A New Lifespan Approach to Conscientiousness and Health: Combining the Pieces of the Causal Puzzle

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Abstract

Conscientiousness has been shown to predict healthy behaviors, healthy social relationships, and physical health and longevity. The causal links, however, are complex and not well elaborated. Many extant studies have used comparable measures for conscientiousness, and a systematic endeavor to build cross-study analyses for conscientiousness and health now seems feasible. Of particular interest are efforts to construct new, more-comprehensive causal models by linking findings and combining data from existing studies of different cohorts. Although methodological perils can threaten such integration, such efforts offer an early opportunity to enliven a life course perspective on conscientiousness, to see whether component facets of conscientiousness remain related to each other and to relevant mediators across broad spans of time, and to bolster the findings of the very few long-term longitudinal studies of the dynamics of personality and health. A promising approach to testing new models involves pooling data from extant studies, as an efficient and heuristic prelude to large-scale testing of interventions.

Keywords: conscientiousness, personality, health, lifespan perspective, integrative data analysis, lifespan development

A New Lifespan Approach to Conscientiousness and Health: Combining the Pieces of the Causal Puzzle

It is now well established that conscientiousness predicts health and longevity in various populations and over long periods of time (Kern & Friedman, 2008; Roberts et al., 2007). The reliable, replicated association of this personality trait to *longevity* is especially remarkable, as longevity is not distorted by self-report or misdiagnosis, is a very long-term outcome, and is generally recognized as the best single measure of a population's health. Although other personality traits are also relevant to health, the very robust importance of conscientiousness that emerged in the past two decades was both unexpected and noteworthy, as it was mostly ignored in the vast research literatures on Type A behaviors, hostility, and health. The question naturally arises as to the reasons for this association and whether and how this information can be used to promote healthy aging.

The causal relations are not yet fully understood. Conscientious children and adolescents usually grow up to smoke less, eat healthier foods, wear seat belts, and engage in a range of other healthy behaviors (Bogg & Roberts, 2004; Lodi-Smith et al., 2010). But it is not known whether or when direct interventions to promote conscientiousness will lead to better habits and to subsequent long-term better health. In fact, existing evidence suggests that the causal relations are multifaceted and complex (Friedman, 2008; Hampson, 2008; Kern & Friedman, 2011). In part, this complexity arises from the fact that not only health behaviors but also biological factors and social relations are highly relevant both to conscientiousness and to health. Better understanding of these matters is essential for optimal health promotion, and it is also fundamental for deeper insight into conscientiousness as a core personality trait.

Personality and health both develop and change as a function of individual, social, and environmental influences, and newly-evolving statistical techniques can be employed to model such change and complexity, given sufficient data. In this article, we describe new, more-comprehensive models of personality and health, and we challenge the field to take advantage of existing resources to consider conscientiousness and health across the lifespan.

Models of Conscientiousness and Health

Theoretical models of personality and health are moving beyond single and static explanatory mechanisms toward sophisticated approaches that address the dynamic unfolding of multiple processes over time. To avoid repeating conceptual errors and methodological dead-ends of the past, it is useful to understand the development of scientific research on personality and health through what we see as three generations of models.

First generation personality-health models emerged in the 1950s and 1960s in response to the impossible-to-test neo-psychoanalytic (neo-analytic) theories of psychosomatics. Personality was to be viewed as a marker or syndrome of health or illness. For example, the Type A pattern was seen as a syndrome of proneness to coronary disease, much as fever, inflammation and exhaustion are a syndrome of developing infection. In a rush to discard unscientific notions of unconscious conflict, such approaches were generally atheoretical, typically ignoring key issues of construct validation and of personality development. They were usually tested cross-sectionally with correlations, and they often assumed that if you reduce the symptoms (such as “hurry sickness”), you would improve health. After thousands of studies (--well over 1,000 studies were published in the 1980s alone), such efforts collapsed as it became clear that much more needed to be known at a deeper level about the validity and conceptual basis of the personality constructs (including convergent and discriminant validity) and the causal mechanisms linking them to health

(Friedman, 2007; Houston & Snyder 1988; Roberts et al., this issue). Applying these lessons to conscientiousness means that a personality trait like impulsivity (a significant facet of unconscientiousness) is not profitably conceived to be a medical syndrome or an infection-like disruption in need of a drug or simple treatment.

The original approaches were generally replaced by second-generation models, in common use in research today, which focus primarily on single-mechanism causal mediation, with fairly stable, valid predictors. Figure 1 shows a behavioral mediation model. Conscientiousness or its close correlates play some role in later health and longevity, and unhealthy behaviors like smoking or drinking are clearly relevant (Friedman et al., 1993, 1995; Hampson et al., 2006, 2007). Mediating variables have been tested using the classic Baron and Kenny (1986) approach, with significance often tested with the Sobel test (1982), or more recently with structural equation modeling (SEM) approaches (MacKinnon, 2008).

Various such second-generation models have been proposed, with mediators involving behavioral, psychological, physiological, or social pathways (Kern & Friedman, 2010; Smith, 2006). Complementary to the models in which personality is hypothesized to affect health through health behaviors, a common second-generation model of personality and health involves stress-and-coping mechanisms, which postulate that traits predispose some individuals to cope poorly with strain, experience more physiological stress, and become ill. Such approaches may emphasize self-reported stress-and-coping differences or physiological reactions such as immune suppression or cardiovascular reactivity. Although sometimes highly sophisticated, such models typically assume that the physiological disturbances ultimately lead to cardiovascular disease, cancer, or other diseases, but the stress, coping, and physiological responses are tested simultaneously or over short time periods (Aldwin & Park, 2004; Smith, Gallo, & Ruiz, 2003). There are almost no

long-term studies showing effects of early personality, chronic psychophysiological disruption in response to later challenge, and resultant significant disease outcome within the same individuals.

