevant to health behaviors will be important to consider as research moves out of the laboratory and beyond single time point experimental designs.

Limitations

Despite many encouraging findings, there are some limitations to note. Namely, retrospective self-report measures were used to assess behavior. Presumably most people can recall, with some degree of accuracy, exercise or smoking behavior over a relatively short period of time. However, it is possible that these self-reported assessments reflect some biases or inaccuracies, and this might be especially true with longer intervals between study time points. Further, reminders of mortality could have also biased responses to these measures. It would be consistent with TMT to suggest that, to the extent mortality salience promotes self-esteem striving, it could elicit the desire to simply present oneself in a favorable way (i.e., healthy), particularly if the culturally desired outcome is well known (i.e., exercising is good; smoking is bad). The prototype manipulation, and associated control condition, in Study 2, does provide some assurance that the effects cannot be attributed solely to biases as a result of the mortality prime (i.e., the effects were unique to the combination of mortality and the negative smoker prototype, and not observed for those primed with mortality but given the typical smoker prime). Additionally, a number of studies have found that mortality salience affects actual health-relevant behaviors (e.g., McCabe et al., 2015). Nonetheless, studies utilizing concrete, observable behavioral outcomes (e.g., accelerometer data; nicotine blood content) or applying a daily diary and day reconstruction designs are needed to validate these effects. In addition, while this is the first research to show effects of mortality reminders that continue beyond the duration of an experiment, even the six-week timeframe falls short of

demonstrating how these processes might function in promoting a permanent change in behavior. Studies tracking individuals over longer time periods would provide further insight into enduring health behavior changes and associated outcomes.

Finally, these studies demonstrate how the interplay of self-oriented motives and health-relevant behaviors unfold over time, but fall short of demonstrating improved health outcomes over baseline (Study 1) or all study conditions (Study 2). Moreover, in Study 1, only 36% of participants in the experimental condition reported levels of exercise that meet the recommended guideline for adults (Haskell et al., 2007). In Study 2, participants in the mortality and unhealthy smoker prototype condition reported more smoking cessation efforts, yet only 13 of them had completely stopped smoking by Time 3. Relatedly, the sample was limited in terms of size and demographic characteristics, reducing the generalizability of the findings. However, the primary aim of this work was to examine basic psychological processes related to the awareness of death, and to inform how this inevitable cognitive state influences behavior and decision making related to health over time. Such early phase research—in which pathways, mechanisms, and moderators of behavior are tentatively identified—holds a critical place in the translational science continuum (Czajkowski et al., 2015). Though the contribution of this work should not be diminished, more research is clearly needed to understand how these mechanisms can be harnessed to promote health behavior change to the levels of clinically relevant benchmarks, and to inform the external validity of the results.

Conclusion

The present research provides evidence of a longitudinal process through which the awareness of mortality influences health behavior over time. Building on prior research, it was posited that the interplay of concerns about mortality and the relevance of health behaviors for esteem and identity can work in a reinforcing dialect such that behavior engaged in as a defense against mortality concerns fosters more esteem and identity relevance, which in turn encourages more behavior (and esteem and

identity relevance). Though there is still work to be done toward understanding and positively impacting health behavior, these studies suggest that insights may be gained by consideration of how terror management processes unfold over time to affect decision making with respect to health.

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Table 1. *Conditional Indirect Effect Estimates: Mortality Salience on Time 2 Outcomes through Exercise Behavior (Time 1-Time 2), Moderated by Baseline Fitness-Contingent Self-Esteem*

	Estimate	SE	LLCI	ULCI
Time 2 Fitness-Contingent Self-Esteem				
Low Baseline Fitness Esteem	-0.56	0.32	-1.27	-.003
Mid Baseline Fitness Esteem	0.40	0.20	0.12	0.94
High Baseline Fitness Esteem	1.42	0.65	0.36	3.02
Index of Moderated Mediation	0.25	0.12	0.05	0.53
Time 2 Intentions to Exercise				
Low Baseline Fitness Esteem	-118.48	63.18	-265.48	-11.78
Mid Baseline Fitness Esteem	85.50	33.70	35.74	177.08
High Baseline Fitness Esteem	303.64	109.72	125.48	573.33
Index of Moderated Mediation	53.59	20.86	18.25	102.17