Bridges to third generation models of personality and health are beginning to emerge, however, as some of the second-generation models are becoming more elaborate and complex, with underlying third variables such as early stress (or abuse) and genetic predispositions being invoked to inform some of the later-life concurrent associations between traits and disease. There is enough evidence of such influences for a "biological base" to be included in lifespan models of conscientiousness and health. For example, serotonin levels in the central nervous system are known to have a genetic basis, be alterable by life circumstances, affect personality (including neuroticism and conscientiousness), and help regulate core bodily functions (appetite and sleep) necessary for good health (Carver, Johnson, & Joormann, 2008; Carver, Johnson, Joormann, Kim, & Nam, 2011; Caspi, Hariri, Holmes, Uher &Moffitt, 2010; van Goozen, Fairchild, Snoek & Harold, 2007). Early stress can lead to increased likelihood of disease many years later, perhaps either by cumulative damage building over time or by the biological embedding of disruptions during sensitive developmental periods (e.g. Anda et al., 2010; Miller & Chen, 2010; Repetti, Taylor & Seeman, 2002; Shonkoff, Boyce, & McEwen, 2009). And importantly, some individuals are genetically more prone both to be impulsive or neurotic and to develop heart disease and probably other diseases as well (McCaffrey et al., 2006; Su et al., 2009; Sutin et al., 2010; Vaccarino et al, 2009). To what extent would lifespan associations between conscientiousness and health be accounted for when genetic variation is taken into account, and if so, what is the causal mechanism? To what extent would behavioral interventions still be effective? This is an area in which twin studies may be profitably integrated.

Still, in most of these studies, personality traits and the hypothesized mechanisms are measured at a single period, and a single type of mediator (such as physiological reactivity) is typically postulated. Importantly, none of these approaches can explain what happens when personality matures or changes, why there is so much variability in individual outcomes, and precisely how personality can predict health and longevity so many years later. Far-reaching but variable influences of traits on remote outcomes such as longevity and health decades later likely require multifaceted explanatory processes that draw on multiple mechanisms operating across the lifespan. That is, it is usually not the case that a psychological predisposition or reaction early in life would have a simple and unalterable effect on health decades later. Rather, intervening processes and trajectories across the years become significant and consequential.

In our view, third generation models of personality and health herald a new class of more sophisticated approaches, which incorporate dynamic concepts of aging and can profoundly alter the way we view personality and health (Aldwin & Yancura, 2011; Hampson & Friedman, 2008). We conceptualize the influence of a personality predictor on a health outcome as changing a course or trajectory—analogous to altering the course of a ship (or as dynamically maintaining course). As a result, the effects are long lasting (though not necessarily permanent), and prior influences may alter both the level and rate of change of a health outcome. The significance of a prior influence may be observable quickly or only after a period of time. In addition, health behaviors, social relations, physiological changes, and health outcomes can feed back and affect personality. This lifespan approach to personality and health focuses on the stability and change in individual differences from cradle to grave. **Figure 2** shows a promising model in this area. This figure includes core causal links that have emerged in recent research but are usually overlooked in traditional work on personality and health. (It is not meant to be a full model.)

As Figure 2 illustrates, third generation models explicitly include social relations, as personality leads individuals to seek out, create, or elicit certain powerful social ties. Personality is directly relevant to who gets married, who stays married, who finishes school, who succeeds at work, and other core social involvements well-documented to have major influences on health and longevity. Social interactions in turn feed back on personality and on patterns of health behaviors (health habits). Social relations (especially social support) also pair with personality in affecting reactions to adversity (i.e., potentially stressful environmental challenges) (Taylor, 2011). The "Biological Base" (here condensed into one box in the figure) represents the fact that genes, the prenatal environment, and central nervous system changes in the post-natal environment and childhood are known to be relevant to personality development, to physiological reactivity, and to disease risk and longevity (Lupien, McEwen, Gunnar, & Heim, 2009). Further, the new emphases represented in Figure 2 suggest that personality itself is not static but slowly evolves, consistent with much recent research in this field (Chapman, Hampson & Clarkin, this issue).

Figure 2 focuses on length of life (longevity) as the outcome because it is the healthiest people who, on average, live the longest; but quality of life, incidence of disease, rate of recovery from disease, and cause of death are also important outcomes. Longevity is the most reliable health outcome, usually not plagued by the measurement biases that appear when self-report is used to assess both personality and health. In addition, many health studies focus on single diseases (such as reduction in a cancer rate) without simultaneously considering all-cause mortality. In our view, not only is it pragmatically problematic to dodge one disease only to die at the same age of another disease, but it is scientifically problematic to focus on one set of biological disease processes (such as immune dysfunction) when the underlying problem may be a more general failure of homeostasis.

These new approaches allow conceptualizations and measures to change across development. Just as the indicators of health in early life can be different from the indicators of health in late life, the relevant indicators of conscientiousness in elementary school children may or may not be identical to the key components of conscientiousness mid–adulthood or in old age. Another way of thinking about this conceptual discontinuity is in terms of the subcomponents (or facets) of a construct. For example, impulse control may be the most relevant aspect of conscientiousness to health in adolescence whereas planfulness might be more relevant in adults. The relevance of particular facets may differ by situation (See Eisenberg, Duckworth, Valiente, & Spinrad, this issue; Roberts et al., this issue). But because patterns or trajectories of healthy or unhealthy development typically emerge, mapping the pathways is a feasible endeavor.

Testing such third-generation models requires data from throughout the lifespan. Personality, behavior, physiology, social relations and health need to be measured prospectively and repeatedly across long periods of time. Then, trajectory models can be tested to determine the best-fitting trajectories and to evaluate the impact of relevant variables on individual variation around the average trajectory. Once the baseline model is established, predictors can be added to the model to see if they explain part of the individual variance in the overall growth model, and trajectories of individual differences can be used to predict late-life health and longevity (Diehr & Patrick, 2001; Kern, Reynolds & Friedman, 2010). Jointly employing latent growth models and survival models facilitates assessment of growth processes and survival (McArdle, Small, Backman & Fatiglioni, 2005; Singer & Willet, 2003).

Combining Existing Archival Data to Address Lifespan Personality-Health Relations

A major driver permitting movement beyond the earlier models has been the theories, methods and statistical techniques emerging from long-term developmental studies. Such new

models, however, pose the powerful challenge of gathering rich, meaningful data throughout the lifespan. Because of the obvious difficulties of collecting lifespan data, we believe that this newest generation of personality and health research will need to employ and adapt longitudinal data from existing datasets, and integrate data across multiple datasets. That is, it is highly unlikely that any one study will soon provide the opportunity to test complete lifespan mechanisms. Rather, the concepts, causal pathways, and potential interventions will need to be pieced together from various studies and archives. Integrative studies and research programs can help the field transition to the next generation of models. For example, the paper by Kern, Hampson, Goldberg & Friedman (this issue) presents a "second generation" model that links two samples and sets the stage for complex "third generation" models to be tested. With sufficient skill, combining snapshots may produce a dynamic picture.

To facilitate such progress, we will now illustrate how parts of this comprehensive model can be developed for testing specific hypotheses by employing integrative approaches, in which data from different longitudinal studies are statistically combined to distill optimal concepts and measures, replicate effects, and test causal models. It is impossible for a single researcher to follow a cohort from birth through death, but by combining resources across investigators and samples, causal processes potentially can be revealed.

Over the past century, a number of researchers had the foresight to gather detailed information on groups of people and follow them over time. Significant resources, in terms of effort, participant burden, and money have been spent studying peoples' lives. Recent efforts to promote data archiving and secondary analysis of existing data have made these resources increasingly available. Archived data that constitute the core of completed and ongoing longitudinal studies offer immense resources for addressing lifespan questions that cannot be

considered in short-term and cross-sectional studies (Block, 1993; Elder, Pavalko, & Clipp, 1993; Martin & Friedman, 2000; Tomlinson-Keasey, 1993).

Although substantial progress has been made in replicating findings across studies, and in compiling results through meta-analyses, methodological advances now make it possible to integrate two or more studies to create a more comprehensive understanding of lifespan processes. In some cases, data from two or more samples can be directly combined (Bauer & Hussong, 2009; Curran & Hussong, 2009). A particularly promising form of integrative data analysis for understanding personality and health is to employ different longitudinal studies to address different parts of the model at different points in the lifespan. For example, some studies have related childhood conscientiousness to health status in adulthood or to longevity through mediating health behaviors assessed in adolescence, while other studies may have data relating conscientiousness in young or mid-adulthood to health status in old age through health behaviors assessed in middle age (cf. Bogg & Roberts, 2004; Friedman et al., 1995; Hampson et al., 2007). Still other studies have health behavior and mortality data in middle to old age (Aldwin, Spiro, Levenson, & Cupertino, 2001). The findings from the separate studies potentially could be integrated across the lifespan. Such integration would be useful for suggesting whether a particular model (e.g., mediation by certain health behaviors) seems especially promising and whether it appears more appropriate at some ages than others—that is, whether there appear to be "critical periods" in the lifespan for particular personality-to-health mechanisms.

A theory-based collaborative network can coordinate measures and analyses across studies and directly combine data from two or more longitudinal studies by creating metric bridges between studies (Hofer & Picinnin, 2009). Such integrative analysis is potentially very powerful, as pooling data increases statistical power, extends periods of development (time) that can be

studied, and provides an explicit test of sample heterogeneity. For example, the collaborative Integrative Analysis of Longitudinal Studies on Aging (IALSA) network currently includes 25 longitudinal studies on aging. That network has been developed as a resource for synthesizing longitudinal studies of aging, health, and cognition (Hofer & Picinnin, 2009; 2010). It is this sort of collaboration that could be applied to studying personality and health, especially to address the new challenges of integrating differing periods of development across the lifespan. Tasks include establishing standard metrics across studies and identifying multiple studies for each segment of development. On the other hand, pooling data can detract from the psychometric properties of the individual measures that have been distilled for a specific study (--see Kern et al. this issue for a discussion); in many cases, both traditional meta-analyses and integrative analyses (with raw data) should be conducted and compared.

Integrating Studies of Personality and Health

Any single study of conscientiousness and health necessarily has limitations, including sample characteristics (especially the health-relevant variables of age, gender, birth cohort, ethnicity, socio-economic status, and health knowledge); the measures of conscientiousness employed; length of follow up, attrition and missed assessments; the social and historical context; and study design. The original studies, especially if longitudinal, often were not explicitly studying personality and health, and their unrefined measures are less than optimal. Working with even a single longitudinal dataset involves a huge commitment in terms of gathering and recasting the data into appropriate measures, and then understanding the intricacies of the data across time; this becomes more complicated when two or more studies are combined. To be successful, integrative data analysis may require collaborative effort, as each dataset is unique and a primary investigator has experience working with the intricacies of the sample (Stwaert & Clarke, 1995).

For example, it is insufficient to use an item that seems to tap a construct of interest without understanding how the variable was measured, the coding structure, the idiosyncrasies of the sample and era, and other hard-to-understand background information. Equivalence of measures becomes especially important, as common measurement scales must be established (Bauer & Hussong, 2009; McArdle et al., 2009). A benefit of attempting to pool data (that goes well beyond meta-analysis) is thus the explicit focus on and testing of measure comparability.

Equivalence can sometimes be obtained by harmonizing measures through a re-coding of items in a similar manner across two or more studies, or by statistically examining factor structures across items and samples (Bauer & Hussong, 2009; Curran et al., 2008). If there are at least some common items across the samples, then invariance can be tested and samples can be linked (Reise, Widaman, & Pugh, 1993). Within each sample, potentially relevant items with good variability are chosen to represent a latent construct, and potential items are evaluated for their intercorrelations and factor structures. Factor invariance is tested across samples by equating factor loadings, mean values, and error variances (for weak, strong, and strict invariance). Partial invariance can often be established, linking the two samples. As the number of invariant items increase, the stronger the links between samples will be, increasing validity and confidence in comparability. A third sample then can be collected to help establish comparability across the two main samples, with the third sample becoming the structural support for the bridge between the two main samples (McArdle et al., 2009). For example, Martin and Friedman (2000) collected NEO PI-R personality data and a battery of archival items taken from the Terman Life Cycle Study on two new (modern) samples. Measurement invariance of the archival scales was assessed, and it was demonstrated that modern interpretable scales could be derived from 50- to 70-year-old archival data. Conceptual equivalence and alignment also may be established through qualitative

judgments, with trained raters determining the extent to which a variable or a narrative assesses a particular construct in each sample.

Once studies are linked, two productive lines of research can be pursued. First, using structural equation modeling, models of personality and health can be directly tested, using a single combined sample. Other sample characteristics are then included in the analysis, and can be tested directly as moderators, similar to a moderator analysis in meta-analysis. For example, one study may be relatively homogenous in terms of ethnicity and socioeconomic status (SES), whereas other samples may be more diverse. Ethnicity and SES can be included as moderators, providing an empirical test of generalizability and potential sample selection effects. Such combination of multiple, complementary samples thus has the added benefit of moving towards a more context-based understanding of personality and health, as personality effects change somewhat (are moderated) by sample characteristics such as gender and ethnicity. That is, some heterogeneity of effects across samples is a benefit of these third generation approaches, which encourage analysis of variation. Indeed the possibility of cohort specificity is a key element of life course approaches.

Second, creating bridges among samples allows the filling in of missing pieces in the lifespan model to uncover likely and unlikely pathways to health and longevity. For example, if one study has comprehensive early-life personality assessments and mid-life health, later-life longevity, and cause of death information, while a second study has comprehensive early-life personality assessments and mid-life health and physiology (such as immune function or cholesterol measures), then it may be possible to test for mid-life physiological mediators of the early personality to late-life longevity associations. An example of this process, along with a

discussion of the technique and challenges involved in integration is presented in the paper by Kern et al. (this issue).

Construct Definition

Ideally, constructs are measured with the same well-validated measures on multiple samples at multiple assessment periods, but the reality of longitudinal research is that one investigator may define "conscientiousness" or "health" in a different manner than another investigator. In a meta-analysis of twenty studies linking conscientiousness to mortality risk (Kern & Friedman, 2008), some of the longitudinal samples measured conscientiousness using the NEO-PI (Costa & McCrae, 1992), whereas others tapped a single component such as low impulsiveness, social responsibility, or order. Although there is a consistent positive relation between higher levels of conscientiousness, longer life, and better physical health, the extent to which this is driven by the factor as a whole versus specific facets or by different facets at different times remains to be determined, as facets are known to differentially relate to specific outcomes (MacCann, Roberts, & Duckworth, 2009; Roberts, Chernyshenko, Stark, & Goldberg, 2005). Moreover, disagreement persists over the facet-level organization of conscientiousness. Most published factor structures include the facets of orderliness/organization, industriousness, responsibility/dependability, and self-control, whereas the facets of traditionalism/conventionality, achievement motivation, caution/planning, and competence have *not* been consistently identified.

A valuable feature of third-generation models of personality and health involves incorporating early-life tendencies (including childhood measures of temperament) and their relation to adult measures of personality and individual differences. For example, there is some long-term stability of physical activity levels, which should not be ignored in studying adult physical activity and health (Friedman et al., 2008). Temperament is usually studied in infants,

toddlers, and young children, whereas personality is largely studied in adults, no coincidence because temperament places more emphasis on "constitutional" differences that, with accumulated experience, become increasingly differentiated and elaborate. Temperament can be conceptualized as the "early-in-life framework" out of which adult personality traits develop (Saucier & Simonds, 2006, p. 118). Distinct theoretical traditions in the temperament research literature, however, have produced competing trait taxonomies (Caspi & Shiner, 2006; De Pauw & Mervielde, 2010; Zentner & Bates, 2008) not directly comparable to omnibus, multi-trait measures of adult personality in their research .

Self-control is the best-studied facet of conscientiousness and provides a useful case study of the challenges associated with overlapping but distinct conceptual and operational definitions. Most conceptualizations of self-control connote the voluntary regulation of attention, emotion, and behavior in the service of personally valued goals and standards. However, there is substantial behavioral evidence that self-control is itself multi-dimensional (Duckworth & Kern, 2011; Whiteside & Lynam, 2001), and while certain neural regions (e.g., lateral prefrontal cortex) associated with exerting self-control are common across domains, distinct subcortical regions seem to be involved in the generation of different kinds of impulses (Heatherton, 2011). Consistent with neuroscience evidence, behavioral studies suggests that there is substantially more within-individual variation in self-controlled behavior across domains than domain-general between-individual variation. Domain specificity in how self-controlled individuals act may partly be explained by how strongly individuals feel compelled to indulge in various temptations (Tsukayama, Duckworth, & Kim, 2011). There are surely implications for weight control, physical activity, nutrition, stress management, work success, substance abuse, and more.

Outside of the personality literature, research on self-control is typically transacted without reference to Big Five conscientiousness, though the conceptual overlap is so great that some researchers (e.g., Caspi & Shiner, 2006; Mofitt et al., 2011) may use the terms interchangeably. In adults, conscientious individuals are described as persevering in the face of difficulty, orderly, neat, responsible, dependable, achievement-oriented, adept at resisting distraction, and inclined to think before acting. Conscientious school-age children often are described in the same terms. Very young children who are high in what temperament researchers call effortful control are adept at modulating their motor responses, can persist at frustrating tasks, and can regulate their emotion and attention appropriately. Empirical studies that directly compare measures of child temperament and adult personality support these theoretical linkages (Deal Halverson, Havill, & Martin, 2005; Halverson et al., 2003; Victor, Rothbart, & Baker, in preparation).

Caution is needed, however, as the behavioral manifestations of effortful control in early childhood (e.g., waiting patiently for one's turn when playing a game) differ substantially from behavioral manifestations of adult conscientiousness (e.g., resisting cigarettes and maintaining an exercise program), and so it may be that particular facets of conscientiousness that improve health can vary across the life course. Impulsivity and lack of constraint may be most relevant in the teenage years, by establishing patterns of substance use that lead to addictions that persist even as this potentially dangerous facet of conscientiousness declines. Traditionalism may be important during late adolescence as a protective factor against alcohol and drug abuse and unprotected sex, whereas industriousness is more important in middle adulthood. Planfulness and orderliness may be more important in mid and later life for carrying out health protective behaviors. Much could be learned about conscientiousness mechanisms from studying the associations between facets of conscientiousness and health outcomes at different points in the life course.

Using Existing Studies to Inform Models

To fuel collaborative efforts on integrating studies of conscientiousness and health, we identified existing archived and ongoing studies that have the potential for integration. A number of organizations are archiving studies, making data more readily available, and working to harmonize large-scale nationally representative studies. **Table 1** lists some of the resources available.

In addition to gathering the resources shown in Table 1, we searched PsycInfo and used Google searches with "personality," "health," and "longitudinal" as keywords. Additional datasets were identified, and we then compiled a list of potential conscientiousness-related terms (Roberts et al., 2005), and examined measures and items to identify studies that tapped at least one element of conscientiousness and health. Studies were included if there were measures of conscientiousness at the item, facet, or scale level, and self-rated, physiological, or mortality measures of health. Overall, 88 completed or ongoing longitudinal studies were identified that include conscientiousness-type variables and health information and potentially can speak to different parts of the theoretical model. A subset of these studies is summarized in **Table 2**, with overlapping elements highlighted.

Is this approach feasible? To test the potential for integrating studies and building more comprehensive models, we collaboratively integrated data from two major longitudinal data sets, the Terman Life Cycle Study and the Hawaii Personality and Health Cohort Study (see Kern et al., this issue). The collaboration extends our own respective projects, and draws on the knowledge and theories of multiple investigators, with the overall intention of piecing together lifespan processes.

Existing studies have captured aspects of conscientiousness with varied degrees of precision. For example, in the PATH Through Life project, the Health and Retirement Study, and the Midlife in the US study, a handful of self-rated traits tap aspects of self-control, organization, carelessness, or other aspects of conscientiousness. Other studies, such as the NICHD Study of Early Child Care and Youth Development, the Mills Longitudinal Study, and the Jyväskylä Longitudinal Study of Personality and Social Development include comprehensive measures of personality and temperament that may connect more limited measures and allow consideration of personality change over time. Likewise, some studies only have a few self-reported items on health, whereas others have extensive physiological, self-report, and observed measures of health. Each study can be used to fill in certain gaps in the others.

Perhaps most intriguingly, data that are found in various samples then can be employed to fill in missing pieces in the full lifespan model. For example, the Hawaii cohort and the Terman cohort cover many of the same key predictor variables for 40 years, prospectively from childhood on, including child and adult personality, health and well-being, health behaviors, stressful life events, and social relations. The Hawaiian sample does not yet have much mortality and cause of death data, but it has much more midlife physiological health information (including blood tests), whereas the Terman data set has less detailed physiological measures but extensive longevity and cause of death information, allowing one to complement the other.

Lifelong studies such as the Terman Study, the Victoria Longitudinal Study, the Normative Aging study, and the Intergenerational Studies identify lifelong patterns that can be more intensely studied in specific time periods. Twin and adoption studies, such as the Early Growth and Development Study, the Swedish Adoption Twin Study of Aging and the Minnesota Twin Family Study may contribute information on the genetic origins of conscientiousness-health relations. The

National Longitudinal Study of Adolescent Health and the Dunedin Multidisciplinary Study of Parents and Children connect the adolescent and young adult periods. Studies such as the Longitudinal Study of Transitions in Four Stages and the Minnesota Longitudinal Study of Parents and Children explicitly capture detailed information across important life transitions. The Berlin Aging Study and OCTO-Twin study can inform late life processes for the oldest-old. Large-scale nationally representative studies, such as the Whitehall Study in England and the Health and Retirement Survey in the United States speak to the generalizability of conscientiousness-health relations. By integrating not only data, but also theoretical and practical expertise from multiple disciplines, a synergy may emerge, with both theoretical and practical relevance.

Finally, with detailed lifespan data, optimal long-term biopsychosocial trajectories to healthy aging and longevity can be derived and described. With a deeper understanding of the developmental pathways to a healthy life, and a good sense of the mediators and moderators of these healthy pathways, more focused and informed intervention can be developed and then tested (Friedman & Martin, 2011). In other words, rather than trying out conscientiousness-relevant health interventions on a willy-nilly basis, it will likely be much more efficient and fruitful to proceed with a fuller grasp of the admittedly-complex forces that lead some individuals to thrive while others falter.

Conclusion

Efforts to promote healthy aging are often aimed at adults at a single point in time, with little attention to the life-span trajectories. Such models—which undervalue or ignore life change and development—fail to consider the many different pathways to healthy or unhealthy patterns and the interactions of relevant biopsychosocial factors. Just as individuals are obese, or poorly nourished, or inactive for a variety of reasons in their life histories and are unlikely to benefit from

exactly the same programs of change, individuals are more or less conscientious at different times, in different ways, and for different reasons. A life pathways or life-course approach—with clusters of predictors and with interactions between variables as moderators and mediators—seems especially promising at this stage, as we need to better understand the trajectories. This life pathways approach—coupled with application of the epidemiological work that has been done on data harmonization and on cognition and aging—is new to the field of personality and health. But without comprehensive causal models, ad hoc interventions to improve the public health will inevitably falter.

As more sophisticated and nuanced models of personality and health emerge—models that incorporate a true biopsychosocial perspective—it becomes more important and more challenging to gather and fully utilize relevant data. For example, how do changing trajectories of self-control relate to changing trajectories of health? Is stability or change more important and which kinds of change are most important at which ages? As ongoing longitudinal studies proceed, it will be important to develop and include commensurate measures across multiple assessments and studies, so that the more complex, dynamic models can be tested. Further, we have focused on conscientiousness but other traits—including neuroticism, extraversion, and agreeableness—are known to be relevant to health and to sometimes interact with each other; they should also be incorporated (Friedman, 2007). In the meantime, we believe there is a significant opportunity to test core models by integrating relevant pieces of the many longitudinal studies already conducted that gathered data on relevant elements of personality and health.

Ultimately, randomized intervention trials will be necessary, but it would probably be a mistake at this point to focus intensively and directly on large-scale interventions to raise levels of individual conscientiousness in an effort to promote health in the broader population. The new

models warn us against repeating the conceptual errors and methodological dead-ends of the past. Some of the links between conscientiousness and health are non-causal, and many are indirect—involving social relations. Promoting societal and cultural conditions that raise the likelihood of a conscientious and socially stable populace might potentially have dramatic health benefits; but efforts could backfire or collapse if an overly-ambitious or premature intervention is begun. Instead, carefully focused pilot intervention studies are more likely to be a helpful complement to the integrative studies we propose to test pieces of the broader lifespan model.

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Table 1
Databases for identifying potential studies for integration.

Database	Brief Description	Website
ESDS Longitudinal	ESDS Longitudinal is a joint venture between the UK Longitudinal Studies Centre (ULSC) and the UK Data Archive that supports the use of a range of the most-widely used UK longitudinal data collections.	http://www.esds.ac.uk/longitudinal/
Henry A. Murray Research Archives at Harvard University	The Henry A. Murray Research Archive is Harvard's endowed, permanent repository for quantitative and qualitative research data at the Institute for Quantitative Social Science, and provides physical storage for the entire IQSS Dataverse Network.	http://www.murray.harvard.edu/
Integrative Analysis of Longitudinal Studies on Aging (IALSA)	A collaborative research infrastructure to coordinate interdisciplinary cross-national research on within-person aging related changes in health and cognition.	http://ialsa.uvic.ca/Plone
Jenage Information Center Ageing-related Databases	The JenAge Information Centre provides various information on ageing and systems biology. It includes databases of biological data, demographic data, diseases, and metadata.	http://info-centre.jenage.de/ageing/databases.html
National Institute of Aging Database of Longitudinal Studies	The NIA provides a searchable database of existing sources of longitudinal data on aging (e.g., ongoing longitudinal cohorts, longitudinal data sets, biospecimen repositories) and would be a valuable resource for facilitating future research on aging changes across the lifespan.	http://www.nia.nih.gov/ResearchInformation/ScientificResources/LongitudinalStudies.htm
NIA Publicly available databases	A listing of publicly available database of studies funded entirely or in part by the National Institute of Aging (NIA).	http://www.nia.nih.gov/NR/rdonlyres/F633C985-9082-4FE3-8E7D-CE9268168FAA/13732/PubliclyAvailDatasets_current1.pdf
U.S. Health Data Community	HealthData.gov is a one-stop resource for the growing ecosystem of innovators who are turning data into new applications, services, and insights that can help improve health.	http://www.data.gov/health
University of Michigan Inter-University Consortium for Political and Social Research	ICPSR offers more than 500,000 digital files containing social science research data. Disciplines represented include political science, sociology, demography, economics, history, gerontology, criminal justice, public health, foreign policy, terrorism, health and medical care, early education, education, racial and ethnic minorities, psychology, law, substance abuse and mental health, and more.	http://www.icpsr.umich.edu/icpsrweb/ICPSR/index.jsp

Table 2
Longitudinal studies with overlapping information on conscientiousness and health-related variables.

Name of study	Country	Baseline Characteristics			Waves	Measured Variables																
		Year	Age	N		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Amsterdam growth and health longitudinal study (AGHLS)	Amsterdam	1976	13	600+	6				X			X	X			X		X	X	X		
Avon Longitudinal Study of Parents and Children (ALSPAC)	England	1991	prenatal	15,224	15-20		X	X		X	X	X	X	X	X	X		X	X	X	X	X
Baltimore Longitudinal Study on Aging (BLSA)	US	1958	20-100 years	3000		X		X	X			X		X	X	X	X	X		X	X	
Berlin Aging Study (BASE)	Germany	1990	70-105	928	8				X	X			X		X	X	X	X	X		X	X
Dunedin Multidicsiplincary Health & Development Study (DMHDS)	New Zealand	1972-73	infants	1037	12		X		X			X	X		X	X		X	X	X	X	X
Early Growth & Development study (EGDS)	US	2002	birth-age 4	561 adoptive families	4	X	X	X	♦	X	X	X	♦	X	X	X		X	♦	♦	♦	♦
Hawaii Personality & Health Cohort Study (HPHCS)	US	1959-1967	grades 1, 2, 5, or 6	2404	6			X	X	X			X		X	X		X	X	X	X	X
Health and Retirement Study (HRS)	US	1992	born 1931-41	12654	7-8				X	X			X		X		X	X	X	X	X	X
Intergenerational Studies (IGS)	US	1928 to 1932	21 months	105	4			X							X					X	X	X
Jyväskylä Longitudinal Study of Personality and Social Development (JYLS)	Finland	1968	8	369	10			X	X	X		X	X		X			X	X	X	X	X
Longitudinal Study of Transitions in Four Stages of life	US	1968	varied	216	5				X	X			X		X					X	X	X
Lothian Birth Cohort Studies (LBCS)	Scotland	1921/ 1936	11	87,498	2					X					X	X	X	X	X			
Midlife in the US (MIDUS)	US	1994	25 to 74	3485+	2				X	X					X	X			X	X	X	X
Mills longitudinal study	US	1956	early 20s	141	5				X	X			X		X		X		X		X	
Minnesota Longitudinal Study of Parents and Children	US	1975	prenatal	267	28-30		X	X	X	X	X	X	X	X	X	X			X	X	X	X
Minnesota Twin Family Study (MTFS)	US	1983	30-50	About 8,400				X				X	X	X	X	X						
National Longitudinal Study of Adolescent Health (ADD Health)	US	1994	grades 7-12	15,356	4			X	X			X	X	X	X	X		X	X		X	X

Name of study	Country	Baseline Characteristics			Waves	Measured Variables															
		Year	Age	N		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
NICHD Study of Early Child Care and Youth Development (SECCYD)	US	1991	1 month	1,364	4		X	X	♦	X	X	X	♦	X				X				♦
Normative Aging Study (NAS)	US	1963	21-80	2280	13				X				X		X	X	X		X	X	X	X
Origins of Variance in the Old-Old: Octogenarian Twins (OCTO-Twin)	Sweden	1990	80+	351 twin pairs	4				X	X					X	X	X	X	X		X	X
PATH through life project (PATH)	Australia	1999/00	20-24; 40-44; 60-64	2404	3				X				X		X	X		X	X	X	X	X
Swedish Adoption Twin Study of Aging (SATSA)	Sweden	1984	40-84	1500	3	X	X		X	X			X		X	X	X	X	X	X	X	X
Terman Life Cycle Study	US	1921-22	6-15	1,528	15			X	X	X	X	X	X	X	X		X	X	X	X	X	X
Victoria Longitudinal Study (VLS)	Canada	1986	55-85	484	7+	X			X	X			X		X	X		X	X		X	X
Whitehall study (Stress and Health Study)	England	1985	35-55	10,308	11				X	X			X		X	X	X	X	X	X	X	X

Note. Waves = total number of assessment waves/occasions. For measured variables, A = genetic info; B = temperament; C = child personality; D = adult personality; E = IQ/ cognitive function; F = infant physical health; G = child physical health; H = adult physical health; I = child mental health; J = adult mental health; K = biological/ physiological measures; L = mortality; M = diet and/or physical activity; N = smoking, drug, and/or alcohol use; O = stress/ life events; P = social support; Q = education. ♦ = information available on the parent/ caregiver, not the child participant.

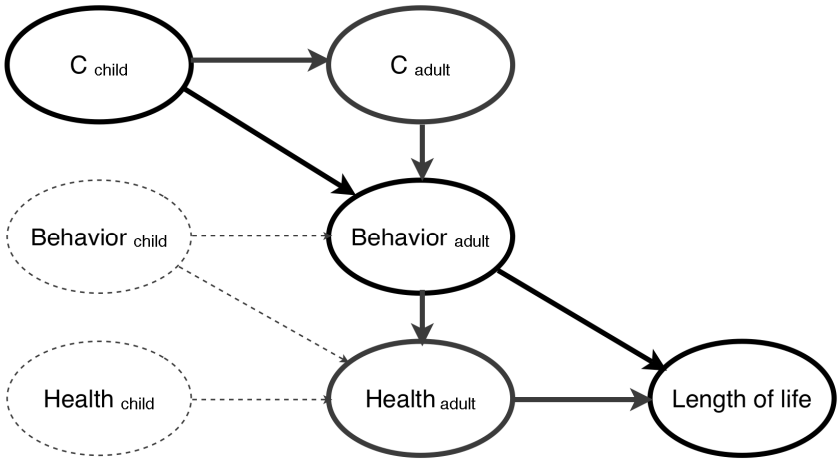

Figure 1. Lifespan mediation model (partial), in which conscientiousness influences the health-related behaviors that a person engages in, which in turn predict length of life. In the lifespan model, conscientiousness is measured prior to and simultaneously with the mechanism (behavior), which is measured prior to the health outcome (length of life). C = conscientiousness; Behavior = health-relevant behaviors; dotted lines indicate implicit but unmeasured variables and processes.

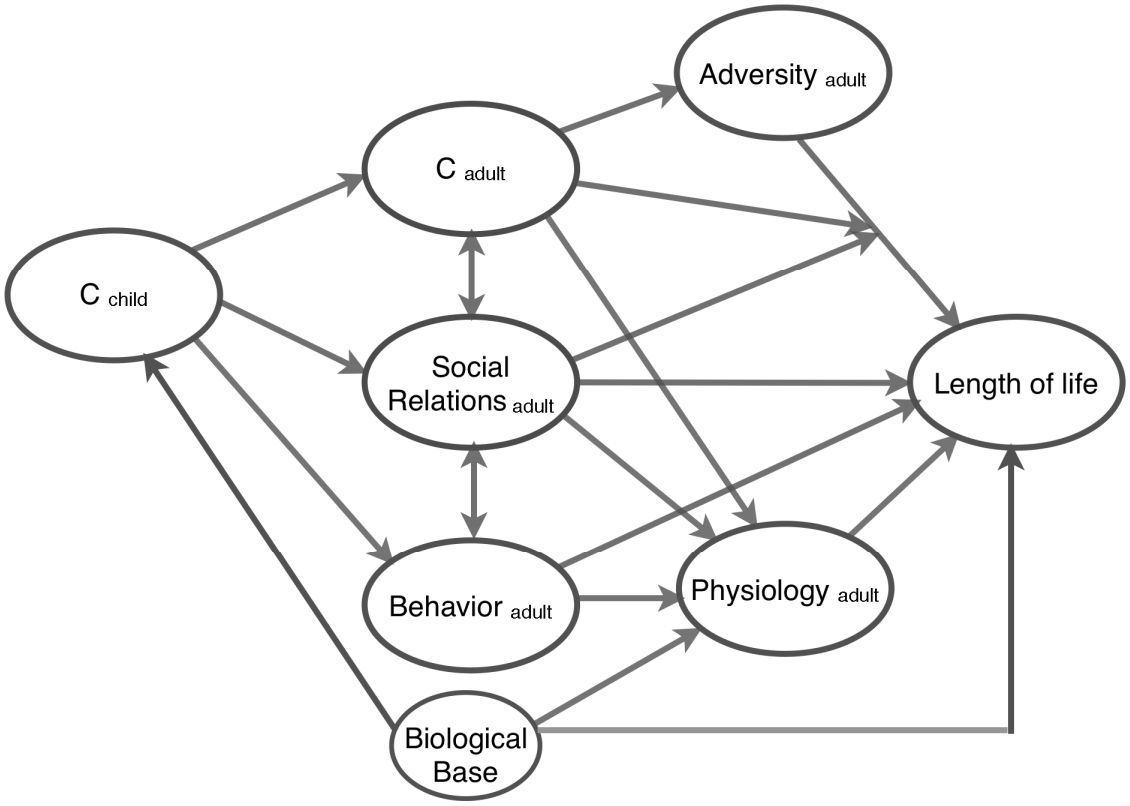

Figure 2. The ultimate goal of collaborative lifespan studies and integrative analyses is to test full causal models. In this example, biological elements and early personality influence personality and health processes throughout life. Personality impacts the behaviors people engage in, the relationships people have, and the situations they select. Conscientiousness and social relationships also moderate stressful experiences that occur. To sort out the various influences, variables necessarily need to be measured prospectively and repeatedly across long periods of life, or carefully combined from relevant overlapping studies. The "Biological Base" includes genes, the impact of the prenatal environment (e.g., mother's alcohol or drug use during pregnancy), and the central nervous system changes in the early post-natal environment. Figure 2 is an example, not a complete model.
C = conscientiousness; Behavior = health-relevant behaviors such as smoking.